Quatrième Conférence Internationale sur les Mycorhizes
ICOM4 — 10-15 août 2003

The Fourth International Conference On Mycorrhizae
ICOM4 — August 10-15, 2003

Conjointement avec/jointly with

la Société canadienne de Science du Sol (SCSS) et
la Société canadienne d'Agronomie (SCA)
10-13 août 2003

Canadian Society of Soil Science (CSSS) and
Canadian Society of Agronomy (CSA)
August 10-13, 2003

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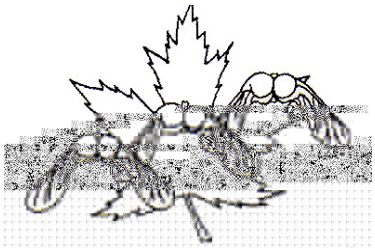

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BIORIZE

Bienvenue

Le Comité organisateur est très heureux de vous accueillir à Montréal pour la Quatrième conférence Internationale sur les mycorhizes (ICOM4), tenue conjointement avec la Société canadienne d'agronomie (SCA) et la Société canadienne de science du sol (SCSS).

Les membres de la communauté scientifique canadienne travaillent et collaborent à de nombreux projets de recherche et de développement au niveau national et international dans les domaines de la phytologie et de la science du sol. L'implication canadienne dans le domaine des mycorhizes s'est traduite par la tenue de deux conférences nord-américaines sur les mycorhizes à Québec en 1981 et à Guelph en 1996 sans oublier, depuis 1993, les rencontres annuelles tenues un peu partout dans l'est canadien. En 2002, en vue d'ICOM4, s'est tenu à Québec le premier symposium pan-canadien sur les mycorhizes.

La Société canadienne d'agronomie et la Société canadienne de science du sol organisent chaque année des rencontres scientifiques à travers le Canada. Leurs membres respectifs forment une communauté dynamique ayant à coeur le développement de systèmes de production agricole durables et une meilleure utilisation des sols des écosystèmes forestiers et agricoles. La participation de ces deux sociétés révèle l'importance des mycorhizes en agriculture au Canada et l'impact des échanges scientifiques sur le développement agricole à travers le monde.

Nous sommes honorés d'avoir eu l'opportunité de mettre en place le programme scientifique de cette conférence. La diversité des disciplines représentées par les participants se reflète dans le thème de la conférence "Les mycorhizes: fondamentales et polyvalentes". Les quelques 750 résumés provenant d'environ 50 pays sont regroupés en 14 symposiums, plusieurs ateliers et sessions de présentations orales et d'affiches. Outre le programme scientifique, vous aurez le temps d'apprécier la vie montréalaise avec le traditionnel "Vins du Monde", les visites et excursions, les dîners et banquets. Nous espérons que vous apprécierez ce programme et qu'il vous permettra d'initier projets et collaborations et de vous créer de nouvelles amitiés.

Le défi que représentait la préparation des programmes scientifiques et des activités sociales conjoints à ICOM4, SCA et SCSS a nécessité la collaboration des nombreux conférenciers et l'appui de plusieurs collaborateurs tant au niveau local, national et international (voir la liste des différents comités). L'occasion nous est donnée ici de souligner leur soutien très apprécié.

Nous espérons que cette conférence conjointe, ICOM4, SCA et SCSS, sera pour vous tous une expérience enrichissante. La participation à de tels événements, quelque soit notre discipline scientifique (biologie, agronomie, science du sol, foresterie, et autres), nous rappelle que nous appartenons à une même communauté scientifique, prêts à relever les défis des années à venir, non pas isolément, mais actifs tous ensemble pour le bénéfice de l'environnement et par conséquent de l'humanité.

Que cette conférence soit inoubliable!

Yolande Dalpé, responsable du comité d'organisation
Gilles Bélanger, représentant du SCA au comité d'organisation
Denis Angers, représentant du SCSS au comité d'organisation

Welcome

The Organizing Committee is very pleased to welcome you to Montreal for the Fourth International Conference on Mycorrhizae (ICOM4) held jointly with the Canadian Society of Agronomy (CSA) and the Canadian Society of Soil Science (CSSS).

Members of Canada's dynamic scientific community lead, or collaborate in, a number of nationally and internationally important research and development projects in the field of plant and soil science. Canada's involvement in mycorrhizal research is supported by the fact that the North American Conference on Mycorrhiza was held twice in Canada (Québec City (Québec) in 1981 and Guelph (Ontario) in 1996). Furthermore, since 1993, eastern Canadian scientists and students working on mycorrhizal fungi have met at annual workshops, and in 2002, in preparation for ICOM4, a pan-Canadian Mycorrhizal Symposium was held in Québec.

The Canadian Society of Agronomy and the Canadian Society of Soil Science both organize annual scientfic meetings across Canada. Their members are part of a dynamic scientific community interested in the development of sustainable agricultural production systems and the better use of soils in forest and agricultural ecosystems. The presence of members of those two societies at this conference highlights the importance of mycorrhizae to Canadian agriculture and the impact such scientific exchanges have on the advancement of agriculture throughout the world.

It was an honour for us to have had the opportunity to put together the scientific program for this meeting. The diversity of disciplines represented by the participants is reflected in the theme of the conference, «Mycorrhiza: Fundamental and multi-purpose». The 750 abstracts, received from 50 countries, have been organized into 14 symposiums, several workshops, oral and poster sessions. Beside the scientific program, you will have time to enjoy life in Montreal with the traditional Wines of the World, tours and excursions, and dinners and banquet. We hope that you will find it stimulating, and that it will generate enthusiasm, new projects and collaborations, and above all new friendships.

Putting together the ICOM, CSA and CSSS's scientific and social program was challenging and required the cooperation of keynote and invited speakers, and the help of a large number of local, national, and international collaborators (see list of different committees). We would like to underline the fact that their support has been greatly appreciated.

We hope that this joint ICOM4, CSA, and CSSS meeting will be a rewarding and enriching experience for all concerned. Participation in such events is evidence that regardless of our scientific disciplines, be it biology, agronomy, soil science, forestry, or any other related field, we are all members of a global scientific society preparing to meet the challenges of the years and decades to come. We are not isolated, instead we are active collaborators dedicated to the well-being of the environment and consequently of humanity.

Let's make this event a most memorable one!

Yolande Dalpé, Chair of the Organizing Committee
Gilles Bélanger, CSA representative on the Organizing Committee
Denis Angers, CSSS Representative on the Organizing Committee

Renseignements généraux/*General information*

BUREAU DES INSCRIPTIONS/REGISTRATION DESK

Le bureau des inscriptions est situé au rez-de- chaussée de l'OACI. Il sera ouvert le dimanche 10 août de 17:00 à 19:00 et du lundi 11 août au vendredi 15 août de 7:00 à 17:00

The registration desk is located on the main floor of the ICAO. It will be open Sunday August 10, from 5:00 pm to 7:00 pm, and Monday August 11 to Friday August 15, from 7:00 am to 5:00 pm.

Messages/Messages

Toute demande d'information peut être adressée au bureau des inscriptions. Les messages seront affichés au babillard situé près du bureau des inscriptions. Pendant les sessions, les délégué(e)s ne pourront être joint(e)s qu'en cas d'urgence seulement.

Requests for information can be addressed to the Registration desk. Messages can be posted on the board next to the Registration desk. While sessions are under way, delegates will be interrupted only in case of emergency.

Salle de préparation /Preparation (Pre-view) room

Vous pouvez visionner votre présentation dans la salle 4C.111(4^{e} étage). Un ordinateur et un projecteur à diapositives seront mis à votre disposition.

Room 4C.111 (4th floor) is available to pre-view your presentation. A computer and a slide projector will be at your disposal.

*Souper Gala/Banquet

Le banquet SCA&SCSS se tiendra au restaurant du Vieux Port dans le Vieux Montréal. Une navette quittera l'OACI à 18h30 et vous ramènera en soirée.

The CSA&CSSS banquet will be held at the Restaurant du Vieux Port in Old Montréal. A shuttle bus will leave ICAO at 6:30 pm and will bring you back.

Le souper croisière s'effectuera sur le bateau « Cavalier Maxim ». Une navette quittera l'OACI à 18h15 et vous ramènera en fin de soirée.

The Dinner cruise is on the "Cavalier Maxim" boat. A shuttle bus will transport participants from the ICAO to the Dinner cruise and will bring you back.

Pour toute question concernant le banquet SCA et SCSS et le souper-croisière ICOM, veuillez vous addresser au bureau des inscriptions/Fore more information regarding the CSA/CSSS Banquet and the ICOM Dinner Cruise please see the registrations desk

Repas/Meals

Si vous suivez un régime alimentaire particulier, veuillez adresser vos demandes au bureau des inscriptions le plus tôt possible après votre arrivée.
If you have a specific restrictions concerning food, please notify the Registration desk as soon as possible after your arrival.

Comité exécutif/Executive Committee

Yolande Dalpé; J. André Fortin; Chantal Hamel ; Denis Angers (CSSS); Gilles Bélanger(CSA)

Comité consultatif/Advisory Committee

Christiane Charest; James W. Fyles; Suha Jabaji-Hare; Mario Jolicoeur; John Klironomos; Peter Moutoglis; Yves Piché; Marc St-Arnaud; Paul Widden.

Organisateurs des symposiums/Symposium organizers

Denis Angers, Robert Augé, Gilles Bélanger, Christiane Charest, Andrew Coughlan, Stéphane Declerck, Élianne Dumas-Gaudot, Keith Egger, J. André Fortin, Serges Gagné, Chantal Hamel, Richard Hogue, Suha Jabaji-Hare, Nancy Johnson, Mario Jolicoeur, John Klironomos, Line Lapointe, John Larsen, Murray Miller, Peter Moutoglis, Uwe Nehls, Christian Plenchette, Arthur Schüßler, Darlene Southworth, Marc St-Arnaud, Horst Vierheilig, Paul Widden, Daniel Wipf.

Organisateurs d' ateliers /Workshop organizers

Marc St-Arnaud, Chair; J.André Fortin; John Klironomos; Nérée Onguene Awana

Comité du programme scientifique/Scientific program committee

J.André Fortin, Chair; Yolande Dalpé ; Denis Angers (CSSS); Gilles Bélanger(CSA). With special contribution of Christiane Charest; Éliane Dumas-Gaudot; John Klironomos; Yves Piché; Marc St-Arnaud; Paul Widden

Comité des activités sociales/Social activities committee

Yolande Dalpé, Mario Jolicoeur, Peter Moutoglis, Marc St-Arnaud,

Comité des bourses de voyage étudiant/Student travel funds committee

Larry Peterson, Chair; Yolande Dalpé; Martin Filion; Chantal Hamel

Comité de la competition étudiante/Student competition comittee

Martin Filion, Serge Gagné, Melanie Jones, Paul Widden

Comité des commanditaires et bourses/Sponsorship and grant committee

Chantal Hamel, Chair; Christiane Charest; Yolande Dalpé; J.André Fortin; Yves Piché

Comité pour la pubicité/Publicity committee

Yolande Dalpé, Chair; France Biron; Judy McCarthy; Yves Piché

Secrétariat de la conférence/Conference Secretariat

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Phone : (514) 340-3215 Fax : (514) 340-4440
Email : icom4@congresbcu.com

Conférenciers invités/Invited speakers

A. Adholeya, I. Alexander, M. Allen, N. Amiour, R. Augé, G. Bécard , M. Bidartondo, P. Bonfante , T. Bruns, V. Estaun, B. Cornelissen, F.T. Davies, D. Douds, D. Durall, K. Egger, M. Filion, A. Fitter, J.A. Fortin , C. Gehring, A. Genre, V. Gianninazzi-Pearson , S. Gianinazzi, F. Grundler, J. Graham, C. Grant, C. Hamel, M. Harrison, A. Hirsch, N. C. Johnson, M. Jones, S. Juniper, Z. Kabir, J. Kliromonos, J. Leake, S. Lerat, R. Marmeisse, H. Massicotte, M. Morel, P. Moutoglis, U. Nehls, G. Podila, J. Querejeta, J. Quinn, D. Read , M. Rillig, I.Sanders, J. Sapp, A. Schüssler, Y. Shachar-Hill, S. Smith, K.S. Subramanian, M. Trépanier, D. vanTuinen, M. Vostaka, H. Vierheilig, Y. Wang, J. Whipps, I. Young, C. Zabinski, J. Zwiazek.

Prix étudiant ICOM / ICOM Student Awards

La Médaille Harley

La recherche sur les mycorhizes B la fin du 19ième siΠcle et le début du 20ième siΠcle a été marquée par les réalisations de plusieurs pionniers. Cependant, la publication en 1959 de la premiΠre édition de « The Biology of Mycorrhiza » constitue le point tournant dans l'histoire de la recherche dans ce domaine. Ce livre écrit par John Laker Harley fut le premier à faire connaitre la recherche sur les mycorhizes devant un large public.

Le professeur Harley était un scientifique de première classe qui fit appel aux techniques les plus récentes de la biochimie et de la physiologie (incluant les traceurs radio-actifs) pour élucider certains des mécanismes fonctionnels de la racine ectomycorhizienne. Ses façons de faire, et celles de ses nombreux étudiants, étaient toujours imaginatives et rigoureuses, et ont contribuéà démontrer l'importance fondamentale des ectomycorhizes. De plus, son enthousiasme a donné un élan à la recherche sur les mycorhizes tant arbusculaires qu'éricoçdes.

Excellent scientifique, le professeur Harley, appelé « Jack » par affection par ses collΠgues et amis, était un communicateur remarquable. En plus de son livre, il a popularisé la connaissance des mycorhizes par ses activités comme éditeur du New Phytologist, et par l'enthousiasme qu'il manifestait dans ses cours et ses conférences. Sa carrière a lancé la recherche sur les mycorhizes telle que nous la connaissons aujourd'hui et il a joué un rôle déterminant dans le développement de nombreuses carrières scientifiques dans ce domaine, à travers le monde.

Par la création de « La Médaille Harley» la « International Mycorrhiza Society » veut proposer la carrière de John Laker Harley comme modèle à suivre par les jeunes scientifiques. La médaille sera attribuée, lors de chaque « International Conference on Mycorrhizae » , à l'étudiant au Ph.D. qui aura présenté la meilleure communication, rappelant le mieux la rigueur scientifique dans l'étude des mycorhizes dont le professeur Harley a tracé la voie au cours de sa carrière.

J. André Fortin Le 23 juillet 2003
Révisé par David Read, Sally Smith et Andrew Coughlan

The Harley Medal

Mycorrhizal research has been marked by a number of pioneers whose activities encompassed the latter part of the 19th century and the early part of the 20th century. However, it was the publication in 1959 of the first edition of AThe Biology of Mycorrhiza@ that provided the turning point in the history of research in this domain. This book by John Laker Harley was the first to bring mycorrhiza and mycorrhizal research to a wide audience.

Professor Harley was a first class scientist who used the most recent biochemical and physiological techniques (including radioactive tracers) to elucidate some of the functional mechanisms of the ectomycorrhizal root. His approaches, and those of his many students, were always imaginative and rigorous, and served to demonstrate the fundamental importance of the ectomycorrhizal symbiosis. Furthermore, his enthusiasm for ectomycorrhiza stimulated a marked increase in research into arbuscular and ericoid mycorrhiza.

As well as being an excellent scientist, Professor Harley, always affectionately known by his friends and colleagues simply as AJack@, was an outstanding communicator. In addition to his book, he popularized the mycorrhizal discipline through his activities as Editor of New Phytologist, and by the enthusiasm he radiated during lectures and conferences. His work set the stage for mycorrhizal research as we know it today and he was instrumental in the development of many scientific careers in this discipline around the world.

The International Mycorrhiza Society would like, through the creation of AThe Harley Medal@, to highlight John Laker Harley's career as a model for younger scientists to follow. The medal will be awarded, at each International Conference on Mycorrhiza, to the Ph. D. student who is deemed to have presented a paper which best emulates the rigorous approaches to mycorrhizal research that Professor Harley pioneered during his lifetime.

J. André Fortin July 16th 2003
Revised by David Read, Sally Smith, and Andrew Coughlan

Prix CPRS

Le « Centre for Plant Root Symbioses » (CPRS), The University of Adelaide, Australie», est heureux de remettre un prix ICOM4 afin de souligner l'excellence d'une présentation étudiante à cette conférence. Cette récompense vise à reconnaître l'importante contribution à la recherche des étudiants et à encourager la réalisation et la présentation de travaux de qualité.

Le CPRS, centre d'excellence de l'Université d'Adelaide concentre ses activités sur la recherche sur les divers partenaires impliqués dans les symbioses végétales, notamment les champignons mycorhiziens

CPRS Award

The Centre for Plant Root Symbioses (CPRS), The University of Adelaide, Australia, is pleased to offer a student prize for an excellent poster presentation at ICOM4. The prize is given to recognise the important contribution that students make to research and to encourage the production of posters of high quality, both with respect to content and to presentation.

The CPRS is recognised as a centre of excellence at the University of Adelaide. The research is focused on the symbioses between plant roots and selected invasive organisms, especially mycorrhizal fungi.

Affiches / Posters

***** Les présentateurs d'affiches doivent être présents durant les deux sessions et 13h30 à 15h00 (Lundi & mardi ou jeudi et vendredi / **The poster presenters must be present during the two poster sessions from 13h30 to 15h00 (Monday and Tuesday or Thursday and Friday)**

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Lundi/ Monday							
8h30-8h45	Bienvenue/ Welcoming						
8h45-9h45	**Conférence d'ouverture/ Opening Lecture** Jonathan Leake						
9h45-10h15	**Pause Café / Coffee Break (4 étage/floor)**						
10h15-12h30	**Symposium** Mycorhizes et pratiques agronomiques/Mycorrhizae and agronomic practices			**Symposium** Biocomplexité des réseaux mycéliens mycorhiziens/Biocomplexity in common mycorrhizal networks	**Session orale / Oral session** CSSS-Gaz à effet de serre et séquestration du C/ Greenhouse gases and C sequestration	**Session orale / Oral session** CSSS-Résidus organiques et biosolides/Organic residues and biosolids	
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13h30-15h00	**Session affiche /Poster session (Salle/Room 1 & 4 étage/floor)** **ICOM (1 & 4e étage/ 4 th floor)** - Agronomie et pratiques agronomiques / Agronomy and crop production - Morphologie et réseaux mycorhiziens / Mychorrhizal Morphology and networks - Qualité des sols, bioremediation et reclamation / Soil quality, bioremediation, and reclamation - Génomique, protéomique et biologie moléculaire / Genomics, proteomics, and molecular biology **CSSS/CSA (1er étage/ 1st floor)** -Résidus organiques et biosolides/Organic residues and bio-solids - Conservation et gestion des sols/Soil Conservation and Management - Cultures fouragères/ Forage Crops - Gaz à effet de serre et carbone du sol/Greenhouse Gases and Soil Carbon - Sols forestiers/Forest Soils - Cultures annuelles/Annual Crops - Physiologie des cultures/Crop physiology - Fertilité des sols et gestion des éléments nutritifs/Soil Fertility and Nutrient Management - Qualité de l'eau, physique des sols et pédologie/Water Quality, Soil Physics, Pedology						
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	Salle AH (4 étage/floor)	Salle 1 (4 étage/floor)	Salle 2 (4 étag/floor)	Salle 3 (1 étage/floor)	SALLE/ROOM C & D (1 étage/floor)	Salle A & B (1 étage/floor)	Salle 7A & 7B (3 étage/floor)
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10h00-11h00		**Symposium (Suite/Continue)** Que sont les mycorhizes ? / What are mycorrhizas?	**Symposium (Suite/Continue)** Mycorrhizes et qualité des sols /Mycorrhizae and soil quality	ICOM-Biodiversité/Biodiversity (Suite /Continue)	CSA-Cultures annuelles/Annual Crops (Suite/ Continue)	CSSS-Physique des sols et hydrologie/Soil Physics and Hydrology (Suite/Continue)	ICOM- Génomique, protéomique et biologie moléculaire/Genomics, proteomics and molecular biology (Suite /Continue)
11h00-12h30					CSA-Réunion générale/Annual General Meeting	CSSS- Réunion générale/Annual General Meeting	
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13h30-15h00	**Session affiche /Poster session ICOM (1 & 4e étage/ floor)** **ICOM (1 & 4e étage/ 4 th floor)** - Agronomie et pratiques agronomiques / Agronomy and crop production - Qualité des sols, bioremediation et reclamation / Soil quality, bioremediation, and reclamation - Morphologie et réseaux mycorhiziens / Mychorrhizal Morphology and networks - Génomique, protéomique et biologie moléculaire / Genomics, proteomics, and molecular biology **CSSS/CSA (1er étage/ 1st floor)** -Résidus organiques et biosolides/Organic residues and bio-solids - Conservation et gestion des sols/Soil Conservation and Management - Cultures fouragères/ Forage Crops - Gaz à effet de serre et carbone du sol/Greenhouse Gases and Soil Carbon - Sols forestiers/Forest Soils - Cultures annuelles/Annual Crops - Physiologie des cultures/Crop physiology - Fertilité des sols et gestion des éléments nutritifs/Soil Fertility and Nutrient Management - Qualité de l'eau, physique des sols et pédologie/Water Quality, Soil Physics, Pedology						
15h00-15h15	**Pause Café / Coffee Break**						
15h15-18h30 (ICOM) 15h15-18h00 (CSA-CSSS)		**Symposium** Mycorhizes dans un monde en changement / Mycorrhizae in a changing world	**Symposium** Mycorhizes, salinité et sécheresse / Mycorrhizae, salinity and drought	**Session orale / Oral session** ICOM- Qualité du sol, bioremediation et réclamation/Soil quality, bioremediation, and reclamation	**Session orale / Oral session** CSA-Cultures fourragères/Forage Crops	**Session orale / Oral session** CSA & CSSS-Fertilité et gestion des éléments nutritifs /Fertility and Nutrient Management	**Session orale / Oral session** CSSS-Biologie des sols/Soil Biology
18h30-22h00	**Banquet CSA & CSSSS**						
19h30-…	**Ateliers / Workshops (salles à déterminer/rooms to be determined)**						

Mercredi/ Wednesday								
	EXCURSIONS & ACTIVITÉS / EXCURSIONS AND ACTIVITIES							
	Salle AH (4 étage/floor)	**Salle 1 (4 étage/floor)**	**Salle 2 (4 étag/floor)**	**Salle 3 (1 étage/floor)**	**SALLE/ROOM C & D (1 étage/floor)**	**Salle A & B (1 étage/floor)**	**Salle 7A & 7B (3 étage/floor)**	
Jeudi/ Thursday								
8h30-9h15		**Plénière/Plenary** Ian Sanders						
9h15-9h45	**Pause Café / Coffee Break**							
9h45-12h30		**Symposium** Évolution, phylogénie et systématique des champignons mycorhiziens / Evolution, phylogeny and systematic of mycorrhizal fungi	**Symposium** Biologie in vitro des champignons mycorhiziens / In vitro biology of mycorrhiza fungi Culture in vitro des champignons mycorhiziens / Root-organ culture of mycorrhizal fungi		**Session orale / Oral session** ICOM-Stress et pathology / Stress and Pathology	**Session orale / Oral session** ICOM-Écologie et écosystème**s** / Ecology and ecosystems		
12h30-13h30	**LUNCH**							
13h30-15h15	**Session affiche/Poster presentation ICOM (1 & 4 étage/ floor)** - Biodiversité/ Biodiversity -Stress et pathologie/ Stress and Pathology -Écologie et ecosystems / Ecology and ecosystems -Biochimie et physiologie/ Biochemistry and physiology -Évolution, phylogénie et systématique / Evolution, phylogeny and systematics -Culture des champignons et production d'inoculum / Fungal cultivation and inoculum production							
15h15-15h30	**Pause Café / Coffee Break**							
15h30-18h00		**Symposium** Processus de transport chez les mycorhizes / Transport processes in mycorrhizas	**Symposium** Aspects industriels des mycorhizes / The industrial side of mycorrhizal fungi		**Session orale / Oral session** ICOM- Evolution, phylogénie et systématique /Evolution, phylogeny and systematics	**Session orale / Oral session** ICOM- / Biochemistry and physiology		
19h00-00h00	**Souper Croisière / Dinner Cruise**							

	Salle AH (4 étage/floor)	Salle 1 (4 étage/floor)	Salle 2 (4 étag/floor)	Salle 3 (1 étage/floor)	SALLE/ROOM C & D (1 étage/floor)	Salle A & B (1 étage/floor)	Salle 7A & 7B (1 étage/floor)
Vendredi/ Friday							
8h30-9h15		**Plénière/Plenary** Wang Yun					
9h15-9h45	**Pause Café / Coffee Break**						
9h45-12h30		**Symposium** Interactions dans la mycorhizosphère et agent de contrôle biologique des parasites / Interactions in the mycorhizosphere and biocontrol of pathogens	**Symposium** Mycorhizes et écosystèmes / Mycorrhizae and ecosystems of the world		**Session orale / Oral session** ICOM- Culture des champignons et production d'inoculum / Fungal cultivation and inoculum production	**Atelier / Workshop** Morphogénèse et physiologie des basidiocarpes de champignons ectomycorhiens / Morphogenesis and physiology of ectomycorrhizal fungi basidiomes	
12h30-13h30	**LUNCH**						
13h30-15h30	**Session affiche/Poster presentation ICOM (1 & 4 étage/ floor)** - Biodiversité/ Biodiversity -Stress et pathologie/ Stress and Pathology -Écologie et ecosystems / Ecology and ecosystems -Biochimie et physiologie/ Biochemistry and physiology -Évolution, phylogénie et systématique / Evolution, phylogeny and systematics -Culture des champignons et production dl'inoculum / Fungal cultivation and inoculum production						
15h30-15h45	**Pause Café / Coffee Break**						
15h45-17h00		Plénière ICOM / ICOM Plenary					
Samedi/ Saturday							
7h00-18h00	**Ville de Québec/Quebec City**						

Liste des salles/List of Rooms

Salle/Room A&H	**4 étage/floor**	**Salle/Room C&D**	**1 étage/floor**
Salle/Room 1	**4 étage/floor**	**Salle/Room 7A&7B**	**3 étage/floor**
Salle/Room 2	**4 étage/floor**	**Salle/Room 8A&B**	**3 étage/floor**
Salle/Room3	**1 étage/floor**	**Affichettes/Posters**	**1 & 4 étage/floor**

Lundi 11 août 2003/Monday August 11th 2003

07H00-17H00 Bureau des inscriptions/Registration desk

SALLE/ROOM AH (4 étage/floor)

08H30-08H45 Bienvenue/Welcome
***Présidente ICOM4/Chairman of ICOM4* — Yolande Dalpé**
***Président SCSS/CSSS President* — Ahmet Mermut**
***Président SCA/CSA President* — Lianne Dwyer**

08H45-09H45
Conférence d'ouverture/Opening Lecture
Prof. Johnathan Leake
The University of Sheffield,United Kingdom

(#458) Networks of power and influence: the role of mycorrhizal mycelium in controlling plant communities and agro-ecosystem functioning.

09H45-10H15 PAUSE CAFÉ/COFFEE BREAK (4e étage/floor)

SALLE/ROOM AH (4 étage/floor)

10H15-12H30 **SYMPOSIUM 1**
ICOM- Mycorrhizes et pratiques agronomiques/Mycorrhizae and agronomic practices
ORGANISATEURS ET MODÉRATEURS / ORGANIZERS AND CHAIRS :
CHRISTIAN PLENCHETTE, GILLES BELANGER ET ANDRÉ FORTIN

Tenu conjointement avec la Société canadienne d'agronomie
Held jointly with the Canadian Society of Agronomy

10H15 – 11H00 Conférenciers majeurs/ Major speakers: Plenchette Christian , Meynard Jean-Marc, Clermont-Dauphin Cathy, **Fortin J. André**
(#158) Managing mycorrhizae in different agricultural systems.

11H00-11H30 Présentation/Lecture 1: **Grant Cynthia,** Shabtai Bittman, Marcia Monreal , Christian Morel, Christian Plenchette
(#73) Soil and fertilizer phosphorus : effects on plant P supply and mycorrhizal development.

11H30 – 12H00 Présentation/Lecture 2: **Kabir Zahangir**

(#410) Tillage or no tillage: impact on mycorrhizae.

12H00 – 12H30 Présentation/Lecture 3: **Douds**, **David,** Nagahashi Jerry, Pfeffer Philip, Kayser William, Reider Carolyn
(#147) On farm production and utilization of mycorrhizal fungus inoculas.

SALLE/ROOM 3 (1 étage/floor)

10H15-12H30 **SYMPOSIUM 2**
ICOM- Biocomplexité des réseaux mycéliens/ Biocomplexity in common mycorrhizal networks
ORGANISATEUR ET MODÉRATEUR / ORGANIZER AND CHAIR : DARLENE SOUTHWORTH

10H15 – 11H00 Conférencier majeur/Major speaker: **Durall Daniel M.** Jones Melanie, Simard Suzanne
(#530) Mycorrhizal networks : their extent, function and importance.

11H00 – 11H30 Présentation/Lecture 1: **Querejeta Nacho,** Egerton-Waburton Louise Allen Michael
(#496) Hydraulic lift: transfer of water and fluorescent tracers between plants connected by common mycorrhizal networks.

11H30 – 12H00 Présentation/Lecture 2: **Bidartondo Martin,** Bruns Thomas
(#285) Obligate cheaters of mycorrhizal networks.

12H00 – 12H30 Présentation/Lecture 3: **Sylvain Lerat**, Piché Yves, Lapointe Line
(#519) AM fungi and carbon transfer between sugar maple saplings and forbs.

SALLE/ROOM A&B (1 étage/floor)

10H15-12H30 (PRÉSENTATION ORALE-ORAL PRESENTATION)
CSSS- Résidus organiques et biosolides/Organic résidues and bio-solids
MODÉRATEUR/CHAIR : M. CHANTIGNY

10H15 – 10H30 (#606) *Hydroponic evaluation of wastewater from anaerobically digested organic waste as a fertility source for selected turfgrass and woody species*
Michitsch Robert C., Chong Calvin, Voroney R. Paul, Holbein Bruce

10H30 – 10H45 (#559) *Compost, Manure, and Gypsum Application to Timothy/Red clover mix on Dykeland Soils*
Zheljazkov Valtcho, McNeil Paul, Savoy Scott

10H45 – 11H00 (#702) *Functional Implications of Changes in Communities of Soil Microfauna Resulting from the Use of Organic Soil Amendments and Mulches in Tree-fruit Production Systems*
Forge Tom, Hogue Eugene, Granatstein David, Neilsen Denise, Neilsen Gerry

11H00 – 11H15 (#344) *Utilization of Seafood Processing Waste as a Nutrient Source for Spelt and Soybeans*
MacLeod John, Ivany Jerry, Grimmett Mark

11H15 – 11H30 (#450) *Composting sheep carcasses*
Barnett Gordon, Rioux Romain, Blanchette Sylvain

11H30 – 11H45 (#718) Fields Under Organic Management: A Survey of Soil Fertility
Knight J. Diane, Buhler R., Shirtliffe S.

11H45 – 12H00 (#388) *Phosphorus fractions in a clay loam soil amended with various composts*
Zhang T.Q., Hu Q.C., Drury C.F, Tan C.S., Reynolds W.D.

12H00 – 12H15 (#134) *PREDICTING TRANSPORT OF SOIL PHOSPHORUS IN LANDSCAPE IN RESPONSE TO MANURE APPLICATION*
Feng Yongsheng, Li Xiaomei, Olson Barry, Hao Xiying, Zhang Mingchu

SALLE/ROOM C & D (1 étage/floor)

10H15-12H30 (PRÉSENTATION ORALE-ORAL PRESENTATION)
CSSS- Gaz à effet de serre et séquestration du C/Greenhouse gases and C sequestration
MODÉRATEUR/CHAIR : J. WHALEN

10H15 – 10H30 (#494) *New Model for Soil Gaseous flux estimation using closed chambers*
Sey Benjamin, Feng Yongsheng, Li Xiaomei

10H30 – 10H45 (#637) *Upscaling of Chamber-based Estimates of Nitrous Oxide Emissions at Snowmelt*
Pennock Dan, Farrell Richard, Desjardins Raymond, Pattey Elizabeth, McPherson Ian

10H45 – 11H00 (#455) *Zone Tillage and Nitrogen Placement Strategies to Reduce Fuel Consumption, Decrease Nitrous Oxide Emissions and Improve Soil Quality.*
Drury Craig, Tan Chin, Reynolds Dan, McLaughlin Neil, Welacky Tom

11H00 – 11H15 (#392) *Greenhouse gas production from biological "hotspots" as influenced by Agricultural management practices*
Sey Benjamin, Whalen Joann, Gregorich Ed, Rochette Philippe

11H15 – 11H30 (#635) *Sediment, carbon, and dentrification potential distribution in a upland-wetland transition, Saskatchewan, Canada*
Yates Tom, Uyl Arina**,** Farrell Richard, McDougal Rhonda, Pennock Dan

11H30 – 11H45 (#757) *Reduced Tillage Does Not Enhance Organic Carbon Sequestration in Southern Ontario Soils*
Voroney Paul, Beyaert Ron, Wanniararchchi Sudas, Winter Julien

11H45 – 12H00 (#115) *Carbon Saturation and the Rates and Limits of Carbon Sequestration in Soil*
Stewart Cathy, Plante Alain, Six Johan, Conant Richard, Paustian Keith

12H00 – 12H15 (#748) *The Contribution of Soil Fractions to the Dynamics of Soil Organic Matter*
Paul Eldor A., Degrysze S., Fortuna, A.M.,Willson T., Wright S., Harwood R.

12H30-13h30 LUNCH

SALLE/ROOM (1 étage/floor)

*13h30-15h00 (Présentation affiche-Poster presentation)
ICOM-Agronomie et grandes cultures/Agronomy and crop production
Lundi 11 août 2003 et mardi 12 aôut 2003 & Monday August 11th and Tuesday August 12th 2003

(#304) *Relationship between Arbuscular Mycorrhiza Fungi Infectivity, Soil Characteristics and Land use History.*
Djuuna Irnanda Aiko Fifi, Abbott Lynette, Boggs Guy

(#267) *Effects of soil tillage, plant diversity and plant identity on the community composition of AMF spores.*
Picone Christopher

(#350) *Field Evaluation Report of a Conference Pear Orchard in a Replant Site. Plant Inoculation with Glomus intraradices (BEG 72) is Combined with Organic Amendment and Biocide Soil Treatments.*
Calvet Cinta, Camprubí Amèlia, Estaún Victoria, Carbó Joaquim, Casals Mariona

(#645) *Effects of Conventional and Native American Agricultural Practices Upon Mycorrhuzal Inoculum Potential in South Western USA.*
Martinez Theodore N., Johnson Nancy C.

(#774) *Mycorrhizal colonisation and the delivery of phosphate in cereal crops.*
Glassop Donna, Schünmann Petra, , Smith Sally, Smith Frank

(#222) *Sugarcane yield decline may be causally linked with early and rapid colonization by arbuscular mycorrhizal fungi (AMF).*
Graham J. H., Irey M.S. ,Morton J. B., Baucum L., Bright D.

(#186) *Community analysis of AMF in Saskatchewan organic farm soils by PCR-DGGE.*
Ma Wai, Siciliano Steve, Germida Jim

(#555) *Diversity and Abundance of Arbuscular Mycorrhizal Fungi In Coffee Agroecosystems Disturbed By Erosion.*
Lara-Capistrán Liliana, Trejo Dora, Flores Rocío

(#140) *Effect of Plant Host Genotype On Interaction Between Mycorrhizal and Rhizobium Symbiosis in White Clover.*
Eason, William, Culshaw Claire Dodd John, Gareth Griffith

(#522) *Populus clones and cultivars differ in ectomycorrhizal and arbuscular mycorrhizal colonization rate when grown in uniform soil conditions.*
Kieliszewska-Rokicka Barbara, Figaj Jarosaw , Rachwa Lesaw ,Welc Monika

(#327) *The Growth Response of Micropropagated Rhododendrons to Inoculation with Oidiodentron Maius and Phialocephala Fortinii under Two Sets of Conditions.*
Vodnik Martin, Vosátka Miroslav, Regvar Marjana, Vohník Dominik

(#272) *Early root and ectomycorrhiza formation in sown-origin Scots pine seedlings after soil preparation.*
Tarvainen Oili, Bergsten Urban, Kubin Eero

(#273) *Growth of Scots pine seedlings in humus and mineral layers from urban vs. natural forest soils.*
Tarvainen Oili, Leal Riesco Iola, Markkola Anna Mari

(#338) *Effect of Ground Leaf Litter from Various Plant Species on Ectomycorrhizal Fungal Communities on Pinus rigida Seedlings.*
Jonsson Lena, Dighton John, Lussenhop John, Koide Roger

(#750) *Effect of Long-Term Contrasting Anthropogenic Emission on Ectomycorrhizal Community Structure of Scots Pine Stands in Poland.*
Leski Tomasz, Rudawska Maria

(#102) *Afforestation of abandoned land with conifer seedlings inoculated with three species of ectomycorrhizal fungi.*
Menkis Audrius, Vasiliauskas Rimvis, Finlay Roger, Taylor Andrew

(#208) *The Influence of different fertilizers on the development of mycorrhiza and fine-roots of containerized conifer seedlings.*
Gaitnieks Talis, Smits Agnis

(#219) *Elevated N input results in reduced growth of ectomycorrhizal mycelium in forest soils.*
Nilsson Lars Ola, Wallander Håkan, Falkengren-Grerup, Giesler Reiner

(#398) *Growth and phosphorus uptake of Eucalyptus seedlings inoculated with monokaryotic and dikaryotic isolates of Pisolithus sp.*
Costa Maurício Dutra, Silva Marcelo Alexandre, Borges Arnaldo Chaer, Kasuya Maria Catarina Megumi,

(#210) *Natural regeneration of holm oak (Quercus ilex L.) forests in Corsica : role of ectomycorrhizal symbiosis in seedling growth and survival and soil feedback.*
Richard Franck, Millot Sophie, Selosse Marc-André, Gardes Monique

(#536) *Influence of weed control, irrigation and fertilization on /Tuber melanosporum/ colonization of /Quercus ilex/ plantation seedlings.*
Olivera Antoni, Fischer Christine, Colinas Carlos

(#563) *Removal of pinegrass and forest floor during site preparation: effects on lodgepole pine growth and ectomycorrhizae.*
Simard Suzanne, Jones Melanie, Durall Dan

(#305) *Community structure and diversity of below ground ectomycorrhiza fungi in Danish beech (Fagus sylvatica) forest with different cropping history.*
Føns Kirsten, Kjøller Rasmus

(#373) *Nitrogen Deposition Effects on Mycorrhizal Communities in the New Jersey Pine Barrens*
Tuininga Amy, Huskins, Rebecca, Dighton John, Belton Thomas

(#443) *ECM community dynamics in boreal Québec.*
De Bellis Tonia, Kernaghan Gavin, Widden Paul, Légaré Sonia, Bergeron Yves, Paré David

(#259) *Ectomycorrhizal fungi structure following increased levels of site disturbance in a pine-oak forest.*
Valdés María, Ramírez Paola, Pereda Verónica

(#322) *The Impact of Genotype of Norway Spruce on Mycorrhizal Fungal Community in Boreal Forest Soil.*
Korkama Tiina, Pakkanen Anne, Pennanen Taina

(#74) *Cultivation of Ascocarps of Tuber Formosanum Hu on Cyclobalanopsis Glauca (Thunb.)Oerst in Siliceous Soils by Liming.*
Hu Hung-Tao

(#791) The Compatibility of Some Formulations of VAM Fungus on P Uptake and Crop Yields Grown in Various Marginal Soils in the Tropics
Sri Tejowulan, Parman A, Wahyu A., Wangiyana W., Sastrahidayat L.R.

(#792) *NP Application and VAM Effect on NPK Uptakes and Corn Growth in the Tropical Entisol of Lombok Island, Indonesia*
Suwardjii M, Silawibawa I.P., Lolita ES, NP

SALLE/ROOM (4 étage/floor)

*13h30-15h00 (Présentation affiche-Poster presentation)
ICOM-Morphologie et réseaux mycéliens/Mychorrhizal morphology and networks
Lundi 11 août 2003 et mardi 12 aôut 2003 & Monday August 11th and Tuesday August 12th 2003

(#747) *A low-cost & low-heat method for transmitted-light dissection microscope examinations of intact root segments.*
Graves Don

(#67) *A method of evaluating systemic coloniztion of leaves by dark septate fungal endophytes in Bouteloua eriopida (Torr.) Torr. a native grass in arid southwestern USA rangelands.*
Aaltonen Ronald, Barrow Jerry

(#478) *Colonization preference and morphologies of arbuscular mycorrhizal fungi among different plant species.*
Kubota Mayumi, Hyakumachi Mitsuro

(#149) *The mycorrhiza of the medicinal and ornamental genus Eleutherococcus Max. (Araliaceae).*
Döring Matthias, Weber Hans Christian, Imhof Stephan

(#117) *Does the size of the air spaces in roots influence the morphology of arbuscular mycorrhizas?*
Toussaint Jean-Patrick, Dickson Sandy, Smith F. Andrew, Smith Sally E.

(#243) *Morphological features of the hyphae of Glomus intraradices: from observations to mathematical models.*
Juge Christine, Parrot Lael, Piché Yves

(#196) *Seasonal fluctuations in the ectomycorrhizal community associated with beech (Fagus sylvatica).*
Kjoller Rasmus

(#733) *Little N is cycled from senescing annual grasses to neighboring plants in a California oak woodland.*
Stout Deborah, Bledsoe Caroline S.

(#414) *Carbon allocation by arbuscular mycorrhizal fungi from one host plant to two different species of introduced plants.*
Nakano-Hylander Aiko, Olsson Pål Axel

(#566) *Arbuscular mycorrhizal fungi colonize decomposing leaves of Myrica parvifolia, M. pubescens and Paepalanthus sp.*
Aristizabal Catalina, Rivera Emma L., Janos David P.

(#431) *The ectomycorrhizal network in tropical rain forests, a link within plant community.*
Diedhiou Abdala, Diabate Moussa, Dreyfus Bernard, Ba Amadou

(#213) *Analysis and comparison of anastomosis formation in Glomus and Scutellospora strains grown in monoxenic culture with Ri T DNA transformed carrot roots.*
de la Providencia Ivan, Fernández Félix, de Souza Francisco A., Declerck Stéphane

(#732) Arbuscular mycorrhizal fungi penetrate into Arabidopsis thaliana roots.
Horii Sachie, Ishii Takaaki

(#190) *Intracellular structure in living hyphae of an arbuscular mycorrhizal fungus, Gigaspora margarita.*
Saito Katsuharu, Uetake Yukari, Saito Masanori

(#500) *Nuclear size in arbuscular mycorrhizal tomato: the role of ploidy and chromatin decondensation.*
Lingua Guido, Berta Graziella, Ugoccioni Roberto, Trotta Antonio, Prigione Valeria

(#417) *Interactions Between Ectomycorrhizal Fungi and Ericoid Plants.*
Villarreal-Ruiz Luis, Alexander Ian J., Anderson Ian C.

(#429) *Effects of cadmium and/or arbuscular mycorrhizal colonization on root ploidy levels of two pea genotypes.*
Repetto Ombretta, Massa Nadia, Dumas-Gaudot Eliane, Gianinazzi-Pearson Vivienne, Berta Graziella

(#621) *Arbuscular mycorrhizae and phosphorus induce endopolyploidization Allium porrum root cells.*
Volante, A, Fusconi Anna, Lingua Guido, Trotta Antonio, Berta Graziella

(#265) *Peleton morphology of orchid mycorrhizas in the Australian terrestrial orchid Arachnorchis formosa (G.W. Carr) D. L. Jones et M.A. Clem.*
McLean Cassandra, Huynh Tien, Coates Fiona, Lawrie Ann

(#510) *Visualization of Polyphosphate in Cryo-Fixed Fungal Cells: a Dark Septate Fungus, Phialocephala fortinii and an Arbuscular Mycorrhizal Fungus, Gigaspora margarita.*
Kuga Yukari, Peterson R. Larry, Saito Masanori

(#493) *Mycorrhizal dependency of Chihuahuan Desert plants is influenced by life history strategy and root morphology.*
Collier Shawn, Yarnes Christopher, Herman R. Peter

(#300) *Colonization of Linum usitatissimum by AM Fungi Forms Arbuscular Pairs.*
Dickson Sandy, Schweiger Peter, Smith Andrew, Söderström Bengt, Smith Sally

(#434) *Effect of Arbuscular Mycorrhizal Fungi (AMF) on the Root Anatomy and Architecture of the Palm Species Phoenix dactylifera, P. cariensis, Brahea armata and Chamaerops humilis.*
Dreyer Beatriz, Honrubia Mario, Morte Asun

(#142) *Description of Quercus ilex ectomycorrhizae.*
Claveria Vanessa, de Miguel Ana Maria, de Roman Miriam

(#481) *Compensation by arbuscular mycorrhizal fungi for lack of root hairs in barley.*
Jakobsen Iver, Lundsgaard Thorben, Knudsen Lisa M.

(#86) Gene expression profiling of preinfection processes in Arbuscular Mycorrhizae formation.
White Holly, Muratet Michael, Podila Gopi, Nagahashi Jerry Douds David

(#787) *Symbiotic strategies for orchid conservation in Mexico*
Ortega-Larrocea, M. P

(#741) *Two-way nitrogen transfer between Eucalyptus and Casuarina linked by a common ectomycorrhizal network: 15N natural abundance studies.*

He Xinhua, Ng Hock, Stewart George, Christa Critchley

(#781) *Quantitative Study of Arbuscular Mycorrhizae and Ectomycorrhizae on Aged Eucalyptus*
Adjoud-Sadadou D., Halli-Hargas R., Lapeyrie F.

SALLE/ROOM (4 étage/floor)

*13H30-15H00 (Présentation affiche-poster presentation)

ICOM-Qualité du sol, bioremédiation et réclamation/Soil quality, bioremediation, and reclamation

Lundi 11 août 2003 et mardi 12 aôut 2003 & Monday August 11th and Tuesday August 12th 2003

(#179) *The Secreted AM Fungal protein Glomalin Binds Strontium in Solution.*
Driver James, Hamilton Melinda, Rillig Matthias

(#182) *Seasonality of the arbuscular mycorrhizal fungal soil protein glomalin.*
Lutgen Emily, Muir-Clairmont Deborah, Graham Jon, Krivtsov Vladimir, Deyo Nicholas, Rillig Matthias
,
(#547) *Use of in vitro grown Glomus intraradices to sensor the effect of agricultural amendments.*
Dumas-Gaudot, Éliane, Bestel-Corre Gwenaëlle, Lenogue Sebastien, Amiour Nardjis

(#297) *Influence of wood ash application on mobilization of cadmium and dissolved organic carbon in coniferous forest soil.*
Jokinen Hanna, Strömmer Rauni

(#427) *Influence of arbuscular mycorrhiza on cadmium tolerance and uptake by tobacco plants with inserted metallothionein gene.*
Malcova Radka , Janouskova Martina, Pavlikova Daniela, Vosatka Miroslav, Macek Tomas

(#314) *Mycorrhizas on Quercus garryana on serpentine soils.*
Southworth Darlene, Moser A. Mariah, Petersen Carolyn, Tugaw Heather, Berninghausen Harold

(#22) *Detoxification of ferulic acid by ectomycorrhizal fungi.*
Münzenberger Babette, Hammer Elke, Wray Victor, Schauer Friedrich, Schmidt Jürgen, Strack Dieter

(#381) *Variation in Function of Arbuscular Mycorrhizal Fungi from Acidic, Alkaline and Neutral Soils.*
Bunn Rebecca, Zabinski Catherine

(#692) *Effect of arbuscular mycorrhizal inoculation and vermicompost on growth of Carica papaya L. plants under greenhouse and field conditions.*
López-Aguirre José Gerardo, Ramiro-Sandoval Ramiro, Aguilar-Espinosa Sergio, Alarcón Alejandro, Flores-Bello María del Rocío, Farias-Larios Javier, Michel Rosales Arnoldo

(#508) *Effect of arbuscular mycorrhizal fungi and Bacillus inoculation on growth of Carica papaya plants growing in vermicompost.*
Tapia-Gone Jesús, López-Moctezuma Héctor, Ferrera-Cerrato Ronald, Farias-Larios Javier, Aguilar-Espinosa Sergio, Flores-Bello Rocío, López-Aguirre José Gerardo

(#95) *Environmental and edaphic factors influencing arbuscular mycorrhizal fungal and soil microbial communities using a tallgrass prairie restoration chronosequence.*
Miller R. M, Allison V. J., Jastrow J. D., Matamala R.

(#165) *Seasonal Mycorrhizal Colonization and Ergosterol Patterns of a Florida Wetland with Nutrient Impact.*
Ipsilantis Ioannis, Sylvia David

(#682) *The Impact of Nitrogen Amendment on Glomalin Content in Soils in three Forest Communities in Lower Michigan, USA.*
Antibus Robert, Lauber Chris, Sinsabaugh Robert, Zak Donald

(#276) *Utilization of Heterocyclic Organic Nitrogen by Mycorrhizal Fungi.*
Caldwell Bruce, Jumpponen Ari

(#277) *Arylsulfatase Production by Mycorrhizal Fungi*
Caldwell Bruce, Jumpponen Ari

(#411) *Micro-analytical tools to study metal sequestration and activity of different AM fungi in polluted soils.*
Turnau Katarzyna, Jurkiewicz Anna, Ryszka Przemyslaw, Orlowska Elzbieta, Anielska Teresa, Mesjasz-Przybylowicz Jolanta, Przybylowicz Wojciech, Budka Dobroslawa

(#687) *Potential and use of mycorrhizae in phytoremediation of soil.*
Heyser Wolfgang

(#341) *Contribution of the arbuscular mycorrhizal fungus Glomus intraradices to plant uptake of uranium.*
Rufyikiri Gervais, Joner Erik J. Jakobsen Iver, Leyval Corinne

(#37) *Ectomycorrhizal Colonization of Birch (Betula pendula Roth) at an Uranium Mining Heap.*
Buscot François, Schmid Sandra, Kaldorf Michael, Renker Carsten, Luis Patricia

(#202) *Studies on copper tolerance and protective effects on host plants among ectomycorrhizal strains of the Hymenoscyphus ericae aggregate (Helotiales, Ascomycota).*
Vrålstad Trude, Adriaensen Kristin, Colpaert Jan V.

(#517) *Arbuscular Mycorrhizal Fungi Enhances Phytoremediation of Chromium in Sunflower.*
Davies Fred T., Puryear Jeffrey D, Newton Ronald J.

(#231) *Mycorrhizal protection of Calluna vulgaris grown on copper-contaminated mine spoil.*
Gibson Brian, Mitchell Derek

(#271) *A Role for AM Fungi in Phytoremediation of Depleted Uranium and Arsenic.*
Lammers PJ, Krijgsman O., De Jong M., Ratnayaka S., Jun J., Reher C., Govindarajulu M., Bücking H, Shachar-Hill Y.

(#108) *Phytoremediation potential and tolerance of Echinochloa polystachya-Gigaspora margarita symbiosis to benzo[a]pyrene.*
Alarcon Alejandro, Davies Jr. Frederick T., Ferrera-Cerrato Ronald

(#118) *Diversity of ectomycorrhizal fungi on Salix spp. at heavy metal contaminated and non-contaminated sites.*
Hrynkiewicz Katarzyna, Baum Christel

(#568) *Chromium effect in the arbuscular mycorrhizal colonisation and the growth of tomato (Licopersicum esculentum) plants.*

Carreón Abud Yazmin, Martínez García Carmen, Martínez Trujillo Miguel

(#446) *Arbuscular mycorrhizal fungi spores in soils from a phytoremediation field trial.*
Ma W. K , Nogueira A. V, Farrell R. E., Germida J. J.

(#188) *Effects of EDTA application and arbuscular mycorrhiza on zinc uptake by maize (Zea mays L.) from soil experimentally contaminated with zinc.*
Li Xiaolin, Chen Baodong, Christie Peter

(#184) *Role of Arbuscular Mycorrhizae in the Phytoextraction of Strontium.*
Rosier Carl, Hamilton Melinda, Rillig Matthias

(#10) *Detecting the heavy metal tolerance level and the metal uptake profile of some ectomycorrhizal fungi.*
Ray Prasun, Tiwari Richa, Reddy U Gangi, Adholeya Alok

(#193) *Survival and growth of inoculated Interior Douglas-fir seedlings on reforestation sites and partially rehabilitated landings.*
Teste François, Schmidt Margaret, Berch Shannon, Bulmer Chuck

(#585) *Mycorrhizal inoculum potential of tailings and spoils from a Canadian oil sand industry.*
Bois Grégory, Piché Yves, Fung Martin, Khasa Damase

(#42) *Revegetation of acid sulfate soil : isolation of symbiotic microorganisms from pioneer plants.*
Nomachi Miya, Mizutani Eitaro, Maki Takanori, Ezawa Tatsuhiro

(#374) *Succession of ectomycorrhizal fungi in Scots pine afforestations on brown coal quarry heap.*
Kalucka Izabela, Mleczko Piotr

(#326) *Significance of arbuscular mycorrhizal fungi in the re-vegetation process in lahar area of Mt. Pinatubo, Philippines.*
Saito M. Masanori, Barraquio W. Wilfred

(#361) *Copper Adapted Suillus luteus, a Symbiotic Solution for Pines Colonising Cu Mine Spoil.*
Colpaert Jan V., Vrålstad Trude, Adriaensen Kristin, Vangronsveld Jaco

(#339) *AMF management in restoration of Mediterranean disturbed area.*
Correia Patricia, Carvalho Luis, Tavares Alice, Martins-Loução Amelia, Klironomos John

(#101) *The function of ectomycorrhizal fungi in initial soil development of post mining landscapes.*
Wöllecke Jens, Gebhardt Sascha, Silberstein Astrid, Hüttl Reinhard F.

(#646) *Determination of the regenerative natural capacity of inoculated Alnus acuminata H.B.K. subsp acuminata with native mycorrhizas in eroded soils of the Colombia Andes.*
Botero Catalina, De Garcia Maria C., Perez Alexander

(#17) Application of Mycorrhizal Grasses from Wetlands in Stabilisation of Zinc Wastes.
Ryszka Przemyslaw*, Turnau Katarzyna*

(#346) *Variation in plant responses to mycorrhizal colonization in Mediterranean prairie species.*
Estaún Victoria, Vicente Sònia, Calvet Cinta, Camprubí Amèlia

(#460) *The Effect of Two Microbial symbionts, Glomus intraradices and Frankia sp. on the growth of Alnus glutinosa in Extremely Alkaline Anthropogenic Sediments.*

Oliveira Rui Sérgio, Castro Paula, Dodd John, Vosátka Miroslav

(#50) *Soil phosphorus depletion capacity of mycorrhizal maize hybrids.*
Liu Aiguo, Hamel Chantal, Begna Suta, Ma Baoluo, Smith Donald

(#343) *Siderophore Release by Mycorrhizal Fungi and Phialocephala fortinii.*
Haselwandter Kurt

(#789) *Mycorrhizal associations as indicators of forest quality after land use practices.*
Onguene N. A.

(#138) *Revegetation of Heavy Metal Polluted European Sites using the Arbuscular Mycorrhizal*
Sieverding Ewald, Johne Siegfried, Stützer Meinolf , Watzke Roland , Sonnenberger Rolf

SALLE/ROOM (4 étage/floor)

*13H30-15H00 (Présentation affiche-Poster presentation)

ICOM- Génomique, protéomique et biologie moléculaire/Genomics, proteomics and molecular biology

Lundi 11 août 2003 et mardi 12 août 2003 & Monday August 11th and Tuesday August 12th 2003

(#189) *Defence gene expression in single mycorrhizal roots of soybean*
Dearnaley John, Learmonth Barbara

(#270) *Characterization of the Glomus intraradices genome by random genomic sequencing*
Ratnayaka R, Reihani S., Rehrer C., Jun J., Lammers PJ., Shachar-Hill Y.

(#534) *Responses of the non-host plant, A. thaliana, to arbuscular mycorrhizal fungi*
Schultze M., Yap H.L.

(#552) *Early recognition stages in mycorrhiza initiation in M. truncatula: from transcripts to proteins*
Weidmann Stéphanie, Amiour Narjis, van Tuinen Diederik, Lenogue Sébastien, Dumas-Gaudot Eliane, Gianinazzi Silvio, Gianinazzi-Pearson Vivienne

(#506) *Molecular changes in Pisum sativum L . roots during arbuscular mycorrhiza development and cadmium stress*
Rivera-Becerril Facundo, Gianinazzi Silvio, Gianinazzi-Pearson Vivienne

(#546) *Proteomics of the early stages of Medicago truncatula arbuscular mycorrhizal symbiosis*
Amiour Nardjis, Dumas-Gaudot Eliane, Gianinazzi Silvio

(#353) *Specific induction of coumestans in roots of Myc- mutants of Medicago truncatula.*
Morandi Dominique

(#239) *The Effect of Root Exudates on Spore Germination, Substrate Uptake, Metabolism and Gene Expression in the Arbuscular Mycorrhizal Fungus Glomus intraradices*
Bücking Heike, Abubaker Jehad, Govindarajulu Manjula, Pfeffer Phil, Lammers Peter, Shachar-Hill Yair

(#211) *Reaching out to the ends of AMF chromosomes.*
Hijri Mohamed, Sanders Ian R.

(#93) *Identification of a low-molecular-weight heat-shock protein that may be associated with ras-mediated signaling pathway controlling the establishment and maintenance of ectomycorrhizal symbiosis*
Hiremath Shiv, Lehtoma Kirsten, Podila Gopi

(#476) *Evidence for mycorrhizal host-races in two non-photosynthetic orchids*
Taylor Lee, Hodges Scott , Bruns Thomas

(#438) *Development and characterization of simple sequence repeat (SSR) markers to survey the introduction of a Laccaria bicolor strain*
Jany Jean-Luc, Bousquet Jean, Khasa Damase P.

(#161) *An expression cDNA library for suppression cloning in yeast mutants and est analysis from the symbiotic basidiomycete Hebeloma cylindrosporum*
Wipf Daniel, Benjdia Mariam, Rikirsch Enno, Steinmetz Dieter, Zimmermann Sabine, Frommer Wolf

(#459) *Analyses of transgene expression in the ectomycorrhizal fungus Pisolithus tinctorius*
Váldes Maria, Rodríguez-Tovar Aída, Ruiz-Medrano Roberto, Xoconostle-Cázares Beatriz,

(#114) *Proteome Screening of Laccaria bicolor for interacting partner(s) of Ras mediated signaling pathways in ectomycorrhizal symbiosis*
Podila Gopi, , Singh Archana, Hymes Matthew, Brand Joshua

(#542) *Root and ectomycorrhiza development and Scarecrow gene expression in Pinus sylvestris*
Raudaskoski Marjatta, Laajanen Kaisa, Vuorinen Irmeli

(#541) *Mutational analysis of Sbcdc42, a Suillus bovinus gene that encodes a putative GTP-binding protein*
Hanif Mubashir, Uuskallio Marjukka, Raudaskoski Marjatta

(#279) *Gene expression during establishment of mycorrhizal associations between Cistus hairy roots and Terfezia boudieri isolates*
Zaretsky Marianna, Sitrit Yaron, Mills David, Kagan-Zur Varda, Roth-Bejerano Nurit

(#233) *Sub-cellular proteomics of the arbuscular mycorrhizal symbiosis: how and why?*
Ginaninazzi, Silvio, Valot Benoit

(#330) *Genomic comparison of isolates of the ectomycorrhizal fungus Paxillus involutus using DNA microarray analysis*
Le Quéré Antoine, Hedh Jenny, Schudzendubel Andres, Johansson Tomas, Erland Susanne, Tunlid Anders

(#136) *Exploring the development of ectomycorrhiza between Paxillus involutus and birch (Betula pendula) using cDNA microarray analyses*
Le Quéré Antoine, Johansson Tomas, Wright Derek, Söderström Bengt, Tunlid Anders

(#734) *Tracking Changes in AM Fungi Grown in Pot Cultures Over Long Periods*
Miller Debra, Smith Andrew, Smith Sally

(#549) *Detection of DNA from Tuber melanosporum Vitt mycelium in soil samples*
Mártin Maria P, Suz Laura M, Colinas Carlos

(#405) *Preliminary protocols for the study of ectomycorrhizal gene expression in northern systems*
Schnabel William, Mutter Edda,

(#122) *Ultrastructural Analyses to Identify Common Marker Genes for Monitoring Ectomycorrhizal Symbiosis*
Hiremath Shiv, McQuattie Carolyn M., Podila Gopi

(#38) *Gene Expression During Pre-Mycorrhizal Confrontation of Oak Micro-Cuttings and Piloderma croceum*
Buscot François, KrügerAndrea, Peskan Tania, Frettinger Patrick, Herrmann Sylvie, Oelmüller Ralf

(#141) *Approaches for breeding better symbioses in white clover*
Eason William, Hooker John, Skøt Leif, Webb Judith, Rhys Kelly

SALLE/ROOM (1 étage/floor)

*13H30-15H00 (PRÉSENTATION AFFICHE-POSTER PRESENTATION)
CSSS-Résidus organiques et biosolides/Organic residues and bio-solids
**Lundi 11 août 2003 et mardi 12 août 2003 / Monday August 11th and Tuesday August 12th*

(#518) *Effect of Shac natural feed additive on the characteristics of cattle feedlot manure*
Hao Xiying, Travis Greg, Chang Chi, McAllister Tim, Wang Yuxi

(#475) *Carbon, ash and organic matter relationships for feedlot manure compost*
Larney Francis, Ellert Benjamin, Olson Andrew

(#46) *Influence of organic amendment on soil organic matter and temporal variability of indicators of soil physical and biological quality in a potato rotation*
Carter Martin, MacLeod John, Sanderson Brian

(#634) *Development of Compost as an Inoculant Carrier for Rhizobia*
Farrell Richard, Wall Cindy, Knight Diane

(#523) *Nutrient Efficiencies and Yield Response to Rotations and Fertility Treatments*
Parsons Kimberly, Jeliazkov Valtcho, Caldwell Claude, MacLeod John

(#607) *Field evaluation of wastewater from anaerobically digested organic waste as a fertility source for selected turfgrass species*
Michitsch Robert C., Chong Calvin, Voroney R. Paul, Holbein Bruce

(#471) *Compost applications increase water-stable aggregates in conventional and no-tillage systems*.
Whalen Joann, Hu Quancai, Liu Aiguo

(#591) *Effects of post-emergence papermill sludge and liming by-product applications on soil properties and crop yields*.
Boucher V., Ziadi N., Simard R. R.

(#721) *Soil And Plant Response To Organic Amendments On Three Strawberry Cultivars.*
Ganapathi Shanmugam Shankar, Warman P.R., Hoyle Jeff, Percival David

SALLE/ROOM (1 étage/floor)

*13H30-15H00 (PRÉSENTATION AFFICHE-POSTER PRESENTATION)
CSSS-Conservation et gestion des sols/Soil Conservation and Management
**Lundi 11 août 2003 et mardi 12 août 2003 / Monday August 11th and Tuesday August 12th*

(#669*) Evaluating Soil Management Practices in Agroecosystems of Malawi: Taking the Biophysical Heterogeneity into Account*
Pelletier Bernard, Fyles James W.

(#516) Effect of tillage and crop sequence on sugar beet, soil conservation and weeds
Moyer Jim, Huang Henry, Blackshaw Robert, Nitschelm Jennifer, Regitnig Peter

(#369) *Effects of two cultural methods of insecticide application on soil Collembola and Mite populations in commercial potato fields on Prince Edward Island*
Noronha Christine, Carter Martin

(#630) *Effects of Landscape Variability on the Rate and Maximum 2,4,-D Degradation*
Nahar Nurun, Shymko Janna, Farenhorst Annemieke

(#671) *Fate of 2,4-D as affected by landscape position, and soil depth*.
Gaultier Jeanette, Farenhorst Annemieke

(#696*) 2,4-D degradation as a result of incubation length of amended soils*
Reimer Marguerite, Farenhorst Annemieke

(#743*) Relation between sorption and biodegradation of 2,4-D in soil, as influenced by soil texture and soil organic matter characteristics*.
Picton Paula, Farenhorst Annemieke

SALLE/ROOM (1 étage/floor)

*13H30-15H00 (PRÉSENTATION AFFICHE-POSTER PRESENTATION)

CSSS-Gaz à effet de serre et carbone du sol/Greenhouse Gases and Soil Carbon

**Lundi 11 août 2003 et mardi 12 août 2003 / Monday August 11th and Tuesday August 12th*

(#370) *Soil Organic Carbon and Management: Improving on the default IPCC coefficients for Canada*
VandenBygaart Bert, Gregorich Ed, Angers Denis

(#387) *Application of landscape element analysis to inventories of soil organic carbon.*
Moulin Alan

(#92) *Soil Aggregation and the Long-Term Stabilization of Organic C in French Silty Soil*
Plante Alain, Balabane May

(#247) *Forages place C deep in the soil profile: Analysis of a long-term study in Uruguay*
Gentile Roberta, Martino Daniel, Entz Martin

(#490*) Using Digital Image Analysis to Locate and Describe Organic Matter in Soil Thin Sections*.
Witt Waldemar, Heck Richard J, Voroney R.Paul

(#551*) Tillage and substrate effects on the production of biogenic gases*
Gregorich Edward, Rochette Philippe, Hopkins David

(#636) *Quantifying N_2O Fluxes Associated with Agricultural Practices in Non-Level Prairie Landscapes*
Farrell Richard, Knight Daine, Si Bing, Pennock Daniel

(#714*) Influence of Tillage and Crop Residue Management on Crop Yield, Greenhouse Gas Emissions and Soil Quality*
Malhi Sukhdev, Lemke Reynald, Farrell Richard, Leach Darwin

(#640*) Factors Responsible for Vigorous Emissions of Nitrous Oxide from Thawing Soil*
Tenuta Mario

(#616) *Tile Drainage Water contribution to Nitrous Oxide loss from agricultural fields*.
Thangaraj Balakumar, Burton David, Macleod John, Madani Ali

SALLE/ROOM (1 étage/floor)

*13H30-15H00 (PRÉSENTATION AFFICHE-POSTER PRESENTATION)
CSSS-Sols forestiers/Forest Soils
**Lundi 11 août 2003 et mardi 12 août 2003 / Monday August 11th and Tuesday August 12th*

(#512) *Determination of an Observable Humus Form Classification Scheme in a Northern Quebec Boreal Black Spruce-Feathermoss Community*
Bailey Stephanie E., Fyles James W.

(#513) *Carbon and Nitrogen Dynamics Along Post-wildfire and Post-harvest Chronosequences for Jack Pine-dominated Sites in Northwestern Ontario*
Edgington Laura, Morris Dave, Duckert Dan

(#717) *Establishment of Hybrid Poplar Plantations in Saskatchewan, Canada: An Agroforestry Initiative*
Knight J. Diane, Block RMA, Van Rees KCJ, Nesdoly R.G., Schroener W.R., Harrison G.

(#132) *Effect of organic matter on growth of tree seedlings grown in reclaimed oilsand tailings*
Li Xiaomei, Feng Yongsheng, Fung Martin

(#88) *Soil properties and tree growth on rehabilitated landings in the Peace River region*
Krzic Maja, Bulmer Chuck

(#203) *Quality of Seeds and Seed bank of the Atlas Cypress (Cupressus atlantica G.) in the area of its natural Distribution in Morocco and the Role of soil components in its Natural regeneration*.
Ouahmane Lahcen, Boumezzough Ali, Hafidi Mohamed

(#504*) Use of stone-soil mix ('structural soil') for improved growth of urban sidewalk trees: a trial in southern Quebec*
Burgess Magdalena, Jutras Pierre, Mehuys Guy, Prasher Shiv, Hamel Chantal

(#395) *Assessment of poplar cell suspensions to study benzene degradation*
Wismer M.E., Knight J.D., Germida J.J.

SALLE/ROOM (1 étage/floor)

*13H30-15H00 (PRÉSENTATION AFFICHE-POSTER PRESENTATION)
CSSS-Qualité de l'eau, physique des sols et pédologie/Water Quality, Soil Physics, Pedology
****Lundi 11 août 2003 et mardi 12 août 2003 & Monday August 11th and Tuesday August 12th 2003***

(#150) *Sampling Methods for Measuring Nutrient and Bacteria Concentrations in Subsurface Water*
Crittenden Steve, Lauzon John, Parkin Gary, Fallow Dave

(#765) *Indicators of Phosphorus Non-Point Source Pollution in a Large Watershed*
Deslandes Julie, Michaud Aubert, Bonn Ferdinand

(#600) *Nitrate Leaching in a Clay Loam Soil after 44 Years of Consistent Soil and Crop Management*
Dadfar H., Groenevelt P.H., Drury C. F., Reynolds W. D., Tan C. S.

(#615) *An evaluation of the use of electromagnetic induction to delineate leaching patterns in tile drained fields.*
Pumphrey Kerry-Anne, Heck Richard, Parkin Gary

(#391) *Modeling Soil Water Budgets with SHAW for Seven Regions of Ontario*
Fallow David, Parkin Gary, Wagner-Riddle Claudia, Brown Murray

(#656) *Shaft-soil interaction on penetrometer probes as a measure of soil-cone friction*
Topp Clarke, Young Joe, Adams Bankole

(#628) *Discrimination of Soil Solid Phases using Axial X-Ray Tomography*
Heck Richard J., van Straaten Peter

(#659) *Application of micromorphology and image analysis to study soil genesis in northern Iran*
Sarmadian Fereydoon, Heck Richard J.

SALLE/ROOM (1 étage/floor)

*13H30-15H00 (PRÉSENTATION AFFICHE-POSTER PRESENTATION)
CSSS-Fertilité des sols et gestion des éléments nutritifs/Soil Fertility and Nutrient Management
**Lundi 11 août 2003 et mardi 12 août 2003 / Monday August 11th and Tuesday August 12th*

(#337) *The current status of the North American Proficiency Testing Program for soil, plant, and water analysis*
Kalra Yash, Crumbaugh Joel, Miller Robert, Kotuby-Amacher Janice

(#367) *The Effects of Storage Methods on Inorganic Nitrogen in Southwestern Ontario Soils.*
Oloya Tom, Drury Craig, Reid Keith

(#383) *Strategies of Copper Fertilization of Wheat in Manitoba - Foliar Applications*
Pomarenski Quinn, Goh Tee Boon, Karamanos Rigas

(#670) *Effect of land application of wood ash on total biomass and grain yield of barley and canola*
Patterson Shane, Acharya Surya, Thomas James, Bertschi Allan, Rothwell Robert

(#548) *Magnesium By-Products as a Substitute for Dolomite in Fertilizing Forage Crops*
Parent Gaétan, Bélanger Gilles, Simard Régis R.

(#462) *Spatial Variability of Soil Test Phosphorus, Potassium, and pH in Ontario Soils*
Lauzon John, O'Halloran Ivan, Fallow David¸ von Bertoldi Peter

(#491) *Soil-Specific Management of Agricultural Inputs using Soil Electrical Conductivity.*
Leclerc Marie-Line, Nolin Michel

(#238) *Delineation of N-management Units Using Aerial Images of Bare Soil*
Gregory Sharon, Lauzon John, O'Halloran Ivan, von Bertoldi Peter

(#597) *Residual soil nitrate as affected by N rates and soil classes in corn production*
Ziadi Noura, Nolin Michel C, Cambouris Athyna N, Simard Régis R

(#650) *Field-Scale Methods for Identifying Management Units on the Basis of Residual Nitrogen and Soil Structure*
Stoklas Ulrica, Gregorich Edward, Lapen David, McLaughlin Neil

(#681) *Soil and corn response to compacted surface soils under variable N fertilizer application*
Lapen David, McLaughlin Neil, Gregorich Edward, Topp Clarke, Wang Xuelian, Ma Baoluo

(#590) *Early Prediction of Nitrogen Requirement for Corn in Eastern Ontario*
Subedi Kalidas, Ma Bao-Luo

(#106) *Improving N efficiency in wild lowbush blueberry*
Lafond Jean

(#465) *Effects of Nitrogen Fertilization on Yields and Effective Components of Chrysanthemum boreale M. (Compositae)*
Lee Kyung Dong, Yang Min Suk, Kim Pil Joo, Smith Donald L.

(#468) *Effects of Lime Application on Terpene Contents and Yields of Chrysanthmum coronarium L. (Compositae)*
Lee Kyung Dong, Yang Min Suk, Kim Pil Joo, Smith Donald L.

(#244) *Effects of Weed Competition on N Fixation by Field Pea and Soil N Availability to the Sequent Crop*
Clayton George, Soon Yoong, Harker Neil

(#558) Residual Value of Various Sulphur Sources
Karamanos Rigas, Poisson Donald

SALLE/ROOM (1 étage/floor)

*13H30-15H00 (PRÉSENTATION AFFICHE-POSTER PRESENTATION)
CSA-Cultures annuelles/Annual Crops
**Lundi 11 août 2003 et mardi 12 août 2003 / Monday August 11th and Tuesday August 12th*

(#82) *Use of NBPT Urease Inhibitor to Increase Safety of Seed-Placed Urea*
Karamanos Rigas, Flore Norm, Harapiak John, Stonehouse Tony

(#333) *Canola Response to Nitrogen and Sulfur in Ontario*
Omielan Joe, Hume Dave, Chu Godfrey, Rowsell John

(#78) *Sclerotinia stem rot of canola in Québec : cultivar resistance and yield losses*
Pageau Denis, Lajeunesse Julie, Rioux Sylvie

(#79) *Productivity of new crops in Quebec*
Lajeunesse Julie, Pageau Denis

(#372) *Effects of cultivars and fertilization on soybean isoflavone content*
Seguin P., Zheng W, Souleimanov A., Smith D.L., Tawaha A.M.

(#162) *Effects of Chemical Desiccation Procedures on Faba Bean Seed Size and Yield*
Strydhorst Sheryl, King Jane, Lopetinsky Ken, Spaner Dean

(#449) *The association of culm anatomy with lodging resistance in spring wheat cultivars*
Kelbert A. J., Spaner D., Briggs K. G.

(#526) *Selection of test sites for field pea variety trials in Alberta*
Yang Rong-Cai, Blade Stanford, Ye Terrance, Bandara Manjula

SALLE/ROOM (1 étage/floor)

*13H30-15H00 (PRÉSENTATION AFFICHE-POSTER PRESENTATION)
CSA-Physiologie des cultures/Crop physiology
**Lundi 11 août 2003 et mardi 12 août 2003 / Monday August 11th and Tuesday August 12th*

(#625) *Nod Bj-V (C18:1, MeFuc) Production by Bradyrhizobium japonicum (USDA110, 532C) at Suboptimal Growth Temperature*
Duzan Haifa, Souleimanov Alfred, Zhou Xiaomin, Smith Donald

(#688) *Crops and agricultural practices for biomass/bio-fuel production and greenhouse gas mitigation in Eastern Canada*
Almaraz Juan, Zhou Xiaomin, Smith Donald

(#691) *Adaptation of eastern Canadian crops and cropping systems to climate change*
Almaraz Juan, Zhou Xiaomin, Smith Donald

(#737) *Lipo-chitooligosaccharide: handling and storage*
Supanjani Supanjani, Souleimanov Alfred, Smith Donald L.

(#738) *Enhancement of Calcium Uptake into Soybean by Nod Factor*
Supanjani Supanjani, Habib Ahsan, Donnelly Danielle, Smith Donald. L.

(#569) *Calcium Uptake into Potato Plants and Tubers*
Habib Ahsan, Donnelly Danielle J.

(#570) *Identification of Ca-Packing Potato Genotypes Through In Vitro Screening and Tracer Technique*
Habib Ahsan, Donnelly Danielle J.

(#595) *UV light and Vitamin D-Regulated 45Ca2+ Uptake into Micropropagated Potato Plantlets*
Donnelly Danielle J., Habib Ahsan

(#627) *Effect of Medium Nitrogen Level on Potato Microtuber Protein Concentrations*
Ortiz-Medina Estela, Donnelly Danielle J.

(#613) *Effect of Varieties and Seeding rates on Internal Green Shoulders(GS) in Carrots (Daucus carota Var. sativus)*
Palanisamy Ravishankar, Lada Rajasekaran, Caldwell Claude, Asiedu Sam, Stiles Azure

SALLE/ROOM (1 étage/floor)

*13H30-15H00 (PRÉSENTATION AFFICHE-POSTER PRESENTATION)
CSA-Cultures fourragères/Forage Crops
**Lundi 11 août 2003 et mardi 12 août 2003 / Monday August 11th and Tuesday August 12th*

(#230) *Kura clover (trifolium ambiguum) as a living-mulch understory crop in wheat production*
Entz Martin, Bamford Keith

(#690) *Modifying the dietary cation-anion difference of timothy using fertilization*

Pelletier Sophie, Bélanger Gilles, Tremblay Gaetan F., Michaud Réal, Brégard Annie, Allard Guy

(#753) *Surface-Banding with Assisted Infiltration- New Low Disturbance Technique for Applying Slurry on Land*
Bittman Shabtai, Van Vliet Laurens, Kowalenko Grant, McGinn Sean

(#740) *Farmer-directed on-farm experimentation examining the impact of companion planting barley and oats on timothy-alfalfa forage establishment in central Newfoundland*
Spaner Dean, Todd Alexander

(#533) *The effects of plant density on yield and maturity of silage corn in central Alberta*
Stanton Dan, Spaner D., Grombacher A.W., Pinnisch R.

15H00-15H15 PAUSE CAFÉ/COFFEE BREAK (1 & 4 étage/floor)

SALLE/ROOM 1 (4 étage/floor)

15H15-18H00 SYMPOSIUM 3
ICOM- De la génomique à la protéomique/From genomics to proteomics
ORGANISATEUR ET MODÉRATEUR / ORGANIZER AND CHAIR : ÉLIANE DUMAS-GAUDOT

15H15 – 16H00 Conférencière majeur/Major speaker: V. Gianinazzi-Pearson
(#498) Functionnal genomics of arbuscular mycorrhiza: decoding the symbiotic cell programme.

16H00 – 16H30 Présentation/Lecture 1: Genre Andréa, Novero Mara, Faccio Antonella, Lanfranco Luisa, Bonfante Paola
(#198) Genetically defined checkpoints along the colonization pathway of *Lotus japonicus* roots by arbuscular mycorrhizal fungus.

16h30 – 17H00 Présentation/Lecture 2: **Podila Gopi K.**, Brand Joshua , Hiremath Shiv, Hymes Matthew, Singh Archana
(#70) Functionnal genomics of early interaction events in ectomycorrhizal symbiosis.

17h00 – 17H30 Présentation/Lecture 3: Combier Jean-Philippe, Melayah Delphine, Raffier Colette, Rasooli Pooneh, Debaud Jean-Claude, Gay Gilles, **Marmeisse Roland**
(#302) Insertional mutagenesis to identify fungal genes necessary for ectomycorrhizal symbiosis establishment.

17H30 – 18H00 Présentation/Lecture 4: **Nardjis Amiour**, Bestel-Corre Gwenaëlle, Dieu Marc, Raes Martine, St-Arnaud Marc, Dumas-Gaudot Eliane
(#545) Proteome analysis of plant-microbe symbioses: current achievements and future prospects establishment.

SALLE/ROOM 2 (4 étage/floor)

15H15-18H00 SYMPOSIUM 4
ICOM-Physiologie comparée des organismes rhizocoles/Comparative physiology of root-inhabiting orgarnisms
ORGANISATEUR ET MODÉRATEUR / ORGANIZER AND CHAIR : HORST VIERHEILIG

15H15 – 16H00 Conférencier majeur/Major speaker: **Horst Vierhelig**
(#715) The regulation of mycorrhization: a new aspect ?

16H00 – 16h30 Présentation/Lecture 1: **Hirsch, Ann M**. ,Fujishige Nancy, Lum Michelle, Jankaew Katherine,Butcher Christopher, Kapadia Neel
(#274) Studies on root colonization and biofilm formation by rhizobia.

16H30 – 17H00 Présentation/Lecture 2**: Florian Grundler**
(#783) Root interactions with nematodes: signals and responses.

17H00 – 17H30 Présentation/Lecture 3: **Cornelissen Ben J.C.,** Houterman Petra M, Rep Martijn, Takken Frank, Tameling Wladimir IL,Vossen Jack H,Dekker Henk, Duyvesteijn Roselinde
(#318) Responses of tomato to infection by the root-invading fungal pathogen *Fusarium oxysporum* .

SALLE/ROOM 3 (1 étage/floor)

15H15-18h00 (PRÉSENTATION ORALE-ORAL PRESENTATION)
ICOM-Agronomie et grandes cultures/Agronomy and crop production
MODÉRATEUR / CHAIR : CYNTHIA GRANT

15H15 – 15H30 (#752) *Effect of Management Practices on Mycorrhizal Colonization, Early P nutrition and Yield in Corn.*
Bittman Shabtai, Kowalenko Grant, Hunt Derek, Wu Xiao, Forge T.

15H30 – 15H45 (#560) *Effect of Liquid Manure and Benlate on Soybeans and Spring Wheat Yields, Nutrient Uptake, and Mycorrhizae Associations.*
Zheljazkov Valtcho, Butler Stephanie, Olson Randy

15h45 – 16H00 (#770) *Phosphorus Fertilization Affects Dryland Alfalfa Forage Yield and Mycorrhizae in Southwestern Saskatchewan.*
Jefferson Paul, Selles Fernando Clapperton Jill, Hanson Keith

16H00 – 16H15 (#742) *Monitoring the impacts of introduced biocontrol agents on mycorrhizal fungi populations in soybean and potato crops using PCR-SSCP analysis.*
Hogue Richard, Plante Edith, Larouche Isabelle, Jeannotte Richard, Daigle Nathalie

16H15 – 16H30 (#722) *Intraspecies Receptivities of Potato Cultivars to Arbuscular Mycorrhizal Colonization.*
Traquair Jame, Singh Betty

16H30 – 16H45 (#109) *Mexican endogenous arbuscular mycorrhizal fungi increase plant quality of Citrus volkameriana Tan & Pasq in comparison with two fertilizer formulations (NPK).*
Ferrera-Cerrato Ronald, Alarcon Alejandro, Manjarrez Maria J.

16H45 – 17H00 (#220) *Management Strategies for Capturing the Benefits of Mycorrhizas in the Production of Field-grown Vegetables.*
Larsen John, Sørensen Jørn, Jakobsen Iver

17H00 – 17H15 (#444) *Are phosphorus fertilizers necessary for asparagus establishment?*
Sommerville David, Joann K. Whalen, Hamel Chantal

17H15 – 17H30 (#232) *Function of arbuscular mycorrhiza during grassland regeneration*
Blanke Verena, Renker Carsten, Füllner Kerstin, Kuhn Arnd J., Buscot François

17H30 – 17H45 (#123) *Phosphorus Availability and Intraspecific Density Conditions That Maximize Arbuscular Mycorrhiza Benefit to Facultative Mycotrophs.*
Schroeder Michelle S., Janos David P.

SALLE/ROOM 7A&7B (3 étage/floor)

15H15-17H30 (PRÉSENTATION ORALE-ORAL PRESENTATION)
ICOM-Morphologie et réseaux mycéliens/Mychorrhizal morphology and networks
MODÉRATEUR / CHAIR : PAUL WIDDEN

15H15 – 15H30 (#159) *Quantification of ectomycorrhizal mycelium in soil by Real-Time PCR.*
Landeweert Renske, Veenman Christiaan, Kuyper Thom, Fritze Hannu, Wernars Karel, Smit Eric

15H30 – 15H45 (#620) Influence of the growth medium on hyphal morphology of Tuber spp.
Iotti Mirco, Zambonelli Alessandra

15H45 – 16H00 (#389) *Are arbuscules always characteristic structures of arbuscular mycorrhiza?*
Coughlan Andrew P., Piché Yves

16H00 – 16H15 (#511) *Host Microtubules Present in The Hartig Net Region of Both Ecto- and Ectendomycorrhizas.*
Peterson R. Larry, Kuga Yukari, Purich Melissa

16H15 – 16H30 (#686) *Do Common Mycorrhizal Networks Limit Plant Competition and Species Exclusion in Temperate Forests?*
Booth Michael

16H30 – 16H45 (#48) *Mobilization of nutrients from organic natural substrates to plants via the external ectomycorrhizal mycelium, an overview.*
Pérez-Moreno Jesús, Read David J

16H45 – 17H00 (#778) *Exploring the Bidirectional Transfer of Carbon and Nitrogen Between Fungus and Host in the Arbuscular Mycorrhizal Symbiosis*
Pfeffer P. E., Douds Jr. D. , Schwartz D., Govinidarajulu M, Bücking H., Shachar-Hill Y.

17H00 – 17H15 (#676) *Transfer Rates of 15Nitrate and Analogs of Phosphorous, Potassium, and Calcium through a Common Mycorrhizal Grass Network.*
Meding Stephen, Zasoski Robert, Beaudette Dylan

17H15 – 17H30 (#345) *Mycorrhiza-bacteria interactions and functioning in boreal forest soils.*
Sen Robin

SALLE/ROOM A&B (1 étage/floor)

15H15-18h00 (PRÉSENTATION ORALE-ORAL PRESENTATION)
CSSS-Chimie des sols/Soil Chemistry
MODÉRATEUR/CHAIR : C. VAN KESSEL

15H15 – 15H30 (#317) *New analytical methods - ESCA for determination of phosphorus in soil.*
Hylander Lars, Gelius Ulrik

15H30 – 15H45 (#668) *Soil Solution as a Tool for Environmental Monitoring Program.*
Anguelov Gueorgui, Bailey Nathaniel, Anguelova Ivanka

15H45 – 16H00 (#565) *Organic Carbon in Wetland Soils: Insights on Structure and Transformation Processes using K-edge XANES and NMR Spectroscopy.*
Jokic A., Cutler J., Ponomarenko E., van der Kamp G., Anderson D.

16H00 – 16H15 (#705) *Root Exudation Patterns of Plants Grown in Hydrocarbon Contaminated and Non-Contaminated Soils.*
Gillespie A.W., Van Rees K.C.J., Farrell R.E.

16H15 – 16H30 (#695) *2,4-D degradation in amended soils.*
Reimer Marguerite, Farenhorst Annemieke

16H30 – 16H45 (#672) *Variability of 2,4-D sorption in agricultural fields as affected by ecoregion, and landscape position.*
Gaultier Jeanette, Farenhorst Annemieke, Cannon Karen

16H45 – 17H00 (#666) *Impact of tillage erosion on the spatial and temporal variability of herbicide sorption by soil.*
Farenhorst Annemieke, Lobb David

17H00 – 17H15 (#736) *Pedological Studies in the Izeh Area of southern Iran.0*
Landi Ahmad

17H15 – 17H30 (#84) *Soil or Nonsoil: Snapshots of Soil Formation in the Cold and Dry Environment of the Qinghai Plateau (China).*
Arocena Joselito, Hall Kevin, Zhu Liping

SALLE/ROOM C & D (1 étage/floor)

15H15-18h00 (PRÉSENTATION ORALE-ORAL PRESENTATION)
CSSS-Sols forestiers et de tourbières/Forest and Peat Soils
MODÉRATEUR/CHAIR : W. HENDERSHOT

15H15 – 15H30 (#703) *Alternative frameworks for the spatial analysis of soil-plant relationships: a case study from a forested catchment of the Lower Laurentians.*
Larocque Guillaume, Fyles James

15H30 – 15H45 (#172) *Fire exclusion, community structure and N mineralization in low elevation forests of western Montana.*
MacKenzie M. Derek, DeLuca Thomas H., Sala Anna

15H45 – 16H00 (#167) *Forest Floor Organic Matter Composition in the Boreal Mixedwood Forest of Northwestern Alberta.*
Hannam Kirsten, Quideau Sylvie, Kishchuk Barbara, Oh Se-Woung, Wasylishen Rod

16H00 – 16H15 (#174) *Factors controlling gross and net transformation rates of forest floor N and plant uptake in clearcut and old-growth coniferous ecosystems of British Columbia.*
Bradley Robert, Grenon Frank, Jones Melanie, Prescott Cindy, Titus Brian

16H15 – 16H30 (#87) *Patterns of C, N and P loss from decomposing foliar litter in Canadian forests.*
Moore Tim, Trofymow Tony, Prescott Cindy, Fyles Jim, Titus Brian

16H30 – 16H45 (#470) IMPACTS OF TIMBER HARVESTING ON *SOIL MICROBIAL COMMUNITIES TESTED BY A NEW DISTRIBUTION-FREE STATISTICAL TEST*
Mariani Lucero, Chang Scott, Kabzems Richard

16H45 – 17H00 (#69) *The effect of drainage, harvesting and restoration on the fluxes of CO2 and CH4 from peatland soils, eastern Canada.*

Moore Tim, Glatzel Stephan, Basiliko Nathan, Marinier Michele

17H00 – 17H15 (#432) *Peat chemical and biological properties and CO-2 and CH-4 dynamics across pristine, harvested and restored Canadian peatlands.*
Basiliko Nathan, Moore Tim, Blodau Christian, Roehm Charlotte

17H15 – 17H30 (#631) *Nitrogen and Phosphorus Transport in a Snow-Dominated Mountain Stream.*
Langlois Jacques, Mehuys Guy, Johnson Dale

17H30 – 17H45 (#461) *Metal leaching behavior under NaCl and tap water from three artificial soil substrates of urban trees.*
Wang Shuhong, Mehuys Guy R., Hendershot William H.

17H45 – 18H00 (#252) *Carbon sequestration patterns in the replanted areas of the Sudbury barrens*
Sherman Geoff, Beckett Peter

VINS DU MONDE/WINES OF THE WORLD
5 étage/floor
18H30-20h00

Mardi le 12 août 2003/Tuesday August 12th 2003

07H00-17H00 Bureau d'inscription/Registration desk

SALLE/ROOM 1 (4 étage/floor)

08H30-09H15
Plénière/Plenary
Prof. Jan Sapp
York University, Canada

(#777) Evolutionary Theory: Symbiosis, Mutualism and Mycorrhizae

Conférencier majeur, symposium Que sont les mycorhizes ?
Major speaker , symposium What are mycorrhizas ?

SALLE/ROOM 1 (4 étage/floor)

09H30-11H00 SYMPOSIUM 5 (Suite - Continue)
ICOM - Que sont les mycorhizes ? / What are mycorrhizas?
ORGANISATEUR ET MODÉRATEUR / ORGANIZER AND CHAIR : KEITH EGGER

9H15 – 9H45 Présentation/Lecture 1: **Massicotte Hugues** , Peterson Larry
(#385) Exploring structural definitions of mycorhhizas.

9H45 – 10H00 Pause café / Coffee Break

10H00 – 10H30 Présentation/Lecture 2: **Jones Melanie**, Smith Sally
(#467) Exploring functional definitions of mycorrhizas : are they always mutualisms ?

10H30 – 11H00 Présentation/Lecture 3: **Egger Keith** Hibbett David S.
(#678) Exploring mycorrhiza phylogeny : mutualism or reciprocal parasitism ?

SALLE/ROOM 2 (4 étage/floor)

08H30-11H00 SYMPOSIUM 6
ICOM/CSSS-Mycorrhizes et qualité des sols /Mycorrhizae and soil quality
ORGANISATEURS ET MODÉRATEURS / ORGANIZERS AND CHAIRS :
MURRAY MILLER, DENIS ANGERS, CHANTAL HAMEL

Tenu conjointement avec la Société canadienne de science du sol
Held jointly with the Canadian Society of Soil Science

8H30 – 9H15 Conférencier majeur/ Major speaker: **Rillig Matthias**
(#176) Arbuscular mycorrhizae, glomalin and soil quality.

9H15 – 9H 45 Présentation/Lecture 1: **Young Iain,** Feeney D, Sturrock C, Ritz K, Crawford J
(#43) Soil biota-structure interactions

9H45 – 10H00 Pause café / Coffee Break

10H00 – 10H30 Présentation/Lecture 2: **Augé Robert M**. Moore Jennifer L., Stodola Ann J.W., Stutz

Jean C., Sylvia David M., Park Soon, Cho Keunho, Saxton Arnold M.
(#706) Arbuscular mycorrhizae and soil/plant water relations.

10H30 – 11H00 Présentation/Lecture 3: **Hamel Chantal**
(#469) Impact of Arbuscular mycorrhizal fungi on soil microorganisms, N and P cycling and crop growth.

SALLE/ROOM 3 (1 étage/floor)

08H30-11H00 (Présentation orale-Oral presentation)

ICOM-Biodiversité/Biodiversity

MODÉRATEUR / CHAIR : ANDREW COUGHLAN

9H15- 9H30 (#53) *Conservation of mycorrhizal fungi: Do we need to be concerned, and if so, how do we provide protection?*
Molina Randy, Smith Jane, Castellano Michael

9H30 – 9H45 (#209) *Ectomycorrhizal fungi diversity in an old-growth sclerophyllous evergreen forest dominated by Quercus ilex (holm oak) : above- and below-ground patterns and impact of small-scale canopy gaps on species diversity*
Richard Franck, Moreau Pierre Arthur, Selosse Marc André, Gardes Monique

10H00 – 10H15 (#131) *Investigation of the diversity of fungal endophytes in root systems of Epacris pulchella (Ericaceae) using traditional culturing techniques and molecular analysis based on total endophyte community DNA*
Bougoure D.S., Ashford A.E.

10H15 – 10H30 (#520) *Diversity of Glomalean Fungi in Selected Brazilian Ecosystems*
Sturmer Sidney L., Siqueira Jose O.

10H30 – 10H45 (#709) Arbuscular Mycorrhizae From Savannah Sites In Namibia
Uhlmann Elisabeth, Görke Claudia, Oberwinkler Franz

10H45 – 11H00 Pause café / Coffee Break

11H00 – 11H15 (#40) *Assembly Rules in Communities of Arbuscular Mycorrhizal Fungi in a Phosphate Polluted Grassland*
Renker Carsten, BlankeVerena, Kaldorf Michael, Buscot François

11H15 – 11H30 (#588) *Diversity of arbuscular mycorrhizal fungi associated with two different plants on heavy metal polluted soils*
Leyval Corinne, Tonin Carole, Vandenkoornhuyse Philippe, Joner Erik, Beguiristain Thierry

11h30 – 11H45 (#120) *A field population of the AMF Glomus intraradices is locally diverse and spatially structured*
Koch Alexander, Kuhn Gerrit, Fontanillas Pierre,Fumagalli Luca, Goudet Jérôme, Sanders Ian

SALLE/ROOM 7A&7B (3 étage/floor)

08H30-12H00 (Présentation orale-Oral presentation)

ICOM- Génomique, protéomique et biologie moléculaire/Genomics, proteomics and molecular biology

MODÉRATEUR / CHAIR : SUHA JABAJI-HARE

9H15 – 9H30 (#651) *Modeling symbiosome-associated protein complexes in the arbuscular mycorrhizal cell*
Lerner Jeffrey, Wick Robert, Ciufo Stacy

9H30 – 9H45 (#310) *Characterisation of retrotransposable-like elements in the genome of Gigaspora margarita*
Golotte Armelle, L'Haridon Floriane, Chatagnier Odile, Arnould Christine, van Tuinen Diederik, Gianinazzi-Pearson Vivienne

10H00 – 10H15 (#112) *The AMF G. intraradices is haploid and has a small genome size in the lower limit of eukaryotes* **Hijri Mohamed**, Corradi Nicolas, Sanders Ian R.

(#103) *AM-specific gene regulations in the model plant Medicago truncatula*
Krajinski Franziska, Doll Jasmin, Frenzel Andre

10H15 – 10H30 (#356) *Macroarray profiling analysis of Medicago truncatula/Glomus versiforme roots reveals novel genes regulated during the arbuscular mycorrhizal symbiosis*
Liu Jinyuan, Blaylock Laura, Endre Gabriella, Cho Jennifer, Town Christopher, VandenBosch Kathryn,

10H30 – 10H45 Pause café / Coffee Break

10H45 – 11H00 (#321) *The Paxillus involutus / Betula pendula symbiosis: Gene expression in ectomycorrhizal root tissue*
Söderström Bengt, Johansson Tomas, Le Quéré Antoine, Wright Derek, Ahrén Dag, Tunlid Anders

11H00 – 11H15 (#761) *Function of the extraradical versus root-associated mycelium in Paxillus involutus/Betula pendula association: identification of differentially expressed genes using High-density cDNA macroarray.*
Morel Mélanie, Duplessis Sébastien, Chalot Michel, Brun Annick

11H15 – 11H30 (#301) *The indolic alkaloid hypaphorine from Pisolithus microcarpus alters gene expression in poplar roots*
Jambois Anne, Kohler Annegret, Wang Yongjin, Martin Francis, Lapeyrie Frederic

11H30 – 11H45 (#436) *Development of AMF strains specific primers for detection in field-grown colonized roots*.
Séguin Sylvie, Désaulniers Nicole, Dalpé Yolande, Lévesque André

11H45 – 12H00 (#145) *Inter- and intra-species 18S rDNA sequence heterogeneity as an accurate and sensitive marker to assess species diversity of arbuscular mycorrhizal fungi of the genus Gigaspora*
de Souza Francisco A., Leeflang Paula, Kowalchuk George A., Smit Eric

12H00 – 12H15 (#352) *Community structure and genetic variation within individuals of arbuscular mycorrhizal fungi in undisturbed vegetation based on analyses of LSU rDNA*
Rosendahl Soren

12h15 – 12H30 (#286) *The occurrence and distribution of mycorrhizas in the ferns - a test of the 'Pirozynski' hypothesis*
Chinnery Louis

12H30 – 12H45 (#653) *Gene expression pattern related to host preferences in the ectomycorrhizal interaction between birch (Betula pendula) and different strains of Paxillus involutus*
Schützendübel Andres, Le Quéré Antoine, Johannson Tomas, Söderström Bengt, Tunlid Anders

SALLE/ROOM C & D (1 étage/floor)

08H30-11H00 (PRÉSENTATION ORALE-ORAL PRESENTATION)
CSA-Cultures annuelles/Annual Crops
MODÉRATEUR/CHAIR: D. SMITH

08H30 – 08H45 (#246) *The Glenlea long-term rotation: Performance of organic systems after 12 years*
Entz Martin, Bamford Keith, Schoofs Allison, Humble Shauna, Hoeppner Jeff

08H45 – 09H00 (#652) *Adaptation of high-protein lupins in western Canada*
Blade Stan

09H00 – 09H15 (#728) *Impact of Spacing and Emergence Variability on Corn Yield*
Deen Bill, Liu Weidong, Tollenaar Thys, Stewart Greg

09H15 – 09H30 (#769) *A protocol for spring milling wheat production in the Maritimes*
Nass H.G., Caldwell C.E., Price M., Sanderson J.B., Walker D.

09H30 – 09H45 (#171) *Time of glyphosate application for weed control in transgenic silage corn.*
Ivany Jerry A., Rodd A. Vernon

9H45 – 10H00 Pause café / Coffee Break

10H00 – 10H15 (#685) *The effect of Bradyrhizobium Japonicum and Methyl Jasmonate (MeJA) on Soybean (Glycine Max) Nodulation, Nitrogen Fixation and Grain Yield under Short Season Conditions*
Mabood Fazli, Zhou Xiaomin, Smith Donald

10H15 – 10H30 (#557) *Response of Juncea Canola to Stresses at Different Development Stages*
Gan Y, Angadi S.V., Cutforth H, McDonald C.L.

10H30 – 10H45 (#673) *Foliar application of NOD factors to one soybean leaf stimulates photosynthesis in remaining, non treated leaf.*
Cholewa Ewa, Smith Donald, McIver John

SALLE/ROOM A&B (1 étage/floor)

08H30-11H00 (PRÉSENTATION ORALE-ORAL PRESENTATION)
CSSS-Physique des sols et hydrologie/Soil Physics and Hydrology
MODÉRATEUR/CHAIR : C. TOPP

8H30 – 8H45 (#377) *Field Studies of the GPR Ground Wave Method for Estimating Soil Water Content During Irrigation and Drainage*
Galagedara Lakshman, Parkin Gary, Redman David, von Bertoldi Peter, Endres Anthony

8H45 – 9H00 (#251) *Measurement of Soil Water Transmission Parameters using Single, Double and Multiple Ring Infiltrometers*
Reynolds W. Daniel, Elrick David E.

9H00 – 9H15 (#562) *Runoff and erosion monitoring and management for reduced nonpoint contaminant export in agricultural watersheds.*
Michaud Aubert, Deslandes Julie, Duguet Frédérique, Rivest Roger, Lauzier Richard

9H15 – 9H30 (#596) *Use of LEACHM to Simulate Water and Solute Transport Through a Clay Loam Soil Under Long-Term Cropping and Fertilization*
Dadfar H., Groenevelt P. H, Drury C. F, Reynolds W. D.,Von Bertoldi P., Tan C. S.

9H30 – 9H45 (#177) *Simulating Residual Soil Nitrogen and Risk of Water Contamination by Nitrogen under Agricultural Policy Scenarios in Canada*
Yang Jingyi, Huffman Edward C., De Jong Reinder

9H45 – 10H00 Pause café / Coffee Break

10H00 – 10H15 (#561) *Identifying Tracers to Characterise E: coli 0157 Transport Through Disturbed and Undisturbed Columns*
Tallon Lindsay, Si Bing Cheng

10H15 – 10H30 (#76) *Gas diffusion under frozen conditions*
Allaire Suzanne

10H30 – 10H45 (#380) *Vegetative buffer efficiency in an irrigated pasture system*
Bedard-Haughn Angela, Tate Ken, Van Kessel Chris

SALLE/ROOM C & D (1 étage/floor)

11H00-12H30
CSA-Réunion générale annuelle/Annual general meeting

SALLE/ROOM A&B (1 étage/floor)

11H00-12H30
CSSS-Réunion générale annuelle/Annual general meeting

12H30-13h30 🍽 **LUNCH** 🍽

SALLE/ROOM (1 & 4e étage)

*13H30-15H00 (Présentation affiche-Poster presentation)
ICOM-Agronomie et grandes cultures/Agronomy and crop production
ICOM-Morphologie et réseaux mycéliens/Mychorrhizal morphology and networks
ICOM-Qualité des sols, bioremediation et reclamation Soil quality, bioremediation, and reclamation
ICOM- Génomique, protéomique et biologie moléculaire/Genomics, proteomics and molecular biology
CSSS-Résidus organiques et biosolides/Organic residues and bio-solids
CSSS-Conservation et gestion des sols/Soil Conservation and Management
CSSS-Gaz à effet de serre et carbone du sol/Greenhouse Gases and Soil Carbon

CSSS-Sols forestiers/Forest Soils
CSSS-Qualité de l'eau, physique des sols et pédologie/Water Quality, Soil Physics, Pedology
CSSS-Fertilité des sols et gestion des éléments nutritifs/Soil Fertility and Nutrient Management
CSA-Cultures annuelles/Annual Crops
CSA- Physiologie des cultures/Crop physiology
CSA- Cultures fouragères/ Forage Crops

* Les mêmes affiches sont présentées lundi et mardi (voir lundi pour les détails du programme)
* The same posters are presented on Monday and Tuesday (see Monday for program details)

15H00-15H15 PAUSE CAFÉ/COFFEE BREAK (1 & 4 étage/floor)

SALLE/ROOM 1 (4 étage/floor)

15H15-17H30 **SYMPOSIUM 7**
ICOM – Mycorhizes dans un monde en changement/Mycorrhizae in changing world
ORGANISATEUR ET MODÉRATEUR / ORGANIZER AND CHAIR : NANCY JOHNSON

15H15 – 16H00 Conférencier majeur/major speaker: **Fitter Alastair** , Olsen Ekla, Heinemeyer Andreas
(#762) System responses to environmental change: the mycorrhizal component.

16H00 – 16H30 Présentation/Lecture 1: **Zabinski Catherine**
(#649) Mycorrhizae and exotic plant invasion.

16H30- 17H00 Présentation/Lecture 2: **Klironomos John**
(#779) Mycorrhizal Diversity and Functioning Under Elevated Atmospheric CO2.

17H00 – 17H30 Présentation/Lecture 3: **Gehring Catherine,** Haskins Kristin
(#382) Global warming and drought effects on mycorrhizal fungi.

SALLE/ROOM 2 (4 étage/floor)

15H15-17H30 **SYMPOSIUM 8**
ICOM – Mycorhizes, salinité et sécheresse/Mycorrhizae, salinity and drought
ORGANISATEUR ET MODÉRATEUR / ORGANIZER AND CHAIR : ROBERT AUGÉ

15H15 – 16H00 Conférencier majeur/Major speaker: **Juniper Sato,** Abbott Lynette
(#298) Arbuscular mycorrhizas and soil salinity - the continuing story.

16H00 – 16H30 Présentation/Lecture 1: **Zwiazek Janusz** , Muhsin Tawfik
(#758) Role of mycorrhizal associations in water flow regulation of woody plants.

16H30 – 17H00 Présentation/Lecture 2**:. Subramanian Kizhaeral S**, Charest Christiane
(#776) Emerging trends in mycorrhiza-alded host plant drought tolerance.

17H00 – 17H30 Présentation/Lecture 3: **Davies Fred T**. Jr. Estrada-Luna Andres A., de Estudios Avanzados, Phavaphutanon Lop
(#514) Arbuscular mycorrhiza and plant water relations - from drought acclimation to acclimatization of tissue culture produced plantlets.

SALLE/ROOM 3 (1 étage/floor)

15h15-17H30 (Présentation orale-Oral presentation)

ICOM-Qualité des sols, bioremédiation et réclamation/Soil quality, bioremediation, and reclamation

MODÉRATEUR / CHAIR : CHANTAL HAMEL

15H15 – 15h30 (#180) *The Arbuscular Mycorrhizal Fungal Soil Protein Glomalin, A Distinct Compound.*
Driver James, Rillig Matthias

15h30 – 15H45 (#503) *Role of Glomalin in Sequestration of Heavy Metals.*
González-Chávez Ma. del Carmen A, Carrillo-González Rogelio, Wright Sara, Nichols Kristine

15H45 – 16H00 (#402) *Effects of organic amendments to soil or soilless potting media on arbuscular mycorrhizae and their microbial associates.*
Linderman Robert, Davis Anne, Marlow Joseph

16H00 – 16H15 (#311) *Contribution of Ectomycorrhizal Fungi to Plant Uptake of Ca, Mg and K and to Mineral Weathering by Tunnelling.*
Van Schöll Laura, Smits Mark M., Hoffland Ellis, Keltjens Willem G.

16h15 – 16H30 (#152) *Al tolerant maize only acquires P from acidic tropical soils through mycorrhizal association.*
Kuyper Thomas, Cardoso Irene, Boddington Claire Janssen Bert, Oenema Oene

16H30 – 16H45 (#85) *Properties of Soils Influenced by Fungal-growth in Hybrid Spruce (Picea glauca x engelmannii (Moench.) Voss).*
Arocena Joselito, Glowa Kevin, Massicotte Hugues

16H45 – 17H00 (#197) *Role of arbuscular mycorrhizal fungi in the uptake of radionuclides by plants.*
Rufyikiri Gervais, Dupre de Boulois Hervé, Thiry Yves, Delvaux Bruno, Declerck Stéphane

17H00 - 17H15 (#448) *Endomycorrhizae and phytoremediation.*
Giasson Philippe, Jaouich Alfred , Gagné Serge, Massicotte Luc, Cayer Pierre, Sabarrato Nicolas, Dutil-Paquette Simon, Moutoglis Peter

17H15 – 17H30 (#544) *Suillus sp.: A potential ectomycorrhizal species for ecological restoration in the arid mountain regions of western China.*
Yan Wei Bao Yuying, Le Tacon Francois, Yao QinZhi, Bao Yuying, Fan Rong, Chen Youjun, Chen Lihong

SALLE/ROOM C&D (1 étage/floor)

15H15-18H00 (PRÉSENTATION ORALE-ORAL PRESENTATION)

CSA-Cultures fouragères/Forage Crops

MODÉRATEUR/CHAIR : P. SEGUIN

15H15 – 15H30 (#287) *Effect of Drying Method on Productivity and Essential Oil Quality of Basil Grown in Nova Scotia*
Bowes Kelly, Zheljazkov Valtcho

15H30 – 15H45 (#235) *Managing Dormancy - The Key to Successful Self-Regenerating Legume Systems*
Braul Alden, Entz Martin H.

15H45 – 16H00 (#663) *Effect of seeding rate and fertilizer on performance of Fenugreek (Trigonella foenum-graecum).*

Acharya Surya, Friebel Doug, Messenger Doug

16H00 – 16H15 (#623) *Short-rotation forage crops affect subsequent barley yield and quality*
Jefferson Paul, Lemke Reynald, Selles Fernando, Zentner Robert

16H15 – 16H30 (#72) *Protein fractions in timothy are affected by N fertilization and genotypes*
Tremblay Gaëtan, Michaud Réal, Bélanger Gilles

16H30 – 16H45 (#371) *Effects of stage of maturity on ensiling characteristics and ruminal nutrient degradability of oat silage*
Gonthier C., Mustafa A.F., Seguin P.

16H45 – 17H00 (#667) *Comparison of forage yield and quality of PC rye, fall rye (Secale cereale) and barley (Hordeum vulgare) when harvested for silage.*
Acharya Surya, Friebel Doug, Messenger Doug

SALLE/ROOM A&B (1 étage/floor)

15H15-18H00 (PRÉSENTATION ORALE-ORAL PRESENTATION)
CSA & CSSS-Fertilité et gestion des éléments nutritifs/Fertility and Nutrient Management
MODÉRATEUR/CHAIR: C. DRURY

15H15 – 15H30 (#624) *Soil test calibration databases for research and education*
Bruulsema Tom

15H30 – 15H45 (#489) *Within-Field Spatial Variability of P Saturation Indicators in Horticultural Fields*
Nolin Michel C., Leclerc Marie-Line

15H45 – 16H00 (#105) *Nitrogen and Phosphorus Leaching as Influenced by Tillage, Crops and Fertilizer Sources*
Jiao You, Hendershot William, Whalen Joann

16H00 – 16H15 (#183) *Inter-relationships between grain yield, grain protein concentration, soil mineral nitrogen levels and nitrogen fertilization on variable landscapes*
Denys Chris, O'Halloran Ivan

16H15 – 16H30 (#505) *Soil Management Zones Delineated by Soil Electrical Conductivity for Potato Production.*
Cambouris Athyna N., Nolin Michel C., Simard Régis R., Laverdière Marc R.

16H30 – 16H45 (#564) *Variations in Grain Nitrogen Removal from Corn Production*
Ma Bao-Luo

16H45 – 17H00 (#335) *Enhanced N efficiency in a corn-soybean rotation under Best Management Practices*
Jayasundara Susantha, Wagner-Riddle Claudia, Parkin Gary, Kay Bev, Voroney Paul

17H00 – 17H15 (#660) *Nutrient and water management of high density sweet cherry*
Neilsen Gerry, Neilsen Denise, Kappel Frank

17H15 – 17H30 (#77) *Physical properties of organic-based fertilizers*
Allaire Suzanne, Parent Léon-Étienne

SALLE/ROOM 7A&7B (3 étage/floor)

15H15-18H00 (PRÉSENTATION ORALE-ORAL PRESENTATION)
CSSS-Biologie des sols/Soil Biology
MODÉRATEUR/CHAIR: A. PLANTE

15H15 – 15H30 (#400) *Microbial Community Structure and Dynamics During Decomposition of 13C-Labeled Ryegrass Residue*
McMahon S. K., Williams M. A., Bottomley P. J., Myrold D. D.

15H30 – 15H45 (#689) *Framework for Predicting Soil Biodiversity Attributes at Regional Scale*
Fox Catherine, Jarvis Ian, Joschko Monika, Lentzsch Peter

15H45 – 16H00 (#633) *USING NEMATODES TO IDENTIFY MANAGEMENT EFFECTS ON SOIL FOOD WEBS*
Tenuta Mario

16H00 – 16H15 (#699) *Effects of Long-term Applications of Dairy Manure Slurry on Structure of the Soil Food Web and Nitrogen Flux under Tall Fescue*
Forge Tom, Bittman Shabtai, Kowalenko Grant, Hunt Derek

16H15 – 16H30 (#525) *Abiotic and biotic soil properties related to Sclerotinia stem rot disease in soybean and bean fields under different management practices*
Jeannotte Richard, Jabaji-Hare Suha, Hogue Richard, St-Arnaud Marc, Vanasse Anne, Hamel Chantal

16H30 – 16H45 (#473) *Mutualism in the earthworm gut: evidence from microbial PLFA biomarkers*
Sampedro Luis, Whalen Joann

16H45 – 17H00 (#662) *The role of plant root exudates in peat decomposition*
Stewart Heather, Basiliko Nathan, Moore Tim

17H00 – 17H15 (#404) *Changes in soil enzyme activities due to fungicide and sulfur additions*
Munroe Michael, Zheljazkov Valtcho

17H15 – 17H30 (#713) *Enzyme Activity as a Measure of Soil Fertility: Why the Correlation is So Low*
Warman Philip

BANQUET CSA & CSSS

18H30-22H00

Restaurant du Vieux Port

(voir le bureau des inscriptions pour tout renseignement/see registration desk for more information)

Ateliers/Workshops ICOM (Salles à determiner/Rooms to be determined)
19H30-…

Voir feuillet détaillé dans la pochette/See details in registration package

Mercredi 13 août 2003/Wednesday August 13th 2003

ACTIVITÉS/ACTIVITIES

- **Saute-Mouton/ Saute-Mouton**
- **Jardin Botanique/ Botanical Garden**
- **Vieux-Montréal/ Old Montreal**
- **Mont St-Hilaire/ Mount St-Hilaire**
- **Tourbière/ Peat Bog**
- **Parc des Milles-îles/ Thousand Island Park**
- **Excursion Mycologique/ Mushroom Field Trip**
- **Route du Cidre/ The Cider Trail**
- **Agronomie et sols/ Agronomy and Soil Tour**
- **Sols forestiers/ Forest Soils**

(Voir le bureau des inscriptions pour les détails/ See the registration desk for all the details)

Jeudi 14 août 2003/Thursday August 14th 2003

07H00-17H00 Bureau des inscriptions/Registration desk

SALLE/ROOM 1 (4 étage/floor)

08H30-09H15
Plénière/Plenary
Prof. Ian Sanders
University of Lausanne, Switzerland

(#236) Intraspecific genetic variation in arbuscular mycorrhizal fungi

09H15-09H45 PAUSE CAFÉ/COFFEE BREAK (4 étage/floor)

SALLE/ROOM 1 (4 étage/floor)

09H45-12H00 **SYMPOSIUM 9**
ICOM - Evolution, phylogénie et systématique des champignons mycorhiziens / Evolution, phylogeny and systematic of mycorrhizal fungi
ORGANISATEUR ET MODÉRATEUR / ORGANIZER AND CHAIR : ARTHUR SCHÜβLER

9H45 – 10H30 Conférencier majeur/ Major speaker: **Bruns Tom,** Shefferson Richard P.
(#759) Evolutionary studies of mycorrhizal fungi: milestones and future directions.

10H30 – 11h00 Présentation/Lecture 1: **van Tuinen Diederik**
(#334) Molecular detection and monitoring of fungal plant symbionts.

11h00- 11h30 Présentation/Lecture 2: **Smith Sally E.,** Miller Debbie, Gao LingLing, Smith Andrew
(#603) Interactions of mycorrhizal mutant plants with different members of the Glomeromycota: Insights into phylogeny.

11h30 – 12h00 Présentation/Lecture 3: **Schüssler Arthur**, Schwarzott Daniel, Walker Chris
(#44) Evolution and molecular phylogeny of AM fungi and Geosiphon - establishing a new model system for AM research.

SALLE/ROOM 2 (4 étage/floor)

09H45-12H00 **SYMPOSIUM 10**
ICOM – Biologie in vitro des champignons mycorhiziens/In vitro biology of mycorrhiza fungi
ORGANISATEUR ET MODÉRATEUR / ORGANIZER AND CHAIR : STÉPHANE DECLERCK

9H45 – 10h30 Conférencier majeur/Major speaker: **Bécard Guillaume**
(#764) Communication between the partners in the arbuscular mycorrhizal symbiosis

10h30 – 11h00 Présentation/Lecture 1: **Trépanier Martin,** Bécard Guillaume, Moutoglis Peter, Gagné Serge, Willemot Claude, Rioux Jacques-André
(#336) Fatty acid synthesis on the Glomerales : key role of the intraradical phase.

11h00 – 11h30 Présentation/Lecture 2: Miozzi Laura, Genre Andrea, Bianciotto Valeria, Lumini Erica, Faccio Antonella, Jargeat Patricia, Bécard Guillaume, **Bonfante Paola**

(#200)Transformed roots : a useful tool to study plant/fungal/bacterial interactions.

11h30 – 12h00 Présentation/Lecture 3: **Alok Adholeya**
(#194) Commercial production of AMF through industrial mode and its large scale application

SALLE/ROOM C & D (1 étage/floor)

09H45-12H30 (Présentation orale-Oral presentation)
ICOM-Stress et pathologie/Stress and Pathology
MODÉRATEUR / CHAIR : CHRISTIANE CHAREST & MARC ST-ARNAUD

9H45 – 10h00 (#499) *Mycorrhizal colonization enhances plant defences against aphids in tomato*
Lingua Guido, Berta Graziella, Digilio Maria Cristina, Massa Nadia, Guerrieri Emilio

10h00 – 10h15 (#151) *Does arbuscular mycorrhiza reduce damage in Striga-infested sorghum?*
Kuyper Thomas, Lendzemo Venasius, Van Ast Aad

10h15 – 10h30 (#12) *Investigations on the bio-protection potential of ericoid mycorrhiza against root pathogens of Rhododendron*
Grunewaldt-Stoecker Gisela

10h30 – 10h45 (#609) *Glomus mosseae BEG 12 and Pseudomonas fluorescens A6RI overcome growth depression and root morphogenetic modifications induced by Rhizoctonia solani in tomato plants*
Berta Graziella, Sampo Simonetta, Gamalero Elisa, Massa Nadia, Lemanceau Philippe

10h45 – 11h00 (#256) *Arbuscular mycorrhizal fungi influence drought tolerance of grapevines under field conditions*
Schreiner R. Paul

11h00 – 11H15 (#11) *Arbuscular mycorrhiza dependent characterization of drought stress impact on rose-plant vitality probed by visual scoring and chlorophyll-a-fluorescence*
Pinior Alexandra, Grunewaldt-Stoecker Gisela, Strasser Reto J.

11h15 – 11h30 (#599) *The physiological response of Acacia tortilis-AMF symbiosis to drought is fungus species-dependent*
Nasr Hafedh**, Ksontini Mustapha, Rejeb M. Néjib, Ghorbel M. Habib, Fortin J.André**

11h30 – 11h45 (#21) *Arbuscular Mycorrhiza, heavy metal and salt tolerance*
Bothe Hermann, Hildebrandt Ulrich,, Ouziad Fouad, Wilde Petra

11h45 – 12h00 (#36) *The effects of mycorrhizal fungi on plant establishment in saline conditions*
Asghari Hamid, Smith Sally E, Chittleborough David, Smith Frank

12h00 – 12H15 (#406) *Effect of sodium chlorides on the growth of Japanese black pine (Pinus thunbergii) seedlings and ectomycorrhizal fungi*
Matsuda Yosuke, Nakanishi Kenichi, Ito Shin-ichiro

12h15 – 12H30 (#710) *Use of the Root-Organ Culture (ROC) System Technology to Study the Suppressive Effect of Arbuscular Mycorrhizal Fungi on Plant Parasitic Nematodes*
Elsen Annemie, Declerck Stéphane, De Waele Dirk

SALLE/ROOM 7A&7B (3 étage/floor)

09H45-12H30 (Présentation orale-Oral presentation)
ICOM-Écologie et écosystèmes/Ecology and ecosystems

MODÉRATEUR / CHAIR : JOHN KLIRONOMOS

9h45 – 10h00 (#746*) Models of Plant & Fungal Population Interactions During Mycorrhizal Symbiosis*
Graves Don

10h00 – 10h15 (#711) *New Conceptual Model for Ectomycorrhizal Succession at an Ecosystem Scale*
Jumpponen Ari

10h15 – 10h30 (#712) *From Australia to New Zealand: How Did Fungi Find a Niche in Hell?*
Moyersoen Bernard , Beever RE, Martin F.

10h30 – 10h45 (#340) *Arbuscular Mycorrhizas in Salt Marshes: Adaptation and Plant Benefits*
Carvalho Luis, Neto Domingos, CorreiaPatricia, Caçador Isabel, Martins-Loução Amélia

10H45 – 11h00 (#234) *Production, standing biomass and natural abundance of 15N and 13C in ectomycorrhizal mycelia collected at different soil depths in spruce stands and mixed (spruce-oak) stands in southern Sweden*
Wallander Håkan, Goransson Hans, Rosengren Ulrika

11H00 – 11h15 (#543) Evidence that suilloid fungi have a unique functional role for pines establishing in the absence of mycorrhizal networks.
Horton Thomas, Ashkannejhad Sara, Dulmer Kristopher

11H15 – 11H30 (#724) *Small scale spatial distribution structure of ectomycorrhizal types in a red oak stand*
Gebhardt Sascha, Wöllecke Jens, Hüttl Reinhard F.

11H30 – 11h45 (524) Characterising the diversity of AM fungi in an upland grassland - links to plant species and spatial scales
Ridgway Karyn, Duck Janette, Nunan Naoise, Young Peter

11h45 – 12h00 (#215*) Arbuscular mycorrhizal fungi promote plant recruitment in experimental grassland)*
van der Heijden Marcel

12h00 – 12h15 (#749) *Phosphorus, Arbuscular mycorrhizal fungi and performance of the wetland plant Lythrum salicaria L.*
Stevens Kevin, Spender Sean, Peterson Larry

12H15 – 12h30 (#538) *Correlation and causation between plant diversity and the diversity of arbuscular mycorrhizal fungi*
Bever James, Schultz Peggy, Miller Michael, Herrera Ricardo, Morton Joseph

12h30 – 12H45 (#655) *Role of arbuscular-mycorrhizal fungi in mediating invasion of three non native plants into native ecosystems in Alabama .*
Greipsson Sigurdur

12h45 – 13h00 (#415) *Exploring Growth and Functioning Constraints Imposed by Temperature in Arbuscular Mycorrhizal Fungi*
Gavito Mayra, Olsson Pal Axel, Rouhier Hervé, Bago Berta, Azcón Concepción

12H30-13h30 LUNCH

SALLE/ROOM (1 & 4 étage/floor)

*13H30-15H15 (Présentation affiche-Poster presentation)
ICOM-Biodiversité/Biodiversity
*Jeudi 14 août 2003 et vendredi 15 août & Thursday August 14th and Friday August 15th 2003

(#168) *Leaving fallen logs lie: managing forests for fungal diversity*
McKay Donaraye, Smith Jane, Elliott Jill

(#648) *Ectomycorrhizal fungal diversity of variously disturbed northern hardwood forests of the Adirondack State Park, NY, U.S.A.*
Bird Claire, Weir Alex, Horton Thomas

(#143) *Considerations about tomentelloid ectomycorrhizae in truffle growing stands in Spain*.
Claveria Vanessa, de Miguel Ana Maria, de Roman Miriam, Saez Raimundo

(#31) *Ectomycorrhizal community patterns from Quercus rubra seedlings grown in soils from regional hemlock-hardwood forests*
Mates-Muchin J.T., Turner Greg, Lewis J.D

(#581) *Species composition and significance of mycorrhizas in young oak plantations of Q.petraea and Q.robur.*
Kavkova Miloslava, Lepsova Anna

(#485) *Biodiversity, productivity and N, P contents of chestnut mycorrhizal associated mushrooms*
Baptista Paula, Meirinhos Julieta, Martins Anabela

(#486) *Evaluation of the biodiversity and relative abundance of mycological flora in chestnut trees, Castanea sativa Mill., in the Northeast of Portugal: preliminary results*
Baptista Paula, Branco Paula, Martins Anabela

(#657*) Effects of spore inoculum on the ectomycorrhiza diversity of Douglas-fir seedlings*.
Luoma Daniel, Eberhart Joyce, Abbott Rick

(#55) *Molecular diversity of mycorrhizal and other soil fungi across a moorland - Scots pine (Pinus sylvestris) environmental gradient*
Anderson Ian, Campbell Colin, Prosser James

(#47) *Diversity of ericoid mycorrhizal fungi from the Australian Ericales*
Burns Stuart

(#766) *Diversity and frequency of occurrence of arbuscular mycorrhizal fungi (AMF) in an agroforestry and monocrop farming system in Malawi*
Bouwman Beatrix, Jefwa Joyce, Sinclair Robert, Van Greuning Johannes, Maghembe Johannes

(#488) *Biodiversity of Mycorrhizal Fungi in the Mycoheterotrophic Orchid Limodorum abortivum*
Perotto, S, Girlanda M., Fabbian R., Cafasso D., Selosse M., Bonfante P., Cozzolino S.

(#342) *Endangered Wetland Plants: Infection by Arbuscular Mycorrhizal Fungi and Dark Septate Endophytes*
Fuchs Birgit, Haselwandter Kurt

(#521) *Arbuscular mycorrhizal fungi (AMF) associated with bromeliads in the Brazilian Atlantic Rain Forest*
Sturmer Sidney L., Grippa Carlos R., Pasqualini Diego

(#240) *Biodiversity of arbuscular mycorrhizal fungi in mountain meadows*
Renker Carsten, Börstler Boris, Buscot François

(#553) *Diversity of Arbuscular Mycorrhizal Fungi in the Dry Deciduous Forest*
Varela Lucia, Zulueta Ramón

(#226) *Occurence of arbuscular mycorrhizal fungi in arable fields in Sweden with emphasis on climate and cultivation management*
Sjoberg Johanna, Persson Paula, Martensson Anna, Adholeya Alok, Ahlstrom Sadhna

(#416) *Diversity of Arbuscular Mycorrhizal fungi in the formation of a functional association with a mutant tomato (Lycopersicon esculentum Mill.)*
Heinsvig Poulsen Katrine , GaoLing-ling, Smith Andrew, Jakobsen Iver, Smith Sally

(#658) *Arbuscular mycorrhizal fungi biodiversity of natural and disturbed savannas in La Gran Sabana (Venezuela).*
Lovera Milagros, De Andrade Zita, Meneses Erasmo, Cuenca Gisela

(#593) *Why are so diverse the Scutellospora at La Gran Sabana, Venezuela?*
Cuenca Gisela, Lovera Milagros, De Andrade Zita, Meneses Erasmo

(#309) Biodiversity, *Population Status and Root Infection of Arbuscular Mycorrhizal Fungi in Relation to Site Factors in Highway Cut-slopes in Korea*
Lee Kyung Joon, Castillo Evangeline Tamolang, Budi Sri Wilarso, Kim Kyung Hoon

(#34) *Arbuscular mycorrhizal fungi and understory plant diversity in Wisconsin oak savannas*
Landis Frank, Givnish Thomas, Gargas Andrea

(#786) *Occurrence of Ectomycorrhizal Fungi in Dipterocarps Forests of Bangladesh*
Mridha M. A. U., Bhuiyan M. K., Uddin M.B., Huda S. M. S., Haque M. M.

(#788) *Diversity and occurrence of ectomycorrhizal mushrooms in rain forests of south Cameroon*
Onguene N. A., Kuyper T. W.

(#584) *Community Structure of AM Fungi Colonizing Roots of Different Varieties of Hordeum vulgare*
Tauschke Marion, Lipiena Ligita

SALLE/ROOM (1 & 4 étage/floor)

*13H30-15H15 (Présentation affiche-Poster presentation)

ICOM-Stress et pathologie/Stress and Pathology

*Jeudi 14 août 2003 et vendredi 15 août & Thursday August 14th and Friday August 15th 2003

(#435) *Introduction of Biocontrol Fungi and Arbuscular Mycorrhizal Fungi (AMF) in the Production System of the Palm Species Phoenix canariensis, P. dactylifera, Brahea armata and Chamaerops humilis*
Dreyer Beatriz, Morte Asun, Honrubia Mario

(#509) *Control of whitefly with Verticillium lecanii on mycorrhizal (Glomus intraradices) common bean plants in greenhouse*
Rivera-Becerril Facundo, Mier Teresa, Camacho Alejandro D., Valdés María

(#497) *Arbuscular mycorrhizae and fungal pathogen interactions and their impact on asexual propagules of Allium vineale*

Ronsheim Margaret, Green Ellen

(#679) *Influence on arbuscular mycorrhizal fungi and phosphorous on disease severity by Phoma costarricencis in coffee plants*
López-Aguirre José Gerardo, Escalona-Aguilar Miguel Angel, Trejo-Aguilar Dora, Farias-Larios Javier

(#756) *The interactive effects of AMF and leaf endophytes on leaf physiology: defense against a common pathogen*
Kyllo Damon, Herre Allen E

(#451) *Effect of the interaction between AMF Glomus manihotis and plant growth promoting bacteria (PGPB) from Bacillus genus on micropropagated banana plantlets.*
Rodríguez-Romero Ana Sue, Piñero-Guerra María Sol, Jaizme-Vega Mª del Carmen

(#363) *Potentiation* of defence response induced by arbuscular mycorrhiza and systemin in tomatoes plants.
de la Noval Blanca M., Olalde Victor, Pérez Eduardo, Vásquez María S., Martínez Norma, Delano Jonh P.

(#187) *Molecular characterization of Fusarium species in asparagus fields and relation with mycorrhization, fertilisation and agricultural practices*
Yergeau Etienne, Filion Martin, Vujanovic Vladimir, Hamel Chantal, St-Arnaud Marc

(#253) *Effects of the alteration of tomato root exudation by Glomus intraradices colonization on Phytophthora parasitica var. nicotianae zoospores.*
Lioussanne Laetitia, Jolicoeur Mario, St-Arnaud Marc

(#218) *Effect of the culture filtrates of edible ectomycorrhizal fungi on microconidia germination of Fusarium oxysporum and F. moniliforme.*
Díez Julio, Olaizola Jaime, Martín Pablo, Fernández Marina, Pajares Juan

(#453) *In vitro studies of the interaction between Trichoderma sp., Pisolithus tinctorius and Phytophtora cinnamomi*
Martins Anabela, Gouveia Eugénia, Estevinho Isabel, Coelho Valentim, Pais Maria Salomé

(#639) *Oxidative stress enzyme activities on Castanea sativa Mill. roots along mycorrhizal association with Pisolithus tinctorius.*
Rodrigues Paula, Martins Anabela, Carnide Valdemar, Pais Maria Salomé

(#206) *Influence of Organic Matter on the Interaction Between the Fungal Biocontrol Agent Clonostachys rosea and a Tomato/Glomus intraradices Symbiosis*
Larsen John, Knudsen Inge, Ravnskov Sabine, Jensen Birgit, Funck Jensen Dan

(#64) *Biocontrol interactions of host cultivar, arbuscular mycorrhiza, and Trichoderma against soil-borne diseases of tomato*
von Alten Henning, Masadeh Ban

(#364) *Effect of the inoculation with Glomus intraradices in plant growth and water relations of Rosmarinus officinalis under drought*
Biel Carmen, Savé Robert, Estaún Victoria, Camprubí Amèlia, Calvet Cinta

(#325) *Alleviation of drought stress on micropropagated Prunus rootstock Myrobalan 29C by inoculation with Glomus intraradices*
Estaún Victoria, Biel Carmen, Camprubí Amèlia, Calvet Cinta, Savé Robert, Pinochet-Brieva Jorge

(#472) *Ecology and function of arbuscular mycorrhizal fungi (AMF) in subsistence agriculture in the semi-arid tropics – a comparison with temperate mesic agroecosystems*

Besmer Ylva, Koide Roger, Twomlow Steve

(#768) *Water relations and biochemical changes in mycorrhizal and non-mycorrhizal tomato plants in response to drought*
de la Noval Pons M, Rodríguez Yakelin, Mazorra Luis Miguel, Fundora Luis Roberto, Rodríguez Pedro, Fernandez Félix

(#754) *Arbuscular Mycorrhizal Fungi and Temperature*
Olsen Erla, Ridgway Karyn, Fitter Alastair

(#170) *Heat resistance in an ericoid mycorrhizal fungus*
Nickerson Nancy, Davies Robert

(#587) *AM fungi in IN PAH-polluted soils, from laboratory to field experiments*
Beguiristain Thierry, G Bidar éraldine, Corgié Stéphane, Joner Erik, Leyval Corinne

(#697) *The effect of arbuscular mycorrhizal (AM) colonization on the aluminum tolerance of two tolerance of two soybean varieties: one tolerant of aluminum and one sensitive*
Watson Dolly, Moyer Kari, Rufty Tom

(#598) *Distribution and plant interaction of endomycorrhizal fungi along a saline soil gradient, in a temperate semiarid environment*
Nasr Hafedh, Fortin J. André

(#556) *Current situation of the mycorrhizal research in Mexico*
Trejo Dora, Ferrera-Cerrato Ronald, Lara-Capistran Liliana, Zulueta Ramón

(#291) *Effects of fire on the mycorrhizal diversity of Caladenia formosa (Orchidaceae)*
Osborn Madeleine, McLean Cassandra, Burns Stuart, Bell Tina

(#423) *Mycobioindication of stress in forest ecosystems*
Kraigher Hojka, Al Sayegh Petkovsek Samar, Vukovic Nada

(#586) *Is the Pinus banksiana - Laccaria bicolor mycorrhizal system salt tolerant?*
Bois Grégory, Bigras Francine, Piché Yves, Fung Martin, Khasa Damase

(#329) *United we stand- how the abiotic stressors affect mycorrhiza under the balance between tree-understorey competition and facilitation*
Ruotsalainen Anna Liisa, Markkola Anna Mari, Kozlov Mikhail

(#452 Effect of AMF Glomus mosseae and plant growth promoting bacteria (PGPB) Pseudomonas fluorescens strain 817 on micropropagated banana plantlets infected with root-knot nematode Meloidogyne javanica.
Rodriguez-Romero Jaizme-Vega Mª del Carmen, Montesinos Emilio, Jaizme-Vega Mª del Carmen

(#223) *Arbuscular-mycorrhizal fungal-nematode interactions in Ammophila arenaria in coastal sand dune systems*
Hol Gera, Eason William, Cook Roger

(#98) *Interrelationships between plant health promoting rhizobacteria and arbuscular mycorrhizal fungi on tomato and their importance in the biocontrol of the root-knot nematode*
Reimann Stephan, Sikora Richard A.

(#583) *Host-plant mediated mycorrhiza effects on the spider mite Tetranychus urticae*
Vierheilig Horst, Riegler Petra, Schausberger Peter

(#775) *Responses of field-grown mycorrhizal tomato plants under varying intensities of drought*
Subramanian K.S., Santhanakrishnan P., Thangaraj T.

(#601) *Heritable variation in growth response of Plantago lanceolata to the soil community*
Bennett Alison, Bever James

SALLE/ROOM (1 & 4 étage/floor)

*13H30-15H15 (Présentation affiche-Poster presentation)
ICOM-Écologie et écosystèmes/Ecology and ecosystems
*Jeudi 14 août 2003 et vendredi 15 août & Thursday August 14th and Friday August 15th 2003

(#622) *Ectomycorrhizal fungal community structure across a bog-forest ecotone in southeastern Alaska*
Wurzburger Nina, Hartshorn Anthony, Hendrick Ronald

(#90) *Approaching mycorrhizal complexity through ecological stoichiometry.*
Swenson William, Prouzova Petra, Allen Michael F.

(#96) *Arbuscular- and Ectomycorrhizas in Selected Tree Species From Tropical Atlantic Rainforest Remnants in Sergipe, Northeast Brazil*
Landim Myrna, Heyser Wolfgang

(#139) *Ectomycorrhizal fungi and forest site classification*
Egli Simon, Ayer François

(#366) *Do individual host trees support different communities of ectomycorrhizal fungi ?*
Saari Susanna, Alexander Ian, Anderson Ian, Campbell Colin, Russell Joanne

(#484) *Ectomycorrhizal fungi on beech coarse woody debris and correlation to some CWD characteristics*
Grebenc Tine, Piltaver Andrej, Kraigher Hojka

(#116) *The communities of ectomycorrhizal fungi associated to Cistus laurifolius L. (rock rose) in basic soils in Central Spain as revealed by molecular analyses of ectomycorrhizal roots*
Muriel Ana, Diez Jesus

(#365) *Consequences of increased nitrogen supply and altered root allocation on the ectomycorrhizal communities of a temperate deciduous ecosystem*
Avis Peter, McLaughlin David, Reich Peter, Charvat Iris

(#466) *A comparison between the fungal community found on ectomycorrhizal roots and the fungal community found as fruiting bodies in a mature stand of Blue Oak (Quercus douglasii)*
Smith Matthew, Rizzo David, Douhan Greg

(#368) *Diversity and spatial heterogeneity of ectomycorrhizal fungi in oak savannas*
Dickie Ian, Reich Peter, Schnitzer Stefan, McLaughlin David, Hobbie Sarah

(#379) *Ectomycorrhizal Communities of Black Spruce (Picea mariana (Mill.) BSP) Across an Environmental Gradient in Central British Columbia*
Robertson Susan J., Massicotte Hugues B.

(#755) *The ectomycorrhizal community of true fir (Abies spp.) in the Southern Sierra appears to have a higher component of hypogeous fungi than previously studied communities*
Izzoa Antonio D., Meyer Marc, Trappe James M., North Malcolm, Bruns Tom

(#45) *Differences in Ectomycorrhiza Succession Between Wild Type and Transgenic Aspen Released in an Experimental Field*
Kaldorf Michael, Renker Carsten, Fladung Matthias, Buscot Francois

(#677) *Differences in ectomycorrhizal infection of conifer seedlings across an alpine-treeline ecotone: relative importance of variation in soil properties and microclimate.*
Hasselquist Niles, Germino Matt, McGonigle Terence, Smith William

(#144) *Effects of fire on ectomycorrhizal fungi in a Quercus ilex forest over a three year period*
de Roman Miriam, de Miguel Ana Maria

(#612) *Ectomycorrhizal fungal community dynamics on Scots pine bait seedlings before and over four years after a boreal forest clear-cut*
Heinonsalo Jussi, Sen Robin

(#71) *Above- and below-ground primary succession of ectomycorrhizal fungi in a volcanic desert on Mt. Fuji*
Nara Kazuhide

(#173) *The Role of Large Mammal Mycophagy on Dune Ecosystem Succession*
Ashkannejhad Sara, Horton Thomas R.

(#181) *The relationship between hypogeous fungi and northern flying squirrels in western hemlock stands of coastal British Columbia.*
Anderson J., Durall D.M.

(#654) *The ectomycorrhizal communities of pinyon pine are influenced more by host genetics than herbivory by the moth Dioryctria albovitella*
Deckert Ron, Theimer Tad, WithamTom, Gehring Catherine

(#292) *Mycorrhizal associations, root specialisations and nutrient acquisition in Australian heathlands*
Bell Tina

(#433) *Mycelial production, spread and root colonisation of the ectomycorrhizal fungi Hebeloma crustuliniforme and Paxillus involutus under elevated atmospheric CO2*
Fransson Petra, Taylor Andy, Finlay Roger

(#665) *Effects of a CO2-enriched atmosphere on EMF communities in a temperate eastern USA pine forest*
Parrent Jeri L., Vilgalys Rytas

(#554) *The effects of free-air enrichment of carbon dioxide and ozone on ectomycorrhizal fungal sporocarp production in aspen stands*
Lilleskov Erik

(#495) *Interactions between AM fungi and soil nitrogen impact prairie community composition*
Antoninka Anita, Wolf Julie, Johnson Nancy

(#643) *Enrichment of atmospheric CO2 and soil nutrients mediates mycorrhizal benefits*
Panter Ashley, Wolf Julie, Johnson Nancy

(#362) *Mycorrhizal inoculation increases growth of Rosmarinus officinalis grown at elevated CO2*
Biel Carmen, Savé Robert, Estaún Victoria, Calvet Cinta, Camprubí Amèlia

(#224) *Factors influencing colonization of arbuscular mycorrhizal fungi in plants of groundwater-dominated wetlands*
Weishampel Peter, Wolfe Benjamin, Bedford Barbara

(#185) *Dissecting the complex effects of mycorrhizal fungal communities on plant growth*.
ProuzovaPetra, Swenson William, Allen Michael F.

(#683) *Can AM-mycorrhizas re-start plant succession in severely disturbed soils?*
De Andrade Zita, Lovera Milagros, Fajardo Laurie, Meneses Erasmo, Cuenca Gisela

(#739) *The use of new Köppen climate map for mycorrhizal sampling*
Bouwman Beatrix, Thackrah Anneke, Kuschke Reinhard

(#258) *Patterns in mycorrhizal fungal biomass in Venezuelan and Cuban ecosystems*
Herrera-Peraza Ricardo, Furrazola E. F., Torres Y., Orozco María O.

(#474) *Local Arbuscular Mycorrhizal Fungal Diversity is Strongly Coupled to Regional Diversity in an Urban Ecosystem.*
Stutz Jean, Whitcomb Sean, Cousins Jamaica

(#680) *Anthropogenic nitrogen input enhances mycorrhiza mediated nitrogen acquisition by plants.*
Watson Dolly, Tu Cong, Rufty Tom, Hu Shuijin

(#97) *Mycorrhizal Colonization of Tropical Seedlings Roots in Two Brazilian Atlantic Rainforest Remnants.*
Landim Myrna, Heyser Wolfgang

(#133) *Dynamics of arbuscular mycorrhizal fungi associated with the vegetational change due to grazing in the semi-natural grassland in Japan.*
Kojima Tomoko, Hayashi Haruo, Saito Masanori

(#399) *Altered state of arbuscular mycorrhizal fungal (AMF) activity following invasion of the non-native Vincetoxicum rossicum (Kleopow) Barbar. in ecosystems of central New York State.*
Greipsson Sigurdur, DiTommaso Antonio

(#617) *Root morphometric analysis and soil AM inoculum potential evaluation in three different herbaceous communities (NW Appennines, Italy).*
Copetta Andrea, Massa Nadia, Barni Elena, Siniscalco Consolata, Berta Graziella

(#35) *Co-Infection and Mutualistic Benefit in a Spatially Explicit Model.*
Golubski Antonio

(#528) *Assessing Local Diversity of Arbuscular Mycorrhizal Fungal Species: The Impact of Spatial Patterns.*
Whitcomb Sean, Stutz Jean

(#228) *Arbuscular mycorrhizal communities in six co-occurring plant species in a dune grassland.*
Scheublin Tanja, van der Heijden Marcel, Ridgway Karyn, Young Peter

(#589) *Shift in community composition of arbuscular mycorrhizal fungi may slow pasture recolonization by a tropical forest tree.*
Aldrich-Wolfe Laura

(#13) *Mycorrhiza of Viola tricolor L. and Plantago lanceolata L. as Indicator of Succession Tendencies.*
Zubek Szymon, Orlowska Elzbieta, Turnau Katarzyna

(#694) *Mycorrhizae and neighbor effects on response to herbivory in spotted knapweed and native bunchgrasses.*
Sartor Karla Zimmerley Sara, Olson Bret, Zabinski, Cathy

(#293) *The effects of grazing ungulates on the structure and function of AMF communities in grasslands of Yellowstone National Park.*
Murray Tanya, Frank Doug, Gehring Catherine

(#178) *Interactions between saprotrophic and ectomycorrhizal fungi.*
Koide Roger, Wu Tiehang, Sharda Jori

(#501) *Gene expression in the ectomycorrhizal basidiomycete Laccaria bicolor under various nitrogen concentrations.*
Peter Martina, Chalot Michel, Le Tacon François, Martin Francis

(#782) *Co-occurrence of Arbuscular Mycorrhiza, Ectomycorrhiza and Ectendomycorrhiza on Aged Eucalyptus: Structural and Ultrastructural Aspect*
Halli-Hargas R., Adjoud-Sadadou D.

SALLE/ROOM (1 & 4 étage/floor)

*13H30-15H15 (Présentation affiche-Poster presentation)

ICOM-Biochimie et physiologie/Biochemistry and physiology

*Jeudi 14 août 2003 et vendredi 15 août & Thursday August 14th and Friday August 15th 2003

(#594) *Interactions between mycorrhizal status, temperature and nutrient fertilisation on growth and nutrient status in a spring ephemeral, Erythronium americanum.*
Lapointe Line, Lerat Sylvain

(#217) *Defoliation Decreases Below-ground Allocation In Ectomycorrhizal Betula pubescens.*
Kuikka Karita, Markkola Annamari, Rautio Pasi, Roitto Marja, Tuomi Juha

(#422) *Carbon fluxes to arbuscular mycorrhizal mycelium and the impact of Collembola.*
Johnson David, Leake Jonathan, Read David

(#701) *Natural abundance stable isotope ratios support myco-heterotrophic nature and host-specificity of certain achlorophyllous plants.*
Trudell Steve, Rygiewicz Paul, Edmonds Robert

(#664) *Arbuscular mycorrhizal status influences rate and source partitioning of belowground respiration in sunflower microcosms.*
Langley Adam, Koch George, Hungate Bruce, Johnson Nancy

(#83) *Mycorrhiza-induced changes in partitioning and composition alters flower and vegetation production of floral geophytes.*
Scagel Carolyn

(#480) *The arginine translocation hypothesis: Advanced mass spectrometry for studying the uptake and assimilation of NH4+ in Glomus intraradices.*
Jakobsen Iver, Trujillo Carmen, Ambus Per, Requena Natalia, Egsgaard Helge

(#442) *Regulation of phosphate transport in the arbuscular mycorrhizal symbiosis*

Karandashov Vladimir, Nagy Réka, Amrhein Nikolaus, Bucher Marcel

(#268) *The identification and expression of putative homologues of nitrogen metabolic genes in Glomus intraradices.*
Govindarajulu M., Abubaker J., Pfeffer P.E., Allen J.W.B., Bücking H., Lammers P.J., Shachar-Hill Y.

(#199) *Uptake and Translocation of Radiocaesium by Arbuscular Mycorrhizal Fungi under Root Organ Culture Conditions.*
Dupré de Boulois Hervé, Delvaux Bruno, Renard Laurent, Declerck Stéphane

(#532) *Competitive Interactions between a Mycorrhizal-Defective Tomato Mutant and its Wild-type Progenitor.*
Smith Frank, Cavagnaro Timothy, Hay Gregory, Smith Sally

(#531) *Arbuscular Mycorrhizal Fungi can Dominate Phosphate Supply to Plants Irrespective of Growth Responses.*
Smith Frank, Smith Sally, Jakobsen Iver

(#51) *A new strategy for acquisition of P in arbuscular mycorrhiza: up-regulation of secreted acid phosphatase gene in the host plant.*
Ezawa Tatsuhiro, Hayatsu Masahito, Saito Masanori

(#191) *Expression of alkaline phosphatase genes in arbuscular mycorrhizal.*
Aono Toshihiro, Maldonado-Mendoza Ignacio, Dewbre Gary, Harrison Maria J., Saito Masanori

(#249) *Locating the site of DNA synthesis and measuring flux through the pentose phosphate pathway in an arbuscular mycorrhizal fungus.*
Lansing MI, Allen James W.B., Pfeffer Philip E., Jin Hairu, Shachar-Hill Yair

(#295) *The H+ATPase from Pisolithus tinctorius.*
Ontiveros-Valencia Aura, Guerra Guadalupe, Amora-Lazcano Enriqueta

(#60) *A dynamic study of chitinase and peroxidase in tomato plants mycorrhized with two glomal species.*
Perez-Ortega Eduardo, De la Noval Blanca, Rodríguez Yakelin

(#492) *Investigating Plant Sucrose Breakdown in Response to Arbuscular Mycorrhizal Fungi.*
Collier Shawn, Sengupta-Gopalan Champa

(#269) *The Effects of Glucose on Carbon Metabolism in Glomus Intraradices during Arbuscular Mycorrhizal Symbiosis.*
Govindarajulu M., Abubaker J., Pfeffer P.E., Bücking H., Lammers P.J., Shachar-Hill Y.

(#439) *Effect of two strains of Pisolithus tinctorius on Physiological Responses of Pinus Halepensis Plants under Different Soil Water Conditions.*
Morte A., Sanchez-Blanco M.J., Ferrandez T., Alarcon J.J., Honrubia M.

(#68) *A Perceived Role of Carbon and Water Management by Systemic Dark Septate Fungi in Bouteloua eriopida (Torr.) Torr. in an Arid Ecosystem.*
Barrow Jerry, Aaltonen Ronald

(#28) *Physiological Response of Tomato plants to the Combined Application of a Mycorrhizal inoculant (LicoMic) in Liquid Medium and a General Growth Stimulant (Fertiactyl GZ).*
Dell'Amico Jose Miguel, Fernandez Felix, Rodriguez Pedro, Lopez Luis Federico

(#26) *Involvement of Auxins and Abscisic Acid in Signaling During AM Symbiosis.*
Kaldorf Michael, Juttam Fitze Dorothee, Jentschel Kerstinm, Herrera Raulm, Ludwig-Müller

(#360) *Physiological Monitoring During Early Mycorrhization Events.*
Corrêa Ana, Martins-Loução Maria Amélia, Strasser Reto J.

(#602) *Phosphate Metabolism in the Association between Medicago truncatula and the Arbuscular Mycorrhizal Fungus Glomus intraradices Studied by in vivo 31p NMR Spectroscopy.*
Smith Sally, Vierek Nanna, , Jakobsen Iver, Cavagnaro Timothy, Smith Andrew

(#107) *Influence of two polycyclic aromatic hydrocarbons on spore germination of Gigaspora margarita.*
Alarcon Alejandro, Davies Jr. Frederick T., Ferrera-Cerrato Ronald

(#610) *Specific increase of 24-Methyl/Methylene sterols in arbuscular endomycorhizal roots grown in vitro.*
Grandmougin-Ferjani Anne, Fontaine Joël, Glorian Virginie, Durand Roger

(#331) *Mutualistic Symbiosis between the Root Endophytic Fungus Heteroconium chaetospira and Chinese Cabbage.*
Usuki Fumiaki, Narisawa Kazuhiko, Kakishima Makoto

(#313) *The Paxillus involutus / Betula pendula symbiosis: Microarray analyses of gene expression during nutrient acquisition.*
Wright Derek, Johansson Tomas, Le Quéré Antoine, Söderström Bengt, Tunlid Anders

(#573) *Influence of sterol biosynthesis inhibitor fungicides on arbuscular mycorrhizal symbiosis.*
Fontaine J., Lozanova E., Renard L., Bivort C., Grandmougin-Ferjani, A. , Durand R.

(#81) *Element storage in spores of Gigaspora margarita Becker & Hall measured by electron energy loss spectroscopy (EELS).*
Cruz Andre Freire

(#464) *Mycorrhizae Alter Fruit Quality By Repressing Ripening Genes in Tomato.*
Mena-Violante Hortencia, González-Castañeda Jaquelina, Saucedo-Arias Luis, Davies Fred, Gómez-Lim Miguel, Olalde-Portugal Víctor

(#393) *Effects of the environmental oestrogen-like endocrine-disrupting chemical Bisphenol A on the hyphal growth of Glomus intraradices.*
Coughlan Andrew P., Chênevert Robert, Piché Yves

(#745) *Chitin Content Influenced by Heavy Metals in Arbuscular Mycorrhial Fungal Spores.*
Gonzalez-Chavez Ma del Carmen Angeles, Sanchez-Viveros Gabriela, Xoconostle-Cazares Beatriz

(#578) *Is Partner Benefit Symmetric in Mycorrhizal Symbiosis?*
Kytöviita Minna-Maarit

(#693) *Arbuscular mycorrhizal fungi isolated from saline soils and their efficiency on lettuce plants (Lactuca sativa L.).*
Tapia-Goné José Jesús, Varela-Fregoso Lucía, López-Aguirre José Gerardo, Farias-Larios Javier

(#727) *Two Cryptosporiopsis species Form Functional Ericoid Mycorrhiza in Dutch Ericoid Plants and Are Able To Degrade Soluble Phenolics.*

Zijlstra Jantineke D., Verkley Gerard J.M., Baar Jacqueline, Summerbell Richard C., Berendse Frank

(#418) *The Effect of Different AM Fungi on Water Loss from Sorghum in a Split-Root System.*
Neri-Luna Cecilia, Seel Wendy E., Alexander Ian J.

(#445) *Self and non-self regulation by AM fungi and rhizobia colonizing alfalfa in a split-root system.*
Catford J.G., Staehelin C., Lerat S., Vierheilig H., Piché Y.

(#20) *Specific isoflavones as signals interconnecting arbuscular mycorrhizas, legume plant and rhizobia.*
Antunes Pedro, Rajcan Istvan, Goss Michael

(#751) *Elemental and Isotopic Partitioning in Ectomycorrhizal Systems under Exponential Growth.*
Hobbie Erik, Colpaert Jan

(#704) *Expression of the ammonium assimilating genes in the Suillus bovinus - Scots pine mycorrhizosphere*
Juuti Jarmo T, Jokela Sanna, Paulin Lars, Sen Robin

(#175) *Induction by AM Colonization of the Phytomedicinal Isoflavonoids in Red Clover*
Phelps Debbie, Charest Christiane

(#192) *Increase of polyphosphate content in the host plant roots during the colonization of arbuscular mycorrhizal fungi*
Ohtomo Ryo, Masanoi Saito

(#166) *Isolation of peptide transporters from the ectomycorrhizal fungus Hebeloma cylindrosporum by functional complementation of yeast*
Benjdia mariam, Rikirsch Enno, Zimmermann Sabine, Sentenac Herve, Chalot Michel, Frommer Wolf, Wipf Daniel

(638) *The fungal hypaphorine reorganises the actin cytoskeleton and abolishes the calcium gradient in Eucalyptus root hairs*
Dauphin Aurélien, De Richter Norbert, Emons Anne Mie, Lapeyrie Frédéric, , Legué Valérie,

SALLE/ROOM (1 & 4 étage/floor)

*13H30-15H15 (Présentation affiche-Poster presentation)

ICOM-Évolution, phylogénie et systématique/Evolution, phylogeny and systematics

*Jeudi 14 août 2003 et vendredi 15 août & Thursday August 14th and Friday August 15th 2003

(#354) *Phylogenetic Relationship of Different Strains of the Ectomycorrhizal Fungus Paxillus involutus*
Hedh Jenny, Schützendübel Andres, Erland Susanne

(#262) *Gene flow between populations of the mycorrhizal mushroom Cantharellus formosus Corner in the Central Cascades of Oregon.*
Collins Kelly, Dunham Susie, Cronn Rich, Molina Randy

(#280) *Phylogenetic studies of some hypogeous Pezizaceae species*
Ferdman Yael, Aviram Sharon, Roth-Bejerano Nurit, Kagan-Zur Varda

(#425) *Morphological, genetic and functional variation of ectomycorrhizal fungi in West African forests*
Bâ Amadou, Rivière Taina, Diédhiou Abdala, Dreyfus Bernard

(#358) *UNITE - a molecular database for the identification of ectomycorrhizal fungi*

Kõljalg Urmas, Larsson Karl-Henrik, Abarenkov Kessy, Nilsson Henrik , Erland Susanne, Alexander Ian, Vrålstad Trude, Taylor Andrews F.S, Kjöller Rasmus, Sen Robin

(#113) *Genetic diversity of Tuber melanosporum Vittad. populations*
Murat Claude, Diez Jesus, Mello Antonietta, Chevalier Gerard, Bonfante Paola, Martin Francis

(#375) *Ectomycorrhizal Associations of Larix laricina (Tamarack) and Betula glandulosa (Scrub Birch) Growing in Wetland Ecosystems of Central British Columbia*
Catherall Jennifer M, Massicotte Hugues B

(#266) *Ectomycorrhizas of Peat Swamp Forest Trees in Central Kalimantan*
Tamai Yutaka, Cha Joo-Young, Tawaraya Keitaro, Turjaman Maman, Shibuya Masato, Limin Suwido, Osaki Mitsuru

(#18) *Isolation and identification of ectomycorrhizal fungi from brown coal*
Münzenberger Babette, Hohensee Christiane, Weiss Michael, Oberwinkler Franz, Hüttl Reinhard

(#359) *Ectomycorrhizas of Gnetum africanum in Cameroon*
Tambe Eneke, Alexander Ian

(#146) *Linking fungi, ectomycorrhizae and host trees in the miombo woodland in Malawi.*
de Roman Miriam, Boa Eric, Meke Gerald

(#124) *comparison of ectomycorrhizal fungal communities based on root tips and soil hyphae*
Koide R.T., Xu B., Sharda J.N.

(#611) *Types of ectomycorrhizae in the canopy gaps in mixed beech-silver fir forest*
Grebenc Tine, Martin Maria P., Kraigher Hojka

(#529) *Concise Descriptions of North American Ectomycorrhizae*
Durall Daniel, Trofymow J.A., Berch Shannon

(#319) *Identification of ectomycorrhiza forming fungi and impact on birch and pine seedling growth in Icelandic soils.*
Oddsdottir Edda Sigurdis, Halldorsson Gudmundur, Leivsson Trondur, Eilenberg Jørgen, Harding Susanne, Nielsen Charlotte, Sen Robin

(#401) *Hypogeous fungi associated with Quercus garryana in southwest Oregon*
Southworth Darlene, Petersen Carolyn, Tugaw Heather, Berninghausen Harold

(#684) *Use of RFLP patterns to determine Cortinarius species groups*
Eberhart Joyce, Yoshinaga Aloha, Luoma Daniel

(#396) *Mycorrhizal fungi from neotropical Brazilian orchids*
Kasuya Maria, Catarina Megumi**,** Pereira Olinto Liparini, Rollemberg Christtianno de Lima, Borges Arnaldo Chaer, Araújo Elza Fernandes de

(#104) *Monophyly of Beta-Tubulin and H+-ATPase gene variants in Glomus intraradices: consequences for molecular evolutionary studies of AM fungal genes*
Corradi Nicolas, Kuhn Gerrit, Sanders Ian R.

(#201) *BiP gene sequences provide insight into AMF genome evolution and phylogeny*
Kuhn Gerrit, Hijri Mohamed, Sanders Ian R.

(#75) *Occurrence and Distribution of AM Fungi in Citrus Orchards of North-Western Himalayan Region of India Grown Under Diverse Management Systems*

Sharma Som Dev, Singh R P, Sharma Naveen

(#264) *Arbuscular Mycorrhizal Fungal Interactions with Saltcedar (Tamarix ramossissima)*
Beauchamp Vanessa, Stutz Jean

(#135) *Arbuscular mycorrhizal colonization of tree species grown in peat swamp forests of Central Kalimantan, Indonesia*
Tawaraya Keitaro, Takaya Yuichiro, Ishikawa Chiaki, Turjaman Maman, Tuah Sehat, Limin Suwido, Tamai Yutaka, Cha Joo, Wagatsuma Tadao, Osaki Mitsuru

(#207) Arbuscular Mycorrhizal Fungal Species Community in a Long-Term Field Experiment
Hijri Isabelle, Oehl Fritz, Ineichen Kurt, Maeder Paul, Wiemken Andres, Redecker Dirk

(#384) *Scanning Electron Microscopy of Spore Walls of Arbuscular Mycorrhizal Fungi.*
Bentivenga Stephen, Kleczewski Nathan, Purin Sonia

(#357) *Identification of Plant-Associated Fungal Spores and Spore-Like Organisms.*
Andrew Carrie, Landis Frank, Gargas Andrea

(#66) *Rapid, Reliable, and Inexpensive DNA Extraction of Arbuscular Mycorrhizal Fungi from Trypan Blue-Stained Roots.*
Ishii Satoshi , Loynachan Thomas

SALLE/ROOM (1 & 4 étage)

*13H30-15H15 (Présentation affiche-Poster presentation)

ICOM-Culture des champignons et production/Fungal cultivation and inoculum production

*Jeudi 14 août 2003 et vendredi 15 août & Thursday August 14th and Friday August 15th 2003

(#608) *Inoculum's Production for Teak Seedlings.*
Sambodo CorryTwn

(#582) *Premier Tech Research Report: In situ efficacy experimentation.*
Roy Geneviève, LeQuéré Dominique, Klironomos J.N., Lafontaine P., Moutoglis P.

(#537) *Assessing the infectivity and effectivity of commercial mycorrhizal inoculants in plant nursery conditions*
Corkidi Lea, Allen Edith, Merhaut Don, Downer James, Allen Michael, Bohn Jeff, Evans Mike

(#155) *Evaluation of (AM) mycorrhizal inoculum on the yield of maize plants under field conditions.*
Aboul-Nasr Amal, El-Fayoumy Mohamed

(#483) *Effects of an AM fungus and two fluorescent pseudomonads on tomato growth, root development and phosphorus accumulation.*
Berta Graziella, Gamalero Elisa, Pivato Barbara , Massa Nadia, Copetta Andrea, Trotta Antonio,

(#515) *Effect of Arbuscular Mycorrhizal Fungi and Organic Fertilizer on Photosynthesis, Growth, Nutrient Uptake and Root Phosphatase Activity of Ipomoea Carnea subsp. Fistulosa.*
Davies Fred T., Amaya-Carpio Lucila, Fox Theodore, Cartmill Andrew, Arnold M. A., He Chuanjiu

(#110) *The effectiveness of a Mexican endogenous arbuscular mycorrhizal fungi consortium on two cultivars of Carica papaya L. depends on the interaction of its own three fungal components*
Ferrera-Cerrato Ronald, Alarcon Alejandro

(#328) *Ecophysiology of Gnaphalium norvegicum: impact of fungal inoculation at two temperatures.*
Ruotsalainen Anna Liisa, Kytöviita Minna-Maarit

(#324) *Response of Norway Spruce Seedlings to Ectomycorrhizal Inoculation at the Nursery.*
Pennanen Taina, Müller Michael, Rikala Risto, Korkama Tiina, Tammi Hanna, Timonen Sari, Garbaye Jean

(#57) *Inoculation effect of Scleroderma columnare on Shorea seminis growth and its effectiveness under different dosages of charcoal.*
Tata M.Hesti, Prameswari Diana

(#477) *Ectomycorrhizal inoculation of containerized Pinus montezumae seedlings with spores of three different fungus isolates.*
Amora-Lazcano Enriqueta, Ortiz-Obregon Ana Paola, Cigarrero Celerino, Varela Lucia

(#148) *Spread of an inoculant strain of the ectomycorrhizal fungus Pisolithus from an experimental plantation of Quercus suber (cork-oak) to other local hosts.*
Muriel Ana, Diez Jesus,

(#386) *Spore Inoculation of Pinaceae with Ectomycorrhizal Edible Fungi in Mexico.*
Perez-Moreno Jesus, Martinez-Reyes Magdalena, Carrera-Nieva Alicia, Aldrete Arnulfo, Cetina-Alcala Victor Manuel

(#89) *Responses of highbush blueberry (Vaccinium corymbosum) to inoculation with ericoid mycorrhizal fungi depends on fertilizer type, fungal isolate, and plant genotype.*
Scagel Carolyn

(#195) *A new mode of mass inoculum production of arbuscular mycorrhizal.*
Tiwari Pragati, Prakash Anil , Adholeya Alok

(#25) *Development of a Liquid Glomus fasciculatum inoculant.*
Fernández Felix, Dell´amico José Miguel, Cabrera Yunieski

(#349) *Application of Fertigation Technology and Oxygen Injection to Glomus intraradices Inoculum Production.*
Camprubi Amelia, Estaun Victoria, Calvet Cinta, Marfa Oriol, Caceres Rafaela

(#440) *Multivalency of AMF root-organ culture in research and development.*
Dalpé Yolande, Séguin Sylvie, Bivort Céline, Declerck Stéphane

(#731) *Peptides as new growth stimulants for arbuscular mycorrhizal fungi.*
Ishii Takaaki, Horii Sachie, Kuramoto Makoto, Matsumura Atsushi

(#294) *In vitro arbuscular mycorrhizal sporulation enhancement using calcium carbonate as media amendment.*
Prakash Anil, Tiwari Pragati, Adholeya Alok

(#212) *Morphological responses of an arbuscular mycorrhizal fungus to exudates from a transformed carrot root in a tri-compartmental root-organ culture system.*
Cranenbrouck Sylvie, Bivort Céline, Corbisier Anne-Marie, Declerck Stéphane

(#576) *Surface-disinfection of AMF spores and relationship with the external spore wall ornamentation.*

N'Gamo Tinkeu Léonard, Declerck Stéphane

(#574) *Establishment of monoxenic culture between the arbuscular mycorrhizal fungus Glomus sinuosum and Ri T-DNA-transformed carrot roots.*
Bi Yinli, Li Xiaolin, Wang Honggang, Christie Peter

(#257) *New aspects of mycorrhization on micropropagation of potato plant (Solanum tuberosum L. Var Alfa).*
Fernández Kalyanne, Fernández Félix, Rivera Ramón, Olalde Víctor, Frias Juan T.

(#216) *Effects of Agar Media pH and Nutrient Composition on the Inoculum Production of Five Ectomycorrhizal Fungi in Pure Culture.*
Lamosa Quinteiro Santiago, Fernández de Ana Magán Francisco, Iglesias Díaz Isabel, Rodríguez Rodríguez Antonio

(#282) *Mycorrhiza formation by hairy root clones with Terfezia boudieri isolates.*
Roth-Bejerano Nurit, Kagan-Zur Varda, Mills david, Zaretzky Mariana

(#281) *Differences between hairy root clones and fungal isolates in forming mycorrhizas.*
Kagan-Zur Varda, Roth-Bejerano Nurit

(#419) *Isolation, culture, and conservation of edible ectomycorrhizal fungi with mediterranean ecotypes of particular ecologic and economic value.*
Díez Julio, Olaizola Jaime, Oria de Rueda Juan Andrés, Pajares Juan

15H15-15H30 PAUSE CAFÉ/COFFEE BREAK (1 & 4 étage/floor)

SALLE/ROOM 1 (4 étage/floor)

15H30-177H45 **SYMPOSIUM 11**
ICOM -Processus de transport chez les mycorhizes / Transport processes in mycorrhizas
ORGANISATEURS ET MODÉRATEURS / ORGANIZERS AND CHAIRS: UWE NEHLS & DANIEL WIPF

15h30 – 16h15 Conférencière majeure/Major speaker: **Harrison Maria**
(#507) Toward an understanding of the molecular mechanisms underlying phosphate transport in the AM symbiosis.

16h15 – 16h45 Présentation/Lecture 1: **Nehls Uwe**, Grunze Nina,Willmann Martin, Bock Andrea
(#59) Sugars: a signal for adaptations of plant and fungal physiology in ectomycorrhizas.

16H45 – 17h15 Présentation/Lecture 2: **Shachar-Hill Yair,** Abubaker J, Allen JWB, Bago B, Bucking H, Douds DD Jr, Govindarajulu M, Jin H, Jun J, Lammers PJ
(#275) Nitrogen and carbon metabolism and transfer in the AM symbiosis.

17H15 – 17h45 Présentation/Lecture 3: Chalot Michel**, Morel Mélanie**, Javelle Arnaud, Brun Annick
(#760) **Molecular physiology of nitrogen assimilation in ectomycorrhizas.**

SALLE/ROOM 2 (4 étage/floor)

15H30-18H00 **SYMPOSIUM 12**
ICOM – L'aspect industriel des mycorhizes/The industrial side of mycorrhizal fungi

ORGANISATEUR ET MODÉRATEUR / ORGANIZER AND CHAIR : PETER MOUTOGLIS

15H30 – 16H15 Conférencier majeur/Major speaker: **Gianinazzi Sylvio**, Vosatka Miroslav
(#527) Mycorrhizal inocula for agricultural systems : achievements and perspectives.

16H15 – 16H45 Présentation/Lecture 1: **Vosatka Miroslav**
(#428) Mycorrhizal inoculations for land reclamation, including contaminated soils.

16H45 – 17H15 Présentation/Lecture 2: **Moutoglis Peter**, Béland Marc, Talbot Pierre, Gagné Serge,
(#614) Challenges in commercializing AM inocula in the retail market.

17H15 – 17H45 Présentation/Lecture 3: **James Quinn**
(#772) Commercial challenges of ectomycorrhizal fungi.

SALLE/ROOM C & D (1 étage/floor)

15H30-17H30 (Présentation orale-Oral presentation)

ICOM-Évolution, phylogénie et systématique/Evolution, phylogeny and systematics

MODÉRATEUR / CHAIR: RICHARD HOGUE

15h30 – 15h45 (#463) Fine scale genetic structure analysis of *Cenococcum geophilum* reveals putative cryptic species
Douhan Greg W., Rizzo David M.

15H45 – 16H00 (#351) *Galaxie – a CGI script for sequence identification through automated phylogenetic analysis*
Nilsson R. Henrik, Larsson Karl-Henrik, Ursing Björn M.

16H00 - 16H15 (#153) *Mycorrhizal symbionts of European orchids (Neottieae) show unexpected diversity and suggest a partial mycoheterotrophy.*
Selosse Marc-André, Julou Thomas Bonfante Paola, Mello Antonietta

16h15 – 16H30 (#225) *A multi-gene approach to studying the phylogeny of the arbuscular mycorrhizal fungi.*
Helgason Thorunn, Young Peter

16H30 – 16h45 (#204) *Evolution of Arbuscular Mycorrhizal Fungi: New Insights from Molecular Phylogeny and Molecular Ecology.*
Redecker Dirk

16h45 – 17H00 (#283) *Phylogeny and Evolution of the genus Gigaspora based on inter and intra-species 18S rDNA heterogeneity.*
de Souza Francisco A Leeflang Paula, **.**, Smit Eric, Kowalchuk George A.

17H00 – 17h15 (#14) *Odd mycorrhizas: Evolution shapes VAM colonization pattern*
Imhof Stephan

17h15 – 17H30 (#160) *A long term drift experiment: are AMF's parasexuals?*
Ehinger Martine, Koch Alexander, Sanders Ian

SALLE/ROOM A&B (1 étage/floor)

15H30-17H30 (Présentation orale-Oral presentation)

ICOM-Biochimie et physiogie/Biochemistry and physiology

MODÉRATEUR / CHAIR : YVES PICHÉ

15h30 – 15h45 (#137) *Root Factors Induce Mitochondrial-Related Gene Expression and Fungal Respiration during the Developmental Switch from Asymbiosis to Presymbiosis in the Arbuscular Mycorrhizal Fungus Gigaspora rosea*
Tamasloukht M'Barek, Séjalon-Delmas Nathalie, Kluever Astrid, Jauneau Alain

15h45 – 16h00 (#255) *In Vitro Study on the Active Role of an AM Fungus in Nitrogen Uptake and Transfer to Roots*
Toussaint Jean-Patrick, St-Arnaud Marc, Charest Christiane

16h00 – 16h15 (#261) *Extractable Soil Water and Transpiration Rate of Mycorrhizal Corn*
Al-Agely Abid, Wahbi Ammar

16h15 – 16H30 (#378) *Identification of symbiosis-specific 'AM-fungal' genes with Geosiphon pyriformis*
Martin Holger, Schüßler Arthur

16H30 – 16H45 (#121) *Blue Light Photoreceptors and Hyphal Branching Sites of an Arbuscular Mycorrhizal Fungus*
Nagahashi Gerald, Douds Jr David

16H45 – 17H00 (#306) *Defoliation of Neighbour Increases Mycorrhizal Benefit of Seedlings*
Pietikäinen Anne, Kytöviita Minna-Maarit

17h00 – 17H15 (#424) *Molecular Biology of Phosphate Transport at Mycorrhiza Interfaces*
Bucher Marcel

17h15 – 17h30 (#237) *Regulation of Transfer Processes in the Symbiosis - Comparative Studies on Ectomycorrhizal and Arbuscular Mycorrhizal Associations*
Bücking Heike, Heyser Wolfgang, Shachar-Hill Yair

SOUPER CROISIÈRE ICOM
ICOM DINNER CRUISE
19H00-0h00
"Cavalier Maxim"

Vendredi 15 août 2003/Friday August 15th 2003

07H00-17H00 Bureau des inscription/Registration desk

SALLE/ROOM 1 (4 étage/floor)

08H30-09H15
Plénière/Plenary
Prof. Wang Yun
Crop & Food Research, New Zealand

(#58) Edible mycorrhizal mushrooms: challenges and achievements

09H15-09H45 PAUSE CAFÉ/COFFEE BREAK (4e étage/floor)

SALLE/ROOM 1 (4 étage/floor)

09H45-12H00 **SYMPOSIUM 13**
ICOM - Interactions dans la mycorhizosphère et agent de contrôle biologique des parasites / Interactions in the mycorhizosphere and biocontrol of pathogens
ORGANISATEUR ET MODÉRATEUR / ORGANIZER AND CHAIR : JOHN LARSEN

9h45 – 10h30 Conférencier majeur/Major speaker: **Whipps John**
(#91) Prospects and limitations for mycorrhizas in biocontrol against root pathogens.

10h30 – 11h00 Présentation/Lecture 1: **Graham James**
(#227) New models for mycorhizosphere interactions.

11h00 – 11h30 Présentation/Lecture 2: Calvet Cinta, **Estaún Victoria**, Camprubí Amèlia, García-Figueres Francesc, Pinochet-Brieva Jorge
(#347) Use of arbuscular mycorrhizae in the control of nematode and fungal root rot diseases in perennial crops.

11h30 – 12h00 Présentation/Lecture 3: **Filion Martin**, Jabaji-Hare Suha H., St-Arnaud Marc
(#163) Brushing a portrait of mycorrhizal-microbial interactions : an impressionist approach.

SALLE/ROOM 2 (4 étage/floor)

09H45-12H00 **SYMPOSIUM 14**
ICOM - Mycorhizes et écosystèmes / Mycorrhizae and ecosystems of the world
ORGANISATEUR ET MODÉRATEUR / ORGANIZER AND CHAIR : JOHN KLIRONOMOS

9h45 – 10h30 Conférencier majeur/Major speaker: **Read David**
(#771) Mycorrhizal fungi as drivers of ecosystem processes in the heathland and boreo-temperate forest biomes of the world.

10h30 – 11h00 Présentation/Lecture 1:. **Johnson Nancy C.**
(#644) Temperate grassland ecosystems.

11h00 – 11h30 Présentation/Lecture2: **Allen Michael**, Allen Edith
(#111) Temperate and tropical dry ecosystems.

11h30 – 12h00 Présentation/Lecture 3: **Alexander Ian J.**, Lee Su See
(#332) Mycorrhizas and ecosystem processes in tropical rain forest.

SALLE/ROOM C & D (1 étage/floor)

09H45-12H30 Présentation orale-Oral presentation)

ICOM-Culture des champignons et production d'inoculum/Fungal cultivation and inoculum production

MODÉRATEURS / CHAIRS : SERGE GAGNÉ & MARIO JOLICOEUR

9H45 – 10h00 (#308) *Production, application and regulation of commercial AMF inoculants in agriculture*
Blal Bachar, Parat Jean

10h00 – 10h15 (#407) *Monitoring inoculated AM fungi in field plants using 25S rDNA-targeted nested PCR*
Zhao Bin, Zheng Shixue, Dong Xiuli

10h15 – 10h30 (#441) *Competition between mycorrhizal fungi: commercial inoculum vs. greenhouse contaminants*
Campagnac Estelle, Coughlan Andrew, Fung Martin, Khasa Damase

10h30 – 10h45 (#572) *Successful mature pine inoculation with Tricholoma matsutake*
Guerin-Laguette Alexis, Matsushita Norihisa, Suzuki Kazuo, Lapeyrie Frédéric

10h45 – 11h00 (#479) Use of mycorrhizal inoculum in propagation of the Australian native Epacris impressa Labill. (Ericaceae)
Conomikes Melanie, McLean Cassandra, Starrett Mark

11h00 – 11h15 (#320) *Development and physiological status of in vitro propagated Rhododendron plants inoculated with mycorrhiza during acclimatisation*
Matysiak Bo¿ena

11h15 – 11H30 (#730) *Improvement of axenic culture of arbuscular mycorrhizal fungi*
Ishii Takaaki, Yachi Yoshinobu, Oida Kouji, Atsushi Matsumura, Atsushi Horii Sachie

11h30 – 11h45 (#119) *Isolated Root Caps, Border Cells, and Mucilage from Host Roots Stimulate Hyphal Branching of an Arbuscular Mycorrhizal Fungus*
Nagahashi Gerald

11H45 – 12h00 (#723) Detection and Partial Purification of a Branching Factor from Root Exudates of Lotus japonicus
Akiyama Kohki, Matsuzaki Ken-ichi, Hayashi Jideo

12h00 – 12h15 (#229) Towards Growth of Arbuscular Mycorrhizal Fungi Independent of a Plant Host
Hildebrandt Ulrich, Bothe Hermann

12h15 – 12H30 (#303) Effects of Sugars on In vitro Growth of Cistus incanus Hairy Roots and of Tuber melanosporum Mycelium
Ventura Yvonne, Mills David, Kagan-Zur Varda, Bustan Amnon, Roth-Bejerano Nurit

SALLE/ROOM A&B (1 étage/floor)

09H45-12H30 Atelier/Workshop

ICOM-Morphogénese et physiologie des basidiocarpes de champignons ectomycorrhiens/Morphogenesis and physiology of ectomycorrhizal fungi basidiomes
MODÉRATEUR / CHAIR : J. A. FORTIN

12H30-13h30 🍽 LUNCH 🍽

SALLE/ROOM (1 & 3 étage/floor)

***13H30-15H30 (Présentation affiche-Poster presentation)**
ICOM-Biodiversité/Biodiversity
ICOM-Stress et pathologie/Stress and Pathology
ICOM-Écologie et écosystème/Ecology and ecosystems
ICOM-Biochimie et physiologie/Biochemistry and physiology
ICOM-Évolution, phylogénie et systématique/Evolution, phylogeny and systematics
ICOM-Culture de champignons et production d'inoculum/Fungal cultivation and inoculum production
—Voir jeudi pour les details/See Thursday for more details—

15H30-15H45 PAUSE CAFÉ/COFFEE BREAK (4 étage/floor)

SALLE/ROOM 1 (4 étage/floor)

15H45-17H00 Plénière ICOM4 / Plenary ICOM4

Conception et mise en page par :
Justine Héroux et toute l'équipe du Bureau des Congrès Universitaires/
Creation and Text editing by :
Justine Héroux and Bureau des Congrès Universitaires team

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RÉSUMÉS/ABSTRACTS

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(# 10) Detecting the heavy metal tolerance level and the metal uptake profile of some ectomycorrhizal fungi.

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Seven isolates of ectomycorrhizal fungi Laccaria fraterna (EM-1083), Laccaria laccata (EM-1191), Pisolithus tinctorius (EM-1081), Pisolithus tinctorius (EM-1293), Scleroderma cepa (EM-1233), Scleroderma flavidium (EM-1235), Hysterangium incarceratum (EM-1185) were grown on specially designed cocktail media prepared by adding various concentrations of different heavy metals, namely, Al, As, Cd, Cr, Ni and Pb. The heavy metals were selected keeping in mind their relative abundance in coal ash and potential toxicity. The fungal isolates were grown on increasing concentrations of heavy metals on such designed cocktail media. The colony diameter was used as fungal growth measurement Absorbed and adsorbed heavy metal in the mycelia was assayed by atomic absorption spectrophotometry. Hysterangium incarceratum (EM-1185) showed maximum tolerance to the heavy metals tested with respect to growth, absorbed and adsorbed heavy metal concentration by the mycelia. Laccaria fraterna (EM-1083) and Pisolithus tinctorius (EM-1293) also showed considerable tolerance to the heavy metals tested.

(# 11) Arbuscular mycorrhiza dependent characterization of drought stress impact on rose-plant vitality probed by visual scoring and chlorophyll-a-fluorescence

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Drought stress tolerance can be increased through arbuscular mycorrhiza (AM). In our experiments the relevance of selected isolates of Glomus intraradices as biocontrol organisms in the production of micropropagated roses was investigated.

Mycorrhizal plants showed less severe drought damage (assessed by data from visual scoring) than non-mycorrhizal plants did. The chlorophyll-fluorescence-analysis (JIP-test, Strasser 2000) proved to be a reliable tool for detailed recording of the physiological changes during stress impact and recovery phase. Parameters obtained from the fluorescence-kinetics qualified the extent and physiological basis of the observed stress tolerance. By this, the effect of drought stress on photosynthetic performance in mycorrhizal plants could be derived. The implemented "Performance Index" was utilized as a parameter of vitality. For detailed physiological information it was deconvoluted into basic parameters, e.g. numberof reaction centres per leaf area, energy needed to reduce the plastochinone pool, etc.Under drought stress impact, mycorrhiza led to a more intense electron flow and more productive photosynthetic activity at several sites of reaction in photosystem (PS) II and PS I. Plant activity was stabilised and enhanced by AM fungi (AMF), resulting in increased vitality under suboptimal conditions and improved recovery potential.

In sustainable horticulture the early implementation of selected AMF in rose plant production can contribute to maintain or enhance plant vitality and plant performance under adverse water supply. Furthermore the results emphasise the suitability of the JIP-test for stress detection at different stages ofplant reaction and plant development.

(# 12) Investigations on the bio-protection potential of ericoid mycorrhiza against root pathogens of Rhododendron

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The physiological benefits of ericoid mycorrhizal fungi (ERMF) for their ericaceous hosts were investigated mainly under ecological aspects. However, there is a striking lack of phyto-pathological knowledge about a potential bio-protection effect in plants under biotic stress. According to the principle of active protection mechanisms of ectomycorrhizas as well as of arbuscular mycorrhizas, we test the hypothesis of a shelter function also of ericoid mycorrhiza towards root pathogens. First results on the bio-control potential of ericoid mycorrhizal iso-lates against Phytophthora spp. are presented: To set up a collection of mycorrhizal isolates for bio-control screenings we isolated autochthonous ericoid fungal isolates from commercial substrate for Rhododendron culture. From a total of 82 isolates 35 slowly growing ones with brown, septate mycelium and colony features similar to Hymenoscyphus ericae or Oidiodendron spp. were selected for re-infection assays with micropropagated Rhododendron plantlets in sterilised substrate. Thirty one out of 35 tested isolates caused typical mycorrhizal structures in hair roots. In agar-plate dual-cultures with fungal root pathogens, several autochthonous isolates and strainsof Oidiodendron spp. produced fungistatic effects: 19 out of 39 autochthonous isolates caused growth inhibition or reduction in hyphal spread of P. cactorum; 10 out of 39 isolates were antagonistic towards P. cinnamomi. Mycelium of P. cinnamomi was altered in structure (e.g. multiple protrusions, excessive branching) and chlamydospores were often disintegrated. Whether these interactions are expressed in planta and can be used in plant production systems needs to be confirmed in pot trials.

(# 13) Mycorrhiza of Viola tricolor L. and Plantago lanceolata L. as Indicator of Succession Tendencies

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Viola tricolor and Plantago lanceolata have been recorded from several zinc wastes in Southern Poland. The succession of plants on mine wastes is very slow, started with nonmycorrhizal plants followed bymycorrhizal ones. A part of the post-flotation waste of the Boleslaw plant, the main observation area of the presented research, was covered subsequently with substratum excavated from the Pomorzany mine. Both substrata were similarly toxic; however, the one from Pomorzany was richer in nitrogen, phosphorus and was characterized by higher water holding capacity. The vegetation cover on this part was more dense, but less diverse. These differences were especially visible during hot summer months, when most plants from the sediment had dried out and the plants on Pomorzany still survived. Spore number and vitality were higher in Pomorzany. Estimation of mycorrhiza parameters showed that both species were strongly mycorrhizal, but in V. tricolor mycorrhizal colonization and arbuscule richness were higher in samples collected from the sediment, while in P. lanceolata it was opposite. This research suggests that mycorrhiza of these plant species might react in a different way to soil conditions. However, the development of mycorrhiza cannot be considered as a sole panaceum for speeding up succession. Other parameters such as fertility and improvement of water holding capacity have to be considered and optimized. Plants such as V. tricolor and P. lanceolata can be important for entrapment of useful AMF strains and subsequent production of inoculum used for revegetation of heavy metal rich soils or substrata.

(# 14) Odd mycorrhizas: Evolution shapes VAM colonization pattern

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The existence of aberrant colonization pattern of vesicular-arbuscular mycorrhizal fungi (VAMF), particularly found in achlorophyllous plants, is little known, and the structural plasticity of VAM is widely underestimated. This presentation gives an introduction to several of those odd mycorrhizas, andexplains them as advanced stages of an evolutionary progression. Mycoheterotrophic plants essentially depend on their root fungus. Therefore the evolutionary pressure on mycorrhizal efficiency should have been hardest here. In fact, each of the three plant families considered here show specific mycorrhizal adaptations, including morphology of the root/rhizome system as well as the fungal colonization pattern. The most progressive stages are represented by 1. the Gentianaceae Voyria tenella, where fungal colonization proceed from the inner toward the outer cortex (!), 2. the Triuridaceae Sciaphila polygyna, having a dorsiventral mycorrhizal root, and 3. the Burmanniaceae Afrothismia winkleri, likely to have the most complex mycorrhiza known so far. Althoughdifferently accomplished, they all show a clump-like root/rhizome system, combined with a high degree of mycorrhizal complexity. Structurally and functionally distinct tissue compartments, where the fungus attains different appearances, allow a sustained benefit from the fungus, by keeping it alive in one compartment, while digesting it in another. Beyond that, Afrothismia winkleri even employs the fungus for several other purposes, like storage, transportation and distribution of matter.Considering all VAM colonization pattern known so far, we may arrange them according to evolutionaryprogression from the intercellular Arum-type, over intermediate types to the intracellular Paris-type, and from there to the various forms of more complicated mycorrhizas in achlorophyllous species, differently accomplished in Gentianaceae, Burmanniaceae and Triuridaceae.

(# 15) Ecology and diversity of AM fungi in two forest of Assam

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A two year intensive bimonthly investigation was made on the ecology and diversity of the AM fungi in two tropical mixed forests of Assam. Infection percentage, number of propagules as spores, diversity of species (species richness, evenness and dominance) were determined in ten different tree species selected in each of the two forests on the basis of dominance and economic importance. All the trees showed mycorrhizal infection with Paris type as dominant type. Marked seasonal variation was observed in the distribution of AM fungal spores. Altogether 46 species were isolated. Glomus spp dominated both sites. These species have been maintained on Rhodes grass using single spore culture technique.

(# 17) Application of Mycorrhizal Grasses from Wetlands in Stabilisation of Zinc Wastes

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Heavy metal ore processing results in numerous waste heaps and sedimental tanks. Toxic components of deposited wastes: thallium, cadmium or arsenic constitute a hazard to local environment and human health. Phytostablisation, including the creation of a dense plant cover, is the best choice to overcome wind erosion. Selection of plants for this aim should consider plants native from such areas. Grasses such as Molinia coerulea were among the most expansive plants on zinc wastes in Poland. They originated from the wetlands presently occupied by sedimental tanks. Under wet conditions the formation of mycorrhiza by these species is limited; however, under periodically extremely dry conditions of the wastes it is usually well developed. Freshly deposited wastes lack arbuscular mycorrhizal fungi (AMF); establishing of sufficient fungal population takes 20-30 years. AMF introduced simultaneously with grasses into such environments accelerates the creation of the plant cover and stimulates beneficial soil-forming microbes. In spring 2002 experimental plots have been established for introduction of grasses and AMF inoculum. Mycorrhizal plants showed improved survival and vigor in comparison to control. Additionally, the use of AgroHydrogel® enhanced the water holding capacity of the substratum; however, it also increased the frequency of parasitic fungi destroying AMF structures. In the first year of the experiment, a dense web of plant roots and fungal mycelium has immobilised the substratum. Further research will result in designing the optimal strategy for zinc waste reclamation. PCR-based methods will serve to select the most efficient AMF taxa among these occurring on such sites.

(# 18) Isolation and identification of ectomycorrhizal fungi from brown coal

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Related to a comprehensive investigation of the ecology of post-mining areas in the Lusatian lignite district of eastern Germany, fungal hyphae were detected in pieces of brown coal. From this observation the hypothesis was established that ectomycorrhizal fungi might play a functional role in weathering of brown coal. A first step to verify this hypothesis was to isolate and identify ectomycorrhizal fungi from brown coal pieces. Therefore, four to six week old seedlings of Pinus sylvestris L. were planted in Petri dishes filled with Modified-Melin-Norkrans agar together with fingernail sized pieces of coal. In this “trap-culture” experiment the fungi grew out from the coal and formed ectomycorrhizas with Scots pine. We succeeded to isolate three fungal species and sequenced the ITS region and the large subunit D1/D2 region of the nuclear rDNA. BLAST searches in GenBank retrieved D1/D2 sequences of Wilcoxina mikolae, Amphinema byssoides and Hymenoscyphus ericae as most similar to the respective sequences of our isolates. A. byssoides and the E-strain fungus W. mikolae were previously found on recultivation sites of this lignite mining district. H. ericae is a fungus that forms ericoid mycorrhizas with members of the Ericaceae. However, H. ericae is probably identical to Piceirhiza bicolorata, a fungus also forming ectomycorrhizas. These findings will be discussed in the context of the function of these special morphotypes.

(# 20) Specific isoflavones as signals interconnecting arbuscular mycorrhizas, legume plant and rhizobia

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Legumes form symbioses with arbuscular mycorrhizal fungi (AMF) and rhizobia. Beneficial effects for the plant due to the interaction between symbionts have been assumed to rely on increased P supply to the plant by the mycorrhizas. Recently, we demonstrated that P does not regulate the tripartite symbiosis. Isoflavones, appear to play a role as early signals for both rhizobia and AMF. In the present study, four soybean varieties known to have different concentrations of the isoflavones genistein, daidzein and glycitein in the seed were used to test two hypotheses. First, that isoflavones control the establishment of the tripartite symbiosis between soybean-bradyrhizobia-AMF and, second, that an increase in isoflavone activity resulting from the development of one microbial partner can stimulate colonization of soybean roots by the other. Since disrupting the extra-radical mycelium network reduces the potential for AMF colonization, a disturbed versus an undisturbed soil treatment was produced to vary the rate of AMF colonization of soybean. The potential for bradyrhizobia was identical for both treatments by planting germinated seeds onto the same amount of peat-based inoculant. The concentration of isoflavones expressed by roots and shoots of soybean varieties at ten days after emergence as a response to indigenous AMF colonization was analysed, while the development of the mycorrhizal and nodulating processes either separately or in context of a tripartite symbiosis was followed. Nitrogen fixation is favoured in the presence of a greater mycorrhizal potential and specific isoflavones are believed to act as signals. Early results are consistent with the hypotheses.

(# 21) Arbuscular Mycorrhiza, heavy metal and salt tolerance

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The Central European endemic zinc violet of heavy metal soils has been shown to be AMF colonized in dependence of the heavy metal stress. A Glomus intraradices isolate from the zinc violet confers heavy metal tolerance to diverse plants in diverse heavy metal soils. Northern analyses and in situ hybridizations showed that the transcript levels of plant genes involved in heavy metal tolerance are down-regulated in the symbiosis. It is suggested that the corresponding fungal gene products overtake the functions in the symbiosis. Plants of diverse salt marshes are AMF colonized, and most of their sporesbelong to the Glomus geosporum clade. Upon salt stress, the expression of plant aquaporines, but not ofthe sodium/proton antiporter, are down-regulated. It is suggested that AMF alleviate drought stress in the diverse salt marshes irrespectively of the salt composition of the soils.

(# 22) Detoxification of ferulic acid by ectomycorrhizal fungi.

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The ectomycorrhizal fungi Laccaria amethystina and Lactarius deterrimus grown in liquid culture were used to study the fate of added ferulic acid. L. amethystina degraded ferulic acid to the major metabolite vanillic acid. The intermediate vanillin was not detected. L. deterrimus showed a completely different detoxification pattern. Two dimers and one trimer of ferulic acid could be identified as polymerization products of this fungus. A bioassay of the possible biological activities of ferulic acid and vanillic acid on these fungi revealed that vanillic acid was less toxic than ferulic acid for L. amethystina but that both phenolic acids were toxic for L. deterrimus. The results are discussed with respect to ectomycorrhizal fungal growth in the organic layer of forest soils and between living root cells of ectomycorrhizas.

(# 23) Occurrence and distribution of AM fungi in apple orchards of Himachal Pradesh(India)

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These studies were carried out in apple orchards of Kullu and Shimla districts of Himachal Pradesh (INDIA) to determine the occurrence and distribution of various species of AM fungi and to assess their relationship with plant growth, fruit yield, soil and foliar nutrient status of apple trees. This survey of apple orchards has revealed the occurrence of fourteen differrent indigenous AM species. These include Glomus, Gigaspora, Entrophospora, Scutellospora and Acaulospora. Glomus species widely occurred in all the orchards selected. Among these, spore population of Glomus fasciculatum was highest, followed by those of G. mosseae and G. macrocarpum. Simple linear correlation studies were also worked out between all the possible combinations. It indicates that AM spore number and per cent root colonization showed positive and significant relationship with plant growth and fruit yield. The interrelationship was positive with soil pH , available P , Cu , Mn, Zn and Fe contents. Similarly, the leaf nutrient contents were correlated. However, the correlation with K was negative.

(# 25) Development of a Liquid Glomus fasciculatum inoculant

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Three tests were carried out, with the objective of studying resistance, viability and effectiveness of a Glomus fasciculatum liquid inoculant. First of all, an experiment was carried out, in order to study spore resistance to Glomus fasciculatum in different liquid formulations, by means of counting daily and every 30 days, during eight months. Later, viability tests were applied to in vitro transformed rootlets from the best formulation, finally, its effectiveness was studied through an experiment based on a liquid inoculation of tomato plants. As controls, a non-inoculated fertilized treatment and a commercial solid mycorrhizal product, which was sticked to the seeds, were used. In the first two tests (measures of spore number and germination percentage) were made and, in the last test, grow and yield samplings, as well as physiologicals measurements were carried out. The spores population had great stability in one of the liquid treatments; and it was found a viable appearance in 100% of the propagules during all the experiment (eight months). However, in the control treatment using water, the number of propagules decreased by half, 48 hours after incubation. The results of in vitro germination of spores stored for eight months, were positive. An effective germination and colonization of transformed carrot little seeds were achieved. Efficiency tests on tomato showed good results as well. There were statistics differences in mycorrhizal colonization, according to crop phenophase and variants of inoculant studied,the highest fungal values being reached at tomato fruiting stage. The higher physiological activity, expressed as the highest values of leaf water potential, hydraulic conductance and efficiency, parameter related to greater efficiency of plant development were always associated to the liquid inoculant. Nowadays, this inoculant is in a scald phase, for its use in irrigation systems.

(# 26) Involvement of Auxins and Abscisic Acid in Signaling During AM Symbiosis

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Plant hormones are suitable candidates to function as continuous signals between roots and arbuscular mycorrhizal (AM) fungi during the establishment of symbiosis. In maize roots inoculated with Glomus intraradices, an increase in indole-3-butyric acid (IBA) but not indole-3-acetic acid (IAA) was observed during early stages of colonization which coincided with an increased number of lateral roots. In contrast, inoculation of nasturtium (Tropaeolum majus) did not result in such a distinct root phenotype, probably due to a different root morphology. IAA, IBA and phenylacetic acid (PAA) were detected as endogenous auxins in nasturtium. Ten days post inoculation (dpi), IAA and IBA were lower in infected than in control roots, whereas 20 dpi, the content of both auxins was higher in infected roots. On the contrary, the PAA concentration was higher in infected roots 10 dpi, and the effect reverted 20 dpi. Abscisic acid (ABA) was induced at all time points in AM-colonized roots, however, the difference was only significant 10 dpi. Glomus intraradices hyphae isolated from a two-compartment system contained ABA (shown by GC-MS full scan spectrum) but neither of the auxins. These findings indicate complex hormone patterns during AM colonization in different plant species. To understand the role of IBA in early events during AM formation we use two different strategies: 1. Investigation of the effect of an IBA antagonist (TFIBA) on the development of the symbiosis; 2. cDNA-AFLP analysis to compare IBA- and AM-induced gene expression.

(# 28) Physiological Response of Tomato plants to the Combined Application of a Mycorrhizal inoculant (LicoMic) in Liquid Medium and a General Growth Stimulant (Fertiactyl GZ).

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It was studied the effect of a combined application of a vegetable general growth stimulant Fertiactyl GZ, having humic acid as a base and commercialized in Spain by INABONOS S.A enterprise, and a Glomus fasciculatum (LicoMic) liquid inoculant, obtained at the National Institute of Agricultural Sciences. The experiment was carried out in concrete gutters with Red Ferralitic Leached soil. Tomato (var. Amalia) seeds were sown directly and, in each gutter, 20 plants were sown. Treatments of Fertiactyl GZ + LicoMic and Fertiactyl GZ were applied only 20 days after seed germination, by means of three irrigations, leaving a week interval between them. Fertiactyl GZ was delivered in a dose of 7 L ha^{-1}. Different variables of mycorrhyzal root infection were evaluated 40 and 55 days after germination. Total dry root biomass, plant leaf area in different treatments, pre-down leaf water potential (Ø), stomatal conductance (gs), and root hydraulic conductivity (Lp), were also evaluated 40 days after germination.

The results showed that there was a proper compatibility level between Fertiactyl GZ and LicoMic; and satisfactory values in variables related to root infection were reached. The combination of both products stimulated considerably biomass and leaf area production. At the same time, it increased root hydraulic conductivity, hydraulic efficiency at a whole-plant level, as well as fruit yield.

(# 31) Ectomycorrhizal community patterns from Quercus rubra seedlings grown in soils from regional hemlock-hardwood forests

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Host composition is an important factor that may influence ectomycorrhizal (ECM) diversity. We examined ECM diversity from northern red oak (Quercus rubra) seedlings grown in soil cores from three northeastern U.S. forests containing two distinct stand types: hardwood and eastern hemlock (Tsuga canadensis) stands. We hypothesized that seedlings grown in soils from hardwood stands would be colonized by different ECM morphotypes and exhibit greater richness and diversity than seedlings grown in soils from hemlock stands. In this study soil cores were taken from each of three hardwood- and hemlock-dominated stands located in each regional forest. Oak acorns were planted individually in the cores and grown for 24 weeks in a greenhouse and harvested intermittently to examine ECM successional patterns. Plants developed extensive ectomycorrhizae. ECM colonization and diversity were significantly higher on seedlings grown in hardwood compared to hemlock soils and on older seedlings, but no differences were found with regard to forest source. Results suggest two important conclusions: (1) that ECM composition differed between stand and forest levels but that diversity patterns differed only at the stand level, and (2) that ECM successional patterns were similar on seedlings regardless of stand or forest soil source. Results imply that ECM beta diversity differs on oak seedlings grown in contrasting host assemblages, but that patterns of gamma diversity may not vary. Oak management and regeneration strategies should consider host composition as a factor affecting associated ECM symbionts since forest growth and productivity may also be affected.

(# 34) Arbuscular mycorrhizal fungi and understory plant diversity in Wisconsin oak savannas

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Arbuscular mycorrhizal fungi (Glomeromycota, AMF) are ubiquitous in most terrestrial plant communities, and a number of researchers have shown that AMF can affect plant community structure and composition in different systems. Furthermore, glomalean fungi are obligate biotrophs, obtaining all their carbohydrates from their photosynthetic partners. Combining these facts creates an interesting question: How do AMF influence plant community composition and structure along steep light gradients? This situation exists in Wisconsin oak savannas, which are among the most species-rich andendangered plant communities in the upper Midwest. Scattered savanna oaks create steep light gradients over short distances, and recent research has shown that these light gradients, along with soil texture patterns, influence the distribution of understory plant species. Our study looks at the relationships between plant diversity, glomalean diversity and light, and soil N and P concentrations. One hundred eight 1-m2 plots were established in three remnant oak savannas in Wisconsin. Plant species and percent cover were tallied repeatedly, and soil cores were taken to determine the species of AMF present. Soil nutrient levels were measured, and hemispheric photography was used to estimate the light regime. Data were processed via NMS ordination and a simple structural equation model. The results show a positive correlation between AMF and plant species richness, and surprising interactionsamong the abiotic factors, AMF composition, and plant community composition.

(# 35) Co-Infection and Mutualistic Benefit in a Spatially Explicit Model

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One plant may be simultaneously colonized by multiple species of mycorrhizal fungi, and a previous theoretical model has already suggested how this co-infection could facilitate the coexistence of competing plants and competing mycorrhizal fungi. Here, the possible significance of co-infection by two fungi is further explored using spatially explicit models that simulate two competing consumers (fungi); a more mutualistic consumer gains less from a given resource patch but has a greater positive impact on future resource availability, while a less mutualistic consumer benefits the resource less but gains more from a given patch. Simulations run using these models suggest that averaging the effects ofconsumers over multiple resource patches (multiple roots on one plant) may decrease the range of parameter values over which the more mutualistic consumer persists or excludes its competitor. Including either an added benefit or an added cost to plants of co-infection can promote the coexistence of multiple consumers, and in some cases an added cost of co-infection leads to the exclusion of the lessmutualistic consumer. These models provide additional insights into what associations with multiple mycorrhizal fungi might mean in natural communities, and exploring the full range of ecological dynamics possible in these communities is an essential step in understanding how consistent the effects of the symbiosis are across various systems.

(# 36) The effects of mycorrhizal fungi on plant establishment in saline conditions

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The effects of mycorrhizal fungi on establishment of sub clover (Trifolium subterraneum) in saline conditions were studied in a glasshouse experiment. Sub clover plants were inoculated with Glomus intraradices and grown in nursery pots. After 15 days colonized seedlings had the same biomass and same phosphorus content as non-inoculated plants. Pre-inoculated and non-inoculated seedlings were transplanted into 1.4 kg pots with different levels of salinity (2.2, 3.5, 5, 7.5 and 12 dS/m). Growth factors and nutrient uptake of the plants were determined 10, 20 and 30 days after transplanting. The results show that mycorrhizal plants had greater shoot and root dry weight, leaf number and phosphorus content than non-mycorrhizal plants at all harvests and all salinity levels. The highest differences between phosphorus content in mycorrhizal and non-mycorrhizal plants were at the first harvest. Calculation of mycorrhizal response in terms of plant dry weight and phosphorus content have shown that this beneficial effects is not only related to increased plant phosphorus content, but some other mechanisms are involved.

Non-mycorrhizal plants had decreased shoot dry weight at 2.2 dS/m, whereas the detrimental effects of salinity was only observed in mycorrhizal plants at more than 5 dS/m. With increasing plant age, salinity had greater effects on plant weight in both mycorrhizal and non-mycorrhizal plants. However the differences between harvests were apparent in salinity levels more than 5 dS/m. Results indicate that increased phosphorus content in early stages of plant establishment may be the major beneficial effect of mycorrhizal fungi on plant establishment in saline conditions. Results are discussed in the context of application of mycorrhizal inoculation to revegetation of salt affected area.

(# 37) Ectomycorrhizal Colonization of Birch (Betula pendula Roth) at an Uranium Mining Heap

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Extensive uranium mining activities in the former German Democratic Republic between 1946-1990 left a devastated area of ~37 km2 near Ronneburg (Thuringia, Germany). Besides many shafts, sludge ponds and a big opencast mining hole, several waste heaps containing up to 0.05% uranium and elevated concentrations of several heavy metals characterize the landscape. Ectomycorrhizal (EM) colonization ofbirch trees growing either on a bare heap site (BHS) or on a heap site with an organic horizon (HS/OH) was compared to a birch EM community on a natural reference site (RS). Total EM colonization was similar at RS (66%) and HS/OH (62%), but significantly reduced at BHS (28%). EM were characterized by morphotyping, PCR-RFLP and sequencing of the ITS-region. Among a total of 23 morphotypes found, 10 were identified at the species or genus level. EM diversity was highest at RS (19 morphotypes), reduced at HS/OH (16 morphotypes) and significantly reduced at BHS (11 morphotypes). All morphotypes dominating at the heap sites were also present at RS, while four morphotypes missing at RS were rare at the heap sites. Thus, the EM communities at both heap sites were not formed by EM species (but maybe strains) especially adapted to uranium or heavy metal pollution. Sørensen index values, calculated to compare the EM composition of different samples, indicated a similar spatial heterogeneity at all three sites. However, temporal variation was high at BHS, intermediate at HS/OH andlow at RS.

(# 38) Gene Expression During Pre-Mycorrhizal Confrontation of Oak Micro-Cuttings and Piloderma croceum

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We used a Petri dish system to synthesize EM between P. croceum and oak micro-cuttings. EM formation occurred after a long pre-mycorrhizal phase of 8-9 associated with morphological and physiological interactions between the partners.

To study the molecular events proceeding EM formation, we identified transcripts up-regulated by suppression subtractive hybridization (SSH) of the cDNA populations of non-inoculated control roots and fungal mycelium from the cDNA population of pre-mycorrhizal oak-roots. Differential expression was confirmed by reverse northern and 60 clones appeared to be up-regulated. None corresponded to genes already described for Quercus roburr, 32 code for new and so far unidentified polypeptides, and the others for polypeptides with homologues from different organisms. A minority of the identified polypeptides appears to be involved in stress responses in plants or animals. Functional analyses of thededuced polypeptide sequences uncovered further that 22 proteins contain membrane-spanning regions. Others contain epitops exhibiting similarities to signal transduction components from metazoa or bacteria or are involved in metabolic processes, mainly related to sugar metabolism.The identified expression pattern is consistent with morphological and physiological observations characteristic for the pre-mycorrhizal phase in that the oak reaction can be described as a balance between defense, positive recognition and onset of exchange processes between both organisms. The most up-regulated transcripts are currently further analyzed and will be discussed in the above mentioned context.

The work is part of the joined research program “Molmyk” granted by the German Research Foundation (DFG) to study gene regulation in mycorrhizal associations.

(# 40) Assembly Rules in Communities of Arbuscular Mycorrhizal Fungi in a Phosphate Polluted Grassland

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Identification of arbuscular mycorrhizal fungi (AMF) on roots is almost impossible with morphological methods, and, due to the presence of contaminating fungi, it is also difficult with molecular biological techniques. We established a method to selectively amplify the ITS region of most AMF with a unique primer set. This was combined in a nested PCR with the already established primer pair ITS5/ITS4. Amplification from contaminating organisms was reduced by an AluI restriction after the first reaction ofthe nested PCR. Members of all families within the Glomeromycota were detected.Using this method in an ecological perspective, the main focus was on community and population structure of AMF in a phosphate-polluted grassland. Ninety one ITS sequences obtained from the polluted site (44 from spores, 37 from roots and 10 from trap cultures) were compared with sequences from 4 other sites in Thuringia (Germany). The AMF diversity at the polluted site was reduced to 6 taxa, only representing members of the genus Glomus (mainly Glomus Group-A). There was no overlapping between species revealed as active mycorrhizas on roots (2 taxa) and as spores (4 taxa). Some sequences detected on the polluted site represent unknown taxa. As these can also be found on unpolluted field sites in the surroundings, they cannot be considered as taxa specially adapted for high phosphate concentrations. This finding illustrates the potential of our method to explore AMF diversity in the field and to detect new taxa.

(# 42) Revegetation of acid sulfate soil : isolation of symbiotic microorganisms from pioneer plants.

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Acid sulfate soil is formed by chemical and microbial oxidation of pyrite (FeS2). Although revegetation of the soil is difficult due to low pH and poor nutrient availability, some pioneer plants succeed to colonize such an extreme environment. We hypothesize that symbiotic microorganisms may play a significant role in colonization of the pioneer plants. Acid sulfate soil found in a quarry in Hazu-cho, Aichi, Japan showed extremely low pH and nutrient deficiency. The percentage of arbuscular mycorrhizal (AM) colonization of pioneer plants (e.g. Artemisia princeps, Miscanthus sinensis and Lespedeza cyrtobotrya) was in a range of 10-30%. AM fungi were isolated and proliferated from the rhizospere soil of the pioneer plants by the trap culture technique. Glomus sp. HR1 and Entrophospora colombiana were identified as dominants based on the spore morphology and the 1.1 kbp sequence of 18S rDNA. Bradyrhizobium spp. were isolated from the rhizosphere of leguminous plants and identified based on the 320 bp sequence of 16S rDNA. The effectiveness of these microorganisms under acidic conditions was assessed by pot experiments. The growth of Miscanthus sinensis was significantly promoted by the inoculation of the AM fungi. The dual inoculation of the AM fungi and Bradyrhizobium sp. promoted the growth of Lespedeza bicolor significantly. These results suggest that symbiotic microorganisms play an important role in the survival and growth of the pioneer plants under acidic and low-fertility conditions and that indigenous microorganisms could be applied for revegetation of acid sulfate soil.

(# 43) Soil biota-structure interactions

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This talk will focus on the interactions between the soil's physical habitat and soil biota. It will develop on the theme of soil biota as ecosystems engineers, at the micrometer scale and above. It will attempt to show how land management and microbial dynamics impact on structural regeneration. Finally, it will introduce the concept of the soil as a self-regulating system.

(# 44) Evolution and molecular phylogeny of AM fungi and Geosiphon - establishing a new model system for AM research

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The Glomeromycota (presently comprising AM fungi and Geosiphon) represent a very old group of terrestrial fungi. Despite the debated age of the group, with estimates of up to 1,300 Myr, small subunit (SSU) rRNA sequence analyses clearly indicated that the Glomeromycota are older then the Ascomycota and Basidiomycota. An updated molecular phylogeny of the Glomeromycota will be shown, as well as the new taxonomic system which is based on the combined molecular phylogeny and morphological approach (phylum Glomeromycota, with one class, Glomeromycetes, including 4 orders).Geosiphon pyriformis - the only known example of a fungus forming endosymbiosis with cyanobacteria -doubtless belongs to the Glomeromycota. Evolutionary implications will be discussed, referring to different possibilities on the colonization of the terrestrial habitat by plants, probably heavily influenced by symbiotic, glomeromycotan fungi. Moreover, with the molecular phylogeny and functional aspects inbackground, the Geosiphon symbiosis can be used as a model for the AM symbiosis. The organisms will be introduced and some examples where Geosiphon could play an important role for AM research will be shown, regarding partner-recognition and expression studies on fungal genes.

(# 45) Differences in Ectomycorrhiza Succession Between Wild Type and Transgenic Aspen Released in an Experimental Field

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Transgenic aspen were obtained by transformation of a wild type aspen line with the rolC gene from Agrobacterium rhizogenes, either under control of a constitutive expressed (35S-rolC) or a light-induced promoter (rbcS-rolC), giving phenotypes with reduced or normal growth, respectively. Based on morphotyping, PCR-RFLP and sequencing of ITS regions, the EM communities of the wild type and the different transgenic lines were compared over four years in a field release experiment. During this period, the EM community changed considerably. In 1998/99, Tomentella sp., Phialocephala fortinii, Laccaria sp. and one member of the Pezizales formed 94% of all EM, while eleven additional morphotypes were rare. In this early phase, the sole significant difference in the mycorrhization of wild type and transgenic lines consisted in a significantly reduced compatibility of one 35S-rolC transgenic line for Phialocephala (Kaldorf et al. 2002, Planta 214: 653-660). In 2000/01, eight additional EMF appeared, among these Cenococcum geophilum, Tuber sp., one member of the Agaricales and one Boletaceae. The share of EM with rhizomorphs increased from 0% to 7%, while EM with a contact type exploration strategy dropped from 68% in 1998/99 to 48% in 2001. EM diversity of wild type and rbcS-rolC transgenic, but not of 35S-rolC transgenic lines increased significantly. While Cenococcum and Tuber colonized all lines to a similar extent, a significantly reduced abundance of hydrophobic EM with rhizomorphs was found on the 35S-rolC transgenic lines.

(# 46) Influence of organic amendment on soil organic matter and temporal variability of indicators of soil physical and biological quality in a potato rotation

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Potato (Solanum tuberosum L.) rotations are often characterized by low levels of soil organic matter and consequently exhibit poor soil physical quality. Compost produced from culled potatoes, manure and sawdust (3:3:1) was applied once (12.5 Mg DM ha-1) or twice (2 × 12.5 Mg DM ha-1), over a four year period, to a three- year barley (Hordeum vulgare L.) - red clover (Trifolium pratense L.) - potato (cv. 'Russet Burbank') rotation established on a Charlottetown fine sandy loam (Humo Ferric Podzol). Soil physical and biological properties were measured throughout each phase of the rotation. The maximum potato yield in response to N (33 Mg ha-1 at 120 kg N ha-1) was lower than the yield (41 Mg ha-1) at the same rate of N plus compost, indicating that the nutrient content of the compost alone could not adequately explain the yield increases due to compost. Compost improved the soil water holding capacity at 0.033 MPa in the potato year. Soil bulk density, soil porosity, and oxygen diffusion rate (ODR) were improved by compost additions at various times in the rotation. Periodic increases were also measured for soil organic carbon and macro-organic carbon.

(# 47) Diversity of ericoid mycorrhizal fungi from the Australian Ericales

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Fungi isolated from the roots of various Australian Epacridaceae and Ericaceae species have been cultured and arranged into morphologically similar groups. The majority of these isolates remain sterile in culture, and therefore cannot be identified by traditional taxonomic means. DNA extraction, PCR and sequencing of the rDNA ITS regions have been used to enable the comparison of the isolates to the GenBank database. A tree of maximum parsimony has been produced based on this data, revealing the relationships within and between the groups of ericoid mycorrhizas native to Australia and those found in other parts of the world. The majority of the Australian fungi have close affinities with previously isolated local endophytes. In some cases there are relationships with fungi from distant Ericaceae populations, including Canada and Europe. The majority of the isolates matched closely with fungi which are also unnamed, presenting difficulties in placing them in appropriate taxonomic groups. Severalof the cultures produced spores in culture, and have been tentatively identified based on their morphology as Oidiodendron sp., which is supported by the sequence data.

(# 48) Mobilization of nutrients from organic natural substrates to plants via the external ectomycorrhizal mycelium, an overview

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The notion that the external ectomycorrhizal mycelium (EEM) could be involved in nutrient mobilization from organic natural substrates to plants, is almost as old as the word "mycorrhiza" itself. In 1894, A. B.Frank hypothesised, in what became known as his "organic nitrogen theory", that the primary role of the ectomycorrhizal (ECM) symbiosis was to facilitate the transfer of nitrogen from soil organic matter to plant roots. However, Frank's theory received little experimental attention in the first two thirds of the twentieth century. Not until the 1970's did further studies confirm that in nature ECM roots proliferate preferentially in the organic fermentation horizons of the soil profile. Later, in the 1980's and 1990's, it was shown under axenic conditions, that ECM fungi were able to produce proteinases, phosphatases, phytases and chitinases which are known to participate actively in the degradation of organic compounds. Recently, more than a century after Frank's initial proposal, studies have demonstrated conclusively that the EEM is able to mobilize nutrients from a wide range of naturally occurring organic substrates. These results have modified our ecophysiological understanding of the EEM, which is now seen to play a far more direct role in mobilization and transfer of nutrients to roots than was previously recognised. The newly described functions are likely to be of vital importance for the proceeses of nutrient recycling at the ecosystem level.

(# 50) Soil phosphorus depletion capacity of mycorrhizal maize hybrids

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The ability of arbuscular mycorrhizal (AM) fungi to help their host plant absorb soil P is well known, but little attention has been paid to the effect of AM fungi on soil P depletion capacity. A greenhouse experiment was conducted to assess, under different P levels, the effects of mycorrhiza on extractable soil P and P uptake by maize hybrids with contrasting phenotypes. The experiment had three factors, including two mycorrhizal treatments (mycorrhizal and non-mycorrhizal), three P fertilizer rates (0 mg kg-1, 40 mg kg-1, and 80 mg kg-1) and three maize hybrids (Leafy normal stature [LNS], Leafy reduced stature [LRS] and a conventional hybrid, Pioneer 3979 [P3979]). Extractable soil P was determined after 3, 6 and 9 weeks of maize growth. Plant biomass, P concentration and total P content were also determined after 9 weeks of growth. Fertilization increased soil extractable P, plant biomass, P concentration in plants and total P uptake. In contrast to P3979, the LNS and LRS hybrids had higher biomass and total P content when mycorrhizal. Mycorrhizae had less influence on soil extractable P than on total P uptake by plants. Absence of P fertilization increased the importance of AM fungi for P uptake, which markedly reduced soil extractable P under AM plants during growth. This effect was the strongest for LNS, the most mycorrhizae-dependant hybrid, intermediate for LRS, and not significant for the commercial hybrid P3979, which did not respond to AM inoculation.

(# 51) A new strategy for acquisition of P in arbuscular mycorrhiza: up-regulation of secreted acid phosphatase gene in the host plant.

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It had been found that arbuscular mycorrhizal formation increased acid phosphatase activity in the roots of marigold (Tagetes spp.) and that the activity correlated with the growth of the host plant. In this study, a gene encoding the acid phosphatase was cloned, and the involvement of mycorrhizal formation in the regulation of the gene expression was investigated. Dwarf marigold was inoculated with Glomus etunicatum or Archaeospora leptoticha and cultured for 6-8 weeks. The phosphatase specific to the mycorrhizal colonization was purified from 500 g of the mycorrhizal roots, and the N-terminal amino acid sequence was determined. Degenerate primers for RT-PCR were designed based on the amino acid sequence and the full-length cDNA of the gene (TPAP1) (accession no. AB029086) was cloned by 5 f- and 3 f-RACE by using poly(A)+ RNAs extracted from the mycorrhizal roots. TPAP1 was of host origin and classified in the superfamily of kidney bean purple acid phosphatase. The expression of TPAP1 and the amount of TPAP1 protein were investigated by quantitative RT-PCR and the western blotting, respectively. The quantity of TPAP1 mRNA increased 3 to 10-fold by the mycorrhizal formation as TPAP1 increased.

It has been believed that enhanced P uptake by arbuscular mycorrhizal formation is mainly due to the increase in the surface area of P uptake. However, the present study suggests another mechanism in which the mycorrhizal formation enhances P uptake through mineralization of organic P in the rhizosphere by promoting the secretion of the host acid phosphatase.

(# 53) Conservation of mycorrhizal fungi: Do we need to be concerned, and if so, how do we provide protection?

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The international scientific community has increasingly called for conservation of biological diversity, with a strong emphasis on protecting rare and threatened species. Most attention focuses, however, on charismatic fauna and flora. Fungi are rarely considered, even though their critical ecosystem functions are well known. Several ectomycorrhizal fungus diversity studies have reported declines in species based on temporal changes in sporocarp presence and RED lists have also been published for some countries. Although mycorrhizasts have clearly demonstrated the ecological importance of mycorrhizal fungus diversity, we have not systematically addressed the need and methods for conserving this vast diversity, nor how to deal with rare species at landscape scales. This presentation synthesizes eight years of results and lessons learned from fungal conservation efforts in forests of the Pacific Northwest. Over 230 rare forest fungi (mostly ectomycorrhizal) were listed for protection as part of a regional ecosystem management plan. Our results from regionwide fungal surveys, species habitat modeling and population studies graphically illustrate the scientific and managerial challenges in providing protection at landscape scales for mycorrhizal fungi. This presentation defines critical knowledge gaps for conserving mycorrhizal fungus diversity. It focuses on integrating concepts of species rarity, detection, and population viability with ecosystem function and management.

(# 55) Molecular diversity of mycorrhizal and other soil fungi across a moorland - Scots pine (Pinus sylvestris) environmental gradient

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The conservation and regeneration of native Scots pine (Pinus sylvestris) woodlands is being actively encouraged by conservation agencies in the UK due to their high biodiversity value. In the present study, three parallel transects were marked out running from open moorland, through an intermediate zone showing seedling colonisation, into a mature Scots pine forest at Abernethy Forest, Cairngorm, Scotland. Soil cores were taken at 18 m intervals along each 180 m transect, and the diversity of the soil fungal community was investigated by DGGE and sequence analysis of ITS fragments PCR-amplified from DNA extracted from root-free soil. Analysis of DGGE profiles generated for two of the three transects indicates a clear shift in the community from the moorland end of the transects to the forest end. While a few bands were present in samples from both ends of the transects, the majority of bands were unique to either the moorland or forest samples. FastA database searches of ITS sequence data generated from excised DGGE bands revealed the closest species match for each band. In some cases, the similarity of ITS sequences to database sequences was poor, however the remaining sequences were most closely related to ITS sequences of both mycorrhizal and non-mycorrhizal fungi. The data are discussed in relation to the effect of native woodland expansion on the soil fungal community.

(# 57) Inoculation effect of Scleroderma columnare on Shorea seminis growth and its effectiveness under different dosages of charcoal

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We investigated the inoculation of Scleroderma columnare on Shorea seminis growth and its effectiveness under growth media using 3 dosages of charcoal (0, 2.5 and 5 gram per polybag). Six months after transplanting, the best growth increment was found in the inoculation of S. columnare and 5 g charcoal. This dosage is the most effective dosage for application of S. columnare on S. seminis. Six months after transplanting, hartig net and mantle were well formed in the root of S. seminis.This paper will also discuss about the growth of S. columnare (in vitro) on charcoal as carbon source.

(# 58) Edible mycorrhizal mushrooms: challenges and achievements

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There are 2000 species of edible mushrooms with the most expensive and sought after belonging to the mycorrhizal group, for example, Tuber melanosporum Vitt., T. magnatum Pico & Vitt., Tricholoma matsutake (Ito & Imai) Sing., Boletus edulis Bull: Fr. sensu lato, Cantharellus cibarius Fr., Amanita caesarea (Scop.: Fr.) Pers: Schw., Lyophyllum shimeji (Kawam.) Hongo and Lactarius deliciosus (L.) Fr. Large quantities of mycorrhizal mushrooms do not pass through marketplaces and consequently are not included in official figures although the total market is certainly measured in US$ billions.

Over the past 100 years harvests of many mycorrhizal mushrooms have declined dramatically and this has spured interest in the development of methods for their cultivation. However, so far only a few species of truffles have been produced in commercial quantities although methods have been developed that may see the cultivation of other species such as Cantharellus cibarius, Lyophyllum shimeji and Lactarius deliciosus. Despite this many of the most expensive mycorrhizal mushrooms including Tuber magnatum and Tricholoma matsutake have defied cultivation.

Our presentation will attempt to highlight possible reasons why mycorrhizal mushrooms have proven so intractable and how we might better manage mycorrhizal mushroom forests to sustain production.

(# 59) Sugars: a signal for adaptations of plant and fungal physiology in ectomycorrhizas

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Most trees of temperate and boreal forests form ectomycorrhizas, symbiotic associations of fine plant roots with fungal hyphae of certain asco- or basidiomycetes. Central to the success of these symbioses is the exchange of nutrients and carbohydrates between the partners. Current conceptual models assume that after cleavage of sucrose in the apoplast of the root/fungus interface, hexoses are taken up by fungal as well as plant cells.

In addition to their importance as nutrient, carbohydrates might also act as signaling molecules in symbiosis. Using degenerate primers, nine plant and two fungal cDNAs encoding different monosaccharide transporters were isolated from a Populus tremula x tremuloides/Amanita muscaria mycorrhizal cDNA library. These and further genes were used to investigate the impact of carbohydrate nutrition in ectomycorrhizal symbiosis.

With respect to the fungus, two hyphal networks could be distinguished, the fungal mantle and the Hartig net. Both structures have different functions regarding to fungal carbohydrate uptake, storage and partitioning. Our investigations indicate a hexose gradient between the apoplasts of the Hartig net and the fungal sheath. This gradient might thus regulate fungal but presumably also plant cortical cell gene expression and thus cellular function within ectomycorrhizas.

(# 60) A dynamic study of chitinase and peroxidase in tomato plants mycorrhized with two glomal species

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A dynamic study was carried out using two Glomal species (G. fasciculatum and G. clarum) and tomato (Lycopersicon esculentum Mill) var. Amalia in order to study chitinases and peroxidases activity during 45 days after germination. Chitinase and Peroxidase activity were determined using Boller (1983) and Fric (1976) methods and isozymes were staining using Barreto and Simon (1979) methods. A differential level and time of activation was observed for both species. G. fasciculatum resulted the most prepared species to colonize this tomato variety in our conditions. A basic chitinase was observed in the interaction tomato-G. fasciculatum.

(# 64) Biocontrol interactions of host cultivar, arbuscular mycorrhiza, and Trichoderma against soil-borne diseases of tomato

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To improve the success of root knot and wilt biocontrol Glomus intraradices and Trichoderma viride inoculations were combined and interactions investigated. G. intraradices and T. viride did not hinder the development of each other. Mycorrhizal root colonization as well as development of T. viride was not suppressed by Fusarium oxysporum or Meloidogyne hapla. The success of biocontrol against Fusarium wilt and root knot depended on the choice of cultivars: in cv. 'Tiptop' (susceptible but less sensitive to wilt; allowing nematode development) none of the treatments enhanced or suppressed plant growth performance or symptom development significantly. In cv. 'Hildares' (susceptible, very sensitive to wilt, root knot sensitive) the beneficals singly inoculated enhanced growth of infected plants and reduced disease development. However, after dual inoculation biocontrol of root knot was reduced to a non-significant level, biocontrol of wilt was totally missing. In split-root trials there was no evidence for an induction of a systemic plant defence by the AM fungus. Beneficial effects are restricted to the mycorrhizal parts of the root system. At least in the case of this two diseases of a tomato cultivar allowing biocontrol the mycorrhizal fungus must spread in the root system as fast as possible: a better mycorrhizal colonization perhaps gives a higher probability of successful biocontrol.

(# 66) Rapid, Reliable, and Inexpensive DNA Extraction of Arbuscular Mycorrhizal Fungi from Trypan Blue-Stained Roots

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Improved DNA extraction techniques from trypan blue-stained root fragments were developed for rapid, reliable, and inexpensive analyses. One cm of trypan blue-stained mycorrohizal root fragments were individually isolated, crushed by bead beating, and purified with Chelex-100 (BioRad). DNA extraction was also carried out using an UltraClean DNA isolation kit (MoBio). DNA was extracted from the mycorrhizal roots of four plant species, quantified by UV absorbance, and PCR-amplified with primers specific to arbuscular mycorrhizal fungi. Results from the two extraction methods were compared. Although inhibitors for PCR might still exist when using Chelex-100, appropriate dilution and employment of nested-PCR overcame this problem. Use of UltraClean DNA isolation kit successfully removed PCR inhibitors, but sometimes, depending on the mycorrhizal colonization within the root fragments, it also required nested-PCR to obtain bands strong enough for restriction fragment length polymorphism (RFLP) or some other applications. In conclusion, both methods enabled us to handle hundreds of samples in a short time. UltraClean DNA isolation kit provided greater reliability and use of Chelex-100 provided better cost performance. Both techniques are useful for PCR-based applications to identify species and estimate species composition after measuring mycorrhizal colonization rate with trypan blue staining.

(# 67) A method of evaluating systemic coloniztion of leaves by dark septate fungal endophytes in Bouteloua eriopida (Torr.) Torr. a native grass in arid southwestern USA rangelands

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Dominant native grasses in arid southwestern USA rangelands are more extensively colonized by dark septate endophytic fungi than by conventional mycorrhizal fungi. A method was developed to determine the nature and extent of colonization of leaves of Bouteloua eriopida (Torr.) Torr. Photosynthetically active leaves were scrapedwith a scalpel to separate tissue layers, dual stained with trypan blue and Sudan IV, placed on a slide and analyzed at 1000X with differential interference microscopy. All leaf cells were colonized and internal fungal morphology was highly variable. Sudan IV stained lipid bodies associated with fungal protoplasts. Non-stained hyaline hyphae were also observed. As leaves became dormant stained and pigmented hyphae and microsclerotia were increasingly evident. This study reveals the systemic association of dark septate fungi with above ground tissues of B. eriopida.

(# 68) A Perceived Role of Carbon and Water Management by Systemic Dark Septate Fungi in Bouteloua eriopida (Torr.) Torr. in an Arid Ecosystem

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Dark septate endophytic (DSE) fungi are the prevalent symbionts of native grasses and shrubs in arid southwestern USA rangelands. The nature and extent of colonization of Bouteloua eriopida (Torr.) Torr., an important native range grass of the northern Chihuahuan Desert was evaluated using dual staining, light and electron microscopy. Several unique and ecologically important features of DSE fungi were revealed. Fungi preferentially reside in the apoplastic environment and function as a protoplasts identified by associated lipid bodies. They form systemic intercellular networks in plants and intracellular structures within sieve elements, parenchyma and cortical cells. Endophyte free plants have not been developed but some fungi were cultured independently. The composite association results in a hybrid organism better equipped to survive in severe nutrient and water stressed ecosystems. Fungi formed stained and pigmented hyphae and microsclerotia, characteristic of DSE in less active tissues. Loosely organized hyphae, embedded within a mucilaginous matrix on the root surface, suggested a protective barrier from dry soil. A precisely organized hyphal network on the leaf surface suggested a protective barrier from atmospheric stress. Colonization of guard and subsidiary cells of the stomatal complex suggested an influence stomatal regulation and transpiration. The size and quantity of fungal associated lipid bodies suggested a role of carbon storage and management within the ecosystem.

(# 69) The effect of drainage, harvesting and restoration on the fluxes of CO2 and CH4 from peatland soils, eastern Canada

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Peat harvesting activities cover ~150 km2 and produce ~1 million t yr-1 in Canada, primarily Alberta, Quebec and New Brunswick. We measured CO2 and CH4 fluxes from May to September at sites that were natural bogs, that were actively harvested by vacuum, that had been abandoned, that had recently been restored and that had been revegetated naturally in block-cuts near Rivière du Loup, QC and Shippagan, NB. The undisturbed bogs showed small net emissions of CO2 and CH4 and vacuum harvested sites had smaller CH4 emissions but lost ~200 g CO2-C m-2. Recent restoration involved raising the water table and applying a layer of fresh peat and straw mulch and increased the fluxes of both CO2 and CH4. Cotton-grass (Eriophorum vaginatum) is an early successful colonizer in restored sites and provides a better habitat for the establishment of mosses and shrubs, but increases emissions of these gases. At old block-cut sites, despite the occurrence of bog-vegetation (mosses, shrubs, sedges) in the trenches and the accumulation of up to 30 cm of fresh peat, there were still large emissions of CO2 and CH4. It appears that, in the short-term (<30 y), restoration efforts increase the emission of these greenhouse gases to the atmosphere.

(# 70) Functional genomics of early interaction events in ectomycorrhizal symbiosis

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The ectomycorrhizas are beneficial fungal associations with temperate tree roots. Ectomycorrhizal fungi improve survivability, pathogen resistance, drought tolerance and provide mobilized mineral nutrient in exchange for fixed carbon from the plant. Our lab has been working on developing Laccaria bicolor x Pinus Resinosa (red pine) as a genetically tractable model system to study early interaction during ectomycorrhizal symbiosis using molecular tools and functional genomic approaches. Biochemical and molecular level analysis suggests that, in response to the perception of the plant root, there is a wide range of signaling activities and directional shift in fungal cell physiology as early as four hours into the interaction. EST and macroarray analyses were used to study multiple factors of interaction, including expression patterns at various time points of early interaction (<96 hours) and fungal reaction to limiting amounts of nutrients (ammonium, phosphate, and glucose) known to be fixed and transported between the symbionts. Similarly, we have developed yeast two-hybrid system to study interactions among the important symbiosis-regulated proteins to decipher signaling mechanisms involved in the early stages of ectomycorrhizal symbiosis. Our results from this pilot study led to a better understanding of signaling pathways and metabolic shifts occurring after host recognition during preinfection stage of symbiosis. Ammonium and phosphate starvations yield insight to fungal response in nutrient deprived soil conditions. Whereas carbon source limitation generates a model of fungal transcription when in need of a host. In all these conditions tested, there was significant increase in expression of genes that regulate transcription of other genes. Several of these genes were further characterized and validated to be interaction-regulated. These results suggest common regulatory circuits of many genes involved in various pathways during ectomycorrhizal symbiosis and also that the ectomycorrhizal symbiotic interaction at gene level starts very early into the interaction.

(# 71) Above- and below-ground primary succession of ectomycorrhizal fungi in a volcanic desert on Mt. Fuji

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The species composition and succession of ectomycorrhizal (ECM) fungi were studied during early primary succession on Mt. Fuji, Japan.

On the southeast side of Mt. Fuji, the vegetation is patchily distributed, forming vegetation islands in a sea of volcanic desert. The total vegetation coverage was about 5%. Weekly sporocarp surveys were conducted over 2 years. The underground fungal constituents were identified at the species level, using ITS terminal-RFLP and ITS sequencing.

An alpine dwarf willow, Salix reinii, was overwhelmingly predominant as ECM hosts. In total, 11,450 sporocarps of 23 ECM fungal species were recorded in the above-ground community, and 21 species were identified from 14,400 root tips in the below-ground community. Species recorded as sporocarps dominated the underground ECM community in abundance.

Associated with small hosts, one of three first-stage fungi (Inocybe lacera, Laccaria laccata and Laccaria amethystina) initiated the sere of ECM fungal succession. Second-stage fungi (Laccaria murina and Scleroderma bovista) were recruited with host growth. Relatively late-stage fungi (Hebeloma spp., Cortinarius spp., Russula spp. and Thelephoraceae) were found with further host development, especially in the soil that developed within a vegetation patch.

With successional recruitment, ECM fungal diversity increased significantly. There was no evidence of any fungus disappearing and being replaced in the sere of ECM fungal succession. The total number of ECM root tips of each fungus associated with each host increased monotonically with host growth.

The succession of ECM fungi might be important for the growth and diversification of plants during early primary succession.

(# 72) Protein fractions in timothy are affected by N fertilization and genotypes

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Protein fractions have not been extensively studied in timothy (Phleum pratense L.). We evaluated the effects of N fertilization (0, 40, and 180 kg N/ha) and 35 early-maturing half-sib families (thereafter called genotypes) on protein fractions of the Cornell Net Carbohydrate and Protein System (CNCPS) during spring growth of two consecutive years. The CNCPS protein fractions, total N (TN), and in vitro true digestibility (IVTD) were estimated using near infrared reflectance spectroscopy and dry matter (DM) yield was measured. Averaged across all genotypes and N fertilization rates (n = 630), fractions A + B1, B2, B3, and C accounted for 294, 458, 212, and 36 g/kg of TN, respectively. There was no genotypes x N fertilization interaction for any of protein fractions. Concentrations of A + B1 fractions, total N, and IVTD increased linearly whereas concentrations of B2 and C fractions decreased linearly with increasing N fertilization. The B3 concentration and DM yield were not affected by N fertilization. Concentrations of A + B1 (282-302 g/ kg TN), B2 (443-467 g/kg TN), and B3 (201-222 g/ kg TN) fractions as well as TN concentration (20.4-22.8 g/kg DM), DM yield (3.68-5.09 Mg/ha), and IVTD (781-813 g/kg DM) varied among genotypes. The fraction B3 was positively correlated with IVTD (r = 0.67) and DM yield (r = 0.38). Genotypes with high DM yield, high B2 and B3 protein fractions, and low A + B1 fraction were identified.

(# 73) Soil and Fertilizer Phosphorus: Effects on Plant P Supply and Mycorrhizal Development

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Plants require adequate P from the very early stages of growth for optimum crop production. Phosphorus supply to the crop is affected by soil P, P fertilizer management and by soil and environmental conditions influencing P phytoavailability and root growth. Phosphorus uptake in many crops is improved by associations with arbuscular mycorrhizal fungi. Availability of P to the crop early in development can influence not only crop yield, but may also influence the ability of juvenile plants to form arbuscular mycorrhizal associations. Cropping system and long-term input of P through fertilizers and manures can influence the amount and phytoavailability of P in the system and the development of mycorrhizal associations. Optimum yield potential requires an adequate P supply to the crop from the soil or from P additions. Effective soil testing is needed to predict early-season P supply. Where early-season P supply is low, P fertilization may improve P nutrition and crop yield potential. Alternately, under low-P conditions, development of arbuscular mycorrhizal associations may enhance early-season P uptake by crops, improving crop yield potential and replacing P fertilizer applications. Soil P supply that exceeds P requirements of the crop may preclude mycorrhizal development. Such suppression of mycorrhizal associations on heavily manured soils can lead to an apparent response of corn to P fertilization. Techniques are needed to encourage arbuscular mycorrhizal association and avoid exceeding threshold levels of soil solution P that restrict their development. Sustainable production practices must be applied both in conventional and in alternative biologically-based agricultural systems.

(# 74) Cultivation of Ascocarps of Tuber Formosanum Hu on Cyclobalanopsis Glauca (Thunb.)Oerst in Siliceous Soils by Liming

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Ascocarps of Tuber formosanum, which is fairly similar to T. melanosporum and T. indicum in morphology, are only found in calcareous soils in natural environment and have not been successfully isolated on agar nutrient culture so far. The aims of this study were to (1) cultivate T. formosanum in siliceous soils by liming the soils and planting Cyclobalanopsis glauca seedlings inoculated with T. formosanum, (2) study the soil characteristics associated with T. formosanum ascocarps, and (3) analyze the amino acids contents in its ascocarps. Results showed that, after planting two years old C. glauca mycorrhized with T. formosanum in limed siliceous soils, the ascocarps appeared in the 8th year. Mycorrhiza frequency was over 45¢M at 15¢Q in depth, 1 m from the C. glauca trunks after two years of planting, and 2 m after four years of planting. The main soil properties of where T. formosanum ascocarps collected were (1) pH 5.2~7.5, (2) total N 0.590¡Ó0.275¢M, (3) total C 7.06¡Ó4.00¢M, (4) total S 0.225¡Ó0.045¢M, (5) available Na, K, Ca, Mg, and P2O5 as 186¡Ó57, 316¡Ó28, 91¡Ó73, 626¡Ó476 and 30 ppm respectively, (7) organic matter 13.80¡Ó1.60¢M, and (8) sandy loam. All the nine essential amino acids that human body needs were found in the T. formosanum ascocarps. The aromatic odor of T. formosanum ascocarps should be ascribed to their high methionine content (710 mg/100 g dry weight).

(# 75) Occurrence and Distribution of AM Fungi in Citrus Orchards of North-Western Himalayan Region of India Grown Under Diverse Management Systems

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Arbuscular-mycorrhizal fungi are both widespread and common in all climatic zones of North-Western Himalayan region. The development of AMF varies with soil type, depth, season and vegetation. AMF of citrus trees growing in Shivalik and North-Western Himalayan regions of India were surveyed during the years of 2001-2003. During this survey, it was found that in growing season some citrus species were heavily infected, (especially their newly formed roots) with arbuscules and coiled hyphae. The soils of Shivalik ranges of Himalayan region have also shown diverse types of AMF in citrus orchards irrespective of the citrus species grown. Spore populations in soil samples obtained during active growing season have shown, areas with low-input orchards tended to have higher populations of AMF spores than under sod culture fields. Further, a higher population of Glomus fasciculatum and G. mosseae was noted in low-input fields (upto 3800 spores/Kg soil) than in sod culture fields (0-320 spores/Kg soil), suggesting that orchard management system promoted proliferation and distribution of these fungi. AMF spores were generally found to be abundant in soils with pH of 5.2-6.7. Location specific qualitative and quantitative differences were also conspicuous. Intensive farming with frequent use of chemicals has shown a depressive effect on mycorrhizal spores. Patterns of root colonization in plant roots did not always reflect AMF spore population of the soil profile. These results have thus indicated that sod culture yield lower levels of AMF spore, whereas low-input sustainable agriculture, with cover crops and intercrops favoured a build up of greater populations of AMF and thus are liable to derive more benefits from AM fungi inhabitation.

(# 76) Gas diffusion under frozen conditions

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Gas flow in soil is of interest for greenhouse gases, hydrocarbons and pesticides. Gas flow under frozen conditions is not well understood. It is usually assumed that it is not important in winter and that the emission is neglected and modeling is also absent from literature for frozen conditions. The research aimed at developing a predictive equation for gas diffusion in soil under different temperature conditions. A gas tracer was allowed to diffuse in repacked soil columns and monoliths under temperature ranging from -25°C to 25°C under controlled conditions. The spatial variability of gas flow was measured, the diffusion corrections for temperature (Currie, 1960; Marrero et al., 1972) were tested and different diffusion expressions for the relative gas diffusivity as related to air content and porosity were compared for a large range of temperature. Different soils were used. Also, the apparent structure of the soil was noted as a function of temperature. The presentation discussed gas diffusion in terms of temperature for different soil textures and structures.

(# 77) Physical properties of organic-based fertilizers

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The need to recycle, dispose and increase the value of organic wastes, combined with the knowledge that organic matter enhances plant-nutrient interactions, led to the development of granular organic-based fertilizers. The objective of this research was to compare the physical properties of compound organic-based (COF), bulk-blended organic based (BOF) with those of mineral fertilizers (MF) found on the market. Standard, modified and new methods were used to measure their static and dynamic physical properties. Bulk density, granule density, angle of repose, water content, tensile strength, porosity, critical relative humidity, capillary rise, stability in water are among many of the physical properties studied. The properties of more than 20 fertilizers were compared. The organic matter affected most of the physical properties. The variation in the physical properties between the different fertilizers could be partly predicted with the N-P-K, organic matter and water contents, and the particle size distribution. The presentation will discuss the relationships between the physical properties and how these relationships could be used as predictors of other properties. Also, examples of uses and application of the static and dynamic properties for the manufacturing and for the prediction of their behaviour once applied in the field will be presented.

(# 78) Sclerotinia stem rot of canola in Québec : cultivar resistance and yield losses

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Sclerotinia stem rot caused by the fungus Sclerotinia sclerotiorum is a disease affecting many canola fields in Québec. Infected plants produce few pods, and the seed number and size are reduced. Some fungicides are recommended to control sclerotinia stem rot in canola and those products must be applied during flowering. During two years (2001-2002), the reaction of many canola cultivars to sclerotinia stem rot were evaluated in the field in Normandin (Québec) under artificial inoculation using conditioned sclerotia of S. sclerotiorum in soil. In 2001, 15 cultivars were evaluated and the disease severity index (DSI) varied from 6.9 to 78.2. The cultivar Hy-per Star 100 was the most resistant (DSI=6.9) and the cultivar Hyola 700RR was the least resistant (DSI=78.2). In 2002, the cultivar Hyola 401 had the lowest DSI (6.2), whereas the cultivar SWD5099RR had the highest DSI (27.8). In an other experiment, 8 cultivars were used to evaluate yield losses caused by sclerotinia stem rot. For each cultivar, the treatments were: 1) application of iprodione (625 g a.i. ha-1 at 20% bloom) without inoculation 2) no fungicide with inoculation. For both years, the fungicide did not control completely the disease. The increase of grain yield in the fungicide treatment compared to the non-fungicide and inoculated treatment varied from 7 to 75% depending on the cultivar. In 2002, the average yield increment associated with fungicide application was 31%. To reduce the problem associated with sclerotinia stem rot, the canola growers should seed cultivars showing less susceptibility and use appropriate crop management such as rotation with grass species.

(# 79) Productivity of new crops in Quebec

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In Northern Quebec, cereal and forage are usually grown and the productivity of non-traditional crops has never been evaluated. New crops are of some interest because they could diversify and extend crop rotation. However, those crops could be limited by the climate and the short growing season. In 2002, canary seed (cv. CDC Maria), proso millet (gold, red, and white), lentil (cv. CDC Robin), dry bean, dry pea, and chickpea (desi and kabuli) were evaluated to determine their adaptability and productivity in Normandin (Quebec). Canary seed grain yield with a seeding rate of 30 kg ha-1 was low (639 kg ha-1) and it was affected by the cold and dry weather that prevailed in June. In the proso millet trial, gold proso millet was the earliest to reach maturity (104 days) and had the highest grain yield (3 569 kg ha-1) whereas white proso millet reached maturity 117 days after seeding and produced 954 kg ha-1 of grain. Lentil seed yields were high (1 782 kg ha-1) and grain quality was good. Dry bean grain yields were ranging from 647 kg ha-1 (cv. GTS 900) to 1 242 kg ha-1 (cv. GTS 1102). Dry pea grain yields were very high and ranged between 5 701 kg ha-1 (cv. Miami) and 6 027 kg ha-1 (cv. Carneval). Chickpea plants never reached maturity and it appears that this crop could be more difficult to establish in Northern Quebec than the others new crops tested in 2002.

(# 81) Element storage in spores of Gigaspora margarita Becker & Hall measured by electron energy loss spectroscopy (EELS).

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The storage structures of spores of Gigaspora margarita Becker & Hall, an arbuscular mycorrhizal fungus were analyzed by transmission electronic microscopy (TEM 902 Zeiss) combined to the electron energy loss spectroscopy (EELS). The spores were hydrated, cryofixed using high pressure freezing, submitted to freeze substitution, embedded and prepared for TEM observations. The cryotechniques revealed the storage structures in the spores composed by lipids, electron dense granules (EDG), protein bodies and glycogen particles. The results revealed by the EELS detected the presence of nitrogen (N), phosphorus (P) and carbon (C) in the storage structures of the spores. The relative amount of N was higher in the protein bodies and EDG as compared to those in the cytosol, Bacteria-like organism (BLO) and lipids, but for the C there were no statistical difference within the internal storage structures, except for the protein bodies and BLO. Some P was detected in the vacuoles and in BLO. These results have shown the occurrence of storage in the fungal spore during the events, and the detection of some essential elements (N, P and C) by the EELS, which belong to these storage structures in the spores.

(# 82) Use of NBPT Urease Inhibitor to Increase Safety of Seed-Placed Urea

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Guidelines for safe seed-placement of nitrogen (N) have been in place for a number of years. Adoption of direct seeding along with the introduction of high yielding cultivars has created the need for seed-placing N in excess of the current guidelines. Agrotain ® urease inhibitor (NBPT for n-butyl thiophosphoric triamide) has created an opportunity for reassessing the existing guidelines. The thinking is that if Agrotain ® treated urea is seed-placed, this will lead to the slow down of hydrolysis of urea and consequently a reduction in seedling injury from high concentrations of ammonia/ammonium in the soil solution. Western Cooperative Fertilizers Limited established a total of 52 trials with cereal and oilseed crops in the period of 1997-1999 over a range of Chernozemic soils (Brown, Dark Brown and Black). Guidelines developed based on these experiments allow for a 50 percent increase in the current urea-N safe placement guidelines for cereal (except hulless barley) and only 10 kg N ha-1 increase in the guidelines for oilseeds and hulless barley. These guidelines weren developed based on the following conditions: (a) an application rate of 5.2 litres of Agrotain ® per tonne of urea, (b) under optimum seedbed, (c) less than 15% seedling damage and (d) no impact on days to maturity. Proper application of Agrotain® on urea is predicated on following these guidelines.

(# 83) Mycorrhiza-induced changes in partitioning and composition alters flower and vegetation production of floral geophytes

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Resource partitioning and plant storage components are important factors that influence the productivity and profitability of geophyte species produced as floral crops. We determined that inoculation with vesicular-arbuscular mycorrhizal fungi (VAMF) can alter different plant characteristics affecting productivity and quality of bulb and cut flower production of several floral geophytes including Brodiaea laxa, Zephyranthes spp., Sparaxis tricolor, Freesia x hybrida, Zantedeschia spp., and Calla spp. Plant growth, flower production, bulb/corm/tuber (bulb) production and composition were measured for two growth cycles after inoculation with Glomus intraradices. In general, shoots and flowers on plants inoculated with VAMF emerged earlier than shoots and flowers on non-inoculated plants for species that produced most of their leaf area prior to flower emergence. However for species that produced leaves throughout the growth cycle or large flowers early in the growth cycle, VAMF inoculation delayed shoot emergence and flower emergence. Many species that exhibited an earlier flower emergence or produced more flowers in response to VAMF inoculation also produced smaller daughter bulbs and more offsets than non-inoculated plants. Across all species, the concentrations and contents of several storage components (Zn, S, N, amino acids, and carbohydrates) that influence bulb quality were increased by VAMF inoculation. Changes in partitioning between bulb and flower production resulting from VAMF inoculation altered important aspects of commercial geophyte production for flowers or bulbs. VAMF-induced increases in mineral uptake and resource storage are also related to aspects of quality important in the production of vegetative propagates.

(# 84) Soil or Nonsoil: Snapshots of Soil Formation in the Cold and Dry Environment of the Qinghai Plateau (China)

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In higher elevations and permafrost areas where the environment is characterized by a cold and dry climate, pedogenesis is active but inadequate to support higher plant forms. The purpose of this presentation is to elucidate the extent of soil formation at 4,700 m asl on the Kunlun Mountains of the Qinghai-Tibetan Plateau, China. In June 2001, we collected samples from 26 soil horizons in three pedons developed on re-worked till materials rich in carbonaceous rocks. The samples were analyzed in the laboratory for pH (H2O and CaCl2), particle size analysis, cation exchange capacity and exchangeable cations, total nitrogen and carbon, and various forms of extractable iron and aluminum. We also determined the minerals in clays, silt and sand fractions using a Bruker D8/GADDS X-ray diffractometer and Philips XLS 30 scanning electron microscope with energy dispersive system. Some of our results indicate early stages of soil formation such as pH > 7.0 reflecting the influence of carbonate-rich parent geological materials and low amounts of total carbon (<10 g C kg-1 soil) and nitrogen (<0.5 g N kg-1 soil) indicative of low degree of biological activity. The relative amounts of minerals in clay fractions follows the order mica >> kaolinite > chlorite. The relative amounts of minerals show no apparent change with depth suggesting minimal transformation of phyllosilicates. Currently, we are still collecting data on the extractable iron, aluminum, silicon, and manganese to ascertain the extent of rock and mineral weathering in a cold and dry environment.

(# 85) Properties of Soils Influenced by Fungal-growth in Hybrid Spruce (Picea glauca x engelmannii (Moench.) Voss)

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Soil properties of rhizosphere zones in coniferous forests are influenced by the presence of ectomycorrhizae. To elucidate the role of ectomycorrhizae on the alteration of the chemical and mineralogical properties of soils, pH, total C and N, cation exchange capacity, and the contents of mica, chlorite, kaolinite, 2:1 type expandable clays, and amorphous minerals were compared in two ECS (soils influenced by ectomycorrhizal fungi) and non-ectomycorrhizosphere soils (N-ECS) of Picea glauca x engelmannii (Moench.) Voss). Specifically, the two ECS soils were dominated by (1) Piloderma spp. (ECS-A) and (2) Inocybe lacera-like and Hebeloma-like morphotypes or where Piloderma spp. colonization was <1% (ECS-B). Our results showed that pH was lower in ECS compared to N-ECS samples. Total C and N were significantly higher in ECS soils than N-ECS samples. Cation exchange capacity as well as exchangeable K+, and Na+ were higher in ECS compared to N-ECS soils. X-ray diffraction analysis showed that the amount of 2:1 expanding clays (vermiculite and smectite) was higher in ECS than N-ECS samples and results suggested that there is an enhanced transformation of mica and chlorite to 2:1 type expandable clays in ECS samples when compared to N-ECS samples. The differences in chemical and mineralogical properties of soils in ECS and N-ECS samples in our study provided further evidence that ectomycorrhizal fungi can alter the properties of soils in the rhizosphere zone.

(# 86) Gene expression profiling of preinfection processes in Arbuscular Mycorrhizae formation

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Arbuscular mycorrhizae (AM) are symbiotic relationships between fungi of the order Glomales and terrestrial plant roots. As obligate biotrophs, AM fungi cannot grow, develop, or reproduce in the absence of a plant host. The signaling and morphogenetic events in the early interaction stages are critical for the recognition of suitable host and eventual formation of mycorrhizae by these fungi. The exudation of signals from host plant roots causes the increased branching of germ tube hyphae necessary for the fungi to find the root. We used the Glomus intraradices – carrot model system and an EST- Macroarray-based approach to understand the effect of root exudates on gene expression in germinating spores. We constructed a cDNA library by extracting RNA from spores of G. intraradices that were germinated in the presence of carrot root exudates. Over 2000 expressed sequence tags (ESTs) were selected arbitrarily and sequenced to recognize differentially expressed genes induced by the root exudates. From these, we prepared macroarrays that consisted of unigene set of 811 ESTs printed in duplicate. The macroarrays were used to observe temporal gene expression patterns using probes prepared from RNA from germinated spores induced by water only vs. germinated spores induced by root exudates. Our result showed that there is a clear temporal pattern of expression of signaling, structural, and metabolism-associated genes in the fungus in response to host root exudate signals. Our results allowed us to cluster genes into functional groups for which identities do not exist in the GenBank. These studies give us a better understanding of the first signaling/recognition event in the AM symbiosis.

(# 87) Patterns of C, N and P loss from decomposing foliar litter in Canadian forests

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As part of the Canadian Intersite Decomposition Experiment (CIDET) we examined the patterns of N and P gain, retention or loss in 10 decomposing foliar tissues over 6 years at 18 upland forest sites. N was usually retained in the decomposing litter until about 50% of the original C remained and the peak N content was observed at C:N ratios between 37 and 71:1 (mean 55:1). The rate of N release from the litters was not related to the original N concentration, which may be associated with the narrow range (0.59 – 1.28% N) in the litters. P was immediately lost from all litters, except beech leaves, with critical litter C:P ratios for P release being in the range 700 to 900:1. The rate of P loss was negatively correlated with the original litter P concentration, which ranged from 369 to 2122:1. Although there was a large variation in N:P ratios in the original litters (5.3 to 25.7:1), and some variation in the retention or loss in the early stages of decomposition, all litters converged on a N:P ratio of 16:1 when the C remaining fell below 30% and 25:1 for C:N and 400:1 for C:P.

(# 88) Soil properties and tree growth on rehabilitated landings in the Peace River region

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Soil rehabilitation refers to tillage, topsoil conservation and replacement, application of soil amendments, and other practices that aim to improve soil conditions and allow for productive tree growth on sites that have experienced soil degradation. In British Columbia (BC), forest soil rehabilitation is carried out on roads, landings, trails and other areas where soil disturbance caused by forestry operations has led to soil conditions unsuitable for productive plant growth.

The objective of this study was to determine post-establishment lodgepole pine (Pinus contorta Dougl. ex Loud. var. latifolia Engelm.) growth and soil properties on rehabilitated landings and undisturbed plantation sites in the Peace River region of BC. Study was replicated on 9 sites, each including adjacent rehabilitated landings and plantations (that were harvested but had no soil degradation) in the Boreal White and Black Spruce biogeoclimatic zone. All selected sites were treated to improve soil conditions in 1994 and planted with lodgepole pine in 1995. Landings ranged in size from 0.2-0.5 ha and were tilled with a winged subsoiler. Soil samples were collected during June-September 2001. Soil bulk density, penetration resistance, volumetric water content, water retention, and tree growth were determined. Average clay content was 24% at 0-7 cm depth on landings and 16% on plantations. Subsoils (10-17 cm) had higher clay content than surface soils. In northeastern BC, surface soils are often scraped away during landing construction, exposing fine-textured soil from deeper parts of the profile. There was a trend towards higher soil bulk density on landings than in adjacent plantations. Soil penetration resistance was often higher than the growth-limiting threshold of 2500 kPa, especially in August and September 2001.

(# 89) Responses of highbush blueberry (Vaccinium corymbosum) to inoculation with ericoid mycorrhizal fungi depends on fertilizer type, fungal isolate, and plant genotype.

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Rooted tissue culture plantlets of seven highbush blueberry cultivars were inoculated with one of three different isolates of ericoid mycorrhizal fungi and grown for two years with either inorganic or organic fertilizer. Root colonization of non-inoculated plants was low (<10%) regardless of fertilizer source. Colonization of inoculated plants ranged from 15-30% and was generally higher when plants were grown with organic fertilizer. Inoculation with any of the different fungi increased biomass of three cultivars, while the biomass responses of the remaining of the cultivars varied with fungal isolate. Our isolate of Pezizella ericae had the most influence on root biomass, while Oidiodendron griseum had the most influence on above ground biomass. Inoculated plants generally partitioned more biomass to the roots than above ground. When plants were grown with inorganic fertilizers, inoculation with all three fungal isolates had no influence on above ground biomass and slightly increased root biomass, while when grown with organic fertilizers inoculated plants had significantly higher stem, leaf, and root biomass compared to non-inoculated plants. Root colonization was significantly correlated with root biomass for three cultivars but showed no correlation to above ground biomass. Mineral composition of stems, leaves and roots were significantly altered by inoculation and changes in composition resulting from inoculation varied with fertilizer type, particularly for phosphorus, calcium, sulfur and nitrogen. Cultivars that were genetically close showed a high degree of variability in response to mycorrhizal fungi, while responses to fertilizer type were similar in closely related cultivars.

(# 90) Approaching mycorrhizal complexity through ecological stoichiometry.

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Within the community of mycorrhizal fungi interacting with roots of even a single plant there may be a high degree of ecological complexity. Different groups or species of mycorrhizal fungi exhibit different functional profiles, and when combined these difference can produce unexpected outcomes. Mycorrhizal fungi vary in their relative abilities to provide important nutrients such as nitrogen, phosphorous, or water to their plant symbionts. We employ the exchange of elemental nutrients between plant, fungus, and soil as the basis for modeling and making predictions about the possible effects of complex fungal communities on plant growth and fitness. Our model predicts that differing combinations of fungal symbionts will have very different effects, for example: plant growth may be increased with addition of multiple species of fungal symbionts, or growth with multiple fungi may be less than that with any individual species. Empirical results from various experiments support the predictions of this model, suggesting that it may be a useful tool for beginning to characterize the mechanisms and consequences of complex interactions in mycorrhizal communities.

(# 91) Prospects and Limitations for Mycorrhizas in Biocontrol Against Root Pathogens

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A large number of studies have examined the potential role of mycorrhizas in protecting plants from fungal, bacterial, nematode and even viral pathogens over the last 30 years. Often the results have been difficult to interpret because of compounding interactions, particularly concerning P availability, but taken overall there is good evidence that both arbuscular and ectomycorrhizas can control diseases. Numerous modes of action have been recognised and several may function in any interaction. Direct effects on pathogens include competition for nutrients and infection sites, physical exclusion and antibiotic production; indirect effects, expressed through changes in the plant, include enhanced plant growth or changes in morphology through a variety of processes, and activation of defence mechanisms or induced resistance which may involve production of phytoalexins, phenolics, structural barriers and PR-proteins. There is also evidence that the microbial population around the root may be modified to become more suppressive to pathogens. However, the reproducibility of the effect in the field is often poor and seems frequently to be dependent on the specific host-mycorrhizal fungus-pathogen combination involved and the environmental and microbiological conditions where biocontrol is required to work. Nevertheless, several mycorrhizal inoculants are available commercially and they may act, in part, through disease control. However, care must be taken with any claim for disease control as this could lead to a requirement for consideration under pesticide regulations in many indutrialised countries. This makes the goal of using mycorrhizal fungi as commercial microbial inoculants for disease biocontrol particularly challenging.

(# 92) Soil Aggregation and the Long-Term Stabilization of Organic C in French Silty Soil

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The role of texture and aggregation in organic C stabilization in silty soils was addressed using samples from long-term field experiments, allowing the comparison of a soil containing different pools of soil organic C versus a soil with only a passive pool. Silty soil aggregates were found to consist of a constant ratio of clay to silt particle size fractions. We propose that such a property be used to estimate true microaggregation in silty soils, and to estimate total soil material dispersed by a given dispersive treatment. Long term stabilization of organic C in silty soils appeared unlikely to be controlled by physical protection within aggregates. Rather, our study suggests that the role of physical protection in aggregates would be to offer the time required for labile organic matter to mature through humification processes or to interact with mineral surface through physico-chemical processes. Clay-associated organic matter is confirmed as an important sink of long-term stabilized soil C.

(# 93) Identification of a low-molecular-weight heat-shock protein that may be associated with ras-mediated signaling pathway controlling the establishment and maintenance of ectomycorrhizal

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Initiation, development and establishment of functional ectomycorrhiza involve morphological changes mediated by gene expression in both partners. We reported the presence of an Lbras gene in Laccaria bicolor which was expressed in response to the fungal interaction with red pine roots [Sundaram et al., Mol Plant Microbe Int. 14: 621-628 (2001)]. The Lbras had structural similarity to other members of the ras family genes, which are known to be associated with signal pathways controlling cell growth and proliferation. We now show the presence of a low-molecular weight heat-shock protein (Lbhsp) gene in L. bicolor that is activated during its interaction with red pine roots. A cDNA library from L. bicolor was subjected to differential screening to identify fungal genes expressed during interaction. One of them, Lbhsp, had amino acid sequence that was significantly similar to the low-molecular weight heat-shock protein genes found in yeast and other fungi. The Lbhsp cDNA was 633 nucleotides in length and encoded a single protein of ~ 17 kD (155 amino acids). Its expression was detectable as early as 8-12 h after interaction. Its similarity to the heat-shock gene of the fission yeast suggests that the Lbhsp expression is associated with the ras-mediated signaling pathways controlling the development and establishment of ectomycorrhiza.

(# 95) Environmental and edaphic factors influencing arbuscular mycorrhizal fungal and soil microbial communities using a tallgrass prairie restoration chronosequence

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We examined environmental factors regulating soil microbial community structure, using the Fermilab tallgrass prairie restoration chronosequence. This chronosequence allows us to examine microbial community structure over a wide range of soil and biotic conditions. Community structure was determined using phospholipid fatty acid (PLFA) patterns, and summarized by correspondence analysis. We found a clear difference between agricultural and restored prairie plots. The prairie plots had higher relative amounts of the saprophytic fungal marker PLFA 18:2?6, and the arbuscular mycorrhizal fungal marker 16:1?5c. In contrast, agricultural plots had higher relative amounts of cy17:0 and cy19:0; markers for gram-negative bacteria. When fungal PLFAs were expressed as a ratio with bacterial PLFAs we found that the proportion of microbial biomass composed of fungi increased with the cessation of agriculture. We further found that the majority of the fungal increase was due to the AMF marker 16:1?5c. Furthermore, the ratio of cyclopropyl fatty acids to their precursors was considerably lower in prairie plots than for agricultural plots, indicating that substrate availability was higher for the restored prairie soils. Regression of ordination plots against environmental variables indicated that the chronosequence represents an aggrading soil system, with microbial composition related to a suite of environmental variables, most notably root biomass, surface litter C:N ratio, soil pH, and plant tissue and soil C:N ratios. These changes in biotic and edaphic factors appear to be related to the termination of tillage and fertilizer inputs, and especially to increases in plant biomass and the accumulation of soil organic matter associated with the restoration process.

(# 96) Arbuscular- and Ectomycorrhizas in Selected Tree Species From Tropical Atlantic Rainforest Remnants in Sergipe, Northeast Brazil

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Information on root symbiosis and fungal flora in tropical ecosystems is still scarce and even absent for many tropical regions. Studies on mycorrhizal symbiosis have been performed in some Atlantic rainforest remnants in the Brazilian northeast region aiming to subside reforestation programs. Analysis of the root samples of some selected species revealed that arbuscular mycorrhizas (AM) were present in almost all species analyzed, with varying levels of colonization. Particularly, the strong AM colonization levels in roots of Vismia guianensis and Cecropia pachystachya, two pioneer species, differ markedly from the non-pioneer species in this study. These species could act as a source of mycorrhizal inoculum in deforested habitats, being important further studies on the composition and properties of their mycorrhizal partners in order to improve successful establishment of AM dependent forest tree species in these areas. Ectomycorrhizal root tips were only found in Coccoloba rosea, but not in C. laevis. Although colonization quantification was not possible, both Coccoloba species analyzed showed some AM colonization. This is a genus of tropical and woody species, occurring predominantly in South America, the largest number being found in Brazil. Reports of ectomycorrhizal Coccoloba species are relatively abundant throughout a wide range of ecosystems in the Neotropics. This genus is therefore worthy of further study in order to understand the role of ectomycorrhizas in the mineral nutrition of Coccoloba species along their distribution area.

(# 97) Mycorrhizal Colonization of Tropical Seedlings Roots in Two Brazilian Atlantic Rainforest Remnants

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Seedlings in two fragments of Atlantic rainforest in Sergipe, Northeastern region of Brazil were studied. Analysis of seedlings sampled in 1m2-quadrats in coconut plantation, forest fringe and forest plots revealed that seedling number and species richness diminished towards the former area. Root colonization did not differed significantly between the three areas in both sites. However, a relatively high number of seedlings presented low colonization grade, especially in the forest plot from the Crasto site, while plantation plots of both sites presented a significant number of plants with highly colonized roots. Root colonization was not significantly correlated with root length, shoot length nor with shoot biomass. Legume seedlings were usually nodulated, but with lower mycorrhizal colonization grade. Subsequent analysis of four selected native tree species in forest areas, revealed also a variable pattern. Some of the species, Annona sp and a still unidentified Myrtaceae species presented low to moderate root colonization, whereas Maytenus sp and Tapirira guianensis showed higher colonization grades. These differences in root colonization do not seem to be related to successional stage or seed size and must be further investigated within a greater number of species. Moreover, some of these species where highly colonized by structures similar to the ones described as dark septate endophytes (DSE). These have been described in roots from a wide range of ecosystems and are regarded to have also positive effects on plant growth. Further investigation on the role of these symbionts on the early establishment of tropical tree species are therefore intended.

(# 98) Interrelationships between plant health promoting rhizobacteria and arbuscular mycorrhizal fungi on tomato and their importance in the biocontrol of the root-knot nematode

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Plant health promoting bacteria (PHPB) and arbuscular mycorrhizal fungi (AMF) have been shown to increase plant resistance toward the root-knot nematode Meloidogyne incognita on tomato. However, these antagonistic bacteria often have to be inoculated repeatedly over time to maintain protection. AMF is only effective in the biocontrol of the nematode, when the plants are well colonized mycorrhizal before they are transplanted into nematode infested fields. The combination of the two microbial antagonists was the objective of the present studies. Because of the total phase out of Methyl bromide in the year 2005 and the lack of safe and effective nematicides there is a vacuum in IPM systems for sustainable vegetable production in the tropics and subtropics, where root-knot nematodes cause severe damage.

Tomato plants were inoculated with different PHPB and Glomus intraradices simultaneously to determine if these PHPB positively or negatively affect AMF colonization. After 8 to 10 weeks the level of AMF colonization was estimated. The rhizobacteria, Rhizobium etli strain G12, that induces systemic resistance to Meloidogyne incognita on tomato, significantly enhanced AMF root colonization.Bacteria were also isolated from the surface of AMF spores and were tested for their antagonistic reactions toward the root-knot nematode on tomato. Two of the nine bacteria examined significantly reduced nematode penetration.

The beneficial effect of Rhizobium etli G12 onto mycorrhization, the importance of the mycorrhizosphere as a source for antagonistic bacteria against pests and the developed strategy for field control of the root-knot nematode will be discussed.

(# 101) The function of ectomycorrhizal fungi in initial soil development of post mining landscapes

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Afforestation is the main exploitation of former lignite-mining landscapes in the Lusatian lignite area in East-Germany. Because of the edaphic dryness, acidification and lack of nutrient, the success of outplanting seddlings is very low. During the reclaimation process the postmining substrates are colonized by diaspores of several mycorrhizal fungi, especially „early stage fungi" like Cenococcum geophilum Fr. or Scleroderma citrinum Pers.. To improve the outplanting success, we isolate ectomycorrhizal fungi from mining substrates and cultivate them. Thus, we get species wich were adapted to the extrem habitat conditions. Afterwards the mycelium serve as an inoculum for seedlings. After field setting of young trees their fungal symbionts are interacting with the ectomycorrhizal fungi in the field. These results in changes of the ectomycorrhizal community structure.We established several projects in recent years to understand the processes of primary and secondary succession, to get an idea of the ubiquitous inocula of fungal diaspores in the post-mining landscape and to understand the function of specific mycorrhizal species in the extreme habitat conditions of mining substrates and initializing soil development. A good view over the first results is given in this presentation.

There exist a high species diversity in ectomycorrhizal fungi, we hypothesise, that one reason for this high species number are the different functions of the fungi in the symbiosis. In wich way different parts of the mining substrates are used by the fungi as nutrient or water ressource or if specific fungi could protect the trees to toxic soil conditions is one of our questions. Exemplarily we investigate, if roots are capable of changing rhizosphere conditions and if mycorrhizae and its mycelia can deteriorate black carbon and/or primary minerals in minesoils.

(# 102) Afforestation of abandoned land with conifer seedlings inoculated with three species of ectomycorrhizal fungi

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At present, bare root Pinus sylvestris and Picea abies seedlings are used to a large extent for afforestation of abandoned (former agricultural) land in Lithuania. Our preceding work has shown that in nurseries bare root seedlings are poorly colonized by ectomycorrhizal (ECM) fungi. The aim of this study is to investigate whether artificial inoculation of root systems with ECM fungi prior to outplanting has any impact on survival, establishment and performance of the seedlings under field conditions. Three species of ECM fungi were selected: Cenoccucum geophilum, which is known to be a drought tolerant ECM fungal species; Piceirhiza bicolorata and Hebeloma crustuliniforme, which apart from being efficient root colonizers, have both shown the ability to suppress root pathogens in vitro. A novel inoculation method was employed using fungal mycelia growing on filter papers surrounded by paper towels. This method enabled rapid preparation of large amounts of inoculum applied in standardized amounts at outplanting. Favorable, semi-sterile conditions for root mycorrhization were also created, temporarily separating the roots from the bulk soil to allow successful colonization by the inoculated fungi without competition from other soil fungi. In total, 8000 pine and 8000 spruce seedlings were planted on poor sandy soil that most likely lacks any natural ECM inoculum. Inoculated and control treatments were arranged randomly in 16 plots for pine and 16 for spruce throughout the afforestation area. Planting density was 4000 seedlings per ha. Patterns and rates of mycorrhizal colonization of seedling roots and survival of plants will be discussed.

(# 103) AM-specific gene regulations in the model plant Medicago truncatula

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Up to now, little is known about transcriptional changes which occur AM-exclusively, i.e. they do not occur during other root-microbe associations nor are induced by a improved phosphate nutrition. In order to identify such AM-specific gene inductions of Medicago truncatula, we used a pool of different RNA samples as subtractor population in a suppressive subtractive hybridization (SSH) experiment. This approach resulted in the generation of 1805 SSH-ESTs. Bioinformatic and molecular analysis of this EST population resulted in an identification of various AM-specifically induced genes. A number of these genes, including three different lectins and a nitrate transporter, were selected for further analysis concerning their regulation and function.

To get insights into molecular mechanisms of AM-specific gene regulation, the promoter structures of the selected genes have been cloned. The promoter of one gene, MtGst1, showing similarities to plant glutathione-S-transferase (GST) encoding genes, could already been shown to activate transcription in all zones of the root cortex colonized by Glomus intraradices, but no elsewhere (Wulf et al. 2003). Different fragments of this promoter are currently being analyzed to identify the minimal promoter sequence, driving the mycorrhiza-specific transcription. These promoter fragments are a prerequisite for an identification of promoter-binding elements involved in AM-regulation cascades using yeast one hybrid experiments.

The function of the genes is currently studied using post transcriptional gene silencing (PTGS) in our model system Medicago truncatula.

(# 104) Monophyly of Beta-Tubulin and H+-ATPase gene variants in Glomus intraradices: consequences for molecular evolutionary studies of AM fungal genes

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Previously studies showed the presence of evolutionary divergent copies of Beta tubulin and H+-ATPase genes in AMF genomes and suggested possible horizontal gene transfer from host plants or mycoparasites to AMF. We performed PCR, using highly degenerate primers for Beta-Tubulin and H+-ATPase fungal genes, with DNA isolated from an "in vitro" cultured isolate of Glomus intraradices that was free of any obvious contaminants. We found the presence of two highly variable Beta-Tubulin genes and variable H+-ATPase sequences in the genome of Glomus intraradices. Despite this high molecular variation, comparison of sequences with those in gene banks and resulting phylogenetic analysis highly supported monophyly of Beta-Tubulin and H+-ATPase genes in Glomus intraradices. Thus, our results are in sharp contrast with the previously reported polyphyletic origin of those genes. Evidence for a contaminant origin of some deposited Glomalean sequences are provided. By using an increased number of taxa for phylogenetic tree construction we reject the prediction of horizontal gene transfer to AMF genomes. Moreover, a clear segregation of the sequences in relation to their GC content, between those of AMF origin and suspected contaminants, is shown in our phylogenetic analysis. The genetic variation and the monophyletic origin of these AMF functional genes highlight their usefulness for phylogenetic analyses and, therefore, should be considered as a useful alternative to rDNA sequences for studies on AMF evolutionary relationships.

(# 105) Nitrogen and Phosphorus Leaching as Influenced by Tillage, Crops and Fertilizer Sources

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There is worldwide concern about ground water contamination with nitrogen (N) and phosphorus (P) originating from agricultural soils. Although certain agricultural management practices can reduce the quantity of N and P leached through soils, there is limited information on the interactive effects of key management practices. The objective of this study was to evaluate the interactive effects of tillage, crops and fertilizer sources on the leaching of N and P from a silt-loam soil (Typic Endoaquent). We chose two tillage systems (no-till or conventional tillage), two crop rotations (continuous corn or soybean/corn) and two fertilizer sources (inorganic fertilizer or composted cattle manure), for a total of eight factorial treatments. Intact soil cores were collected from three replicates of each factorial treatment, plus a control adjacent to the field site (27 soil cores in total). Soil cores were maintained at 6~{!c~}C and leached eight times with 960 mm synthetic rainwater under suction to simulate mean annual temperature and precipitation conditions at the field site. The quantities of N + P leached were not affected by tillage, but more dissolved reactive P was leached from soils under a soybean/corn rotation than from soils under continuous corn production. More dissolved nitrate N and less dissolved reactive P were leached from soils receiving inorganic fertilizers than those amended with composted cattle manure. The relationships between soil properties and nutrient leaching will be discussed. Interactive management practices that may reduce N and P leaching through soils will be identified.

(# 106) Improving N efficiency in wild lowbush blueberry

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Generally, soils in wild lowbush blueberry production have very low nutrient and water storage capacities. An experiment was initiated to determine the effect of N fertilization during the sprout year and the first year of wild lowbush blueberry (Vaccium angustifolium Ait.) fruit production in the Lac St-Jean area, Quebec, Canada. Four nitrogen fertilization treatments (split application or not of 0, 30, 60 and 90 kg N/ha) were applied in the sprout year and the first year crop production. Phosphorus and potassium were applied at 20 and 30 kg/ha respectively for each treatment. The single application of N increased fruit yields by 25 to 200% when compared to the control. The split application of N had the same effect than the single application. Apparent N recovery was higher with a split application of 21 and 9 kg N/ha in sprout and first year respectively (8.57%) compared with a single application of 30 kg N/ha applied in the sprout year (4.35%). Apparent N recovery decreased with higher N rates (2.99%). Soil N-NH4 increased significantly one month after the application of 60 and 90 kg N/ha but was not significantly affected by split application of 30 kg N/ha. These preliminary results indicated that split application of N recommendation rate in the proportion of 66% in the sprout year and 33% in the first year crop production increased fertilizer efficiency and reduced potential N leaching in soil profile.

(# 107) Influence of two polycyclic aromatic hydrocarbons on spore germination of Gigaspora margarita

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Arbuscular mycorrhizal fungi (AMF) are ubiquitous soil microorganisms that occur in soils contaminated by organic and inorganic compounds. However, little is known about the interaction of AMF with organic contaminants such as polycyclic aromatic hydrocarbons (PAH). To evaluate the influence of PAH on the spore germination of AMF, water-agar (1%) plates were contaminated with two PAH: phenanthrene (PHE) and benzo[a]pyrene (BaP). Contaminants were separately diluted in acetone and sprayed on the agar surface to apply 0, 25 (0.1 mM of BaP & PHE), 50 (0.2 mM BaP & 0.3 mM PHE), 75 (0.3 mM BaP & 0.4 mM PHE) and 100 µg mL-1 (0.4 mM BaP & 0.6 mM PHE), respectively. Twenty-four hours later, a superficially disinfested-spores of Gigaspora margarita Becker & Hall were placed on treatment plates with water-agar (1%). There were five treatments per concentration utilized per PAH species. Each treatment consisted on four replicate plates with 20 spores per plate (n=80). Plates were incubated at 24°C in darkness for 25 days, and then spore germination and hyphae length were evaluated. Spore germination was drastically affected by all concentrations of PHE. The spore germination percentage was reduced < - 92% > at 100 µg mL-1 (0.6 mM) of PHE compared to the non-contaminated medium (control). In contrast, the effect of BaP was less negative on spore germination percentage than PHE. Spore germination at 100 µg (0.4 mM) of BaP was reduced < - 42.8% > compared to the control. BaP stimulated total hyphal length compared to the control.

(# 108) Phytoremediation potential and tolerance of Echinochloa polystachya-Gigaspora margarita symbiosis to benzo[a]pyrene

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Arbuscular mycorrhizal fungi (AMF) play an important role in plant adaptation to contaminated soils. However, little is known about the role of AMF on the development of specific plants utilized for phytoremediation such as Echinochloa polystachya (H.B.K.) Hitchcock. In Mexico, E. polystachya was recently evaluated on petroleum and benzo[a]pyrene (BaP) contaminated soils. This plant species showed excellent potential for phytoremediation. In addition, the arbuscular mycorrhizal associations of E. polystachya have not been reported. The present work evaluated the role of Gigaspora margarita (Gm) Becker & Hall on BaP degradation from the rhizosphere of E. polystachya established in artificially contaminated sand. Rooted cuttings of E. polystachya were inoculated with 300 spores of Gm. Non-mycorrhizal (Non-AMF) and AMF-plants were exposed to sterile sand contaminated with several concentrations of BaP diluted in acetone [0, 25 (0.1 mM), 50 (0.2 mM), 75 (0.3 mM) and 100 mg kg-1 (0.4 mM)]. After 70 days, neither AMF colonization nor plant biomass was significantly affected by the presence of the BaP. Root colonization of Gm measured by alkaline phosphatase stain, was increased at 75 mg BaP kg-1. Dehydrogenase activity in the rhizosphere of AMF-plants was not significantly affected by BaP; however, this activity was higher at 50 to 100 mg BaP kg-1 in comparison with Non-AMF plants. Polyphenoloxydase (PPO) activity in roots was low in plants growing in contaminated sand. Gm-plants showed a diminished root PPO activity. Although AMF did not improve the intrinsic tolerance of E. polystachya to BaP, the degradation of this contaminant in AMF-plants was enhanced.

(# 109) Mexican endogenous arbuscular mycorrhizal fungi increase plant quality of Citrus volkameriana Tan & Pasq in comparison with two fertilizer formulations (NPK)

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Twenty-five days-old seedlings of Citrus volkameriana were inoculated with endogenous AMF from Mexico: the fungal consortium Glomus Zac-19 (CPMexZ19), and the single isolate of Glomus intraradices (Schenck & Smith) (CPMexFS18). Non-inoculated plants were also considered. Three fertilizer formulations (kg ha-1) based on: 0NPK (F1), 40N-36P-32K (F2) and 240N-108P-96K (F3). Fertilizer formulations were estimated in accordance to those recommended to citrus nurseries. Nine treatments and 10 replicates were considered. Plants were weekly watered and maintained at minimum /maximum temperature of 18/30°C and relative humidity of 65% under greenhouse. After 210 days, Dickson´s plant quality index commonly used in forestry, was estimated [Total dry matter/(height/stem diameter)] + [shoot dry matter/root dry matter], and the leaf N, P and K concentration and mycorrhizal colonization were measured. Plant biomass was significantly enhanced by the mycorrhizal consortium whereas fertilized plants showed lower growth. Glomus Zac-19 plants at F1 produced the highest plant quality despite its low root colonization percentage. Glomus Zac-19 plants plus F3 showed a synergistic effect on leaf N-concentration; however, P and K concentrations were higher in plants inoculated either Gl. intraradices or Glomus Zac-19 but at F1. Mycorrhizal inoculation increased significantly the growth, nutrition and quality of plants in comparison with the utilized fertilizer formulations. Dickson´s index can be utilized to establish a standard quality for Citrus volkameriana Tan & Pasq plants in order to release them to field.

(# 110) The effectiveness of a Mexican endogenous arbuscular mycorrhizal fungi consortium on two cultivars of Carica papaya L. depends on the interaction of its own three fungal components

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The fungal consortium Glomus Zac-19 (CPMexZ19) was isolated from a bean crop established in the semi-arid region of Zacatecas, Mexico. Since more than 15 years, this consortium has been successfully tested in several fruit and horticultural crops. This fungal consortium is integrated by three species of Glomus: G. claroideum (70% of abundance), G. diaphanum (20%), and G. albidum (10%). To evaluate the effectiveness of each single fungus of this consortium, seedlings of two cultivars of Carica papaya L: Chich´put (Mexican wild-type) and Red Maradol (Selected variety) were inoculated separately with each fungus and with the natural consortium. Inoculants were propagated in river sand during seven months using sorghum as a trap culture. Each fungal inoculum was adjusted to apply 70 spores per plant. Plant growth and nutrimental status in both cultivars were significantly increased by the inoculation of the natural consortium. In contrast, the three single isolates did not improve the growth of both cultivars whose response was similar to that from non-inoculated plants. The root acid phosphatase activity in both cultivars was significantly increased by the presence of G. claroideum and G.albidum, However, this effect did not correlate with the uptake of P in shoot so that inoculated plants with the consortium showed the highest values of P-content. Mycorrhizal colonization measured as succinate dehydrogenase activity, did not show significant differences. The consortium and the three single isolates showed colonization less than 10%. Wild-type plants showed higher mycotrophism than the cultivar Red Maradol. Further studies are needed to clarify fungal interrelationships, which might be responsible of the effectiveness of this mycorrhizal consortium on plant growth. The study and evaluation of beneficial bacteria cohabiting with the consortium need to be considered.

(# 111) Temperate and Tropical Dry Ecosystems

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Mycorrhizae are diverse in arid to semi-arid ecosystems and function differently than in mesic ecosystems. The first factor in understanding mycorrhizae is to describe the soil, mycorrhizal fungal hyphae, and plant root structure across the soil-plant-atmosphere continuum. This scales from individual hyphal tips to entire stands. The second factor is across seasons from saturated to dry soils through decadal events. In most arid ecosystems, there is a pronounced wet and dry season. In saturated soils, some nutrients and water readily move by mass flow. Hyphae extend the surface area taking up immobile resources. As the plant transpires, roots shrink from the soil creating air gaps. Mycorrhizal fungal hyphae bridge these gaps providing conduits for continued water flow and nutrient transport. This break occurs at as little as –0.3 MPa. As soils dry, deeper roots become more important. Nutrients are concentrated near the soil surface. Under extremely dry conditions, (<–5 MPa) roots and mycorrhizae take up and re-distribute ground water or water deep in rock fractures. At night, water is re-distributed laterally back out through fungal hyphae, mineralizing nutrients at individual hyphal tips. In granite, these fractures have few nutrients, but enough water to sustain an evergreen plant through the drought. Root and EM fungal longevity is highly variable. Many disappear with drought, but some persist much longer than expected, and can survive 3 years through drought cycles. Integrating all of these dynamics requires knowledge of individual daily, mm3 dynamics scaled across ecosystems to decadal time-steps.

(# 112) The AMF G. intraradices is haploid and has a small genome size in the lower limit of eukaryotes

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The genome size, complexity, and ploidy of the AMF G. intraradices (DAOM 181 602) was determined using genomic reconstruction, reassociation kinetics and flow cytometry. Nuclear DNA from G. intraradices that was maintained in in vitro culture, was analyzed by genomic reconstruction with four putative single-copy genes (Rad32, RecA, malate synthase, and ATPase). We found that genome size of G. intraradices was 15 Mb (12 to 16 Mb). The genome size estimate using b-tubulin was, however, four times larger, indicating that this gene is multicopy. As an independent method of genome size estimation, reassociation kinetics was performed. A preliminary genome size estimate was 15 Mb using this method.

Flow cytometry was carefully performed on G. intraradices nuclei using different standards for calibration (haploid, diploid and tetrapoid Saccharomyces cerevisiae, and chicken erythrocyte nuclei). Flow cytometry genome estimate was very close to the predictions from genomic reconstruction (11 Mb). This shows that G. intraradices has a very small genome size for an eukaryote. To determine ploidy, the DNA mass per nucleus measured by flow cytometry was compared with the genome estimate from genomic reconstruction and ressociation kinetics to yield a DNA index (DNA per nucleus per haploid genome size). G. intraradices was found to have a DNA index of 0.8, indicating that it is haploid, unless Rad32, RecA, malate synthase, and ATPase are all multicopy and in exactly the same copy number.

(# 113) Genetic diversity of Tuber melanosporum Vittad. populations

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Mutualistic root symbionts, such as ectomycorrhizal fungus, likely migrated with their host trees during the reductions and expansions of the European forest during the Quaternary period. In the present study, we have evaluated this hypothesis by assessing genetic variability in regional populations of the ascomycete Tuber melanosporum, which suffered a drastic genetic bottleneck in the last glacial period. Sequence analysis of ribosomal DNA internal transcribed spacer (ITS) of fruiting bodies collected in northern and southern France revealed four haplotypes characterized by three single nucleotide polymorphisms. Molecular variance analyses (amova) showed significant genetic differences among isolates sampled in various regions (Burgundy, Lorraine, Poitou-Charentes, Provence and Rouergue) and northern Italy (Piedmont, Italy). No significant correlation was found between geographical and genetic distances. Thus, among-region differences could not be explained by isolation-by-distance. Nested clade analyses (NCA) of phylogenetic data revealed a geographical association of haplotypes. This data suggests that the current haplotype distribution resulted from a rapid post-glacial expansion of a small relict population along two main re-colonization routes (i.e., the Perigord-Poitou route and the Rhone valley). This re-colonization pattern is reminiscent of the one observed for white oaks, major calcicolous host trees of the black truffle. This suggests that T. melanosporum post-glacial re-colonization of its biota in France was dictated by the northern expansion of its host trees from a small southern Mediterranean refuge, which shaped the genetic structure of its populations. To evaluate the above hypothesis, a similar approach for the most precious truffle, T. magnatum, is in progress.

(# 114) Proteome Screening of Laccaria bicolor for interacting partner(s) of Ras mediated signaling pathways in ectomycorrhizal symbiosis

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The formation and maintenance of functional ectomycorrhiza involves dynamic biochemical events including signaling interactions between the plant host and the fungus, leading to recognition between the partners and establishment of a symbiotic organ. Despite its importance, the signaling pathways involved in mycorrhizal symbiosis are not well understood. We have cloned a symbiosis-regulated gene, Lbras, from the ectomycorrhizal fungus Laccaria bicolor, which has been shown to be associated with signaling pathways controlling cell differentiation, proliferation and apoptosis in multicellular organisms. Functional similarity of Lbras was established by complementation of ras2 function in Saccharomyces cerevisiae and the ability Lbras to transform mammalian cells. To identify the downstream and upstream targets for ras mediated signal transduction pathway, we cloned Lbras as a binding domain fusion (bait) and all of the L. bicolor cDNAs from interaction library and L. bicolor x red pone root mycorrhizal library individually as a DNA-activating domain fusions (prey) and performed a yeast two-hybrid assay. Our initial examination of over 600 yeast clones revealed several two-hybrid interactions, which were strictly selected for the activation of two different interaction-dependent reporter genes. We have identified one of the ras interacting clones as PF6.2, previously isolated and characterized in our laboratory. We have also identified Lbras interacting small hsp class proteins and vesicular transport proteins. This approach and the data obtained will enable us to understand the novel ras-interacting partner(s) of the symbiosis-related pathway(s) and contribute towards understanding the signaling pathways involved in various stages of development of ectomycorrhizal symbiosis.

(# 115) Carbon Saturation and the Rates and Limits of Carbon Sequestration in Soil

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Increasing soil C through changes in land use and management is a low cost and environmentally beneficial method of sequestering atmospheric CO2. However, it has been proposed that soils have an inherent upper limit above which no additional C can be stored. This C saturation limit may govern the rate and extent of any further soil C sequestration. We tested for C saturation in a 2.5-year incubation of A- and C-horizon soil with low and high additions of 13C-labeled wheat straw to six agricultural soils, the hypothesis being that C-horizon samples will retain a greater proportion of added residue than the A-horizon because the C-horizon is further from the theorized 'saturation' limit. Preliminary soil respiration results 6 months into the incubation support the hypothesis. Carbon stabilized in microaggregate POM, mineral associated, and biochemically resistant pools will be further evaluated through a physical fractionation scheme to test for C saturation in pools associated with different organic C stabilization mechanisms.

(# 116) The communities of ectomycorrhizal fungi associated to Cistus laurifolius L. (rock rose) in basic soils in Central Spain as revealed by molecular analyses of ectomycorrhizal roots

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In the Mediterranean, the disturbance of climax forests leads to successional series of vegetation, from shrub-lands to communities of xerophilous herbs. One of our objectives is to study the succession of the ectomycorrhizal fungi along vegetation series in the Mediterranean. Cistus species (rockroses, Cistaceae) are major ectomycorrhizal shrubs in Mediterranean shrub-lands. We hypothesize that Cistus roots are major refugees of ectomycorrhizal fungi until the recovery of the arboreal layer. In the present work, we studied the ectomycorrhizal fungi associated to Cistus laurifolius L. (rockrose) shrub-lands after the disturbance of Quercus faginea Lam. woodlands in Central Spain. Molecular typing of ectomycorrhizal roots within six plots showed drastic differences; four plots were dominated by basidiomycetes (mainly gateromycetes), and two plots were characterized by species of Tuber. This is the first molecular survey on the ectomycorrhizal fungi associated to Cistus species growing onto calcareous soils. This molecular study contrasts with our data on fungal symbionts associated to C. laurifolius in acid soils, which are communities rich in epigeous basidiomycetes (e.g. Amanita muscaria). In contrast, in calcareous soils the ectomycorrhizal fungal biota of Cistus spp. is often dominated by Tuber species, in particular by calcicolous species (e.g. Tuber melansoporom). Our data suggest that the composition of ectomycorrhizal fungal communities of Cistus shrub-lands is drastically determined by the soil features.

(# 117) Does the size of the air spaces in roots influence the morphology of arbuscular mycorrhizas?

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Two main morphological types of arbuscular mycorrhizal (AM) fungi are known, the Arum-type and the Paris-type, which are characterized respectively by intercellular hyphae and arbuscules, and intracellular hyphal coils. It has been shown previously that both plant and fungal identity play major roles in defining the morphological type. Tomato, for example, forms both Arum- and Paris-types. However, the factors controlling this morphology are still obscure. The presence and size of air spaces in root cortical cells may influence the formation of either morphological type. The aim was to determine if the size of air spaces in tomato roots affects the morphology of mycorrhizas formed by different fungal species. Tomato roots of two different cultivars, a wild type (76R) and a mutant (rmc, reduced mycorrhizal colonization) were grown for four weeks in pots or axenic cultures and harvested to measure the size of air spaces in transverse and longitudinal sections. The size did not differ significantly between 76R and rmc when grown in the same medium. However, roots grown in vitro had smaller air spaces than those grown in soil. Hyphal diameters were measured in a wide range of AM fungal species growing within several hosts. In tomato roots, hyphal diameters were much smaller than the average size of air spaces, and although 76R roots had discontinuous air-spaces, it did not preclude them from forming Arum-types with different AM fungi. This suggests that the size and continuity of air-spaces do not control the morphological type of AM, at least in tomato.

(# 118) Diversity of ectomycorrhizal fungi on Salix spp. at heavy metal contaminated and non-contaminated

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High concentrations of heavy metals in the soil have shown to affect the diversity of ectomycorrhizal fungi on different host plants. Well adapted mycorrhizal strains are assumed to enhance the capability of phytoremediation at contaminated sites. The aim of this present study was to compare the ectomycorrhizal diversity on Salix spp. at four heavy metal and four control sites without contaminations in Germany and Poland. Living root tips were extracted from contaminated and control sites, and the root tips were classified morphologically into 14 ectomycorrhizal types (8 from non-contaminated sites, 6 from contaminated sites). Parallel DNA was isolated from ectomycorrhizal roots and sporocarps and amplified using the universal primer pairs ITS1/ITS4, ITS1f/ITS4b and NL1/NL4. The PCR products from the ITS regions were analysed by sequencing and identifying comparative analysis with the GenBank database. It was shown that the diversity of ectomycorrhizal fungi on Salix spp. was decreased at heavy metal contaminated sites. Ectomycorrhizal strains from heavy metal contaminated sites will be investigated for their capability to enhance phytoextraction of heavy metals with Salix spp..

(# 119) Isolated Root Caps, Border Cells, and Mucilage from Host Roots Stimulate Hyphal Branching of an Arbuscular Mycorrhizal Fungus

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The results presented here deal with the precolonization role of particulate and viscous fractions isolated from host roots. Root caps and mucilage were rapidly isolated and separated from Ri T-DNA transformed carrot roots (D. carota L.)grown in liquid culture in the presence or absence of phosphorus. In addition, border cells (BC's) and mucilage were removed from aseptically grown corn roots (Z. mays L.). The isolated fractions were tested in a bioassay using germinated spores of G. gigantea. All three isolated fractions (root caps, BC's, and mucilage) contained compounds which stimulated hyphal branching of the fungus.

(# 120) A field population of the AMF Glomus intraradices is locally diverse and spatially structured

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Different AMF species have been shown to alter plant growth, diversity and ecosystem function. Given that AMF have evolved to contain a surprisingly high genetic diversity and genetically different nuclei within individual spores populations of one AMF species could also be functionally diverse. Drift or selection could lead to within-species variation with regards to genetics, physiology and ecological function among individual AMF spores, a consequence that has been largely neglected. To date no study of an AMF population has been attempted and ecological studies on AMF have mostly been based using single spore isolates to represent different species, i.e. the implicit assumption of genetic homogeneity among individual spores. We conducted an experiment to test the hypothesis that no phenotypic and genetic variation occurs in a field population of the AMF Glomus intraradices. Strong and highly significant phenotypic and genotypic differences were found between isolates. Further analyses showed that only a minimum of 5 to 7 spores represent 90% of the total population variation. Genetic differences exceeded phenotypic differences indicating that not only drift but also selection had occurred in this population. The implications of our findings with regards to sampling practices for experiments, inoculum production, and the different levels on which diversity in AMF may be ecologically relevant will be discussed.

(# 121) Blue Light Photoreceptors and Hyphal Branching Sites of an Arbuscular Mycorrhizal Fungus

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Blue light can induce hyphal branching of Gigaspora gigantea. Various tip lengths and various segments of the primary germ tube were exposed to high intensity blue light for a short duration. The results showed that photoreceptors were located all along the axis of the germ tube but not in the apical 2mm. When 3mm segments of the germ tube were exposed at greater distances from the tip (6-9mm and 9-12mm), branches were induced in areas not directly exposed to light. Results indicated that the photoreceptors and sites of branching did not necessarily coincide and suggested a probable involvement of a second messenger during the photo-induction event.

(# 122) Ultrastructural Analyses to Identify Common Marker Genes for Monitoring Ectomycorrhizal Symbiosis

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Initiation, development and formation of a functional ectomycorrhiza are mediated by changes in gene expression in both partners. Functional genomics in Laccaria bicolor X red pine system has shown that the interaction leads to turning on and turning off of several genes, some of which appear to be related to signaling pathways that control cell growth and proliferation. It is likely that a similar set of genes is involved in the formation and maintenance of functional symbiosis in all ectomycorrhizal systems. If so, these genes could serve as common molecular markers to monitor the progression and establishment of ectomycorrhizal symbiosis. We tested this hypothesis using Lbras and PF6.2 genes isolated from L. bicolor. Both PF6.2 and Lbras are induced very early during interaction and continue to be expressed even in established ectomycorrhizae. Transmission electron microscope (TEM) analyses using Lbras and PF6.2 antibodies showed that these proteins were present in both mantle and Hartig net tissues and were localized near the fungal cell wall.

We subjected seven different ectomycorrhizal fungi to immunological TEM analysis after they had interacted with red pine roots to form ectomycorrhizae. The fungi examined were Amanita rubescens, Laccaria laccata, Cenococcum geophilum, Suillus luteus, Pisolithus tinctorius and Laccaria bicolor. Results showed that antibodies raised against the L. bicolor proteins cross-reacted with similar proteins in all other fungi. Also, as in the case of L. bicolor, these proteins were localized near the fungal wall in both mantle and Hartig net tissues. This suggests that all ectomycorrhizal fungi have genes similar to PF6.2 and Lbras that can be used as markers to monitor formation and functioning of ectomycorrhizal symbiosis.

(# 123) Phosphorus Availability and Intraspecific Density Conditions That Maximize Arbuscular Mycorrhiza Benefit to Facultative Mycotrophs

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In this study, we investigated how phosphorus availability, arbuscular mycorrhizas, and their interaction affect plant responses to intraspecific density. Four facultatively mycotrophic species: chile dulce, cilantro, tomato, and corn were examined separately in pot experiments that employed a tropical phosphorus-immobilizing soil. Each experiment comprised nine soluble phosphorus additions, inoculation with arbuscular mycorrhizas or not, and low or high intraspecific density. High phosphorus significantly diminished mycorrhizal colonization of corn, cilantro, and tomato, but not chile, which was highly variably colonized. Corn roots were colonized by other root-inhabiting fungi and mycorrhizas significantly reduced colonization by these potential root parasites. High phosphorus significantly increased relative growth rates (RGR) of all species, and high density significantly reduced RGR of cilantro, tomato, and corn. Chile had little growth at all but the highest phosphorus additions, and consequently had no RGR response to mycorrhizas or density. For both RGR and dry weights at harvest, cilantro, tomato, and corn benefited most from mycorrhizas at low phosphorus availability, and this benefit diminished or turned to disadvantage as phosphorus was increased. High density decreased the effects of mycorrhizas on cilantro and tomato biomass. This study demonstrates that phosphorus availability and mycorrhizas modify the responses of facultatively mycotrophic plant species to intraspecific density. Mycorrhizas can be disadvantageous to facultative mycotrophs at high phosphorus availability and at low phosphorus availability if density is high. Consequently, the benefits of mycorrhizas to facultative mycotrophs, such as agricultural species, in monospecific stands may be maximized at intermediate phosphorus availabilties.

(# 124) A comparison of ectomycorrhizal fungal communities based on root tips and soil hyphae

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In this study, we investigated how phosphorus availability, arbuscular mycorrhizas, and their interaction affect plant responses to intraspecific density. Four facultatively mycotrophic species: chile dulce, cilantro, tomato, and corn were examined separately in pot experiments that employed a tropical phosphorus-immobilizing soil. Each experiment comprised nine soluble phosphorus additions, inoculation with arbuscular mycorrhizas or not, and low or high intraspecific density. High phosphorus significantly diminished mycorrhizal colonization of corn, cilantro, and tomato, but not chile, which was highly variably colonized. Corn roots were colonized by other root-inhabiting fungi and mycorrhizas significantly reduced colonization by these potential root parasites. High phosphorus significantly increased relative growth rates (RGR) of all species, and high density significantly reduced RGR of cilantro, tomato, and corn. Chile had little growth at all but the highest phosphorus additions, and consequently had no RGR response to mycorrhizas or density. For both RGR and dry weights at harvest, cilantro, tomato, and corn benefited most from mycorrhizas at low phosphorus availability, and this benefit diminished or turned to disadvantage as phosphorus was increased. High density decreased the effects of mycorrhizas on cilantro and tomato biomass. This study demonstrates that phosphorus availability and mycorrhizas modify the responses of facultatively mycotrophic plant species to intraspecific density. Mycorrhizas can be disadvantageous to facultative mycotrophs at high phosphorus availability and at low phosphorus availability if density is high. Consequently, the benefits of mycorrhizas to facultative mycotrophs, such as agricultural species, in monospecific stands may be maximized at intermediate phosphorus availabilties.

(# 131) Investigation of the diversity of fungal endophytes in root systems of Epacris pulchella (Ericaceae) using traditional culturing techniques and molecular analysis based on total endophyte community DNA

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Three Epacris pulchella (Ericaceae) plants were collected from two dry sclerophyll forest sites in eastern Australia. Alternating 5mm pieces of hair roots were separated for traditional culturing of endophytes or collection of a 'bulked' root sample from which total DNA was extracted. Genomic DNA was extracted from 185 culturable endophytes. These isolates were grouped according to ITS-RFLP patterns which were produced by digestion of PCR amplified ITS products with the endonucleases Rsa I, Hinf I and Hae III. The ITS regions of representative isolates from each of the RFLP types were sequenced and compared with sequences in the Genbank nucleotide database. Most products sequenced to date had highest sequence similarity with known ericoid mycorrhizal endophytes. Total DNA was used in denaturing gradient gel electrophoresis (DGGE) analysis. A 'fingerprint' was produced whereby ITS products from the endophyte community were compared to those obtained from the culturable endophytes. Bands that represent taxa present in the total community patterns that were absent from the culturable endophyte assembalage are being sequenced and compared. ITS products amplified from the total community DNA are also being cloned and RFLP analysis and sequencing will be used to group these ITS clones. Pooled data from these different techniques will be compared and used to give a broader picture of the structure of endophyte community in the hair roots of ericaceous plants.

(# 132) Effect of organic matter on growth of tree seedlings grown in reclaimed oilsand tailings

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A major challenge in the reclamation of mine tailings generated by the oil sands mining operations is to re-establish a self-sustaining ecosystem. A healthy plant-soil system is the key for creating such ecosystem. A research site on Mildred Lake site of the Syncrude Canada Ltd., Alberta, was established to assess plant performance. The topsoil material consisted of aggregated 1:1 mixture of mature fine tailings (MFT) with composite tailings (CT), amended by various amounts of peat moss. The subsoil is the composite tailings (CT). Six tree/shrub seedling were planted after the site was established, including hybrid poplar, aspen, jack pine, spruce, green alder and dogwoods. Soil biological activity is increasing with growth of plant biomass and with the aging of the materials. Increasing quantities of peat moss result in higher organic carbon content and nitrogen content and cause an increase in microbial abundance and diversity. As a consequence, the higher plant biomass was produced in the materials with higher soil organic matter.

(# 133) Dynamics of arbuscular mycorrhizal fungi associated with the vegetational change due to grazing in the semi-natural grassland in Japan

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Semi-natural grassland in Japan is maintained by cutting or animal grazing. For 4 years from 1999 to 2002, we studied the dynamics of arbuscular mycorrhizal (AM) fungi associated with vegetational change due to grazing in a semi-natural grassland, where Pleioblastus chino and Miscanthus sinensis had dominated We investigated the AM colonization in plant roots in summer and AM fungal spores in the soil in fall. The AM fungal groups colonizing in the roots were detected by the PCR method using the taxon specific primers in the region of 18S rRNA gene, reported by Simon et al. (1993), and Archaeospora sp.-specific we designed.

Coverage of a tall grass, M. sinensis, decreased with grazing, and it was partly taken over by a turf grass, Z. japonica. Coverage of P. chino did not change much during the experimental period. The degree of AM fungal colonization and spore population in rhizosphere did not show remarkable yearly change during 4 years. Among spores collected from soils, Sclerocystis rubiformis was always dominated in soils during the period. Glomus spp. were the most frequently detected in roots by PCR method. Archaeospora sp. was often propagated from the soils by the soil-trap culture. The spores of this species were rarely found, but it was sometime detected in roots by PCR method. Thus, no significant change in AM fungal flora was found

(# 134) PREDICTING TRANSPORT OF SOIL PHOSPHORUS IN LANDSCAPE IN RESPONSE TO MANURE APPLICATION

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Several processes are involved in determining the amount of P transported off agricultural fields and watersheds in relation to manure application. The P applied to a soil with manure is not all in water soluble form that can be readily transported off the field. As the organic C in manure is mineralized, the organic P in manure mineralize gradually. The first component in predicting P transport and its relationship to manure application is the relationship between the amount of mobile or "available" P in soils and amount and duration of manure application. Soil P is transported off the field by water. The second component therefore is the amount runoff generated. Thirdly, to predict the amount of P transport by surface runoff, the relationship between soil P status and P concentration in surface runoff must be established. The forth component that need to be considered is the relationship between the amount of P transported off a local field and that eventually exported from the watershed: some of the locally mobilized P may simply redistribute within the watershed and, as a result, only a fraction is actually exported from the watershed and, as a result, cause environmental concerns. In this presentation, we present the results of a study that predicts P transport in the landscape by combining models of soil C, N and P turnover, infiltration and surface runoff generation, and transport and delivery processes in watersheds. The study is part of a soil P research program with experimental sites distributed across Alberta that attempts to develop site specific manure application limits

(# 135) Arbuscular mycorrhizal colonization of tree species grown in peat swamp forests of Central Kalimantan, Indonesia

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Arbuscular mycorrhizas improve the growth and nutrient uptake of plants. Little information is available on the status of arbuscular mycorrhizas in tropical peat soils. The objective of this study was to clarify mycorrhizal colonization of tree species grown in tropical peat soils. Seedlings of twenty-two tree species in fourteen families grown in a peat swamp forest were collected from Central Kalimantan, Indonesia. Arbuscules, vesicles and internal hyphae were observed under a compound microscope. Seventeen of twenty-two species showed arbuscular mycorrhizal colonization. Arbuscular mycorrhizal colonization was observed for the first time in roots of Shorea teysmanniana, Shorea balangeran, Shorea uliginosa (Dipterocarpaceae), Calophyllum sclerophyllum, Calophyllum soulattri (Guttiferae), Cratoxylum arborescens (Guttiferae), Tetramerista glabra (Tetrameristaceae), Palaquium gutta (Sapotaceae), Melastoma melabathricum (Melastomataceae), Gonystylus bancanus (Thymelaeaceae), Hevea brasiliensis (Euphorbiaceae) and Campnosperma auriculatum (Anacardiaceae). C. soulattri, C. arborescens, G. bancanus, Acacia mangium, M. melabathricum and H. brasiliensis showed a percentage mycorrhizal colonization of 50% or higher. No arbuscular mycorrhizal colonization was found in Hopea mengarawan (Dipterocarpaceae), Koompassia malacensis (Caesalpiniaceae), Tristaniopsis whiteana (Myrtaceae), Combretocapus rotundatus (Rhizophoraceae) and Dyera costulata (Apocynaceae). It is suggested that inoculation of arbuscular mycorrhizal fungi can improve the early growth of some tree species grown in peat swamp forests and this will be expected as a key technology to rehabilitate disturbed peatlands.

(# 136) Exploring the development of ectomycorrhiza between Paxillus involutus and birch (Betula pendula) using cDNA microarray analyses

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The basidiomycete Paxillus involutus is forming ectomycorrhizal (EM) symbiosis with a broad range of forest trees. Despite the ecological importance of this symbiosis, little information is available on the molecular mechanisms of the interaction. In order to search for differentially regulated genes in the symbiosis between P. involutus and birch, we have analyzed EST sequences from three different cDNA libraries representing transcript expressed in the EM tissue, free-living mycelium and plant roots, respectively. In total more than 10,000 clones have been sequenced that cluster into a set of ca 2,000 unique genes of either fungal or plant origin. EST clones of the uniset were spotted on glass slides. The cDNA array is used to analyze the patterns of genes that are expressed during the development of mycorrhiza between Paxillus and birch. In addition to identify clusters of co-regulated genes, this work can lead to the characterization of molecular markers that can be used to follow the establishment of a functional mycorrhiza in natural ecosystems.

(# 137) Root Factors Induce Mitochondrial-Related Gene Expression and Fungal Respiration during the Developmental Switch from Asymbiosis to Presymbiosis in the Arbuscular Mycorrhizal Fungus Gigaspora rosea

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Arbuscular mycorrhizal (AM) fungi show limited hyphal development during spore germination in the absence of a host plant (asymbiosis). In the presence of root exudates, they switch to a new developmental stage (presymbiosis) characterized by extensive hyphal branching. First signs of presymbiotic branching of Gigaspora rosea germinating spores was observed in liquid medium six hours after induction by a semipurified exudate fraction from carrot (Daucus carota) root organ cultures. In order to identify genes related to developmental switch, differential RNA display and suppressive subtractive hybridisation experiments were carried out. DNA fragments have been cloned and sequenced and the corresponding genes were analysed by reverse Northern blots and quantitative RT-PCR. Clustering of the sequences according to their similarities showed that genes are induced one hour after addition of the exudate fraction, which encode factors involved in DNA synthesis, signal transduction and gene regulation. In addition, one group of genes encoded proteins involved in mitochondrial development and function. The hypothesis that respiratory activity of AM fungi is stimulated by root exudates was confirmed by physiological and cytological analyses in G. rosea and Glomus intraradices. First respiration activation was detected after 90 minutes and changes in mitochondrial morphology, orientation, and overall biomass were observed after four hours. In summary, the root-exuded factor rapidly induces the expression of certain fungal genes and, in turn, fungal respiratory activity before intense branching.

(# 138) Revegetation of Heavy Metal Polluted European Sites using the Arbuscular Mycorrhizal Inoculation Technology

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Field experiments were established in Germany (Hettstedt) and Spain (Tharsis) to investigate the potential of arbuscular mycorrhizal (AM) inoculation to rehabilitate sites which are contaminated with heavy metals through industrial activities. The German site is a dry fill with residues from the exploitation and metallurgical operations of copper. The Spanish site is an old pyrite mine. At both the sites the soil contains high amounts of Cu, Pb, Zn, and As. Acer platanoides (Aceraceae), Eleagnus angustifolia (Eleagnaceae), Fraxinus excelsior (Oleaceae), Prunus avium (Rosaceae), and Sorbus aucuparia (Rosaceae) were planted in Germany; Chamaerops humilis (Palmae), Olea europaea (Oleaceae), Pistacia lentiscus (Anacardiaceae), Quercus ilex (Fagaceae), Rhamnus lycoides (Rhamnaceae), and Tetraclinis articulata (Cupressaceae) in Spain. Bare root plants were inoculated at planting with 100 ml of an expanded clay inoculum containing Glomus intraradices. Plants were irrigated only once after planting. Fertilizer were not applied.

The survival rate, two years after planting, was only 15 to 40% of the none-inoculated Eleagnus, Prunus and Sorbus trees. Inoculation increased survival to 50 – 90%. At the dry Spanish site, inoculation improved the survival to 70-100% from 50-70 % for none-inoculated, only of those plant species which were best adapted to the edapho-climatic conditions, Chamaerops, Quercus and Pistacia. Translocation and uptake of heavy metals was influenced by AM inoculation depending on the tree species. AM inocula are now commercially available and their use is indispensable for all revegetation practices when AM plants are used.

(# 139) Ectomycorrhizal fungi and forest site classification

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17 forest sites in three Swiss cantons (Bern, Solothurn, Fribourg) were investigated mycologically during a 4 year period to find out to what extent higher fungi are bound to specific forest sites and whether they are suitable for characterizing forest types. The species lists reveal a species specific dependency on soil pH: 32% of the totally 306 inventorized fungal species can be found in the whole pH range, 50% were found only in acid soils up to a pH of 5.75, and 18% in only neutral to alkaline soils. The species fructifying on slightly acid to neutral soils are considered to be possible indicator species for such environmental changes as acidification or eutrophisation. The present classification of higher fungi into pH-classes and forest types is a tentative one. The data set will be further increased with supplementary observations so as to arrive at a more definitive classification. The four-year investigation showed that pure coniferous forests are richer in macromycetes species than generally supposed. Additionally, they contain a higher percentage of mycorrhizal fungi than deciduous forests. These first analyses already reveal the suitability of higher fungi for characterizing and classifying forest types.

(# 140) EFFECT OF PLANT HOST GENOTYPE ON INTERACTION BETWEEN MYCORRHIZAL AND RHIZOBIUM SYMBIOSIS IN WHITE CLOVER.

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Two near-isogenic lines (2 and 40) of the legume, white clover which had been previously been shown to differ in their response to inoculation with mycorrhizal fungi were used to examine the effect of plant genotype on the interaction between a range of mycorrhizal and Rhizobium symbionts. Two isolates of arbuscular mycorrhizal fungi (AMF) (Glomus mosseae, BEG25 and G. microaggregatum, BEG56) and three isolates of Rhizobium spp (SP20, R19 and BL2B) were used in this study. There were significant interaction effects of clover genotype and combinations of microsymbiont inocula on plant growth and nutrient responses. Specific combinations of mycorrhizal, Rhizobium and plant genotypes resulted in significant differences in plant growth responses. Inoculation with BL2B and BEG56 on line 2 significantly depressed leaf development when compared to line 2 plants with BL2B and BEG25 or no AMF. In line 40 there were no significant differences between AMF treatments. The results suggest that the host clover genotype can influence the interaction between the two microsymbionts. The potential for improving the effectivity of these symbioses in agricultural applications, through selection and improvement of plant germplasm is discussed.

(# 141) APPROACHES FOR BREEDING BETTER SYMBIOSES IN WHITE CLOVER

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Our approach capitalises on progress made in model legumes and utilises uniquely available near-isogenic lines (NILs) of clover in order to identify genes involved in interactions of legumes with its symbionts Rhizobium and arbuscular mycorrhizal fungi (AMF). Marker assisted selection can then be used to improve existing germplasm in plant breeding programmes. Heritable effective mycorrhizal associations offers significant potential for future plant breeding programmes designed to increase sustainability and minimise environmental impact in low-input agricultural systems.

NILs and clover cultivars differ in their levels of AMF colonisation and response to infection. We have used differential display to identify differences in gene expression in plants expressing contrasting behaviour with AMF (including levels of infection and their response to it). Preliminary results indicate clear differences in gene expression including homology to unidentified sequences in Medicago.

(# 142) Description of Quercus ilex ectomycorrhizae

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During the last years many studies which compare the ectomycorrhizal community structure on the roots below and sporocarps above ground have been undertaken. They have proved that many fungi considered to be lignicolous are able to form ectomycorrhizae. Nevertheless, most of these studies have been mainly carried out in conifers in the U.S.A. and northern Europe, and there is a lack of information on other ecosystems such as those typically mediterranean.Therefore, we have collected and described several Quercus ilex ectomycorrhizae which supposedly have a resupinate basidiomata, and we provide in this work photographs and drawings of some of the most outstanding features.

(# 143) Considerations about tomentelloid ectomycorrhizae in truffle growing stands in Spain.

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Since 1993 we have been monitoring the mycorrhizal state of different tree species (Quercus ilex, Q. faginea and Corylus avellana) previously inoculated with Tuber melanosporum and then planted in several truffle growing stands in Navarra (northern Spain). The aim of our research is to confirm the presence of black truffle ectomycorrhizae on the roots of the inoculated trees over a long period of time, studying also the occurrence of other competing ectomycorrhizae which play an important role on the ectomycorrhizal community of the truffle growing stands.

The data gathered after 10 years of monitoring show that tomentelloid fungi are one of the dominant groups within the ectomycorrhizal community in such an environment, a fact that has been overlooked in the studies on the ecology of truffle growing stands carried out until now.
We provide a catalogue of all the ectomycorrhizae found and described in each tree species, including pictures featuring the most outstanding characteristics, with a special emphasis on tomentelloid morphotypes, among which we can cite Tomentella galzinii, T. subtestacea and Quercirhiza squamosa

(# 144) Effects of fire on ectomycorrhizal fungi in a Quercus ilex forest over a three year period

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The study started in autumn 1998 in a Quercus ilex forest located in northern Spain, four years after the forest had caught fire, and carried out during three years until autumn 2001, has revealed there is a significant change in the relative abundance of certain ectomycorrhizal morphotypes after fire, as well as a significant decrease of the percentage of ectomycorrhizal tips found. On the contrary, fire does not seem to affect significantly neither the diversity nor the species composition of the ectomycorrhizal community of such a mediterranean forest, although the ascomycetes play a more important role within the ectomycorrhizal community compared to the non-disturbed site. Tomentelloid fungi and Cenococcum geophilum seem to be very well adapted to mediterranean ecosystems, because they are the dominant ectomycorrhizal morphotypes both in the burned and the non-disturbed sites. Finally, over the three year period of study we have recorded a significant progressive recovery of the ectomycorrhizal community after the disturbance, being most of the ecological parameters measured very similar in the burned and non-disturbed sites seven years after fire.

(# 145) Inter- and intra-species 18S rDNA sequence heterogeneity as an accurate and sensitive marker to assess species diversity of arbuscular mycorrhizal fungi of the genus Gigaspora

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The characterisation of Arbuscular Mycorrhizal Fungi (AMF) species is essential to understand their ecology, phylogenetics and evolution. AMF form multinucleated heterokaryotic spores with no evidence of sexual reproduction. Nevertheless, AMF presents high intraspecific variations among rDNA copies within a single spore. The inter and intra-species variation of 18S rDNA of the genus Gigaspora was explored using PCR-Denaturing Gradient Gel Electrophoresis (DGGE) and a cloning and sequencing approach. PCR-DGGE analysis targeting two (V3-V4 and V9) regions of the 18S rRNA genes were performed on 48 Gigaspora isolates and two soil samples. Little sequence heterogeneity was detected in the V3-V4 region. The DGGE banding pattern of V9 region could be used to distinguish all Gigaspora species. Furthermore, specific markers were identified to differentiate geographic isolates of G. albida, G. gigantea and G. margarita but not for G. rosea. Spore-to-spore variation was detected only in two of the 48 isolates analysed, and where caused by mixture of different species within the samples. G. margarita was shown to be the dominant species within two agricultural soils by using a Gigasporaceae-specific nested PCR approach. Sequence and phylogenetic analysis of selected clones confirmed the identity of the sequences. Some of the 18S rDNA copies were more similar among different morpho-species then within the same species. These data have important implications for phylogenetic and evolutionary studies of AMF. Using PCR-DGGE we were able to exploit the 18S rDNA sequence variation for generating banding patterns, which enable the discrimination between species and even isolates

(# 146) Linking fungi, ectomycorrhizae and host trees in the miombo woodland in Malawi.

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Little is known on the ectomycorrhizae in the tropics, because most of the research has been undertaken in temperate zones. Although some miombo tree species belonging to the genera Brachystegia, Uapaca or Julbernardia have been already reported to be ectomycorrhizal, there is still a lot of work to be done. We have carried out a preliminary study on the ectomycorrhizal fungi of the miombo woodland in Malawi, aiming at linking the fruit bodies with the ectomycorrhizae below them and then tracing the roots back to the trees they belong to, thus showing that a given fungal species is associated with a given tree species. Our records show that Uapaca kirkiana is one of the most common ectomycorrhizal partners in miombo woodlands, followed by several species of the genus Brachystegia. The fruit bodies found belong mainly to the genera Lactarius, Russula and Cantharellus. A total of 18 different ectomycorrhizal morphotypes were found and described, being the most striking fact that most of them seem to belong to the genus Russula, although more research needs to be done in order to identify most of them, since we found in several cases more than one ectomycorrhizal morphotype below a single fruit body.

(# 147) On-farm production and utilization of mycorrhizal fungus inocula.

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Arbuscular mycorrhizal [AM] fungi colonize the roots of the majority of crop plants, forming a symbiosis which enhances nutrient uptake, pest resistance, water relations, and soil aggregation. It is widely accepted that inoculation with effective isolates of AM fungi increases plant growth in low nutrient soils. Although inocula are available commercially, on-farm production of AM fungus inoculum would save farmers the associated processing and shipping costs. In addition, on-farm methods can be used to produce locally adapted isolates, a potentially important consideration in marginal soils. A variety of on-farm inoculum production methods have been proposed. These entail increasing inoculated isolates or indigenous AM fungi in fumigated or unfumigated field soil, respectively, or transplanting pre-colonized host plants into compost-based substrate. Subsequent delivery of the inoculum to the field presents technological barriers requiring that the fungi be pelletized in some form amenable to farm machinery. However, a readily available method for utilization of inocula is mixing it with potting media for growth of vegetable seedlings for transplant to the field. Results of a representative sample of these and other examples of use of AM fungi in the field also will be reviewed. Recent evidence indicates that pre-inoculation of seedlings can increase yields even in high P soils.

(# 148) Spread of an inoculant strain of the ectomycorrhizal fungus Pisolithus from an experimental plantation of Quercus suber (cork-oak) to other local hosts

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In forestry, the beneficial effects of ectomycorrhizal fungal inoculants depend on their persistence on the roots of the inoculated seedlings during the early years of the plantation. Consequently, many studies focused on the persistence of ectomycorrhizal strains on the roots of the inoculated trees. However, there has been little interest in the spread to local hosts and long-term persistence of the inoculant strains in natural ecosystems. In 1999, seedlings of Quercus suber L. (cork-oak) co-inoculated with the ectomycorrhizal fungi Scleroderma polyrrhizum and Pisolithus were planted in an abandoned farm in western Spain. Four years later, 30% of the root tips corresponded to S. polyrrhizum, but morphological/molecular typing did not identify ectomycorrhizas of Pisolithus in the inoculated cork-oaks. In contrast, within the experimental plots we collected fruit bodies of Pisolithus. The random amplified polymorphic DNA (RAPD) patterns of these fruit bodies matched those of the original inoculant strain. Molecular and morphological typing of the ectomycorrhizal shrubs present in the inoculated plots (i.e. Cistus ladanifer) identified ectomycorrhizas of Pisolithus. Our results indicate that even if the inoculant strains that do not persist on the inoculated trees such strains can spread to other local hosts. Our study remarks the need to study the roots of the local ectomycorrhizal plants, if we wanted to assess the long-term persistence and the effects of an inoculant strain on communities of ectomycorrhizal fungi and the functioning of local natural ecosystems.

(# 149) The mycorrhiza of the medicinal and ornamental genus Eleutherococcus Max. (Araliaceae)

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Eleutherococcus (Araliaceae) species, particularly E. senticosus and E. gracilistylus, are highly appreciated for the essences obtained from their roots, rhizomes, bark and leaves, that have a reinforcing effect on the human immune system. Growers are interested to cultivate these species for medicinal purposes and, therefore, as much information as possible on aspects affecting plant growth is desired. Mycorrhiza doubtless has an important effect on plant vigour. Own studies suggest that Arum- and Paris-Type vesicular-arbuscular mycorrhiza (VAM) should be treated differently in cultivation management. Research on the exclusively Paris-Type mycorrhizal Gentianaceae showed a high dependency on the root fungus. Moreover, plants having a Paris-Type VAM tend to use up their mycorrhizal partner, manifesting in decreasing spore densities in soil, unless a neighbouring species (‘wet nurse plant’) helps to support the root fungus. In this study we investigate the structural aspects of the mycorrhiza of six species of Eleutherococcus, in order to evaluate mycorrhizal type and its consistency in the genus.

All investigated species showed an intense colonization by thick, largely aseptate, intracellulary coiled hyphae, indicating a Paris-Type VAM. The structures differ only marginally between the species, although the material originate from several Botanical Gardens in Germany. The fungal structures are similar to the related ginseng (Panax ginseng, P. quinquefolius), and we suggest to also equip plantations of Eleutherococcus with ‘wet nurse plants’ (having an Arum-Type VAM), as it is already under investigation for ginseng plantations in Canada.

(# 150) Sampling Methods for Measuring Nutrient and Bacteria Concentrations in Subsurface Water

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Manure application to agricultural land is a potential source of subsurface water contamination. Two possible transport mechanisms include leaching through the soil matrix and preferential flow. A field experiment will be conducted to assess the loss of nitrogen, phosphorous and E. coli as influenced by time of manure application and tillage practice. Water samples will be collected from tile drains, monitoring wells, pan lysimeters, and over land flow monitors. The determination of the pathway of loss will be assessed through monitoring of soil moisture content as a surrogate indicator of the pathway of flow. The poster presentation will contain experimental design, a discussion of sampling methods, and preliminary results.

(# 151) Does arbuscular mycorrhiza reduce damage in Striga-infested sorghum?

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While it is generally accepted that mycorrhizal fungi increase tolerance or confer resistance to plants that are infected with pathogenic, root-inhabiting bacteria, fungi, and nematodes, the possible role of mycorrhizal fungi in reducing damage by parasitic plants is not yet settled. As mycorrhizal plants are larger and / or have higher nutrient concentrations, they may also provide a better habitat for parasitic plants. Striga hermonthica (witchweed) is a major parasite of cereals and the cause of substantial cereal yield decline, especially in the nutrient-depleted soils of sub-Saharan Africa. We investigated the tripartite interaction between Striga, sorghum, and arbuscular mycorrhizal fungi (AMF) in greenhouse and field experiments in Cameroon. In a greenhouse experiment the beneficial effect of AMF on sorghum was of the same magnitude as the negative effect of Striga. No evidence for a direct interaction between Striga and AMF was obtained. In field experiments, addition of AMF did neither change root colonisation of sorghum nor plant performance in the presence of Striga. However, addition of AMF significantly reduced the number of Striga on sorghum. These results suggest that AMF cause qualitative and / or quantitative changes in root exudation patterns that could affect Striga germination. In a laboratory setting root extracts of mycorrhizal sorghum almost completely inhibited Striga germination compared to root extracts of non-mycorrhizal plants. Implications of the tripartite interaction for sustainable cereal production in sub-Saharan Africa will be discussed.

(# 152) Al tolerant maize only acquires P from acidic tropical soils through mycorrhizal association

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Aluminium (Al) toxicity and phosphorus (P) deficiency are the primary problems for crop production in acidic soils. Both problems are considered related, although the relation is not clear. Phosphorus deficiency is mainly caused by strong adsorption of H2PO4- to Al- and Fe-(hydr)oxides, turning large proportions of P into forms unavailable to plants. Current knowledge suggests that Al-tolerant crop varieties are capable of uptake of P from acidic soils, but also that arbuscular mycorrhizal fungi (AMF) facilitate P uptake. We investigated the role of AMF in uptake of P from an (acidic) Oxisol by an Al-tolerant maize variety. Plants were grown in the A (high exchangeable Al) or B (low exchangeable Al) horizon and had access to a nutrient solution that only lacked P. Through a double pot set up, plant growth was limited in all cases by P bioavailability, and all plants had similar P-concentrations. Nine different P pools, both organic and inorganic, were determined independently by P fractionation. On the basis of these pools we set up a complete P balance for the system. The P balance clearly showed that plants without mycorrhiza did not acquire P from either horizon. Mycorrhizal plants acquired P from labile and moderately stable inorganic P pools, whereas the organic P pools were not plant available. Our results show that P acquisition from this soil was not enhanced by Al-resistance, but through association with AMF. Various implications will be discussed.

(# 153) Mycorrhizal symbionts of European orchids (Neottieae) show unexpected diversity and suggest a partial mycoheterotrophy

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Mycoheterotrophic plants (MHPs) are achlorophyllous plants that reverse the usual mycorrhizal symbiosis (where plants exchange photosynthates against mineral nutrients) by recovering carbon from the fungus. MHPs have been demonstrated to be specific to narrow fungal clades that are mycorrhizal with surrounding green plants, which provide carbon to both heterotrophs. Here, we investigated symbionts of chlorophyllous species phylogenetically related to MHPs. MHPs evolved often among orchids by shifting from usual orchid partners, the Rhizoctonias, to other basidiomycetes forming ectomycorrhizae (ECM) with trees. The forest orchid tribe Neottieae contains MHPs, such as Neottia nidus-avis, and photosynthetic species, e.g. in the genera Epipactis and Cephalanthera. The latter species show infrequent survival of achlorophyllous individuals. We studied symbiont diversity in three Epipactis and two Cephalanthera species from various French populations, including achlorophyllous and fully subterranean individuals. Symbionts were identified by ITS amplification and sequencing, using various primer sets, and sometimes by TEM analysis. We found an unexpected fungal diversity, including various basidiomycetes such as Sebacinaceae, Thelephoraceae, Russulaceae… as well as Ascomycetes belonging to Helotiales, Pezizaceae (e.g. truffles – Tuber sp.). These orchids are therefore low specificity associates of ECM fungi. In addition, since green orchids have symbionts similar to the achlorophyllous and subterranean individuals, which are mycoheterotrophic, we suggest that some green Neottieae could partly behave as MHPs. Acquisition of ECM symbionts, perhaps replacing the Rhizoctonias as Neottieae shifted to forest niches, probably entailed a predisposition to chlorophyll loss by giving access to tree photosynthates.

(# 155) Evaluation of (AM) mycorrhizal inoculum on the yield of maize plants under field conditions

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Expanded clay was used as inoculum carrier for arbuscular mycorrhizal fungi (AMF) isolate Glomus etunicatum. The effect of AM fungus was examined in a combination with different levels of phosphorus fertilizer on the growth and yield of maize (Zea mays L.) plants under field conditions. Inoculated plants with low and medium levels of P2O5 had led to increase the percentage of infected roots significantly (61.67-65.0%).

Mycorrhizal plants significantly increased the plants fresh and dry weights at 80 days old and harvesting stage by 17.71 and 3.88% more than the uninoculated plants with zero P2O5 fertilizer. A combination between G. etunicatum and only half the recommended dose of P2O5 had led to a significant increase by 10.31, 3.61 and 8.97% in the case of ear weight in g, 100 seed weight in g and the grain yield (ton/hec.), respectively compared to the uninoculated plants in the presence of the above level of P2O5 . Phosphorus uptake in grains and plant tissues were increased by 19.40 and 9.58%, respectively, in case of the inoculated plants with 47.62 units P2O5 compared to the uninoculated plants with the same level of P2O5 . Inoculated plants with AMF was very effective using expanded clay under field conditions in the presence of half amount the recommended dose of P fertilizer.

(# 158) Managing mycorrhizae in different agricultural systems.

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Market globalisation, demographic pressure and environmental degradation lead, in numerous regions of the world, to questionning the present agricultural systems. Artificialisation of environment by the use of chemical inputs, fertilisers and pesticides, has showed its limits : pollution and decrease of biodiversity in the most intensified regions ; degradation of weak agroecosystems ; forbidding costs for the poorest farmers. Conventional agriculture should switch to more sustainable pratices, but low input sustainable cropping systems will succeed only if we reach a better knowledge and use of biological interactions within the agroecosystems. Among the telluric microorganisms that will be essential to take into account we find the arbuscular mycorrhizal fungi. Mycorrhizae, resulting from the symbiotic association of these fungi with plant roots, are directly implicated in mineral nutrition of plants, control of plant pathogens as well as drought tolerance. Most horticultural and crop plants form arbuscular mycorrhizae. Mycorrhizal literature is very abundant, particularly on the beneficial effects of the symbiosis for plant growth stimulation, which was mainly attributed to an improved phosphorus nutrition. The potential of mycorrhizal symbiosis to enhance crop production is widely recognized, but not exploited in agricultural systems. Less fertilizers, pesticides and tillage will favor arbuscular mycorrhizal fungi. But, to shift from one system to a more sustainable one is not easy, since all the components of the cropping system are linked. Different actual cases, from agriculture of different countries, are analysed to enlight the situations where mycorrhizae might or not play a role for the development of a more sustainable agriculture

(# 159) Quantification of ectomycorrhizal mycelium in soil by Real-Time PCR

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The extramatrical mycelium represents the component of the ectomycorrhizal symbiosis that is actively involved in mobilization, uptake and translocation of nutrients and presents a significant component of the ectomycorrhizal symbiosis. Mycelial biomass estimates in soils are usually obtained by measuring total hyphal length or by measuring the amount of fungal specific biomarkers like ergosterol and phospholipid fatty acids (PLFAs). These methods determine the biomass of the fungal community as a whole. Molecular methods based on the extraction of total soil DNA and the use of a gene as biomarker enable detection and identification of mycelia directly from soil. We examined whether these molecular methods can also be used to quantify the occurrence of individual fungal species. Three molecular techniques were compared to conventional fungal biomass measures. The growth of extramatrical mycelium of two ectomycorrhizal fungal species (Suillus bovinus and Paxillus involutus) was monitored by denaturing gel gradient electrophoresis (DGGE), a cloning technique and Real-Time Quantitative PCR and compared to results obtained with hyphal length determination and PLFA analysis. In a more-species environment, the conventional methods enabled quantification of both species together, while the molecular methods enabled identification and relative quantification of both species separately. Amounts of target DNA per gram soil were used to quantitatively compare soil samples. The molecular methods consistently showed that amounts of S. bovinus DNA increased and amounts of P. involutus DNA decreased over time. This work demonstrates that molecular methods provide promising tools to identify and quantify the extramatrical mycelium of individual ectomycorrhizal fungal species

(# 160) A long term drift experiment: are AMF's parasexuals?

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Recent findings show high within-spore genetic variation and revealed the multi-genomic nature of AMF and this has raised many questions regarding their evolution. How evolutionary forces such as drift, selection and migration act on this system to maintain the observed polymorphism is unclear. One possible action would be that only a portion of the genetically different nuclei are inherited by each spore during spore formation. This would represent a type of drift where a mycelium (parent) would give rise to genetically different spores (offsprings).

We have performed a long term experiment to detect drift. Monosporic lines of three genetically and phenotypically different isolates of Glomus intraradices were established in in-vitro cultures over several generations. These were maintained by starting each new generation with one single spore. Phenotypes were measured and genotypes were assessed by fingerprinting with AFLP to test wether any change had occured.

Evidence for drift would suggest the importance of anastomoses in maintaining the genetic diversity in AMF's populations. The combined action of drift and anastomoses would be an evidence for a type of parasexuality (nuclei shuffling).

(# 161) An expression cDNA library for suppression cloning in yeast mutants and est analysis from the symbiotic basidiomycete Hebeloma cylindrosporum

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In ectomycorrhizas the fungal symbiont plays an important role in plant root metabolism and participates actively in the assimilation and transfer of newly absorbed compounds. We are particulary interested by the transfer of organic nitrogen in ectomycorrhiza. To understand, at the molecular level, the role of symbiosis in N acquisition, we need to identify the transporters involved in the uptake of the organic nitrogen compounds by the fungal hyphae and their transfer to the plant. Therefore it is necessary to develop genomic tools. The ectomycorrhizal association Hebeloma cylindrosporum/Pinus pinaster has been selected as model system since both partners are able to be genetically transformed. An oriented expression library was constructed from the mycelia of the fungus Hebeloma cylindrosporum in the high-level yeast expression vector pDR196. Sequencing of around 500 ESTs showed that 15% correspond to known genes, two thirds contain sequences with unknown function, whereas the remaining 20% showed no significant similarity to any known genes

(http://www.uni-tuebingen.de/plantphys/hebeloma/index.html). The ESTs had a GC content between 44 and 56%, with most of them having a GC content of 52-54%, which could be correlated with GC contents of fungal genes.

The library was successfully used to identify by functional complementation the Hebeloma HIS4 (histidine synthesis) and HcGAP1 (amino acid transporter). Thus demonstrating the suitability of the library to identify Hebeloma genes also via their function

(# 162) Effects of Chemical Desiccation Procedures on Faba Bean Seed Size and Yield

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Chemical desiccation procedures were tested on faba bean to determine the most effective means of achieving optimal yield and seed size of faba beans grown in north central Alberta. A split-split plot design, replicated four times, was developed to assess the effects of chemical desiccant, application timing, and cultivar. Two faba bean (Vicia faba L.) cultivars, Snowbird, tannin free, and Earlibird, tannin containing, were seeded at 43 plants meter -2, on April 25, 2001 and May 8, 2002 at two locations in north central Alberta. Chemical desiccants included; diquat, glyphosate, and an untreated control, applied at two physiological stages; 60-70% black pods, and 90¨C95 % black pods. Chemical desiccant did not significantly affect yield or seed size (p¡Ü0.05). However, in three of the four site years, the untreated control had the highest yield, while the diquat treatment had the lowest yield. The untreated control resulted in the largest seeds while the diquat treatment had the smallest seeds. Desiccation at the 90¨C95% black pod stage resulted in higher yields compared to desiccation at the 60¨C70% black pod stage, although this effect was only significant in one site year (p¡Ü0.05). Seed size was not significantly affected by desiccation timing (p¡Ü0.05). In all site years, the cultivar Snowbird yielded significantly more, but had significantly smaller seeds than the cultivar Earlibird (p¡Ü0.001). Based on these findings, faba bean seed size and yield is not affected by chemical desiccation procedures occurring after the 60-70% black pod stage, under north central Alberta growing conditions.

(# 163) Brushing a portrait of mycorrhizal-microbial interactions: an impressionist approach

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The soil environment under the direct influence of plant roots and mycorrhizal partners, best known as the mycorrhizosphere, is a site of complex microbial interactions. As these interactions may have a profound effect on plant nutrition, resistance to abiotic stresses and root diseases, a large and increasing number of studies have been conducted in an attempt to better understand this environment. It has been demonstrated that specific taxonomical (e. g., Pseudomonas, Paenibacillus, Burkholderia) and functional groups (e. g., plant growth promoting rhizobacteria, antibiotic producers, free-living nitrogen fixing bacteria) of soil inhabiting microorganisms are qualitatively and quantitatively altered by the mycorrhizal symbiosis. Our understanding of the mechanisms that lead to such alterations is at its infancy. However, extensive effort has recently been undertaken to improve and refine the experimental systems used to address these complex questions. In light of the valuable information gained on these interactions, some ecological trends are emerging, while others still appear highly variable, mainly due to the complexity of the environment under study. In parallel, the techniques applicable to this field of research are rapidly evolving. The emergence of molecular technologies, especially polymerase chain reaction (PCR)-based assays, have significantly contributed to improve methods of detection, identification, characterization and quantification of soil microorganisms, overcoming the limitations of cultivation-based approaches. A general review of this topic is presented using an analogy between the preoccupations of contemporary researchers and artists of the impressionist era, highlighting their common desire to better represent and understand their environment

(# 165) Seasonal Mycorrhizal Colonization and Ergosterol Patterns of a Florida Wetland with Nutrient Impact.

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Soil and detrital ergosterol and AM fungal root colonization were measured seasonally from samples collected in different vegetation types and nutrient impacted or nonimpacted areas of a Florida wetland. Soil ergosterol levels were higher during the dry season, but this was not the case for AM fungal root colonization. Flooding did not inhibit AMF root colonization. Elevated P levels lead to a slight increase of soil and detrital ergosterol and a decrease of AM fungal root colonization

(# 166) Isolation of peptide transporters from the ectomycorrhizal fungus Hebeloma cylindrosporum by functional complementation of yeast

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In boreal and temperate forest ecosystems nitrogen is the most important growth-limiting nutrient. In these forest soils nitrogen is mainly available as organic compounds which are not accessible for plants but for the ectomycorrhizal fungi. The fungal partners are able to assimilate organic nitrogen in the form of free amino acids and peptides and to transfer it to the plant, which acts as strong sink for amino acids, available from the fungus. The ectomycorrhizal association Hebeloma cylindrosporum/Pinus pinaster was used as model to investigate peptide transport at the soil-fungus interface. Peptide transporters were cloned by functional complementation of yeast mutants deficient in peptide uptake systems. Two putative transporters (HcPTR2A and B) were isolated by selection of transformed yeast on a medium containing peptides as sole nitrogen source. Both cDNAs showed a strong similarity to peptide transporters of yeast, plant and animals.The characterization of these transporters shows that they play different roles in importing organic nitrogen compounds into Hebeloma.

(# 167) Forest Floor Organic Matter Composition in the Boreal Mixedwood Forest of Northwestern Alberta

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The forest floor is an important C pool and the site of active nutrient cycling. Effects of timber harvesting on forest floor processes are being studied at the Ecosystem Management Emulating Natural Disturbance (EMEND) site using a series of integrated experiments to examine relationships among forest floor organic matter quality, nutrient availability and microbial activity. Here, we present the results of a study examining forest floor composition in deciduous- and conifer-dominated stands under varying levels of harvesting intensity. Moss was the predominant litter input to the surface of forest floors in conifer-dominated stands while tree litter was the predominant litter input to the surface of forest floors in deciduous-dominated stands. Examination of FH-layer forest floor C chemistry using chemical extraction and CPMAS 13C NMR indicated differences in the composition of forest floor from the two stand types. For example, aromatic C (associated with lignins and tannins) was significantly more abundant in forest floor from conifer-dominated stands than from deciduous-dominated stands. The high aromatic C content of forest floor from conifer-dominated stands is probably a consequence of humification, because neither spruce needles nor moss are characterized by particularly high levels of aromatic C. Aromatic C was also significantly more abundant in forest floor from uncut conifer-dominated stands than from clearcuts. This was unexpected; aromatic C has been widely reported to increase as decomposition proceeds. A decline in aromatic C following clearcutting in conifer-dominated stands may be due to a shift in carbon inputs to the forest floor.

(# 168) Leaving fallen logs lie: managing forests for fungal diversity

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Forest management strategies that maintain old-growth components (e.g. logs) in young managed stands have the potential to conserve biodiversity through recruitment and retention of old-growth associated species in young stands. Logs provide important ecosystem functions such as water and nutrient storage, habitat for wildlife, seedlings, and ectomycorrhizal fungi (EMF). Conservation of forest fungi and the organisms they support depend on these habitat conditions. Little is known about whether the chemical properties of logs in young managed stands are similar to those in old-growth stands, and whether logs in young managed stands support EMF communities similar to those found in logs in old-growth stands. We compared the chemical properties and EMF communities of logs in advanced stages of decay in twelve paired young and old-growth stands in the Cascade Range of Oregon. We used PCR-based methods to determine fungal species on fine tree roots inhabiting the logs. Chemical properties and EMF species richness was similar within logs in the two stand age classes. The most abundant EMF species were found in logs both in the young and old-growth stands. Our results suggest that logs in advanced stages of decay provide similar species habitat for EMF regardless of stand age. Knowledge of EMF communities in legacy old-growth logs improves our ability to maintain fungal diversity in young stands.

(# 170) Heat resistance in an ericoid mycorrhizal fungus

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By definition, heat-resistant fungi have ascospores that can survive exposure to 75°C for 30 minutes. Most of these fungi are soil-inhabiting moulds belonging to the genera Byssochlamys, Eupenicillium, Neosartorya and Talaromyces. They are best known as spoilage organisms in pasteurized food products. Recently, we isolated numerous colonies of an unidentified dematiaceous fungus from heated soil from forests and managed native stands of lowbush blueberries (Vaccinium angustifolium Ait.) in Canada. Levels of this fungus in some soils exceeded 10,000 colony-forming units per gram. Conidia from cultures germinated readily after exposure to 75°C for 30 minutes.Typical ericoid mycorrhizal structures developed in the roots of sterile Vaccinium seedlings inoculated with the fungus. The significance of these findings is discussed in relation to the occurrence of fires

(# 171) Time of glyphosate application for weed control in transgenic silage corn.

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Weed control in corn (Zea mays L.) has been changed with the introduction of glyphosate tolerant, transgenic lines now available in the region. We evaluated time of application of glyphosate on DK335RR silage corn with glyphosate applied at the 1st , 2nd , or 3rd leaf stage and in sequential treatments compared to four standard herbicide treatments. An experiment at Nappan in 2001 and at Charlottetown in 2001 and 2002 examined applications at later growth stages. In 1999 and 2000, only nicosulfuron + rimsulfuron and rimsulfuron alone caused early injury that lasted 3-4 weeks. Glyphosate applied at the 1st to 3rd leaf stage controlled weeds present at application but many barnyard grass (Echinochloa crus-galli L. Beauv) and crabgrass (Digitaria sanguinalis, L.), plants emerged after initial application. The sequential treatments did not give better weed control than the single treatment at the 3rd leaf stage. The standard herbicide treatments, except for atrazine which has slightly lower yield in 1999, all gave comparable yields. Corn yield was not different between single application vs sequential treatments. In 2001 and 2002, application at the 5th leaf stage provided 99+ % weed control and application at the 3rd leaf stage gave 90 % control. As in the earlier experiments, early application gave control of weeds present at application but barnyard grass and lamb's-quarters (Chenopodium album, L.) emerged after initial application. There were no differences among the glyphosate treatments in corn yield between first 4 stages of application but yield was reduced if application was delayed until the 7th leaf stage. Weed control was acceptable with glyphosate applied as a single application up to the 7th leaf stage and late emerging weeds had little effect on corn yield. Maximum yields were obtained with application at the 3rd to 5th leaf stage of corn growth.

(# 172) Fire exclusion, community structure and N mineralization in low elevation forests of western Montana

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The common perception is that the low elevation ponderosa pine forests of western Montana have been maintained historically by frequent low intensity wildfires that result in open, uneven aged stands, with a grass dominated understory. Fire exclusion over the last 100 years is believed to have caused a shift in forest structure towards greater domination by Douglas-fir and shade tolerant shrubs. To date it is not clear how this long-term change in fire frequency has influenced ecosystem function in terms of nitrogen availability and allelopathic interaction. A fire chronosequence approach was adopted with the objective of studying how fire exclusion shapes forest structure and understory composition, and how these in turn alter soil nitrogen availability. Evidence from this study indicates that, Douglas-fir basal area increases to co-dominance with ponderosa pine and that shrubs seem to regenerate quickly after fire and maintain co-dominance with graminoid species. Resin capsules, used to measure N availability, showed significant decreases of amino nitrogen, ammonium and nitrate with increasing time since fire. Without quantifiable shifts in understory vegetation and non-significant concentrations of total phenols, there was little evidence for allelopathic inhibition of nitrification. There is, however, some evidence of an increasingly difficult substrate to decompose from various microbial indices, including metabolic quotient and anthrone reactive carbon. This implies that microbes are being inhibited by the availability of labile substrate to decompose, which is mediated on site by vegetation. The results indicate that the disturbance interval does little to shape N cycling in this ecosystem

(# 173) The Role of Large Mammal Mycophagy on Dune Ecosystem Succession

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Pinus contorta seedlings are establishing in isolated locations on the Oregon Dunes, south of Florence, Oregon, U.S.A., hundreds of meters from neighboring forest mycorrhizal networks. We examined mycophagy as an alternative inoculum source for the isolated dune seedlings. Small mammals are well-known vectors of mycorrhizal fungi. However, the vast unvegetated spaces on the dunes ecosystem may inhibit much small mammal movement from the forests where the fungi fruit to seedlings in remote areas. We looked instead to large mammals due to their greater mobility in traveling across the dunes. Most deer feces collected contained incredible quantities of spores. In a bioassay, sterile seedlings inoculated with these deer fecal pellets developed mycorrhizae dominated by the fungal genera Suillus and Rhizopogon. We compared the fungal species composition of the deer pellet bioassay with the fungal species composition of isolated seedlings collected on the dunes. The ectomycorrhizal fungal species on the isolated dune seedlings almost mirrored those found in the bioassay seedlings. Our results show that deer vector large, concentrated spore packages that readily inoculate seedlings in a laboratory setting. We suggest their mobility across the dunes and consequent spore packages may aid in the establishment of mycorrhizal seedlings under primary succession

(# 174) Factors controlling gross and net transformation rates of forest floor N and plant uptake in clearcut and old-growth coniferous ecosystems of British Columbia.

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We present data from a three-year project focussed on the effects of clearcutting on forest floor N dynamics and correlates to conifer seedling nutrition. The work was conducted in two contrasting coniferous ecosystems (CWH and ESSF) of British Columbia. Mineral N dynamics, defined by net and gross mineralization rates, were either responsive or non-responsive to clearcutting, depending on site characteristics. Among responsive sites, we also noted contrary effects of clearcutting on measured N variables. A +10 °C shift in ambient temperature resulted in a 2-4 fold increase in gross mineralization rates on responsive sites, but had no significant effect on non-responsive sites. The proportion of nitrification ascribed to heterotrophic microorganisms was about 50 % on each site. The effects of available C and mineral N pool size on gross N transformation rates, and on rates of seedling and microbial N uptake, were measured to compare competitive abilities of seedlings and microbes, before and after clearcutting. We noted (i) a significant negative effect of NH4+ concentrations on gross NO3- consumption rates, (ii) a decrease in the maximum rate of seedling N uptake after clearcutting, (iii) higher maximum N uptake rates by microbial biomass than by plants, and (iv) a lower Michaelis-Menten affinity contant (KM) for seedlings indicating that seedlings are more competitive in acquiring N at low N concentration. Exploratory path analysis is being used to test the causal structure between mycorrhizal colonization, gross mineral production rates, N pool size, plant and microbial N uptake rates. Results are discussed in light of our knowledge of the ecology of each site and on the various sources and sinks of forest floor N.

(# 175) Induction by AM Colonization of the Phytomedicinal Isoflavonoids in Red Clover

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Red clover, Trifolium pratense L., is an important phytomedicinal plant. Four isoflavonoids (biochanin A, formononetin, genistein, and diadzein) produced in red clover have been shown to have estrogenic, anti-cancer, and antioxidant properties. The purpose of this study was to determine the effect of colonization by the arbuscular mycorrhizal (AM) fungus, Glomus intraradices Schenck & Smith, and rhizobium, R. leguminosarum bv. trifolii (ATCC 14480), on secondary and nitrogen metabolism, in red clover. Studies have shown that AM colonization induces secondary metabolism in some plant species. In addition, AM colonization may enhance the activity of key enzymes involved in nitrogen assimilation such as glutamine synthetase (GS, E.C. 6.3.1.2). A factorial greenhouse experiment was performed using red clover inoculated or not with G. intraradices and/or rhizobium. After a twelve-week growth period, isoflavonoids and GS activity have been analyzed in roots and shoots. Results indicate that AM colonization (22-32%) significantly increased the concentrations of biochanin A and of soluble proteins, and the activity of GS in the roots, not in the shoots. Rhizobium inoculation, however, significantly decreased biochanin A and formononetin concentrations and GS activity in the shoots, not in the roots. Further experiments including a time course study and an inducing hormonal factor (methyl jasmonate) of isoflavonoids will also be discussed.

(# 176) Arbuscular mycorrhizae, glomalin and soil quality

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Arbuscular mycorrhizal fungi (AMF) have a well-recognized role in maintaining soil quality. A major consequence of AMF growth in soils is their contribution to the maintenance of soil structure. We summarize the effect of AMF on soil aggregation with the premise that we need to better understand certain aspects of fungal biology related to soil aggregation. We focus on the AMF-produced soil protein glomalin, a substance defined operationally by extraction/ solubility properties. Glomalin is consistently positively (and curvilinearly) correlated with aggregate water stability, although the mode of action is still unclear. In summarizing present data concerning glomalin, we emphasize three points: (1) its persistence in soil, (2) its potential regulation, and (3) its significance in the life history of AMF. Fractions of glomalin appear to have slow turnover in soils, as evidence from carbon dating, chronosequence studies, seasonal studies, and lab incubation experiments suggests. The persistence of this AMF product may be related to the lasting effects of AMF on aggregate stability compared to some other soil microbes. In vitro studies have shown that glomalin production may be controlled by a variety of environmental factors. The significance of glomalin in fungal biology/ ecology is still being unraveled, although recent evidence suggests a role in hyphal protection and habitat modification. We conclude that by learning more about glomalin and its role in fungal biology, we may be able to better inform management strategies aimed at maximizing beneficial effects of AMF on soil structure and quality.

(# 177) Simulating Residual Soil Nitrogen and Risk of Water Contamination by Nitrogen under Agricultural Policy Scenarios in Canada

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Two Agri-Environmental Indicators are reported in this paper; 1) Residual Soil Nitrogen (RSN), and 2) Indicator of Risk of Water Contamination by Nitrogen (IROWCN). A Canadian Agriculture Nitrogen Budget (CANB) model was developed to calculate these indicators and integrate them with economic model, in order to test policy scenarios.

Two sub-models (one for the eastern provinces and one for the western provinces) were developed with built-in scaling-up and scenario-analysis capabilities, so that outputs could be produced at the different spatial scales. Input data were prepared from the Census of Agriculture and the Canadian Soil Information System (CanSIS). Crop management parameters were derived from the literature, and policy scenarios came from the CRAM model.

The results show that RSN levels in 2008 exceeded 80 kg N/ha in Newfoundland, varied from 30 to 50 kg N/ha in Ontario, Manitoba and Saskatchewan and were less than 30 kg N/ha in the remaining provinces. RSN levels generally increased from 1981 to 2001 in most provinces. Significant differences in RSN were found among CRAM regions on the Prairies.

The current CANB model cannot be used to calculated IROWCN in the Prairie provinces because the soil in most years does not fully recharge during the spring snowmelt period. For the Eastern provinces, the IROWCN levels were excessive in Newfoundland in the years 2001 and 2008, but all other provinces fell below the safe limit for drinking water (10 mg N l-1). Future improvements of the model will be discussed.

(# 178) Interactions between saprotrophic and ectomycorrhizal fungi

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Recent studies suggest that some plants may circumvent N mineralization carried out by saprotrophs because their ectomycorrhizal fungi have the capacity to hydrolyze protein. When complexed by tannins, however, proteins may be unavailable to some ectomycorrhizal fungi. We tested the hypothesis that when protein-tannin complex is the N source, ectomycorrhizal fungi promote N uptake only in the presence of saprotrophs. P. tinctorius could not obtain N from protein-tannin complex while saprotrophs could. Pretreatment of the complex by saprotrophs did make its N available to ectomycorrhizal fungi. However, when protein-tannin complex was the major N source, colonization by P. tinctorius increased shoot P but not N content, even in the presence of saprotrophs. Interactions between saprotrophs and ectomycorrhizal fungi may be different for N and P because of immobilization of N by ectomycorrhizal fungi, or by the more rapid diffusion of ammonium than phosphate, rendering the absorptive surface area of ectomycorrhizal fungi superfluous for uptake of N but not for P.

(# 179) The Secreted AM Fungal protein Glomalin Binds Strontium in Solution

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Phytoremediation, the use of plants to remove metals from contaminated soils, is becoming a common bioremediation method. Understanding the fundamental processes occurring at the plant root-contaminant interface is hampered by a lack of information on the role of arbuscular mycorrhizal fungi (AMF). AMF have been shown to increase or decrease contaminant uptake into plants, suggesting that extraradical hypha – contaminant interactions should be examined in greater detail. A recently discovered soil protein, glomalin, is produced by AMF hyphae (Wright et al., 1996), and accumulates in soil to unusually high concentrations of several mg g-1 soil (e.g., Rillig et al. 2001). Our lab has identified a distinct protein recognized by the monoclonal antibody MAb32B11 (used to operationally define glomalin). Data from our laboratory indicated that extracts containing glomalin are capable of binding metals in solution. We partially purified secreted glomalin from the hyphal compartment culture medium of in vitro cultures of Glomus intraradices and Ri T-DNA transformed carrot roots (Daucus carota). This culture supernatant was used to test the binding of Sr in solution with various concentrations and across a pH gradient. The results indicate that the glomalin solution binds Sr in a concentration- and pH-dependent manner. This is consistent with the hypothesis that glomalin is a charged molecule capable of binding cations. Since glomalin concentrations in soils are relatively high and this protein is associated with AMF extraradical hyphae, our results suggest that glomalin may play a critical role in phytoremediation.

(# 180) The Arbuscular Mycorrhizal Fungal Soil Protein Glomalin, A Distinct Compound

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Phytoremediation, the use of plants to remove metals from contaminated soils, is becoming a common bioremediation method. Understanding the fundamental processes occurring at the plant root-contaminant interface is hampered by a lack of information on the role of arbuscular mycorrhizal fungi (AMF). AMF have been shown to increase or decrease contaminant uptake into plants, suggesting that extraradical hypha – contaminant interactions should be examined in greater detail. A recently discovered soil protein, glomalin, is produced by AMF hyphae (Wright et al., 1996), and accumulates in soil to unusually high concentrations of several mg g-1 soil (e.g., Rillig et al. 2001). Our lab has identified a distinct protein recognized by the monoclonal antibody MAb32B11 (used to operationally define glomalin). Data from our laboratory indicated that extracts containing glomalin are capable of binding metals in solution. We partially purified secreted glomalin from the hyphal compartment culture medium of in vitro cultures of Glomus intraradices and Ri T-DNA transformed carrot roots (Daucus carota). This culture supernatant was used to test the binding of Sr in solution with various concentrations and across a pH gradient. The results indicate that the glomalin solution binds Sr in a concentration- and pH-dependent manner. This is consistent with the hypothesis that glomalin is a charged molecule capable of binding cations. Since glomalin concentrations in soils are relatively high and this protein is associated with AMF extraradical hyphae, our results suggest that glomalin may play a critical role in phytoremediation.

(# 181) The relationship between hypogeous fungi and northern flying squirrels in western hemlock stands of coastal British Columbia.

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The northern flying squirrel, Glaucomys sabrinus, is an arboreal sciurid inhabiting forested habitats across North America. Hypogeous fruit bodies of mycorrhizal fungi (truffles) are a predominant food eaten by G. sabrinus. Previous studies have suggested that the abundance of truffles in a stand may be an important factor associated with the density of G. sabrinus. Over a two year period, five second-growth western hemlock (Tsuga heterophylla) stands in coastal British Columbia were used year-round to sample truffles and to live trap G. sabrinus in order to: (1) describe the diversity and productivity of truffles; (2) determine the importance of truffles in the diet of G. sabrinus; (3) identify which truffle genera were consumed by G. sabrinus; and 4) evaluate associations between the density of G. sabrinus and the production of truffles on a site. Eleven species representing six genera of truffles were collected, with Elaphomyces making up over 93% of the total number and 99% of the total biomass. Estimates of annual truffle production at each site ranged from 1.96 kg/ha to 19.17 kg/ha. Plant material was a major year-round component of the diet of G. sabrinus. Truffle spores occurred more frequently in the summer and fall diets. Rhizopogon was over-represented and Elaphomyces was underrepresented in feces relative to their abundance at the site. G. sabrinus consumed five genera of truffles that were not collected during fungal surveys. The density of G. sabrinus showed a significant positive correlation with the annual truffle production from four of the five sites.

(# 182) Seasonality of the arbuscular mycorrhizal fungal soil protein glomalin

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Jon Graham (Department of Mathematical Sciences, University of Montana)
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Despite the importance of AMF in ecosystems, there are few studies that examine the seasonality of external hyphae and their products (e.g. glomalin), the AMF variables directly related to ecosystem function through their contributions to soil aggregation. This study examined seasonal dynamics of glomalin, a glycoprotein produced by AMF (correlated to soil aggregate stability), from soils of a Scottish grassland and birch forest and a Montana intermountain grassland, in an effort to more fully understand the natural history of this compound. Prior studies of glomalin in natural systems have not considered seasonal effects on glomalin. A seasonal cycle of some glomalin fractions was observed in both Scottish and Montana soils, indicating that despite its on average slow turnover time in soil, a proportion of glomalin can fluctuate through time. The variability in the seasonal cycle of some fractions from Scottish soils was quite large compared to soils from the Montana grassland. For example, the coefficient of variation for the immunoreactive easily-extractable glomalin fraction in the Scottish grassland soil was 0.68 compared to 0.12 in the Montana soil. This suggests that the labile fraction of glomalin varies in different ecosystems, a result that has to be taken into account in designing sampling protocols. We also documented the absence of correlation of glomalin with extraradical hyphal length, reinforcing the notion that glomalin and hyphal persistence are different, and that glomalin pools, as currently defined, may not be good predictors of soil hyphal lengths.

(# 183) Inter-relationships between grain yield, grain protein concentration, soil mineral nitrogen levels and nitrogen fertilization on variable landscapes

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Winter wheat (Triticum aestivum L.) grain protein content is an important factor in the bread making quality of the wheat flour, and as such is a factor that affects the dollar value of the crop. A reasonable degree of spatial variation in grain protein concentration has been observed, which often reflects spatial variations in soil properties. This study examined the inter-relationships between grain yield, grain protein concentration, soil mineral nitrogen levels and nitrogen fertilization on variable landscapes in two Southwestern Ontario fields. Spring soil N sampling (prior to fertilization) and grain yield measurements (1.5mx6m plots) were taken on a 3x20m grid from two fields (456 grid points/site). Six nitrogen rates of 0, 30, 60, 90, 120, and 150 Kg N/ha were applied to field length (400 m) plots, replicated four times in a randomized complete block design (RCBD). Grain yield and protein concentration varied with slope position and nitrogen rate. Yield responses were fitted to quadratic-plateau regression models. The most economic rate of nitrogen (MERN) for yield, average over the entire field was determined to be 103.1 and 105.2 kg N/ha, although the MERN varied with slope position. At nitrogen rates over the MERN, yield response to nitrogen leveled off while protein concentrations continued to increase. Knolls typically had a lower yield than the depressions; however, protein concentration was greater on the knolls. Potential impacts of variable N application on grain yield and protein content will be discussed.

(# 184) Role of Arbuscular Mycorrhizae in the Phytoextraction of Strontium

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Winter wheat (Triticum aestivum L.) grain protein content is an important factor in the bread making quality of the wheat flour, and as such is a factor that affects the dollar value of the crop. A reasonable degree of spatial variation in grain protein concentration has been observed, which often reflects spatial variations in soil properties. This study examined the inter-relationships between grain yield, grain protein concentration, soil mineral nitrogen levels and nitrogen fertilization on variable landscapes in two Southwestern Ontario fields. Spring soil N sampling (prior to fertilization) and grain yield measurements (1.5mx6m plots) were taken on a 3x20m grid from two fields (456 grid points/site). Six nitrogen rates of 0, 30, 60, 90, 120, and 150 Kg N/ha were applied to field length (400 m) plots, replicated four times in a randomized complete block design (RCBD). Grain yield and protein concentration varied with slope position and nitrogen rate. Yield responses were fitted to quadratic-plateau regression models. The most economic rate of nitrogen (MERN) for yield, average over the entire field was determined to be 103.1 and 105.2 kg N/ha, although the MERN varied with slope position. At nitrogen rates over the MERN, yield response to nitrogen leveled off while protein concentrations continued to increase. Knolls typically had a lower yield than the depressions; however, protein concentration was greater on the knolls. Potential impacts of variable N application on grain yield and protein content will be discussed.

(# 185) Dissecting the complex effects of mycorrhizal fungal communities on plant growth.

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Résumé: Mycorrhizal fungi are known to exhibit differences in their relative capacities to provide important nutrients such as nitrogen, phosphorous, or water to plants. We hypothesize that differing combinations of fungi will have very different effects on their plant symbionts. With addition of one or more species of fungi, plant growth may increase, may remain the same, or may be less than that with any individual species. In a greenhouse experiment in which potted plants are inoculated with differing combinations of mycorrhizal fungi, we explore the consequences to plant growth of complexity in the mycorrhizal community. This experiment parallels our development of a stoichiometric model of the effects of mycorrhizal communities upon plant and fungal growth. We test our predictions through controlled addition of isolated strains of mycorrhizal fungal species to the root systems of potted plants that form ecto- or endomycorrhizal symbioses. We inoculate with one, two, or three fungal species in various combinations and measure changes in plant growth. Results of these experiments will have important consequences for the understanding of relationships between fungal diversity and function in mycorrhizal systems.

(# 186) Community analysis of AMF in Saskatchewan organic farm soils by PCR-DGGE

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Arbuscular mycorrhizal fungi (AMF) are important components of agro-ecosystems and are especially significant for productive low-input agriculture. To better manage these organisms in organic farming situations, their in situ community composition must be determined. A polymerase chain reaction-denaturing gradient gel electrophoresis (PCR-DGGE) approach for the detection and characterization of AMF 18S ribosomal RNA gene was developed and applied to the study of AMF communities in Saskatchewan organic farm soils. Seven AMF species were putatively identified in a previous survey of conventional farms. Five of the species were procured from INVAM. A reference PCR-DGGE profile was developed using DNA extracted from the spores of these INVAM cultures. DNA was extracted directly from soil for the community analysis in organic farms, and prominent bands resulting from AMF-specific PCR-DGGE profiles were excised for sequence analysis. The majority of the sequences detected were Glomus species; however, the species richness varied amongst sites in different soil zones and sites with different land-use and cropping histories. This approach for identifying AMF was much faster than conventional trap cultivation methods, but its accuracy depended on the available sequence database.

(# 187) Molecular characterization of Fusarium species in asparagus fields and relation with mycorrhization, fertilisation and agricultural practices

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Martin Filion (Institut de recherche en biologie végétale)
Vladimir Vujanovic (Institut de recherche en biologie végétale)
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Asparagus (Asparagus officinalis L.) is a low input arbuscular mycorrhizal perennial crop with a production-life expectancy of about 20 years. Root diseases, mainly caused by a complex of different Fusarium species, are the main limiting factor hampering survival and profitability of the crop. Disease incidence is fluctuating in relation with several factors, including plantation age, agricultural practices and time of the year. Asparagus is a good model to study both long-term and seasonal effects of mycorrhizas on root disease suppression. There are no efficient chemical control or sanitation measures available to limit the disease and efforts are now concentrated on the sustainable management of the disease through manipulation of soil microbial populations. Since current isolation methods fail to reveal the whole microbial biodiversity, a culture-independent method was developed to study Fusarium populations in environmental samples. Fusarium specific primers were designed and validated in PCR-DGGE (denaturing gradient gel electrophoresis)-assays. The specificity of the primers was successfully tested against genomic DNA extracted from a large collection of organisms and DGGE patterns effectively differentiated almost every Fusarium species. This PCR-DGGE assay is an effective method to monitor Fusarium populations and total fungal biodiversity (using fungal general primers) and to assess the qualitative influence of mycorrhizas on fungal communities.

(# 188) Effects of EDTA application and arbuscular mycorrhiza on zinc uptake by maize (Zea mays L.) from soil experimentally contaminated with zinc

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A pot experiment was conducted to investigate the uptake of Zn from a contaminated calcareous soil of low nutrient status by arbuscular mycorrhizal (AM) and non-mycorrhizal maize after application of EDTA to the soil to mobilize Zn and thus enhance plant Zn uptake. Maize yield was increased by mycorrhizal colonization when no Zn was added and under the highest Zn addition level of 600 mg/kg, while application of EDTA to the soil generally inhibited plant growth. EDTA application also increased plant Zn concentration, and Zn accumulation in the roots increased with increasing EDTA addition level. The effects of inoculation with the AM fungus Glomus caledonium on plant Zn uptake varied with Zn addition level. When no Zn was added, Zn translocation from roots to shoots was enhanced by mycorrhizal colonization. In contrast, when Zn was added to the soil, mycorrhizal colonization resulted in lower shoot Zn concentrations in mycorrhizal plants. The results indicate that application of EDTA mobilized soil Zn, leading to increased Zn accumulation by the roots and subsequent plant toxicity and growth inhibition. Mycorrhizal colonization alleviated both Zn deficiency and Zn contamination, and also increased host plant growth by influencing mineral nutrition. However, neither EDTA application nor arbuscular mycorrhiza stimulated Zn translocation from roots to shoots or metal phytoextraction under the experimental conditions. The data are discussed in relation to the environmental risk associated with chelate-enhanced phytoextraction and the potential role of arbuscular mycorrhiza in soil remediation

(# 189) Defence gene expression in single mycorrhizal roots of soybean

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In the initial stages of plant arbuscular mycorrhizal formation, plant defence genes are weakly expressed but as the symbiosis proceeds, a number of key defence genes appear to be upregulated in arbuscule containing root cells. We have investigated the expression of three plant defence genes in mycorrhizal & non mycorrhizal roots of soybean (Glycine max L.). We have selected single mycorrhizal & non mycorrhizal roots for study using UV illumination from an epifluorescence microscope. Clearing of adjacent parts of the same roots used for RT-PCR with KOH and staining with trypan blue confirmed the mycorrhizal and non-mycorrhizal status of roots. RT-PCR on the remaining portions of selected roots was used to monitor the levels of transcripts for allene oxide synthase (AOS), B-1,3-glucanase and thaumatin-like proteins. Preliminary results suggest that although the levels of transcripts for B-1,3-glucanase and thaumatin-like protein change little between non-mycorrhizal & mycorrhizal roots, there is an increased expression of AOS mRNA in mycorrhizal roots.

(# 190) Intracellular structure in living hyphae of an arbuscular mycorrhizal fungus, Gigaspora margarita

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Intracellular structure in living hyphae of Gigaspora margarita was observed with a combination of fluorescent probes and laser-scanning confocal microscopy. Nuclei and a number of vesicles were observed with differential interference contrast (DIC) optics. The vesicles included at least two types of organelles: acidic vesicles and lipid bodies. The acidic vesicles were stained with LysoTracker Red that is known to selectively stain acidic compartments. The acidic vesicles were around 0.5 micrometer diameter and were densely and evenly distributed in the hyphae. The lipid bodies were stained with BODIPY 493/503 that selectively stain neutral lipid. The size of lipid bodies varied form about 0.3 to 3.0 micrometer in diameter and their distribution was diverse: sparsely distributed, densely distributed or formed aggregate. Both type of vesicles moved bidirectionally at various rates. These vesicles were distinct from the tubular vacuoles that were stained with Oregon Green 488 carboxylic acid diacetate. Function of these organelles on phosphate translocation was examined by staining polyphosphate with DAPI. DAPI bound to polyphosphate is known to emit yellow fluorescence. Many of yellow fluorescent granules were observed in hyphae, showing polyphosphate granules. In consideration of the shape and size, polyphosphate appears to accumulate in acidic vesicle. However there are possibility that it was artifact because toxic level of DAPI was applied to the hyphae.

(# 191) Expression of alkaline phosphatase genes in arbuscular mycorrhiza

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Function of alkaline phosphatase in arbuscular mycorrhizal (AM) fungi in the nutrient exchange between AM fungi and host plant has long been investigated. Recently, it was found that the efflux of phosphate from intraradical hyphae was suppressed by ALPase-specifc inhibitors (Kojima et al. ICOM3, 2002), suggesting that the ALPase may have an important role in the transfer of phosphate from AM fungi to host plants. However, the function of ALPase is still speculative. In this study, we analyzed the expression of the genes for AM fungal ALPase to understand the function of ALPase. A partial cDNA clone showing similarity to yeast ALPase was found in the EST library constructed from extraradical hyphae of Glomus intraradices. By using this clone, we cloned full-length cDNAs for ALPase from Glomus intraradices and Gigaspora margarita (designated GiALP and GmALP, respectively). GiALP and GmALP were constitutively expressed in the mycorrhizal roots, irrespective of the growth stage and infection rate. The transcript level of GiALP and GmALP in the mycorrhizal roots was higher than that in the germinating spores and also higher than that of extraradical hyphae. These results suggest that the AM fungal ALPase is mainly expressed in intraradical part of the fungi under symbiotic conditions, and that the ALPase may have some roles in the nutrient exchange with host plants rather than the nutrient uptake from soil.

(# 192) Increase of polyphosphate content in the host plant roots during the colonization of arbuscular mycorrhizal fungi

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Polyphosphate (poly P) is a linear molecule of many phosphate (Pi) residues linked by high-energy phosphoanhydride bonds. In the extraradical hyphae of arbuscular mycorrhizal fungi (AMF), the Pi from the soil environment has been thought to be converted to poly P for long distance translocation to the host plants. Therefore, the poly P is a key compound for understanding the Pi metabolism of AMF. Poly P kinase from Escherichia coli (PPK) has an activity to generate ATP by transferring poly P terminal Pi residues to ADP, and is useful for in vitro poly P quantification. We applied this technique to analyze the poly P metabolism of AMF. Because the poly P was heat labile compound, the fungi or plant samples was first disrupted in cold acetone and poly P was extracted after the acetone was removed by evaporation. For the poly P extraction from acetone powders, the buffer containing 8M urea was the most effective among tested. The onion roots colonized by AMF contained significant amount of poly P and the content of poly P increased as the infection proceeded. The poly P content of non-inoculated roots was almost negligible. The simple gel-filtration experiment indicated that the poly P in the mycorrhizal roots had smaller molecular weight than that of AMF spores or extraradical hyphae. These results agreed with the previous finding (Solaiman et. al, 1999), and support the model that AMF trasnlocate Pi as poly P and provide to their hosts after hydrolyzing.

(# 193) Survival and growth of inoculated Interior Douglas-fir seedlings on reforestation sites and partially rehabilitated landings.

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Most conifers in the Pacific Northwest form ectomycorrhizae and the benefits of such symbiotic associations are increased nutrient and water uptake, resistance to root pathogens, and tolerance to environmental extremes. In this study, survival and growth of commercially inoculated Douglas-fir seedlings raised under current nursery conditions and outplanted on standard reforestation sites and degraded sites such as landings were evaluated. Landings were significantly more compacted and had lower levels of organic matter and mineralizable-N compared to adjacent clearcuts. Commercially available inoculants did not improve growth, possibly because it was found that at time of outplanting seedlings were not heavily colonized. On the same sites, the ectomycorrhizal status and growth of nonectomycorrhizal (at time of outplanting) Douglas-fir (Pseudotsuga menziesii var. glauca (Beissn.) Franco) seedlings outplanted on degraded and standard reforestation sites were also assessed. Chemical analysis revealed that seedlings grown on landings had potentially toxic levels of Fe and Al in their needles. In both the field and greenhouse, Rhizopogon vinicolor-like was the most abundant ectomycorrhizal type found in landing soil. On landings ectomycorrhizal colonization was significantly higher than on adjacent clearcuts, however seedling growth and the diversity of ectomycorrhizal types were significantly lower. Before drawing conclusions concerning the potential of commercial inoculants, nurseries should modify growing conditions if they wish to favor good ectomycorrhiza formation before outplanting. This research indicates that under the harsh conditions that are found on landings Douglas-fir can readily form ectomycorrhizae but with a limited number of symbionts.

(# 194) Commercial production of AMF through Industrial mode and its large scale application

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Arbuscular mycorrhiza fungi are well established globally as plant promoting fungi. The fungus is known to occur in soil universally, however, they are in fewer numbers in tropical conditions. The fungus is yet to get commercial value because of several constraints in its mass production. Centre for Mycorrhizal Research, The Energy and Resources Institute, India has developed a technology for mass production of AM fungi. The root organ culture technique exploited for technology development, enables to produce bulk inocula offering pure, viable and contamination free healthy propagules, which are otherwise produced in fewer numbers with interfering microbes in other techniques of bulk production. Several rate-limiting factors have been dealt with during the technology development. The product based on this technology before being handed over to the Industries for commercialization was extensively tested in diverse agro climatic regions of the country using wide range of plant species ranging from agricultural, horticultural, floricultural and forestry species. AMF thus appears to have a bright future gaining tremendous importance in an effort towards reducing chemical application for sustainable agriculture particularly among marginal farming community.

(# 195) A new mode of mass inoculum production of arbuscular mycorrhiza

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Three different prime light regimes were tested for their response on AM fungus Glomus intraradices (Schenck and Smith) in vitro, otherwise conventionally propagated globally under dark conditions. The fungus was investigated for its behavioral expression with respect to extramatrical mycelial biomass, mycorrhizal colonization percentage (MCP), and sporulation dynamics in different light regimes. Fungus was observed to show very early sporulation in white light (WL) then other treatments. Higher vegetative mycelial proliferation was observed with yellow light (YL) exposure. Blue light (BL) was observed to have initial suppressive role but later fungi was found to overcome the effect and sporulated well. The white light treatment seized the spread of the fungi early then other treatments. Yellow light exposure had maximum longevity of the system both in roots and fungi increasing its possibility for further sporulation and spread, these observations were different from dark treatment (DL). The functional activity was found normal in all treatments when studied by enzymatic assay of alkaline and acidic phosphatases. The viability test showed 90-95 % viable spores in all treatments. The findings provide useful information on its versatile nature in adapting to stressed environment. It may be useful especially towards mass inoculum production wherein higher propagule production is a desirable feature.

(# 196) Seasonal fluctuations in the ectomycorrhizal community associated with beech (Fagus sylvatica)

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The seasonal fluctuations in an ectomycorrhizal (ECM) community associated with beech (Fagus sylvatica) were analyzed. In 2001, intensive sampling was performed in a 15 x 15 m plot located in mid Zealand (Denmark). Twenty soil cores were sampled at each of eight harvests from March to November. Identification of ECM root tips was done by comparing sequences obtained from ECM to sequence databases. Fruiting bodies of EM species from Danish beech forests were collected (with help from Morten Christensen and Jacob Heilmann-Clausen) and sequenced to add more relevant sequences for these comparisons. Overall, more than 75 species were detected but typically only 20-25 species were found at each harvest. The community was dominated by Russuloid spp. followed by Cortinariaceae spp., Thelephoroid spp., Cantharelloid spp. and Pezizalian spp. The community differed significantly between individual harvests and three general abundance patterns could be identified: 1) Abundant throughout the growing season 2) abundant in early and late harvests but rare in summer harvests 3) Abundant in summer harvests but rare in early and late harvests. These patterns were followed both by individual species but also by some of the higher order taxonomical units. The data put emphasis on the temporal aspect of ECM communities, which have previously not been extensively studied. At least in regions with a long potential growth period a temporal sampling scheme will be necessary to monitor the total ECM diversity at a given site.

(# 197) Role of arbuscular mycorrhizal fungi in the uptake of radionuclides by plants

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Mycorrhizas are the most widespread associations between microorganisms and higher plants in diverse ecosystems throughout the world. Their extraradical mycelium forms an active continuum from soil to plant able to take up, translocate and transfer nutrients to their host. Beside the abundant literature on their effect on mineral nutrition of plants, there is increasing information reporting that arbuscular mycorrhizal (AM) fungi can influence the uptake of radionuclides by plants, and hence their bio-cycling. In some studies comparing mycorrhizal and non-mycorrhizal plants, radionuclides concentrations or contents was increased in mycorrhizal plants as it was reported for 137-Cs, 134-Cs, 90-Sr and 238-U, while in others, the presence of AM fungi resulted in decreasing radionuclides concentrations or contents in plants or had no effects. Experimental conditions such as the duration of the experiment and the soil properties seemed to be important factors influencing the AM fungal effects. The approach followed for these experiments was, however, inappropriate to estimate the contribution of the mycosymbiont to the transfer of these radionuclides from the medium to the mycorrhizal plants. Recently, studies were carried out using a two-compartment root-organ culture system allowing a spatial separation of a root compartment from a surrounding root-free compartment where only hyphae were allowed to grow. They provided data demonstrating that the extraradical mycelium network of AM fungi could take up and translocate 137-Cs and 233-U towards the plant roots. The magnitude of both uptake and translocation was, however, very low as compared to that observed for an essential element such as P, suggesting that the hyphae may have a higher sequestration than translocation function for radionuclides, and inversely for P.

(# 198) Genetically defined checkpoints along the colonisation patway of Lotus japonicus roots by an arbuscular mycorrhizal fungus.

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Plant mutants impaired in arbuscular mycorrhizal (AM) symbioses are a powerful tool to identify genetically defined steps in the development of the symbiotic interaction. Several Lotus japonicus lines were generated by mutating single SYM loci: such mutants block the colonisation process at various stages. The role of Lotus japonicus LjSym4 gene during the symbiosis with the AM fungus Gigaspora margarita was investigated through a cytological approach on plants harbouring the mutant alleles LjSym4-1 and LjSym4-2.Mutant LjSym4-2 blocked the colonisation process at the epidermis, where cytoskeleton disorganisation and eventual cell death was observed. Mutant LjSym4-1 allows occasional overcome of the epidermal block and shows a second block at the wall of cortical cells. In fact, this mutant allows occasional inner cortex colonisation with abundant intercellular hyphae but rare arbuscules.Attention was further focussed on the molecular mechanisms acting in the epidermal cells of mutant LjSym4-2 interacting with the fungus. ROI species were hypothesised to be produced during the early contact events based on their central role in plant defence.Peroxide production was demonstrated by cytological analysis inside the hyphae contacting the mutant, as well as the expression of a regulated superoxide dismutase fungal gene. The results suggest a multistep dialogue between AM fungi and plants, where many checkpoints have to be overcome for the symbiosis to be successful.

(# 199) Uptake and Translocation of Radiocaesium by Arbuscular Mycorrhizal Fungi under Root Organ Culture Conditions

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Radiocaesium uptake and translocation by the arbuscular mycorrhizal fungus (AMF) Glomus lamellosum were studied under root-organ culture conditions with Agrobacterium rhizogenes transformed carrot (Daucus carota) roots as host.Bi-compartment Petri plates were used to spatially separate a root compartment (RC) and a hyphal compartment (HC). Mycorrhizal root growth was restricted to the RC while extraradical mycelium (ERM) grew in both the RC and HC. The HC was labelled with 10723 ± 52 Bq 134Cs. At the end of the experiment (8 weeks), 134Cs was measured in the RC (i.e. in the mycorrhizal roots and in the medium containing the ERM) and in the HC (i.e. in the labeled-medium and in the ERM). Hyphal density was determined by the Gridline-intersect method. Frequency (%F) and intensity (%I) of root colonization was also measured.We observed that G. lamellosum readily absorbed 134Cs. Absorption involved 134Cs uptake by the ERM growing in the HC, and 134Cs translocation from the HC to the RC. Radiocaesium measured in the roots represented 4.25 % of that inoculated in the HC. The magnitude of this translocation was highly correlated with the hyphal density in the HC and the number of hyphae crossing the partition wall. No correlation was observed between 134Cs root content and %F or %I of root colonization.Our results confirm that AMF can actively uptake and translocate radiocaesium towards roots. However, it was not possible to determine if the translocated radiocaesium was transferred to the root tissues or accumulated in AMF intraradical structures.

(# 200) Transformed roots: a useful tool to study plant/fungal/bacterial interactions

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Root-organ cultures have been particularly successful for studies dealing with AM development. By contrast, their potentiality for the understanding of other plant/microbe interactions is less known. The presentation is aimed to describe two systems where root-organ cultures have been used to investigate plant/ectomycorrhizal fungi as well as fungal/bacterial interactions. Transformed roots were obtained from explants of Cistus incanus leaves after treatment with Agrobacterium tumefaciens with the aim to get roots mycorrhized by Tuber borchii. Three genetically different fungal strains were used to inoculate C.incanus transformed roots. The "in plate" system allowed us to follow the developmental steps of the fungal structures and to reveal an important intracellular colonisation, immediately after the contact between the fungus and the root.The second system was set up to investigate the transmission pathway of the endobacteria Candidatus Glomeribacter gigasporarum that live inside the AM fungus Gigaspora margarita. Due to the biotrophic status of the bacterial and fungal partners, transformed carrot roots were used as a 'substrate' for keeping them alive along generations. The bacteria were identified through each spore of various fungal generations by using primers designed on 16S and 23S ribosomal sequences. They were visualised and quantified with confocal microscopy, being present in all the generations so far obtained.Taken in their whole, the results show how root-organ cultures represent a versatile tool to investigate plant/microbe interactions, also those involving non-cultivable microbes.

(# 201) BiP gene sequences provide insight into AMF genome evolution and phylogeny

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Until now the phylogeny of AMF has been based on rDNA sequences. This has partly been controversial because rDNA is known to exist in multiple and variable copies. However, surprisingly little information exists on variation in AMF genes that code for proteins. We have analyzed variation in the BiP gene that is highly conserved in other eukaryotes and thought to be single copy. We sequenced a representative population of cloned DNA of a fragment of BiP that was obtained from a single spore culture of Glomus intraradices that grew on Ri T-DNA transformed carrot roots in sterile conditions. We found 31 variants of 274bp length. Despite this high variation sequences were monophyletic if compared to homologs in taxa of different fungal phyla. The within-individual phylogenetic relationship of the variants showed three well supported groups. Based on predicted amino acid sequences 12 variants were likely to be pseudogenes and these almost exclusively comprised one phylogenetic group. Due to the likely low copy number of BiP, we argue against the hypothesis that all 31 variants are harbored within one nucleus and propose that segregation of genetic information occurs. Using an extensive resampling procedure of the obtained dataset we estimated a maximal genetic diversity of 70 BiP variants in this single spore isolate. Given the nature of variation and given its likely low copy number this gene may therefore be a good candidate for studying a wider AMF phylogeny.

(# 202) Studies on copper tolerance and protective effects on host plants among ectomycorrhizal strains of the Hymenoscyphus ericae aggregate (Helotiales, Ascomycota)

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Ectomycorrhizal and ericoid mycorrhizal fungi have traditionally been perceived as taxonomically distinct, but recent studies have shown that both types of symbioses have evolved among strains of the monophyletic species-complex commonly referred to as the "Hymenoscyphus ericae aggregate". Ectomycorrhizal strains of the H. ericae aggregate produce brown to black ectomycorrhizal morphotypes with a range of conifer and hardwood hosts, and have been observed as particularly common on seedlings colonizing copper mine-spoils in Central Norway. These mine-spoils offer an extremely toxic and stressed environment both with regards to metal content, low pH, drought and lack of organic matter. Despite this, pine, willow, birch, ericoid plants and grasses are now colonizing the mine-spoils. It is known that H. ericae protect its hosts of Ericales against Cu- and Zn-toxicity in such environments, and strains of H. ericae seem to possess constitutive high tolerance to a range of heavy metals. However, little is known about the ectomycorrhizal relatives of H. ericae with regards to metal tolerance and ecological role in metal polluted habitats. We have therefore initiated a study with the following objectives: 1) to characterise genotypic variation in populations of ericoid and ectomycorrhizal strains of the H. ericae aggregate from non-polluted and Cu-polluted soils, 2) to study their Cu-tolerance under nutrient rich and nutrient poor conditions in relation to origin and genotypic patterns, and 3) to investigate if some selected ectomycorrhizal strains of the H. ericae aggregate protect pine-seedlings against Cu-toxicity. Results from these experiments will be presented during ICOM4

(# 203) Quality of Seeds and Seed bank of the Atlas Cypress (Cupressus atlantica G.) in the area of its natural Distribution in Morocco and the Role of soil components in its Natural regeneration.

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In Morocco the Atlas Cypress (Cupressus atlantica G.) is suffering a natural regeneration scarcity.The analysis of the Seed quality of this endemic species showed that 51% only of seeds are capable to germinate, 20% are attacked and 29 % are empty. In soil seeds extracted of two Levels : 0-5 cm and 5-10 cm show a Rate of germination of 5 % only, 38% of seeds are attacked and 58 % of seeds are empty. The chemical analysis of the soil under and out of trees showed that soil is rich in organic matter even out . Components of the Humique Balance are similar to the one of a soil enriched in organic Matter and that permitted the obtaining of plantations of Atlas Cypress having interesting quality norms. However under the tree, soil is richer in total polyphenolic components that intervene negatively on the germination of seeds.
The same site visit during three years showed that seeds lose their germinative power in soil in less than one year.

(# 204) Evolution of Arbuscular Mycorrhizal Fungi: New Insights from Molecular Phylogeny and Molecular Ecology

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Molecular sequence data have facilitated rapid progress in elucidating the phylogeny of arbuscular mycorrhizal fungi (Glomeromycota). The number of major subgroups within this group of fungi has risen to at least six clades, each with a long evolutionary history. Morphology-based taxonomy faces the challenge to keep pace with these new concepts. At the same time molecular ecological studies are revealing a large diversity of yet unnamed Glomeromycota by analyzing sequence data from colonized roots from field sites. These studies also provide a growing body of evidence that the host specificity in the arbuscular mycorrhizal symbiosis is not as low as previously postulated. Myco-heterotrophic plants from several families were shown to be strikingly specific for their fungi. Both host preferences and reverse carbon transfer are therefore factors that have to be considered in future studies of the ecology of arbuscular mycorrhizal fungi.

(# 206) Influence of Organic Matter on the Interaction Between the Fungal Biocontrol Agent Clonostachys rosea and a Tomato/Glomus intraradices Symbiosis

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Clonostachys rosea (CR) is an effective biocontrol agent against several root pathogens. However, possible interactions between CR and AM-fungi might impair the plant beneficial effects of these fungi. The objective of the present work was to examine the interactions between CR and a tomato/Glomus intaradices (GI) symbiosis with and without a food base (wheat bran) for CR. Mycorrhizal and non-mycorrhizal tomato plants were grown in soil:sand mix (1:1, w/w) with and without wheat bran (1% w/w) and CR inoculation in a full factorial design. The plants were harvested six weeks after sowing. Wheat bran amendment resulted in marked plant growth depressions, which were completely counteracted by GI inoculation, most likely due to an increase in the development of the extra radical phase of GI. Moreover dual inoculation with GI and CR gave the highest plant growth. In the absence of wheat bran, CR inoculation also increased plant growth and altered shoot nutrient conc. with an increase and decrease in P conc. and N conc., respectively, whereas GI inoculation had no affect on plant growth, but increased shoot P conc. and N conc. Overall, CR inoculation reduced mycorrhiza development and this effect was more pronounced in treatments with wheat bran. The population density of CR, in terms of cfu, was increased by wheat bran amendment, whereas GI inoculation reduced the population density of CR. In conclusion, in the present experiment, GI and CR were mutually inhibitory, but this inhibition did not affect their plant growth promoting effect.

(# 207) Arbuscular Mycorrhizal Fungal Species Community in a Long-Term Field Experiment

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In a Swiss long term field experiment, the influence of organic and conventional agricultural management on the soil and its organisms has been studied side by side for 22 years. We studied the species communities of arbuscular mycorrhizal fungi (AMF), using molecular tools specifically targeted at the ribosomal RNA genes. Small subunit and Internal Transcribed Spacer sequences were amplified from colonized roots and analyzed phylogenetically. Roots directly sampled from the field and from trap cultures were characterized. A wide range of arbuscular mycorrhizal fungi was detected. Glomus groups A and B, Acaulospora and Archaeospora were detected in trap cultures. In the field roots, we also found Scutellospora and Paraglomus. Most sequence types detected did not have close matches among database sequences previously obtained from spores.

(# 208) The Influence of different fertilizers on the development of mycorrhiza and fine-roots of containerized conifer seedlings

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The degree of mycorrhization, as well as the proportion of above-ground biomass against roots biomass are among the most essential indices describing the containerized seedling quality. The application of fertilizer of specified composition can affect the development of mycorrhizza and fine-root system in seedlings. The aim of this study was to investigate the fertilization effect on the morphological characteristics and mycorrhization of containerized conifer seedlings, using different fertilizer compositions.The experiments were established in the Strenci nursery in north-east part of Latvia. The effect of two basic fertilizers of four compositions on containerized spruce and pine seedlings was tested.Micorrhization of containerized seedlings was estimated, using the gridline intersection method to count ECM roots as well as by scoring amount of external mycelia (in classes from 0 to 4). The effect of fertilizers on morphological characteristics was analysed, using multiple ANOVA (GLM procedure). The comparative coefficients, describing mycorrhization and seedling vitality, were calculated. All fertilizers increased the above-ground part / roots ratio. Root system biomass of non-fertilized seedlings comprised 52% of total plant biomass. However, the root system of fertilized seedlings comprised only 26% to 34% of the total plant biomass. N-P-K (6-5-20) fertilization had a positive effect on mycorrhiza development in containerized spruce seedlings. Instead, best morphological characteristics were found for the treatment with fertilizer composition 2-5-18 (NPK).The highest degree of mycorrhization in containerized pine seedlings was found in the treatment with 6-5-20 composition of NPK. Morphological characteristics were best in the treatment with 8-3-25 composition of NPK.

(# 209) Ectomycorrhizal fungi diversity in an old-growth sclerophyllous evergreen forest dominated by Quercus ilex (holm oak) : above- and below-ground patterns and impact of small-scale canopy gaps on species diversity

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Holm oak (Quercus ilex L.) is often the dominating tree species in sclerophyllous forests of the Mediterranean basin; however, old-growth stands are rare. In this study, we used morphological and molecular techniques to characterize the community of mycorrhizal macromycetes in a 250 year-old holm oak forest located on the island of Corsica. A total of 3659 fruitbodies was collected over 3 years from a permanent sampling site of 6400 m2. One hundred and sixty six species distributed over 25 genera were described. This high taxonomic richness was confirmed using ITS-RFLPs performed on fruitbodies. The above-ground fruiting community : 1- was dominated by species of (i) Russula (44 taxa, 27.7 % of the total fruitbody number) and (ii) Cortinarius (39 taxa but 6.7% only of fruitbodies), and 2- contained a large number of rare species (102) producing a few fruitbodies. The three most abundant species (32.9% of fruitbodies) were Laccaria laccata, Lactarius chrysorrheus, and Inocybe tigrina. However, in contrast to the above-ground fruiting patterns, the fungal community retrieved from mycorrhizae from both Q. ilex and Arbutus unedo (strawberry tree) was dominated by Cenococcum geophilum and thelephoroid fungi. Preliminary results on mycorrhizae also suggest: (i) species aggregation at small scales and (ii) a large number of rare taxa. Finally, comparisons of fruiting patterns in different areas (i.e. gaps and non-gaps) indicate that small canopy gaps were species-rich and often dominated by species such as Inocybe tigrina, Russula vesca or Russula persicina.

(# 210) Natural regeneration of holm oak (Quercus ilex L.) forests in Corsica : role of ectomycorrhizal symbiosis in seedling growth and survival and soil feedback

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In Corsica, holm oak (Q. ilex) forest develops into ericaceous chaparrals. Heather (Erica arborea) chaparral (EAC) appears first, and is replaced by strawberry tree (Arbutus unedo) shrublands (AUC). Finally, a holm oak forest stage (O) establishes in AUC. We investigated the role of ECM fungi in the establishment of oak seedlings in chaparral-oak transitions. Acorns were sown in EAC, AUC, and O. Seedling survival, growth and ECM colonization was monitored monthly. By the end of the growing season, seedling survival and growth were significantly higher in AUC than in EAC and O. In addition, ECM colonization was the greatest and the most diverse in AUC. Mortality occurred in early spring for seedlings grown in oak forest, and during the summer in EAC. We repeated this experiment on the following year, in addition plants were watered. We also planted 1 year-old mycorrhizal seedlings in EAC and O. Survival was significantly increased in EAC; no positive effect was observed in oak forest. To investigate further the mechanisms leading to seedling mortality in oak forests, we tested for soil feedback. In situ reciprocal soil transfers between: (i) O and EAC, and (ii) O and AUC showed similar responses for acorns planted in soil from oak forests whatever the habitat, confirming soil feedback. One more experiment was finally set up to test for biotic factors (pathogens and mycorrhizal fungi) as mechanisms for the observed responses. Acorns were planted in fumigated and non-fumigated soils from both O and AUC. Preliminary results will be presented.

(# 211) Reaching out to the ends of AMF

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Cytological techniques are very difficult to use with AMF. Therefore, we have used molecular approaches to study chromosome number and telomere length in the AMF Glomus intraradices. Telomeres consist of short G-rich repeats at the chromosome ends. When the cell divides the telomeres are not replicated in the same manner as the rest of the genome, but synthesized by telomerase, that operates less precisely. This creates variation in the number of repeats. We cloned and sequenced telomeres and subtelomeric regions of G. intraradices. Telomeres of G. intraradices contain the TTAGGG repeat, as in other fungi. Telomere length length was estimated using southern blot on genomic DNA of G. intraradices and (TTAGGG)4 probe. Hybridization patterns showed a range from 50 to 1900 bp with a mean of 1480 bp, indicating that G. intraradices maintains very short telomeres. A total of 396 subtelomeric sequences were screened by dot-blot hybridization with (TTAGGG)4 probe, and 247 clones showed a hybridization signal of different intensities. 43 clones were sequenced, and phylogenetic analysis showed six different telomere types. To assess chromosome number, we also used pulsed field gel electrophoresis (PFGE). PFGE showed a pattern of four more or less diffuse bands ranging from 0.9 to 1.6 Mb which is in agreement with our estimates of genome size. Our results indicate clearly that 4 is the minimum number of different chromosomes in G. intraradices.

(# 212) Morphological responses of an arbuscular mycorrhizal fungus to exudates from a transformed carrot root in a tri-compartmental root-organ culture system

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The signalling process between host root and arbuscular mycorrhizal fungi (AMF) before root colonization is poorly understood and the impact of root signals on AMF morpho-anatomy seldom investigated. The current knowledge on the role of root exudates has been obtained partly with the in vitro root-organ culture (ROC) technology. Further studies involving multi-compartmental in vitro devices could be developed to investigate the pre-symbiotic stage. A unique and complex ROC tri-compartimental system was designed to compare the morpho-anatomy of Glomus clarum influenced or not by a root signal, in particular before the establishment of a physical contact. It consisted of a central compartment (containing the mycorrhizal carrot root) separated from two side-compartments by plastic walls. The fungus was allowed to cross both partitions and develop on one side (test compartment) on a membrane separating a carrot root (root exudates) from the mycelium, and on the other side (control compartment) on a membrane without carrot root (no root exudates) beneath.

The number of spores, mycelium length and growth strategy, was compared in both compartments.The first results showed that the mycelium of G. clarum had a more structured growth strategy when confronted to root exudates. This difference was better marked on the mode of development adopted by the AMF, than on the number of spores and mycelium length. The poster presents a complete description of the experimental system, the results of the experiment and an attempt to model the mycelium architecture. The perspectives offered by this model are further.

(# 213) Analysis and comparison of anastomosis formation in Glomus and Scutellospora strains grown in monoxenic culture with Ri T DNA transformed carrot roots

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Anastomosis is an important mechanism allowing for exchange of genetic material and cytoplasm/protoplasm flow in vegetative mycelia of Ascomycetes and Basidiomycetes. In arbuscular mycorrhizal fungi (AMF) complete fusion of hyphal walls and protoplasm continuity were observed on germlings, but seldom considered in intact mycelial networks. We reported and compared the anastomosis formation in Glomus lamellosum, G. claroideum and Scutellospora reticulata strains, using monoxenic culture between RiT-DNA transformed carrot root and AMF. Anastomosis formation in extramatrical mycelium was assessed using the grid line method, under a dissecting microscope. The number of anastomosis varied from 5.0x10-2±1.5 cm-1 (length of hypha) and 4.8x10-2±1.1 cm-1 in G. lamellosum and G. claroideum, respectively, to 0.6x10-2 ±0.2 cm-1 in S. reticulata.. In Glomus, anastomosis were observed connecting different hyphae, while in S. reticulata, few anastomosis were observed and most often corresponded to a healing mechanism (hypha bridges) to reconnect broken hyphae or overcoming septated parts of a hypha. Our results suggests that anastomosis frequency and the mechanisms for hyphae repair may have ecological implication for species survival (exchange of genetic material is important to maintain genetic variability and repairing damaged hypha can affect species reproductive success and consequently species abundance), maintenance and biodiversity in natural as well as man-made ecosystems.

(# 215) Arbuscular mycorrhizal fungi promote plant recruitment in experimental grassland

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Seedling establishment is one of the key factors that determines the structure and diversity of natural plant communities. It has been suggested that arbuscular mycorrhizal fungi (AMF) play a key role in that they promote seedling recruitment into permanent vegetation, but experimental evidence is scarce. The influence of AMF on seedling recruitment in one-year old experimental calcareous grassland communities was tested in this study. Seeds of four plant species (two grasses and two forbs) were added to patches within one-year old grassland microcosms that were inoculated with AMF or those that remained un-inoculated. The four plant species performed better when AMF were present. The mean seedling biomass of Trifolium pratense, Brachypodium pinnatum, Bromus erectus and Prunella vulgaris was respectively 2600%, 80%, 55% and 17% higher in the microcosms inoculated with AMF compared to microcosms without AMF. The seedlings obtained a higher biomass and nutrient content in the mycorrhizal communities despite lower availabilities of soil nutrients. The results indicate that AMF promoted seedling establishment by integrating emerging seedlings into extensive hyphal networks and by supplying nutrients to the seedlings. The results also show that AMF can be viewed as a symbiotic support system that is essential for establishment of seedlings into established vegetation.

(# 216) EFFECTS OF AGAR MEDIA pH AND NUTRIENT COMPOSITION ON THE INOCULUM PRODUCTION OF FIVE ECTOMYCORRHIZAL FUNGI IN PURE CULTURE

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Pinus pinaster Aiton. is widely used for afforestation and wood production in northwest Spain. Nurseries produce plants from seeds without use mycorrhizal techniques. However, pine roots are mycorrhiced by fungi present within growth media, not knowing the effects on the stablishment and the growth of the plants. Moreover, some of this fungi could not be useful for the plant, as Telephora terrestris, frequently found in roots of P. pinaster grown in the nurseries. Inside a program of production of mycorrhizal plant of quality of P. pinaster, adapted to the ecological conditions of northwest Spain, was designed a test to study the effects of pH and nutrient composition in the growth, in pure culture, of three native ectomycorrhizal fungi and two selected ones, to know the best conditions to produce fungi inoculum to be used by nurseries. The native ectomycorrhizal fungi were two isolates of Boletus badius and one of Paxillus involutus; one isolate of Pisolithus tinctorius and another of Laccaria laccata, were also used. Every fungus was cultivated in four different agar media: modified Melin-Norkrans (MMN) with glucose (Marx, 1969), Raper (Raper and Raper, 1972), PDA (Lacy&Bridgmon, 1962) and agar-malt (4%). For each cultivation media, three treatments of pH were tested between 4.5 and 7.5. There were six replicates for each fungus/media/pH combination. Mat size and macroscopic and microscopic characteristics of the mycelia were recorded regularly. Significative differences were found among isolates, agar media and pH treatments.

(# 217) Defoliation Decreases Below-ground Allocation In Ectomycorrhizal Betula pubescens

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Boreal forest trees are highly dependent on root colonizing mycorrhizal fungi. Since the maintenance of mycorrhizal symbiosis implies a significant carbon cost for the host plant, the loss of photosynthetic leaf area due to herbivory is expected to reduce the host investment in mycorrhizae. We exposed ectomycorrhizal white birch (Betula pubescens) seedlings to simulated insect defoliation conducted with 50 or 100% intensity during either the previous or current summer or repeatedly during both seasons. Shoot and root growth of seedlings were distinctly reduced by both 100% defoliation treatments and by repeated 50% defoliation. Root to shoot ratio significantly decreased after 100% defoliation indicating a reduced proportional allocation to the roots. Ergosterol (i.e. fungal biomass) concentration in the fine roots was decreased by 100% defoliation conducted either in the year of the final harvest or repeatedly in both years. The trend was similar in the proportion of thick-mantled mycorrhiza, the strongest decline occurring in repeatedly defoliated seedlings. The patterns in fungal biomass and mycorrhizal colonization rates contrast the responses of stem and root biomass, which were more strongly affected by previous-year defoliation than current-year defoliation. While the present results support the prediction that mycorrhizal colonization may decline as response to foliage loss, the decline in fine root biomass may in fact be more important in maintaining a functional balance between below- and above-ground investments of defoliated birches. Functional balance is also highlighted by the fact, that proportion of thick-mantled mycorrhizae correlated positively with leaf to stem ratio.

(# 218) EFFECT OF THE CULTURE FILTRATES OF EDIBLE ECTOMICORRHIZAL FUNGI ON MICROCONIDIA GERMINATION OF Fusarium oxysporum and F. moniliforme.

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Fusarium oxysporum and Fusarium moniliforme are two of the most important fungal species associated to Damping-off complex in Castilla y León (Spain). Several fungicides are used to control the disease in nurseries, induced resistance to pesticides results in reduced protection. Biological control, by ectomycorrhizal fungi, may be a reasonable alternative for controlling Damping-off. Boletus edulis, B. pinicola, B. fragrans, B. aereus, Rhizopogon roseolus, Laccaria laccata, Lactarius deliciosus and Leccinum lepidum, were isolated and grown in liquid MMN in 50 ml erlenmeyer flasks. Culture filtrates were obtained after fifteen days by filtering and sterilizing fungal suspensions through 0,22 µm pore size filter; filtrates were stored at 4ºC in the dark

.Microconidial suspensions for two strains of Fusarium oxysporum and for two of Fusarium moniliforme, were prepared and adjusted to 3x106 spore/ml. For each of the microconidial fungi and of the pathogenic strains, one hundred µl of culture filtrate and 100 µl of spore suspension were placed together in 1 ml Eppendorf tubes and incubated at 22,5ºC. during 0, 6, 12 and 24 hours. At the end of this period the germination of microconidia was screened under microscope.

Germination of F. oxysporum and F. moniliforme spores after 6 hours was significantly inhibited in three of the four strains used. An inhibitory effect against Fusarium sp. spore germination was observed for all of the mycorrhizal fungi tested, after 12 hours, (ANOVA; $P<0.05$). The highest inhibitory effect (Higher than 50%) was achieved by L. deliciosus and R. roseolus 24h after incubation.

(# 219) Elevated N input results in reduced growth of ectomycorrhizal mycelium in forest soils

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We have studied the production of ectomycorrhizal mycelia (EMM) in different systems with varying N availability, by using ingrowth mesh bags. Nitrogen fertilisation (100 kg N ha-1 yr-1 since 1988) of a spruce forest in SW Sweden, reduced the growth of EMM to about 50% of that in non-fertilised plots. Our findings confirm earlier results from laboratory experiments showing that the mycelium is more sensitive than mycorrhizal root tips to N fertilisation.

Oak forest soils in South Sweden receiving 20 kg N ha-1 yr-1 by deposition produce about half the amount of EMM compared with forests receiving 10 kg N ha-1 yr-1, and N mineralisation and rate of nitrification were higher in these soils exposed to more N deposition.

We have also found that reduced amounts of EMM were produced in four natural nutrient gradients in North Sweden when soil nutrient availability and pH increased along the gradients.

Thus not only raised levels of N due to anthropogenic activities affect amounts of EMM in forest soils, but also varying levels of N in unmanaged ecosystems.

EMM has been suggested to be important in retaining added N to forest ecosystem and we intend to test the importance of EMM in preventing nitrate leaching from forest soils.

We will present results at the conference of EMM production from a mor layer CN ratio gradient, since the risk for nitrate leaching is suggested to be higher from soils with CN ratios lower than 25.

(# 220) Management Strategies for Capturing the Benefits of Mycorrhizas in the Production of Field-grown Vegetables

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Two approaches of exploiting AM fungi in the production of field grown leeks were investigated: 1) Manipulation of indigenous populations of AM fungi through crop rotation and the use of cover crops increasing the AM inoculum potential and 2) Use of transplants, which were pre-colonized by AM fungi selected for high plant growth response. Results from field experiments, in soil with moderate P levels, showed that colonisation, P uptake and growth of leeks increased if the previous crop was leek or onion compared to cabbage. A cover crop of black medick, established the previous autumn, increased the AM colonization, plant P concentration and growth of leek. Differences in colonization, P uptake and plant growth diminished during the growing period and nearly disappeared at the final harvest. Leek transplants inoculated with Glomus intraradices, G. clariodeum, G. mosseae or a field population of mycorrhiza increased the colonization, P uptake and growth of leeks, compared to non-inoculated transplants. The concentration of P, Zn and Cu in the roots were more influenced by inoculation, compared to the leaves. As for the experiments on previous crops and cover crops, differences between treatments nearly disappeared at the final harvest. An explanation for this lack of response could be due to a sufficient supply of soil P or other nutrients low in mobility. In conclusion, in terms of plant growth, field-grown leeks did not benefit from the mycorrhiza management strategies employed in the present project.

(# 222) Sugarcane yield decline may be causally linked with early and rapid colonization by arbuscular mycorrhizal fungi (AMF)

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Loss of productive capacity of sugarcane in the first year after successive planting is a widespread problem in sugarcane worldwide. Fallow management of sugarcane soils by repeated tillage to break up the root crown and to reduce weed cover before replanting produces up to a 30% increase in biomass at the first cutting, but only a slight response in the second cutting and no response in the third cutting. Soil treatment with methyl bromide duplicates the fallowing effect. No soil microorganisms deleterious to sugarcane roots have been identified in most instances. Several AMF were trapped from successively planted fields in South Florida, and three Glomus isolates were selected to reconstitute a steamed local Tory muck soil in glasshouse experiments. Roots emerged from sugarcane seed pieces and only those in non-steamed soil were rapidly colonized in advance of shoot development. Colonization rate varied with Glomus isolate in reconstituted soils. Shoot growth rate was inversely related to colonization rate among soil and Glomus isolate treatments. Depression of biomass gain compared to the steamed soil treatment was best predicted by root colonization at 2 weeks and to a lesser extent by later colonization. Results suggest that early colonization of sugarcane roots before shoots emerge produces a carbon cost that isn't recoverable by the first cutting. This hypothesis will be tested in fallowed or biocide-treated field plots reconstituted with native AMF.

(# 223) ARBUSCULAR-MYCORRHIZAL FUNGAL–NEMATODE INTERACTIONS IN AMMOPHILA ARENARIA IN COASTAL SAND DUNE SYSTEMS

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The EU-funded ECOTRAIN project is studying the ecology of plant parasitic nematodes, their host plants and antagonists in European coastal sand dunes. As one of the participants in ECOTRAIN, we are focussing on the effects arbuscular mycorrhizal fungi may have on ecto- and endo parasitic nematodes of marram grass (Ammophila arenaria). During the first year of this three-year project, our objectives will involve:

a. culturing arbuscular mycorrhizal fungi (AMF) isolated from sand dune systems
b. studying seasonal shifts in AMF
c. estimating mycorrhizal dependency of marram grass

In order to establish cultures of AMF three approaches are being used: single spore cultures, trap cultures with soil inoculum and trap cultures with root inoculum. Seasonal shifts in the AMF colonization of the roots of A. arenaria will be investigated with molecular tools. Mycorrhizal benefits to the plant's dry weight will be measured under conditions with different phosphate supplies. In addition, we will try to characterise the root colonization of A. arenaria by AMF along the European West Coast. In co-operation with Susana Rodriguez Echeverria from the Instituto da Mar, (Portugal) and Francisco da Souza from the Netherlands Institute of Ecology (The Netherlands), a PCR-DGGE approach will be used to compare the AMF diversity from different geographic sites along the European coast. In collaboration with other researchers we will also examine the interaction of AMF and parasitic nematode populations.

(# 224) Factors influencing colonization of arbuscular mycorrhizal fungi in plants of groundwater-dominated wetlands

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Researchers have established that the diversity and function of arbuscular mycorrhizal fungi (AMF) can influence plant community diversity, but these aboveground-belowground linkages seldom have been explored in wetland habitats. As a first step toward understanding the role of AMF in plant communities of calcareous fens, groundwater-fed peatlands with high plant diversity, we examined AMF colonization in 57 plant species. While some of the dominant monocot species (e.g., members of the Cyperaceae and Typhaceae) were non-mycorrhizal, a majority of the subordinate species hosted AMF. We followed this investigation with studies that separately addressed how hydrology, nutrients, and light influence AMF colonization. Two independent studies of the influence of hydrology on colonization of 3 different fen species surprisingly found that groundwater saturation of the rooting environment had little effect on the percentage of root length colonized. In a greenhouse experiment using field-collected individuals of Solidago patula with surrounding soil, we found that AMF colonization increased when P was added at a rate of 1g m-2 but declined with higher levels of added P. Finally, we observed that the long-term removal (10 years) of a dominant non-mycorrhizal species (Typha angustifolia) and subsequent changes in the light environment significantly affected patterns of root colonization in one annual and two perennial understory species. Our initial survey demonstrates that AMF potentially could influence a majority of species in the fen plant community, but to clarify this influence, a better understanding of the environmental factors that influence mycorrhizal colonization and subsequent plant response to AMF is needed.

(# 225) A multi-gene approach to studying the phylogeny of the arbuscular mycorrhizal fungi.

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The last decade has seen an explosion in the amount of DNA sequence data obtained from organisms, and AM fungi are no exception. The large number of ribosomal DNA sequences has led to the elevation of the order Glomales to a new phylum, the Glomeromycota, based on the sequence variation in this gene. We have obtained DNA from single spores of isolates representing the 3 'traditional' glomalean families, the Glomaceae, Gigasporaceae and Acaulosporaceae. We have generated partial sequences from the SSU rRNA gene, and also actin and EF1-alpha genes. The latter have been used extensively for studying phylogeny of the eukaryotes. We will present analysis of these gene sequences and show whether or not the resulting phylogenies are congruent with the SSU rRNA phylogeny, and what is the most likely placement of the Glomeromycota in the phylogeny of the Fungi.

(# 226) Occurence of arbuscular mycorrhizal fungi in arable fields in Sweden with emphasis on climate and cultivation management

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An investigation is done of arbuscular mycorrhiza (AM) fungi, belonging to the order Glomales in arable field in Sweden. Sweden belongs to the temperate region but the western and most nothern parts of the country are subarctic. Soil samples were taken from 45 different sites distributed over seven different production regions, due to both climate and soil properties. Samples were taken from long term agricultural trials and from unploughed farmland with high diversity of the flora. The present crop in the trials were mainly cereals. The soil samples were taken down to a depth of 30 cm in the rhizospere. To compare the distribution in the soil profiles, the samples were then divided into two parts. The cultivation history of the collection sites was recorded. AM fungi spores was found in all soil samples, at densities between 3-44 spores per gram air dried soil. In eight out of the 45 samples the spores were identified to the genus or species level. Without using trap plants eight species were identified, and the other 24 morphologically different spores were identified to the level of genus. The soils were also analysed for some physical and chemical properties. There was significantly more AM spores in the upper half than the lower half of the upper 30 cm of soil profiles. No other major causal determinant was identified for spore densities.

(# 227) New models for mycorrhizosphere interactions

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Two models for the interactions among biotrophic, root-colonizing microorganisms will be discussed. The first recognizes that arbuscular mycorrhizal fungi (AMF) have an obligate relationship with roots that is functionally regulated by carbon (C) and other nutrients from cortex cells. The hypothesis is that resource competition among symbiotic fungi, bacteria and a biotrophic root pathogen may reduce the others colonization and reproduction when co-inhabiting the root cortex. AMF and bacteria with the greatest functional compatibility that preemptively colonize the root cortex are predicted to be most competitive with biotrophic pathogens for resources. Neutral and phospholipid fatty-acids provide an estimate of 'resource status' for the interacting fungi, if the signature acids comprise more than 50% of the storage lipid in each fungus. The specificity of signature fatty acids for evaluation of direct interactions of selected microbe and plant species should greatly facilitate studies, particularly under field conditions. The second model is based on evidence that AMF differ in genetic compatibility with host root as defined by recent studies with root colonization mutants of tomato. Incompatibility of AMF with the host root is signaled by 1) up-regulation of plant defense genes, and 2) reduction of fungal ingress and development of biotrophic exchange structures in root cortex cells. Phenotypes for incompatibility of AMF may indicate whether a selected isolate will be effective for induction of resistance to subsequent infection by the pathogen.

(# 228) Arbuscular mycorrhizal communities in six co-occurring plant species in a dune grassland

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Arbuscular mycorrhizal fungi (AMF) are one of the most important plant symbionts. They play a major role in the acquisition of phosphorus, which is the main limiting nutrient in many ecosystems. Surprisingly, little is known about the composition of AMF communities in plant roots from natural vegetation. Knowledge about this composition is important, as different AMF species are known to vary in their ability to promote plant growth and nutrition. In this study we describe the community composition of AMF in the roots of six different plant species that coexist in dune grassland. We aimed to test whether different plant species were colonised by different AMF communities and whether any evidence for host specificity exists. Six plant species were examined, including one grass (Festuca ovina), two herbs (Plantago lanceolata and Hieracium pilosella) and three legumes (Lotus corniculatus, Trifolium repens and Ononis repens). Each species was sampled at three locations within 4 m2 in homogeneous vegetation and AMF in the roots were characterised by PCR-RFLP. AMF communities varied among plant species. In Festuca and Plantago they were most diverse. In both species we found 11 different AMF sequence types. Hieracium had the lowest AMF diversity and only 4 different sequence types were found. Interestingly, the AMF community composition in Hieracium roots was similar at the three locations while those in Festuca and Plantago varied greatly. This suggests that Hieracium selects its fungal associates, while Festuca and Plantago are colonized by the AMF that are present at a certain location. These results also indicate a certain degree of specificity in Hieracium.

(# 229) Towards Growth of Arbuscular Mycorrhizal Fungi Independent of a Plant Host

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When surface-sterilized spores of the arbuscular mycorrhizal fungus (AMF) Glomus intraradices were germinated on agar plates, slime-forming bacteria, identified as Paenibacillus validus, frequently grew up. These bacteria were able to support growth of the fungus on the agar plates. In the presence of P. validus, hyphae branched profusely and formed coiled structures. These were much more densely packed than the so-called arbuscule-like structures which are formed by AMF grown in coculture with Ri T-DNA transformed carrot roots. The presence of P. validus alone also enabled G. intraradices Sy167 as well as G. lamellosum (MUCL 43195) to form new spores, mainly at the densely packed hyphal coils (DPC). This is, to our knowledge, the first report that an AMF can be grown up to spore formation independently of a host root or any plant component. The new spores were not as abundant and on the average smaller than those formed by AMF in the monoxenic carrot root culture system, but they also contained lipid droplets and a large number of nuclei. In these attempts to grow AMF independently of a plant host P. validus could not be replaced by bacteria such as E. coli K-12, Azospirillum brasilense Sp7 or by others of the Bacillus group like Bacillus mycoides, P. amylolyticus and P. polymyxa.

Hildebrandt, U. et al. (2002) Appl. Env. Microbiol. 68, 1919-1924

(# 230) Kura clover (trifolium ambiguum) as a living-mulch understory crop in wheat production

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Living mulch understory crops provide benefits such as soil erosion control, weed suppression, soil N additions and reduced leaching. Kura clover (Trifolium anbiguum) is a persistent, perennial legume that spreads by rhizomes. This study was conducted to assess the feasibility including Kura clover as an understory crop in a no-till or organic wheat system. Clover was established at two Manitoba locations in 2001 (Winnipeg - clay soil; Carman - sandy soil) and managed as a forage. In spring 2002, clover regrowth was suppressed using either tillage (1 or 2 passes with field cultivator) or herbicide (2.5 or 5 L/ha glyphosate). Wheat was seeded into plots immediately after clover suppression. Plots were split into in-crop herbicide treated and untreated subplots. Measurements included initial wheat and clover establishment, wheat and clover above-ground biomass at harvest, wheat grain yield and clover biomass and population in late-fall. Results were as follows: 1) tillage was more effective than glyphosate herbicide in initial suppression of clover though both appear to be feasible strategies; 2) in-crop herbicide was more critical in the glyphosate-terminated vs tillage-terminated clover; 3) wheat yield was suppressed in all systems, but to different degrees; and 4) clover persistence in late fall was considered acceptable in all systems. Measurements of clover persistence will be taken again in spring 2003 and data will be reported.

(# 231) Mycorrhizal protection of Calluna vulgaris grown on copper-contaminated mine spoil

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Mycorrhizal colonization is essential for the establishment of many plants species on mine spoil. The effect of direct exposure to copper-contaminated spoil on the growth of ericoid mycobionts and mycorrhizal Calluna vulgaris was assessed. Ericoid mycobionts from contaminated and uncontaminated sites were grown on 2.0 % water agar plates overlain with cellophane and supplemented with 10 % Rorison's solution, glucose (10 g/l) and mine spoil at varying concentrations (0 – 10 % w/v). The mycobionts were capable of growth even at the highest mine spoil concentration. Differences between isolates were observed but were not related to the isolates' site of origin. Calluna vulgaris plants, obtained as cuttings from a contaminated and an uncontaminated site, were inoculated with two ericoid mycobionts (one from a contaminated and the other from an uncontaminated site). Inoculated and uninoculated plants (n=16) were grown in pots containing a perlite/mine spoil (2:1) mixture for 18 weeks. A significant increase in biomass yield, as a result of mycorrhizal colonization, was observed in those plants that originated from the contaminated site but not from the uncontaminated one. The stimulatory effect of mycorrhizal colonization was dependent on the mycobiont involved. Improved growth was associated with a reduction in copper translocation to the aerial parts of the plant. It is proposed that mycorrhizal protection of C. vulgaris against mine-spoil toxicity is dependent on both host and mycobiont.

(# 232) Function of arbuscular mycorrhiza during grassland regeneration

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Colonization of plant roots by arbuscular mycorrhizal fungi (AMF) is dependent on soil parameters like phosphorus and nitrogen concentrations.

We examined a calcareous grassland in the neighborhood of a former P-fertilizer plant near Jena (Thuringia, Germany) which has emitted alkaline dust into the surroundings from 1960 to 1990. The soil is still contaminated mainly with high amounts of P (up to 121 g/kg soil) whereas the N-content is very low.

In spite of the high P-concentrations plants at this field site are mycorrhizal, possibly due to N-limitation.

To get information about the function of the symbiosis, mycorrhization rates of Artemisia vulgaris in comparison to element-contents in the soil and in the plants were analyzed.

With increasing distance from the factory the N/P-ratio increased, while the mycorrhization rates of Artemisia vulgaris decreased. This might indicate that AMF at our site are mainly responsible for N-nutrition of the plants.

(# 233) Sub-cellular proteomics of the arbuscular mycorrhizal symbiosis: how and why?

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The arbuscular mycorrhiza (AM) symbiosis involves the formation of haustoria, called arbuscules, in which the fungal cell wall is surrounded by the plasma membrane of the root cortical cells. These structures are thought to be the major site of nutrient exchanges between the two symbionts.

Recently, proteomics has emerged as a powerful approach to get insight into protein synthesis and regulation during AM symbiosis (1). Based on the combination of two-dimensional electrophoresis (2-DE), mass spectrometry (MS) and bio-informatic, it has allowed the identification of some Medicago truncatula root proteins expressed during the functional AM symbiosis (2). However, none of them was directly involved in nutrient transport. Since arbuscule formation involves the modification of the plant plasma membrane into the peri-arbuscular one, we aimed at setting up a sub-cellular proteomic approach to differentially analyse these membrane proteins.

Following the purification of microsomal fractions by differential centrifugation, membrane proteins were extracted by organic solvents. Because of their low solubility together with their hydrophobic properties, these proteins are known to be difficult to be resolved by classical 2-DE. Nevertheless, by improving our protocols, we have been able to reveal 2-DE differentially displayed membrane proteins in response to AM colonisation. These proteins are being analysed by MS/MS. Meanwhile, the purification of the plasma membrane is under way. Differential analyses between control and mycorrhizal roots of this particular membrane will be then realised. By this way, we expect to find out essential mycorrhiza-related proteins involved in nutrient transport.

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(# 234) Production, standing biomass and natural abundance of 15N and 13C in ectomycorrhizal mycelia collected at different soil depths in spruce stands and mixed (spruce-oak) stands in southern Sweden

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We estimated the production of EM mycelia in spruce and mixed spruce-oak stands as mycelia grown into sand-filled mesh bags placed at three different depths. More EM mycelia were produced in spruce (590 kg ha-1) than in mixed stands (420 kg ha-1). The EM biomass was also determined in soil samples taken from different depths by using phospholipid fatty acids as markers for fungal biomass. The EM biomass in the soil profile did not differ between the stand types. The total EM biomass in the spruce stands was estimated to be 4.5 x 10^3 kg ha-1 down to 70 cm depth and in the mixed stands 5.2 x10^3 kg ha-1. The amount of N present in EM mycelia was 91 kg N ha-1in spruce stands and 138 kg N ha-1 in mixed stands.

The natural abundances of 13C and 15N were estimated in mycelia collected from mesh bags. The 13C value for EM mycelia in the mesh bags was similar to values obtained from fruit bodies of EM fungi but different from values determined from the fruit bodies of saprotrophic fungi. The 13C value was not influenced by soil depth. The 13C values in mycelia collected from mixed stands suggested that the EM mycelia received more carbon from spruce than from oak. The 15N value for the EM mycelia and the surrounding soil increased with soil depth. EM mycelia were enriched in 15N in comparison with the host trees, but depleted in 15N in comparison with the surrounding soil.

(# 235) Managing Dormancy - The Key to Successful Self-Regenerating Legume Systems

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Adapting self-regenerating legume systems to continuous annual cropping systems will increase the efficiency, sustainability and profitability of farming operations. Self-regenerating legumes capture unused thermal and moisture resources by establishing under the main crop canopy and forming a cover crop after the main crop harvest. The legume improves soil fertility, nutrient cycling, and weed control. No annual seeding expenses are incurred by the producer since the legume is self-regenerating. The success of self-regenerating legume cover crops depends on timely recruitment patterns determined primarily by dormancy loss prior to and during crop development. Field experiments using Black Medic (Medicago lupulina L.; cv 'George') as the self-regenerating legume were conducted in Manitoba in 2002 to determine the impact of crop type (oat and flax), tillage system (conventional and zero tillage), and nitrogen (N) fertilizer rates (low N and high N) on timing and rate of recruitment. Black Medic recruitment was not significantly different between crop types or between N fertilizer rates. Significant differences were observed between tillage systems where average Black Medic recruitment for zero tillage and conventional tillage was 8.0 seedlings/m2 and 4.6 seedlings/m2, respectively. Recruitment patterns indicate that Black Medic is a strong generalist. Seedlings were established throughout the growing season except when light penetration into the canopy was reduced by the main crop. The absence of radiation fluxes in the seed microsite by crop shading reduced dormancy loss and subsequent recruitment of Black Medic. Management practices which stimulate and maintain the recruitment cohort of Black Medic prior to canopy closure will enhance the viability of Black Medic as a self-regenerating cover crop in annual cropping systems.

(# 236) Intraspecific genetic variation in arbuscular mycorrhizal fungi

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Understanding the extent of intraspecific genetic variation in arbuscular mycorrhizal fungi, how it is organized, and how much this variation can alter the phenotype of the fungus and functioning of the symbiosis is fundamental to AMF research. Our group has coupled a population genetic approach with classic molecular biology techniques to understand AMF genome organization and its functional significance. This combined approach has indicated unusually high levels of genetic variation in AMF and the existence of genetically different co-occurring nuclei. Unexpectedly high genetic variation also exists among 16 single spore isolates of Glomus intraradices that represent a population from one field. This variation is also responsible for altering the fungal phenotype, meaning that genetic variation is notrestricted to non-coding regions of the genome or to rDNA. Indeed, our studies show high within-isolate diversity in a number of genes that code for essential proteins, with a large number of predicted changes in amino acid sequences. Our estimates of genome size and relative copy number of these genes suggest it highly unlikely that all of these variants co-exist in each nucleus. I will discuss why this high within-isolate genetic variation should not be ignored in studies of AMF functional/symbiosis genes, AMF ecology and also how such studies can be used to develop inoculum with higher functional diversity.

(# 237) Regulation of Transfer Processes in the Symbiosis - Comparative Studies on Ectomycorrhizal and Arbuscular Mycorrhizal Associations

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The basis of the compatible interaction between plant and fungus in a mycorrhizal symbiosis is a bidirectional transfer of nutrients across the symbiotic interface. However, the rates of movement of P and carbohydrates across plasma membranes are calculated to be insufficient to account for the nutrient transfer rates across the interfacial apoplast. Therefore, conditions in the interface, which cause an enhanced efflux or a decrease in the level of competing uptake systems, have been proposed. Presently, we have very little information about the regulation of these transfer processes and the mechanisms involved in polarizing the transfer. To address this question, the effect of the carbohydrate transfer from the host plant to the mycobiont on P uptake, transport and transfer across the interface in an ectomycorrhizal and an arbuscular mycorrhizal association were examined. The results showed clearly that the carbohydrate flow from the host plant affects; (1) the P absorption by the mycobiont; (2) the P allocation between different P pools; (3) the P efflux across the plasma membrane; and (4) the P transfer across the mycorrhizal interface. We will present a model that describes a putative linkage between carbohydrate and P transfer and a possible regulation of the exchange processes between both symbiotic partners in a mycorrhiza.

(# 238) Delineation of N-management Units Using Aerial Images of Bare Soil

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Variable rate nitrogen application, VRNA, involves the recognition of inherent field variability and the subsequent adjustment of N inputs to be more appropriate to local requirements within the field. To facilitate VRNA, a means to determine how and where N rates should be adjusted is required. Aerial images have the potential to indicate areas that may be managed individually with respect to N. Bare soil images show visual similarities between soil colour and patterns in yield. The variation in soil colour is likely related to organic matter, provided the soil was dry when imaged. With the association between bare soil image patterns, yield, and organic matter, areas observed in the images may indicate both yield and mineralization potential, thus N requirement and availability, which may make the images useful for delineating N-management units. Visual and near-infrared aerial image data corresponding to bare soil conditions were obtained between 2000-2002 for field sites in Southern Ontario. Bare soil image data were compared to the corresponding yield data by linear regression analysis. Comparisons were made using unclassified data, as well as data organized based on average yield and unsupervised image classification. Yield response to N was evaluated within the zones identified by image classification. Despite visual similarities, preliminary unbiased analysis of bare soil image data with yield has not indicated a relationship, nor has the ability to determine N requirement been improved. This suggests that bare soil image data may not be useful for identifying areas within the field for nitrogen management.

(# 239) The Effect of Root Exudates on Spore Germination, Substrate Uptake, Metabolism and Gene Expression in the Arbuscular Mycorrhizal Fungus Glomus intraradices

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Arbuscular mycorrhizal (AM) fungi are obligate biotrophic root symbionts that show only limited hyphaldevelopment in the absence of a host plant. The developmental stages involved in establishing the symbiosis include spore germination, hyphal branching, appressorium development and formation of arbuscules and of an extraradical mycelium. This developmental program requires signaling and recognition between partners, and the roots of host plants constitutively secrete compounds that stimulate ramifications in hyphae from germinating spores. We are using stereomicroscopy, isotopic labeling and real-time quantitative PCR to address the effects of exudates of Ri T-DNA transformed carrot roots on germination, on the uptake and metabolism of exogenous substrates and on the expression of genes putatively encoding key enzymes of central metabolism in Glomus intraradices. Rootexudates supplied to AM fungal spores in various concentrations significantly affect germination, hyphal branching, and uptake and metabolism of carbon substrates in these spores. The implications forsignaling, development and the potential for axenic culture will be discussed.

(# 240) Biodiversity of arbuscular mycorrhizal fungi in mountain meadows

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A study on the influence of herbivory and drought on plant-biodiversity of mountain meadows is performed in the frame of the German program on biodiversity "BIOLOG". We investigated the diversity of arbuscular mycorrhizal fungi (AMF) at two different plots of this project which were situated in the Thüringer Schiefergebirge (Germany). One plot was part of an intensively farmed meadow with a low plant biodiversity producing high amounts of biomass, while the other one was part of an extensively farmed site with a high plant biodiversity producing low amounts of biomass.

Field collected plant roots and spores were investigated with molecular methods. Sequence analysis of the 5.8S region in the rDNA allowed the identification of AMF species, while analysis of the whole ITS allowed to consider the intraspecific diversity. All families within the Glomeromycota were detected during the work. The number of phylotypes (which were interpreted as species) detected on both meadows were identical. The most common sequence types, representing species with high affinities to Glomus intraradices, Glomus clarum and Glomus claroideum, were found as well on the intensively as on the extensively farmed meadow. Other species with low frequencies were so far mostly found on only one of the meadows. Even species thought to be rare in Central Europe, like Gigaspora rosea, were detected. ITS sequences corresponding to one species, tend to cluster in separate clades depending on the field site.

(# 243) Morphological features of the hyphae of Glomus intraradices: from observations to mathematical models

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As a result of their biotrophic and symbiotic nature, AM fungi have evolved a diverse and complex range of hyphal morphologies. While the hyphae associated with the pre-colonization and subsequent extraradical phases have been described in numerous studies, the information provided is not always easy to interpret. Furthermore, it is particularly difficult to distinguish between hyphae developing under'normal' conditions and those developing under 'stress' conditions. The picture is further complicated by the fact that fungal morphology alters with changes in the fungal life cycle: germ-tubes giving rise to pre-infection hyphae which, following colonization, give rise to extraradical hyphae. Each phase is highly specialised and has specific characteristics. Following on from work on germ-tube morphology associated with different pre-germination treatments, we focused on pre-infection and extraradical development under different in vitro conditions. These studies aimed to clarify and explain the diverse morphological features, which are presently grouped under terms such as 'fan-like structures' and 'arbuscule-like structures'. Moreover, based on our measurements, we investigated the possibility of applying fractal mathematical models to developing hyphal systems in order to improve our understanding of AM fungi and to predict potential growth patterns.

(# 244) Effects of Weed Competition on N Fixation by Field Pea and Soil N Availability to the Sequent Crop

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The effects of weed competition on N uptake and fixation by legume crops have not been adequately studied. Therefore, we evaluated weed competition effects on the N economy of field pea (Pisum sativum L.) and the sequent crop. Plots were seeded to pea, canola (Brassica napus L.)and barley(Hordeum vulgare L.)in 1997 and 1998, and weeds, augmented by cross-seeding experimental plots with oats(Avena sativa L.), were removed with herbicides 1 and 4 weeks after crop emergence (1 and 4 WAE). Nitrogen fixation by pea was estimated by 15N isotopic dilution using barley or canola as the reference crop. The sequent crop, barley, received 0 or 60 kg N ha-1. The amount of N fixed by pea was not affected by the time of weed removal, however, total N uptake (and seed yield) was greater with early weed removal due to less competition for soil N. Mean percentage of N derived from the atmosphere (%Ndfa) for the two years was 51% for the 1-WAE treatment and 81% for the 4-WAE treatment, indicating that the pea plant subjected to greater weed competition derived more of its N requirement from symbiotic fixation. Early weed removal resulted in net N export in pea seeds while later weed removal resulted in gains of 1.1-1.3 g N m-2. However, time of weed removal during pea cultivation had no effect on the yield or N uptake of the sequent barley crop. Except when limited by drought, barley yields and N uptake were greater where the preceding crop was pea. Nitrogen fertilization benefitted the sequent barley regardless of preceding crop type.

(# 246) The Glenlea long-term rotation: Performance of organic systems after 12 years.

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The Glenlea long-term rotation study compares organic and conventional production in 3 different cropping systems (annual grain system; green manure-containing system; perennial forage-containing system). The study was started in 1992 on a clay soil 20 km south of Winnipeg, MB. Annual measurements include soil nutrient status, weeds, biomass, and crop yield. Energy and economic budgets are calculated. Sustainability of cropping systems are compared with a native grass planting. The trial is replicated 3 times. The performance of organic production in the 3 cropping systems will be reviewed. Where only annual grain crops are included in the rotation, organic crop performance is poor (20 to 50% of conventional yields) and is not considered economically sustainable. Weeds and lack of N are the major problems. Where a red clover green manure crop is included 1 year in 4, organic crop performance is 50 to 115% of conventional, and this system is considered to be economically sustainable. This rotation suffers from perennial weeds which are getting worse over time. Where alfalfa hay is grown 2 years in 4, organic systems are close to conventional in terms of yield (80 to 110% conventional) and better than conventional systems in terms of economic performance. A problem in the organic forage hay system is depletion of soil nutrients (P and S). This problem is being addressed by recycling manure back to organic plots. The perennial-containing cropping system mimics that native grass plot most closely in terms resourse use.

(# 247) Forages place C deep in the soil profile: Analysis of a long-term study in Uruguay

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Interest is increasing in management practices that can accumulate soil organic carbon levels as a step to mitigate climate change. Physical fractionation was used to study the carbon allocation of forages in Uruguay. An experiment of short duration yielded little difference in soil organic carbon between forage treatments and an annual crop rotation. The 7 yr forage stands did have greater coarse particulate organic carbon at a depth of 0-7.5 cm, which represents the youngest carbon fractions and was more responsive to management practices. A 38 yr rotation study showed higher organic carbon in all size fractions for a rotation of pasture with annual grain crops, than an annual crop rotation, at depths of 20-40 and 40-60 cm. These differences in carbon may have been due to greater carbon additions at depth from the forage crops, and indicate that the subsoil contributed to carbon sequestration in these soils.

(# 249) Locating the site of DNA synthesis and measuring flux through the pentose phosphate pathway in an arbuscular mycorrhizal fungus

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The pentose phosphate pathway (PPP) is both an important source of reducing equivalents for lipid synthesis and the major pathway by which pentose is synthesized de novo for the production of nucleotides. This has allowed us to develop a novel means to simultaneously locate the synthesis of DNA and determine the flux through the PPP. The method is based on analysis by NMR spectroscopy, GC-MS, and flux modeling of 13C labeling patterns in the deoxyribosyl moieties of extracted DNA after exposure to labeled precursors. This method was demonstrated using E.coli, then applied to the mycorrhizal fungus Glomus intraradices in an in vitro split-plate culturing system. The potential usefulness of this method as well as the information on the site of DNA synthesis and PPP fluxes is discussed in the context of the metabolism and life cycle of arbuscular mycorrhizal fungi.

(# 251) Measurement of Soil Water Transmission Parameters using Single, Double and Multiple Ring Infiltrometers

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Soil water transmission parameters, such as field-saturated hydraulic conductivity, Kfs, and macroscopic capillary length, á*, are essential for accurate prediction of water infiltration and movement within the soil profile. As a consequence, field measurement of Kfs and á* are critically important to both soil scientists and hydrologists for a vast range of activities associated with agricultural production, watershed dynamics, and the development, management and protection of soil and water resources.

Ring infiltrometers are among the oldest, simplest and most frequently used methods for field-measurement of soil water transmission parameters. However, infiltrometer technologies are also among the least understood and most frequently misused of field methods. In this talk, traditional approaches and some recent advances in the theory, analyses and applications are presented for single, double and multiple ring infiltrometers.

(# 252) Carbon sequestration patterns in the replanted areas of the Sudbury barrens

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Due to industrial pollution by the mining industry and deforestation, much of the forest cover in the Sudbury region had been disturbed or destroyed by the 1960's. Starting in 1978 after a major reduction in SO2 emissions a replanting initiative commenced on the Sudbury 'barrens'. In recent years how these forested sites are recovering has become increasingly important as concerns over carbon cycling increases due to the problems of global warming. This project is examining how the carbon pools are recovering, due to re-vegetation, across different areas of the Sudbury region. Sampling took place over the summer and fall of 2002 with mineral soil cores taken to a depth of 20cm at 14 sites. Sampling was done in five age classes, planted in 1979, 1983, 1987, and 1993 respectively and at 3 non-restored sites. Sampling was also done for the forest floor layer and the vegetative components which were divided into tree, shrub and herbaceous layers. Ecosystem carbon showed significant gains in the replanted areas. The oldest site (planted 1979) had a total carbon pool of 106.5 + 6.16 Mg C ha-1, compared to an adjacent non-restored site with 35.54 + 6.47 Mg C ha-1 in the carbon pool. The majority of change came via the tree level vegetation which was significantly correlated with age (r =0.921) and contributed up to 59% of the total carbon pool at the oldest site. The litter layer was also a significant contributor to the increase in the total community carbon pool contributing up to 12.37 Mg C ha-1 and up to 16% of the total. Mineral soil carbon was highly variable across the region with different areas showing distinct patterns in their carbon levels. However, no regional pattern was observed with age of the replanting site.

(# 253) Effects of the alteration of tomato root exudation by Glomus intraradices colonization on Phytophthora parasitica var. nicotianae zoospores.

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A mycorrhiza-induced modification in root exudation has been reported. Furthermore, zoospores liberated through the asexual reproduction of Phytophthora parasitica var. nicotianae have been shown to be attracted by plant-root-exudates which also promote their encystment and germination. In order to better elucidate the mechanisms involved in the bioprotection induced by arbuscular mycorrhiza in symbiosis with tomato then infected by P. parasitica, transformed tomato roots were grown with or without Glomus intraradices, in Magentas boxes split into two compartments, in vitro. After 16 to 24 weeks of culture, the liquid medium containing the root-exudates was collected and biotests carried out. Preliminary results suggest that non-mycorrhizal-root-exudates attract more the pathogen zoospores than exudates from mycorrhizal roots possessing a higher level of arbuscular colonization. The opposite was observed when a higher number of G. intraradices chlamydospores was accounted in the culture medium and the root colonization was lower. These results indicate that P. parasitica development might be impacted in the mycorrhizosphere before it penetrates the mycorrhizal tomato roots through the modification of root exudation whereas its development would be stimulated in the mycosphere (a zone away from the roots) by the mycorrhizal exudates. As a consequence, the pathogen development would be reduced to a few roots which would then be able to trigger resistance mechanisms. P. parasitica proliferation would, in this manner, be limited. The effect of exudates on zoospore encystment, germination and appressoria formation capability is presently ongoing.

(# 255) In Vitro Study on the Active Role of an AM Fungus in Nitrogen Uptake and Transfer to Roots

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The nitrogen (N) metabolism was examined in monoxenic cultures of carrot roots (Daucus carota L.) colonized with the arbuscular mycorrhizal (AM) fungus Glomus intraradices Schenck and Smith. The activities of key N-enzymes were determined, the uptake of labelled-N from the extraradical mycelium to AM roots was assessed, and N-assimilating enzymes were characterized by immunodetection. Glutaminesynthetase and Nitrate reductase activities were significantly increased in mycorrhizal roots for which only the extraradical mycelium had an exclusive access to NH4NO3 in a distinct hyphal compartment inaccessible to the roots, compared to the water controls, and similar to those of non-AM roots which had a direct access to NH4NO3. In addition, Glutamate dehydrogenase activity was significantly enhanced in AM roots compared to non-AM roots. Carrot roots took up 15NH4+ more efficiently than 15NO3- and the extraradical hyphae transferred 15NH4+ to host roots from the hyphal compartment, but not 15NO3- at a detectable level. The extraradical mycelium was shown, for the first time, to have a different GS monomer than roots. Our overall results highlight the active role of AM fungi in N uptake, transfer and assimilation in their symbiotic root association.

(# 256) Arbuscular mycorrhizal fungi influence drought tolerance of grapevines under field conditions

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The seasonal dynamics of root growth and colonization by arbuscular mycorrhizal fungi (AMF) were studied over two years in a deficit-irrigated Cabernet Sauvignon vineyard on a sandy soil and in a dryland Pinot Noir vineyard on a silty clay loam. Cabernet vines received one of the following irrigation regimes 3 years prior to and during our study; Control vines received 60% Et from fruit set to harvest, Early deficit vines received 30% Et from fruit set to veraison and 60% Et afterwards, and Late deficit vines received 60% Et to veraison and 30% Et from veraison to harvest. Growth of roots expressed on a mass or length basis was greatest between bloom and veraison in the irrigated vineyard. Fine root growth was depressed, however, in both water deficit treatments relative to control vines. Colonization of fine roots by AMF was consistently high (87-97% root length colonized) in all treatments throughout the study. However, the frequency of fine roots with arbuscules was significantly greater in both water deficit treatments throughout most of the year. Whole vines were removed from the dryland vineyard over two years to construct a mineral uptake and allocation budget in addition to monitoring AMF. Results from this study showed that arbuscule frequency in fine roots peaked after the period of maximalN and P uptake, when soil moisture was at a minimum. These studies indicate that AMF enhance the drought tolerance of grapevines in vineyard production systems.

(# 257) New aspects of mycorrhization on micropropagation of potato plant (Solanum tuberosum L. Var Alfa)

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The objective of the current investigation was to evaluate the responses of micropropagated potato plantlets (Solanum tuberosum L. var Alfa) to in vitro and ex vitro inoculations with Glomus clarum using pre-germinated spores as in vitro inoculant. The spores were germinated in liquid media and incubated in CO2 (5%) atmosphere during three days. The in vitro plantlets were inoculated over different culture media: M, N (media designed for this study) and MS as control. After 25 days of culture, all plants were collected in order to measure plant height, fresh weight, chlorophyll content and fungal colonization. Ex vitro inoculations of the micropropagated plantlets were performed during transplanting to green house conditions using three AMF strains of Glomus and two concentrations of strains over two different substrates in a completely randomized design. After 35 days of culture, 5 plants per treatment were collected to measure : Total Dry Weight, Fungal and Physiological variables and Mineral content. The use of a CO2 atmosphere during incubation of disinfected spores provoked complete germination (100%) in only three days. Mycorrhized in vitro plantlet development was greatest on the M media, similar to the control MS with a more extensive root system and better shoot growth than plants on N media. Furthermore, the inoculated plants, during transplanting, showed higher values of all variables compared to non AM ones, and it was dependent of the used strain as well as the growing substrate. This enhanced the capacity of transplant shock tolerance and plants growth during acclimatization phase.

(# 258) Patterns in mycorrhizal fungal biomass in Venezuelan and Cuban ecosystems

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Arbuscular mycorrhizae (AM) were studied along a gradient determined by changes in altitude, temperature and soil water content, at six Venezuelan (Desertic Páramo, Andean Páramo, Cloudy Forest, Replacement Grassland of Cloudy Forest, Open – treeless – Savanna and Close – with trees – Savanna) and two Cuban (Medium Evergreen Forest and Replacement Grassland of Small Evergreen Forest) ecosystems. Six transects per ecosystem were sampled, each being composed by 5 soil sub-samples. Soil chemical and physical analysis were carried out. Rootlets, root hairs, AM % root colonization, endophytic mycomass and mass of external mycelium were measured to characterize AM fungal community allocation. Soil water content was strongly correlated with increased rootlet phytomass and AM endophyte mycomass while significantly negatively correlated with mass of external mycellium. Increasing soil water content values significantly correlated with increasing amounts of raw humus particles 0.04 – 2.00 mm size remaining at soil sievings, which is concomitant with increasing turnover rates. AM endophyte mycomass positively correlated with increasing water content values, while the ratio of external mycelium to rootlets was negatively correlated with increasing water content values. The results are discussed in the context of mycorrhizal and ecosystem functioning.

(# 259) Ectomycorrhizal fungi structure following increased levels of site disturbance in a pine-oak forest.

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This study was conducted to evaluate the effects of increasing levels of site disturbance on different forestry practices on ectomycorrhizal (EM) communities in pine (P. oaxacana) stands in Southern Mexico. Bellow-ground EM communities were analysed in terms of species richness by examining the ectomycorrhizas (morphotypes) in a untreated stand (Control), a clear-cut stand (Seed Tree treatment), and a clear-cut stand plus controlled burning (Seed Tree plus Burning treatment). The internal transcribed spacer (ITS) region of fungal DNA from single EM root tips was digested with restriction enzymes and compared with different ITS-RFLP reference databases of EM sporocarps. The diversity of EM fungi present in the roots showed not to be high considering that the forest is a young secondary forest and that there were only three EM host genera (pine, oak and alder). In total 30 EM taxa were identified on the basis of their RFLP patterns and morphotypes. Abundance and richness of fungi was not affected by clear-cutting nor by fire, but species composition was different. Several RFLP-taxa were found only in the control stand and others only in the treated stands. The Seed Tree stand showed to have the highest diversity of the root colonizing fungi, 24 RFLP-taxa versus 18 of the control stand.

(# 261) Extractable Soil Water and Transpiration Rate of Mycorrhizal Corn

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Substantial research has been done to describe plant response to mycorrhizal association anddrought conditions. There is, however, lack of information on the roles of mycorrhizal association in plants under various transpiration rates and soil water availabilities. This study assumed that soil physical properties alone are not sufficient to define the amount of extractable water from soil without knowledge of mycorrhizal fungi biophysical activities. Objectives of this research were to evaluate shoot and root biomass productivity of mycorrhizal corn (Zea mays L.), and to examine mycorrhizal roles in extracting soil water under drought conditions. Plants were grown in pots with or without mycorrhizalfungi. Plant extracting soil water was tested based on physiological definition of the upper and lower end-point. In both mycorrhizal and non-mycorrhizal treatments, a decrease in plant productivity was not observed until the soil water decreased to the level where approximately one third of the water that couldbe extracted by plants remained in the soil. No differences were observed in the volume of extractable soil water at the upper end-point between dehydrated mycorrhizal and non-mycorrhizal treatments (0.139 and 0.155 m3m-3), respectively. In contrast, dehydrated mycorrhizal plants extracted more soil water (0.400 m3m-3) than did the non-mycorrhizal plants (0.329 m3m-3) at the lower end-point. Greater dried biomasses were observed for both dehydrated and watered mycorrhizal plants than for the non-mycorrhizal treatments in respective treatments. These results form the basis for additional studies to examine the role of mycorrhizal fungi on shoot and root enzymatic activities under drought conditions.

(# 262) Gene flow between populations of the mycorrhizal mushroom Cantharellus formosus Corner in the Central Cascades of Oregon.

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Conservation genetic approaches for conserving allelic diversity and natural process are well-developedfor animals and plants, but are in their infancy in the conservation of rare and commercially important mushrooms. Demographic and population genetic surveys of mushrooms are complicated by a high frequency of cryptic species in many groups; in addition, total below-ground abundance and diversity may show a poor correspondence to ephemeral fruiting bodies, which can be the focus of intense commercial harvest. In order to establish a conservation strategy for the commercially-important chanterelle of the Pacific Northwest (Cantherellus formosus), we are determining population genetic structure for eight populations of this species located on the 15,000 acre H.J. Andrews Long-Term Ecological Research site. Sporocarp samples from two time points (240 individuals from 1997; 215 from 2000) have been evaluated for multi-locus genetic variation at six micro-satellite loci. Data from the 1997 sample reveal minimal interpopulation genetic differentiation, with an Fst of 0.02 across sites, and a high interpopulation migration rate (Nm = 1.3 per generation). These results contrast those obtained for Russula brevipes in eastern Wyoming (S. Bergemann, per. comm.), although the latter study may show artificially inflated genetic differentiation due to the inclusion of cryptic species in this taxonomically-challenging complex. Results obtained from the H.J. Andrews LTER from 1997 show that loss of individual subpopulations of C. formosus are unlikely to result in a substantial reduction in overall genetic diversity.

(# 264) Arbuscular Mycorrhizal Fungal Interactions with Saltcedar (Tamarix ramossissima)

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Tamarix ramossissima is an invasive tree species that has colonized hundreds of miles of riparian areas throughout the western United States. This non-native tree is reported to be non-mycorrhizal. A glasshouse experiment was conducted to determine the ability of arbuscular mycorrhizal (AM) fungi to colonize saltcedar and the effect of AM colonization on seedling growth. Saltcedar seedlings were grown in autoclaved soil and soil inoculated with AM fungal cultures collected from a riparian area along the Upper Verde River, Arizona. The seedlings were maintained under wet conditions to simulate close contact with groundwater. Mycorrhizal colonization was very low in the inoculated seedlings (7.8%) and only hyphae and vacuoles were observed. Dark septate endophytes were detected in all samples, with higher intensities of colonization in inoculated plants. No differences were found between inoculated and non-inoculated seedlings in above-ground biomass and total plant length (sum of all stems) per pot. Seedlings in non-inoculated pots had a higher average number of stems ($p=0.08$). These results indicate that saltcedar can be colonized by AM fungi, but the low levels of colonization, lack of arbuscules, and similarity in growth between the two treatments suggest that saltcedar is not affected, either positively or negatively, by mycorrhizal colonization in the wet conditions used in this experiment.

(# 265) Peleton morphology of orchid mycorrhizas in the Australian terrestrial orchid Arachnorchis formosa (G.W. Carr) D. L. Jones et M.A. Clem.

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The mycorrhizal fungi of Arachnorchis formosa were examined by SEM at six developmental plant stages across two seasons (2000-2001). Peletons were observed in the collars of all plants but were also seen, for the first time in this species, in the old tubers. This suggests that the old tubers may act as a reservoir for mycorrhizal fungi during the dormant stage of the plant's life cycle. Hyphal morphology of the peletons differed across seasons. Collars collected early in the plants emergence and at bud formation and flowering had peletons consisting of thin (1-2 mm) hyphae in loose coils, with low percentage digestion (25%). As plants produced capsules and at senescence the peletons were composed of a coarse hyphae (4-6 mm) with 94% of all peletons digested. This difference may represent different fungi or different developmental stages in one fungus. Fungi were isolated at each life stage, the sub-cultured, and in each year fungi six were selected to be tested for their ability to germinate A. formosa seed. In both years only fungi isolated from early life stages (leaf emergence, bud formation and flowering) were able to germinate seed. Protocorms produced by symbiotic germination were planted out into pots and survived to form tubers. Plants from these tubers re-emerged in the following season suggesting that this symbiotic method could be used in re-introduction programs of this rare Australian orchid.

(# 266) Ectomycorrhizas of Peat Swamp Forest Trees in Central Kalimantan

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Silvicultural techniques, specifically the use of mycorrhizal fungi, are necessary for the effective restoration of degraded (over forested) peat swamp forest. Mycorrhizal symbiotic relationships play many important roles in the growth cycle and survival of trees. The objective of this research is to observe the extent to which ectomycorrhizae exist for a variety of tree species found in a typical peat swamp forest in central Kalimantan. The roots of sixteen tree species from the peat swamp area surrounding Palangkaraya city were collected and examined microscopically for the characteristics of their roots. Abundant ectomycorrhizal colonizations were observed in Shorea balangeran and S. teysmanniana (Dipterocarpaceae) while partial colonization was observed in several species of Myrtaceae. Eighteen other species of ectomycorrhizal fungi were collected from the forest floor, the mostcommon being Scleroderma spp.

(# 267) Effects of soil tillage, plant diversity and plant identity on the community composition of AMF spores

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Community composition of AMF spores were studied in a range of agricultural plots and native grasslands of the central USA. Specifically, the relative effects of tillage, plant diversity, and plant composition were compared. Tillage treatments included highly disturbed, annually ploughed soils, unploughed soils of varying ages, and never-ploughed prairie. Tillage was found to significantly reduce species richness of the spore community by an average of 27%. Community diversity recovered, however, with only a few years without tillage. Species in the Gigasporaceae were most reduced by tillage; spores of some Glomus species were more abundant after tillage. In separate studies, plant diversity was varied from one-four host species. Plant diversity had no impact on the diversity or composition of AMF spores. The impacts of host identity on AMF communities were compared for 23 plant species in the four dominant functional groups of prairie regions: warm-season grasses, cool-season grasses, legumes, and composites. Warm-season grasses generally produced the most spores of Glomus species. Other AMF genera sporulated best with host species that exhibited no pattern in regards to plant functional groups. With a better understanding of the functions provided by certain AMF species or genera in this region, certain plant hosts may be used to promote optimal soil communities for agriculture and restoration.

(# 268) The identification and expression of putative homologues of nitrogen metabolic genes in Glomus intraradices

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The mechanisms and regulation of nitrogen assimilation and transport in AM fungi are not well understood. To test hypotheses about the uptake, transformation and transfer of N we are taking a dual approach using stable isotope labelling, gene identification and expression measurements. We identified several potential genes of primary nitrogen metabolism in Glomus intraradices by mining the expressed sequence tag (EST) databases and by PCR amplification using multiple alignments of fungal protein sequences to create degenerate primers. Using a sterile in vitro split plate culture system, mycorrhizal roots and extraradical mycelium (ERM) were exposed to different forms and levels of N, and the resultant pattern of fungal gene expression was analyzed by quantitative real-time PCR. Expression of these genes in both intraradical and extraradical tissues was found to be rather responsive to the forms and levels of external nitrogen. We will also report on the results of stable isotope labelling experiments designed to determine the form(s) of nitrogen translocated within the AM fungal mycelium and transferred to the host plant.

(# 269) The Effects of Glucose on Carbon Metabolism in Glomus Intraradices during Arbuscular Mycorrhizal Symbiosis

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Isotopic labeling and gene expression studies have revealed that hexose is the main carbon form obtained by the fungus from host plants, and that carbohydrate as well as lipid made from this is translocated to the ERM. To understand the extent by which these pathways are regulated at the transcriptional level in AM fungi, glucose was added to the mycorrhizal roots in split plate cultures that had no C-source on the ERM side. The timing and extent of C export to the ERM was measured by stable- and radio-isotopic labeling and quantitative real-time PCR was used to monitor the changes in gene expression in pathways involving glucose, trehalose, glycogen, and lipid metabolism after glucose addition. Gene expression levels were measured at 24, 48, 96, 144 hours after glucose addition relative to two reference genes: ribosomal protein and siderophore regulatory protein. Following glucose addition tothe mycorrhizal roots large amounts of C were exported to the ERM but this caused only modest expression changes of putative fungal homologues of malate synthase, glycogen synthase, acylCoA dehydrogenase, glucose-6-P dehydrogenase, and trehalase genes in IRM and ERM tissues.

(# 270) Characterization of the Glomus intraradices genome by random genomic sequencing

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Little is known about the genome structure or content of arbuscular mycorrhizal fungi. Their genome sequences are of great interest for studying the evolution and function of this important group of organisms. Genomic phage libraries of Glomus intraradices were constructed using genomic DNA digested with restriction endonucleases (BglII and bamHI). Analysis of the sequences of randomly chosen clones showed close to 30% GC content. The median insert size of the BglII library was determined at 3kb; the expected median insert size of bamHI library is 6kb. While neither library is likely to be complete alone, together they will maximize representation of the genome. Of the first 400 randomlysequenced clones, close to 25% had significant homology to known or putative open reading frames in the non redundant database (Genbank). The initial sequencing results indicate the occurrence of small introns within genes. The estimated gene density, together with the higher-than-expected occurrence of positives when screening for previously identified homologues of metabolic genes, suggests that the genome size of G. intraradices may be less than 20 million base pairs. Such a size estimate is about 10 times lower than the lowest published estimate of genome size for other Glomus species.

(# 271) A Role for AM Fungi in Phytoremediation of Depleted Uranium and Arsenic

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A number of studies have demonstrated that plants are able to accumulate depleted Uranium (dU) from the soil. AM fungi colonize the roots of over 80% of land plants and are reported to be involved in the transport of, and protection of plants from, heavy metals. The molecular mechanisms regulating the interaction between heavy metals and AM fungi are largely unknown. We identified several potential metal responsive genes in Glomus intraradices by mining the expressed sequence tag (EST) databases and by PCR amplification using multiple alignments of fungal protein sequences to create degenerate primers. Real-time quantitative PCR was used to measure gene expression, in response to treatment of the extraradical mycelium with elevated Cu, Zn, Cd, and Mn, for close homologs to an arsenite resistancetransporter, a heavy metal ion resistance protein, a copper resistance protein, a manganese oxidase, and glutathione-S-transferase. The treatments caused elevated levels of mRNA's for these genes with the greatest enhancement in the intraradical mycelium. We will also report progress towards direct localization of metal accumulation within the symbiotic system using electron microscopy. The significance of these finding for phytoprotection and phytoremediation will be discussed.

(# 272) Early root and ectomycorrhiza formation in sown-origin Scots pine seedlings after soil preparation

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A new field study was established in the summer 2002 to investigate the impacts of seedling density andspecies composition (monoculture vs. mixed stand) on the nutrient cycling and leaching in regenerated boreal forest areas. The aim of the study is to provide the forestry practice with the knowledge of new environmentally friendly silvicultural recommendations in regard to protection of watercourses.The root growth potential is affected by many physical, chemical and biological properties of the soil as well as species-specific features. Seasonal changes in root development and ectomycorhiza formation in Scots pine is still not well understood. In northern forests, low temperature inhibits plant growth and the thermal growth period is relatively short. Most of the photosynthates are allocated to aboveground growth during early summer months when air temperature is high compared to soil temperature. When shoot growth stops, root growth proliferates as well as accumulation of storage compounds and mycorrhizal activity. These phenological changes during the growing season will be studied from early stages after seedling establishment through out several years. Preliminary results will be presented how different soil preparation methods affect on root and ectomycorrhiza formation in sown-origin Scots pine seedlings.

(# 273) Growth of Scots pine seedlings in humus and mineral layers from urban vs. natural forest soils

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The effects of humus removal on the early development of sown-origin Scots pine seedlings were studied in a greenhouse experiment. The soil cores (intact humus or intact upper part of mineral layer or both) were taken from three urban and three natural forest stands. Urban forests were more nutrient rich whereas natural forest soils were nutrient, especially N, limited. The growth and mycorrhizal status of the seedlings were investigated four months after sowing. Significant differences in growth parameters were observed between different origins of soil and different soil layers. The seedlings in urban soils with humus layer had higher root, stem and needle biomass. Also the needles were longer, the number of buds and fungal biomass (ergosterol) content were higher in seedlings grown in urban soils. On the contrary, there were no differences in growth parameters when seedlings were grown in mineral soil from either urban or natural forests.The results are discussed in the context of earlier experiments from the same forests.

(# 274) Studies on root colonization and biofilm formation by rhizobia

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In the Rhizobium-legume symbiosis, Gram-negative rhizobia provide fixed-nitrogen to a host-legume. In return, the legume provides carbohydrates and houses the rhizobia in root nodules. Symbionts recognize each other by exchanging species-specific molecular signals. Lectins are carbohydrate-binding proteins, which immunolocalize to root hair tips. They are thought to mediate attachment to compatible rhizobia by binding to the characteristic surface polysaccharide(s) of the bacteria. In a previous study of transgenic alfalfa plants carrying either the soybean or pea lectin gene, we found that strains that normally do not nodulate alfalfa would do so, but only if the nod genes of the compatible Sinorhizobium meliloti were transferred to the heterologous strain. Furthermore, we observed greater attachment of the transconjugent Bradyrhizobium japonicum or Rhizobium leguminosarum bv. viciae to the appropriate transgenic root[1]. We analyzed these strains for the ability to form biofilms. Biofilms are structured communities of microbes enclosed in a self-produced polymeric matrix and adherent to an inert or living surface. Biofilms constitute the majority of bacterial biomass in natural environments, and may improve survival under adverse environmental conditions. We hypothesize that rhizobia express genes for biofilm formation under conditions where their hosts do not develop nitrogen-fixing nodules or when faced with other environmental stresses. To test this hypothesis, we developed assay conditions for biofilm formation of R. leguminosarum bv. viciae and S. meliloti. Furthermore, we will discuss mutants that are impaired in biofilm formation on both plant roots and on inert surfaces. [1]van Rhijn et al., 2001. Plant Physiol. 125: 133-144.

(# 275) Nitrogen and Carbon metabolism and transfer in the AM symbiosis

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Mycorrhizal fungi exchange vast quantities of nutrients with their host plants worldwide. This exchange has profound influence on the physiology and ecology of plant systems yet we have only a very partial understanding of the mechanisms and regulatory processes involved. This presentation will focus on carbon and nitrogen and in it we will compare what is known about fluxes in different mycorrhizal types and will review our progress on analyzing the mechanisms and regulation of uptake, metabolism translocation and transfer of C and N in the arbuscular mycorrhizal symbiosis. Models remaining questions and implications of recent findings will be discussed.

(# 276) Utilization of Heterocyclic Organic Nitrogen by Mycorrhizal Fungi

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The capacity of various groups of root-inhabiting fungi to use organic forms of nitrogen is well-established. However, these studies have almost exclusively been limited to amino acid-N, either asfree amino acids or in polymeric forms as peptides or proteins. In nature, non-amino acid-N can be a substantial component of the organic nitrogen in soil. Uric acid is a major excretion product among manyinvertebrates that graze on plant detritus and microbial biomass, while guanine is a common waste product among mites. Six isolates of dark-septate root endophytes (Phialocephala fortinii) and six isolates of ericoid mycorrhizal fungi (Hymenoscyphus ericae, Oidiodendron maius, and variable-white-taxa) produced significantly greater biomass when grown on guanine or uric acid as a sole nitrogen source compared to growth on media without added N. These results, while limited to pure cultures under laboratory conditions, suggest the potential of certain mycorrhizal fungi to exploit a largerrange of soil organic nitrogen than previously considered.

(# 277) Arylsulfatase Production by Mycorrhizal Fungi

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Although the widespread capacity of root-associated fungi to access organic nitrogen and phosphorus is well known, the capacity to use organic sulfur has received little attention. Isolates of dark-septate root endophytes (Phialocephala fortinii) and ericoid mycorrhizal fungi (Hymenoscyphus ericae, Oidiodendron maius, and variable-white-taxa) were able to hydrolyze the synthetic arylsulfatase substrate, p-nitrophenylsulfate, when grown under sulfur-limited conditions. In contrast, ten representative ectomycorrhizal fungus cultures did not produce detectable arylsulfatase activity. Although further screening is needed, these results suggest that arylsulfatase production among the mycorrhizal fungi may be limited to the ericoid mycorrhiza-forming fungi and dark-septate root endophytes. Ester-bound sulfate can represent a major labile fraction of the soil sulfur pool in forest ecosystems, so mycorrhizal fungi with this trait may significantly enhance the sulfur nutrition of the hostplant.

(# 279) Gene expression during establishment of mycorrhizal associations between Cistus hairy roots and Terfezia boudieri isolates

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Studies in our laboratory have shown that all but one (clone M2) of our Cistus hairy root clones form Terfezia-type ectomycorrhizal associations with different Terfezia isolates. Clone M2 formed ectendomycorrhiza with two of our isolates, but ectomycorrhiza with the other isolates in media with low phosphorus concentrations. The genes involved in mycorrhiza establishment between two hairy roots clones, M2 and W51, and two T. boudieri isolates, Iso 42a and Iso 27, were studied by cDNA-AFLP. (Ectendomycorrhiza were produced by the M2/Iso 42a combination, while the other three combinations formed ectomyccorhiza.) Each clone/isolate pair was grown in the same plate, with the hairy roots being separated from the fungus by a sheet of cellophane paper to prevent physical contact between the two symbionts. Roots and fungi growing in separate plates served as the controls. Total RNA was extractedfrom the two fungal isolates under, cDNA libraries were constructed, and AFLP reactions performed. The differences in the response of the isolates to the various hairy root clones corresponded to isolate-specific, hairy-root-clone-specific, and ecto- and ectendomycorrhizal-specific signals. Fragments of interest were cut out of the gels. Some were cloned, sequenced and compared to sequences available at the GenBank.

(# 280) Phylogenetic studies of some hypogeous Pezizaceae species

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The ITS (internal transcribed spacers of the rRNA gene family) region including the 5.8S rRNA gene as well as the 5' end of the 28S rRNA gene of members of the truffle family Pezizaceae were studied. Resultssupport placement of Mattirolomyces terfezioides (Terfezia terfezioides) in a separate genus distinct from Terfezia and appear to confirm that Terfezia pfeilii Henn. too belongs outside Terfezia. As expected,members of the genus Choiromyces generally grouped closer to the Tuberaceae family representative (Tuber melanosporum). Choiromyces echinulatus, however, emerged near members of the genus Terfezia, placing even closer to that genus than T. pfeilii. The classification of both T. pfeilii and C. echinulatus should therefore be reconsidered.

(# 281) Differences between hairy root clones and fungal isolates in forming mycorrhizas

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Using our transformed Cistus root system, we studied the initial responses of root and fungus to mycorrhiza formation. All clones tested so far were capable of forming mycorrhiza with either T. melanosporum or Terfezia boudieri, regardless of differences in growth habit, growth rate or physiological parameters. When root and T. melanosporum mycelium were placed on a sucrose-containing medium, the growing root (two clones tested) appeared to initially inhibit fungal growth, probably due to the build-up of fructose in the medium during first stages of root development. This phenomenon may mask the direct influence of the roots on fungal performance, which appeared to be clone-dependent (one clone exhibited extended growth inhibition, while another eventually supported fungal growth at similar concentrations of reducing sugars). When mycorrhiza was finally formed, fungal hyphae spread along the growing root. Mycorrhizal roots seemed to grow faster. Of all the root clones, one (M2) formed ectendomycorrhiza with two isolates of T. boudieri but not with others. Under very low phosphorous concentrations, M2 continued to form ectendomycorrhiza with the specific isolates but formed Terfezia-type ectomycorrhiza with the other isolates. No mycorrhizal associations were obtained under high phosphorus. M2 seemed to be more sensitive than the other clones to exogenous IAA. A study of gene expression (mRNA) of two fungal isolates (one forming ectendo- with M2, the other forming only ecto-) in contact with M2 and with an ectomychorrhiza-forming clone showed that the two isolates responded differently to the two root clones. These differences will be discussed.

(# 282) Mycorrhiza formation by hairy root clones with Terfezia boudieri isolates

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In the current study, the morphology, growth rate and ability of Cistus hairy roots to form mycorrhiza with Terfezia boudieri isolates were examined. Root clones differed in morphology with respect to degreeof branching and length of primary and secondary roots. Root clones could be divided into slow, intermediate and fast growing types according to their ability to grow on a nutrient-rich medium. Irrespective of their morphology and growth rate, all hairy root clones were able to form mycorrhizal associations with different T. boudieri isolates. All the clones formed Terfezia-type ectomycorrhiza exclusively, with the exception of clone M-2, which formed ectendomycorrhiza with two of the isolates but ectomycorrhiza with all the other isolates. Mycorrhiza formation was also tested at various phosphorus levels. At very low P levels, ectendomycorrhiza was still formed between the same two isolates and M-2 (but not with others), while augmented phosphorus inhibited formation of all types of mycorrhiza. All other hairy root clones still formed exclusively ectomycorrhiza, even under very low phosphorus. Clone M-2 is likely to be more sensitive to exogenous auxin than the other clones. Since a high P concentration was shown to decrease root sensitivity to IAA, lack of mycorrhiza under high P may be attributed to this phenomenon. Examination of the relationship between phosphorus concentration, IAA and ectendomycorrhiza development is currently under way.

(# 283) Phylogeny and Evolution of the genus Gigaspora based on inter and intra-species 18S rDNA heterogeneity

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A detailed analysis of 18S rDNA variability in Gigaspora was performed using 48 well-defined isolates. We explore the extent of rDNA heterogeneity within species of this genus and evaluate the level of phylogenetic integrity encompassed by the species designation, and the usefulness of 18S rDNA markers as identifying characters below genus level. Nearly full-length 18S rRNA genes were amplified by PCR, cloned and sequenced. Before sequencing, clones were selected using denaturing gradient gel electrophoresis (DGGE) analyses to discriminate the level of heterogeneity within clones originated from single spores and relate the total intra- and inter-species variation of 18S rRNA gene copies. Highly consistent patterns of 18S rDNA heterogeneity were found within different spores and even geographic isolates of the same species. A single spore appeared to typify the genetic variation present in the entirespore population of a given isolate. The 18S rDNA sequence variants within most morpho-species were not monophyletic, and although each species possessed unique 18S rDNA sequences, closely related species hold some 18S rDNA variants in common. Thus, some closely related species form species complexes with at least an 18S rRNA genes sequence in common. In terms of AMF description, the total pattern of 18S rDNA information is clearly necessary to describe the ribotype of AMF isolates, and ambiguous assignments will be unavoidable for some environmental clones. With regard to AMF evolution, we are performing a quantitative approach to assess genetic drift based on frequency of similar 18S rDNA copies held by different morpho-species.

(# 285) Obligate cheaters of mycorrhizal networks.

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Epiparasitic plants are entirely dependent on inter-plant fungal linkages to obtain fixed carbon. We havestudied distant examples of cheating within mycorrhizal networks: monotropes-basidiomycetes (Tricholoma, Russulaceae, Hydnellum, Gautieria, Rhizopogon), Cryptothallus-Tulasnella, and Arachnitis-Glomus. We found that epiparasitic plants have achieved the greatest levels of specificity to fungi known throughout the otherwise diffuse mycorrhizal symbiosis. Consequently, from the perspective of epiparasites, the high diversity of mycorrhizal communities lacks redundancy. To investigate the evolutionary and ecological trade-offs involved in achieving such specificity, we examined the germination of monotrope seeds in nature. We found high specificity to fungi at germination, but host range was broader than observed in mature plants. Seeds can germinate in response to close relatives of the mature plants' exclusive mycorrhizal lineage. Epiparasitic plants are extremely prolific producers of seeds and it has been argued that the strongest selection pressure in their life history must act on belowground stages. We propose a model for symbiotic seed germination in which 1) overcoming fungal defences to maximize reverse carbon flow in mycorrhizas selects for specificity at every generation and 2) the cost of lowered establishment opportunities has been reduced by producing dust-like seeds and using fungal cues to break dormancy.

(# 286) The occurrence and distribution of mycorrhizas in the ferns - a test of the 'Pirozynski' hypothesis

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Molecular clock and fossil evidence suggest that the Glomales were present when green plants colonized land. The hypothesis that a species' dependence on a fungal mutualist should decrease over evolutionary time is investigated. Published records of the presence/absence of mycorrhizas in pteridophytes have been evaluated. These are problematic since different authors have used different criteria to determine mycorrhizal presence or only assayed a single specimen. The frequency of mycorrhiza formation and mycorrhizal dependency within fern families will be mapped onto cladograms based on molecular and morphological data to test the hypothesis.

(# 287) Effect of Drying Method on Productivity and Essential Oil Quality of Basil Grown in Nova Scotia

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Basil essential oil is used as a natural ingredient in numerous industries including, food, cosmetic and pharmaceutical. During the summers of 2001 and 2002 three basil cultivars belonging to two species (Ocimum basilicum and O. sanctum), were grown in two of the main agricultural areas in Nova Scotia: Truro and Canning (plant hardiness zones 5B and 6A, respectively). The goal of the research was to evaluate the potential of basil varieties and species as new cash crop for the Maritimes. Further lab experiments were conducted to determine the effect of air-drying and freeze-drying on the essential oil productivity and quality. Essential oils were extracted from the plant tissue by steam distillation of fresh, air-dried and freeze-dried above ground plant material. Basil yields from the two locations suggest that these species have potential to be grown in this region. O. sanctum had lower plant yields and essential oil yields than O. basilicum. The quality of the essential oils (determined using GC-FID and GC-MS) indicated a typical marketable composition. The main component of O. basilicum cv. Mesten was linalool, the main components of O. basilicum Italian Broadleaf cv. were methyl chavicol and linalool and the main component in O. sanctum were eugenol and methyl chavicol. Air-dried and freeze-dried basil also had acceptable oil productivity and composition. The freeze-dried basil in some instances had higher oil recovery. Results from our study suggest that all three varieties of basil can be grown as an essential oil crop in the Maritimes.

(# 291) Effects of fire on the mycorrhizal diversity of Caladenia formosa (Orchidaceae)

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An investigation on the diversity of mycorrhizal fungi from the endangered orchid Caladenia formosa was undertaken. Plants were collected from burnt and unburnt sites in Western Victoria and fungi isolated from single pelotons in the collar region. The study focused on determining the effects of fire onthe diversity of the mycorrhiza, and therefore ascertained if the habitat of this orchid should receive controlled burning for conservation management. Physiological diversity of isolates was assessed by germination and nitrogen and salt utilisation experiments. Significant differences between responses of individual fungal isolates were found in all three experiments. Significant differences were also found between fungal types (burnt and unburnt). More positive responses were observed in each experiment for isolates which received burning compared to unburnt isolates, with such physiological differences suggesting possible species diversity. Molecular analysis of isolate diversity was then undertaken using the ITS-RFLP method and DNA sequencing. Fragments within the ITS-RFLP patterns added to the sum of the original PCR products of 850 base pairs. Patterns of all isolates, both burnt and unburnt were found to be the same within each enzyme used. Sequencing results also suggested all isolates werethe same species, as forward and reverse sequence alignments matched in the 96.5-100% range. Sequences were then submitted to the Genebank database, with the closest matching sequences being those of species within the Sebacinaceae family, producing a 96% match. Such results suggest that while fire appears to have significant effect on orchid mycorrhizal physiology, it has no effect on species diversity.

(# 292) Mycorrhizal associations, root specialisations and nutrient acquisition in Australian heathlands

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Researchers have long argued that oligotrophic soils are the most conducive to development of roots specialized for nutrient acquisition. Adaptations include mycorrhizal symbioses and N-fixing nodules relying on the mutualistic interchange of carbon and nutrients between plant and microsymbiont. Cluster roots function by increasing the absorptive surface of roots and releasing organic acids to promote uptake of nutrients. Of the 18 species investigated in this study, four were ectomycorrhizal (Allocasuarina, Jacksonia spp.), three were arbuscular mycorrhizal (Anigozanthos, Leptospermum), six were both ecto- and arbuscular-mycorrhizal (Eucalyptus spp., Calothamnus spp.) and five were non-mycorrhizal (Banksia spp., Hakea spp.). The presence of root nodules confirmed that five species were N-fixers (Acacia spp., Jacksonia spp., Nemcia) and eight species possessed cluster roots (Banksia spp., Hakea spp., Actinostrobus).

Using these taxa, a glasshouse trial aimed to determine the importance of inorganic and organic forms of N in plant growth. The greatest growth response was to addition of ammonium or ammonium nitrate, with little response to nitrate. When plants were supplied with different sources of ^{15}N, ecto- and arbuscular mycorrhizal species were significantly enriched with organic-^{15}N or ammonium-15N. Non-mycorrhizal, cluster rooted species were also enriched with organic-^{15}N but to a lesser extent. Dry matter of legumes was less enriched with ^{15}N as might be expected considering the capacity for legumesto fix N and thereby dilute labelled pools of soil N with unlabelled atmospheric N. Plants with mycorrhizal associations appear to have greater benefit over non-mycorrhizal plants through enhanced access to organic N.

(# 293) The effects of grazing ungulates on the structure and function of AMF communities in grasslands of Yellowstone National Park

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Knowledge of the structural and functional attributes of arbuscular mycorrhizal fungal (AMF) communities in systems that support grazers may improve our mechanistic understanding of how plants respond to herbivory. We examined the AMF communities inside and outside long-term (42- and 44-year old) ungulate exclosures at seven sites on the northern winter range of Yellowstone National Park that isgrazed Nov-May by large herds of ungulates (Bison bison, Cervus elaphus, and Antilocapra americana). The sites varied from dry upland to wet lowland. At each site, soil samples were collected randomly throughout plots and underneath the same dominant grass growing inside and outside exclosures to separate effects of grazers and topography on the mycorrhizal communities. AMF species composition and diversity were determined from spore data. Potential plant benefit from the mycorrhizal association was investigated by comparison of the relative fungal investment in arbuscules vs. other internal root structures. Grazer effects on the qualitative relationship between mycorrhizae and plants was also examined by comparing internal and extramatrical hyphal abundance in roots vs. soil in grazed and non-grazed grassland.

(# 294) In vitro arbuscular mycorrhizal sporulation enhancement using calcium carbonate as media amendment

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In vitro experiment was conducted to evaluate the influence of calcium carbonate as media amendment on arbuscular mycorrhizal fungi as calcium is known to influence the fungal systems. The modified whites' s media was amended using 1% calcium carbonate without pH adjustment. Root organ culture based symbiosis of AM fungi Glomus intraradices (Schenck and Smith) on transformed roots of carrot clone Gp (Daucus carota cultivar Pusa Kesar) were inoculated on both amended and un-amended media. Roots without mycorrhizal inoculation were used as separate controls. The system was incubated for three months. Regular observations during the initial incubation period indicated very early sporulation in CaCO3 amended media as compared to non-amended controls. At harvest the following mycorrhizal parameters such as sporulation, extramatrical mycelial biomass, root biomass and mycorrhizal colonization were investigated. Spore count and mycelial biomass was found showing significant alterations due to calcium carbonate in the media. However, internal colonization in roots was significantly higher in the calcium-amended media. These observations have scope of exploitation in manipulating media for designing mass inoculum production of AM fungi for developing better technology in future.

Key Words- Glomus intraradices, in vitro, calcium carbonate, AM fungi.

(# 295) The H+ATPase from Pisolithus tinctorius

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Pisolithus tinctorius is an ectomycorrhizal fungi which lives in symbiosis with roots of pines. The mechanisms of nutrients uptake by the mycelium involves the transport of ions from the soil to the fungi. In this process, the regulation of plasma membrane H+ATPase should be an important subject. In fulgal and plant cells the activity of the proton pump is regulated by a large number of environmental factors at both transcriptional and postranscriptional levels. There are evidences of the presence of H+ translocating ATPase in cultures of Amanita muscaria and Hebeloma crustuliniforme. The aim of this work is to identify and study the activity of the H+ATPase from mycelium of Pisolithus tinctorius. The cells were grown in modified Melin Norkans medium. After eight weeks they were harvested by filtration and washed with cold distilled water. The mycelium was incubated with chitinolytic and proteolytic enzymes by 30 min at 30°C. Cells were broken with glass beds in 50 mM Tris-manitol buffer pH 7.5 and proteases inhibitors. Plasma membranes were obtained by differential centrifugation. The H+ATPase activity was measured using Fiske Subarrow's method in microsomal fractions and showed a specific activity of 194 nmol Pi/mg min, with a protein yield of 0.13%. We will discuss the reactivity of the H+ATPase of P. tinctorius against yeast antibodies of this enzyme.

(# 297) Influence of wood ash application on mobilization of cadmium and dissolved organic carbon in coniferous forest soil

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Wood ash can be used as a forest fertilizer, as it contains substantial amounts of nutrients essential for tree growth. Wood ash contains also heavy metals e.g. Cd and Pb, which has raised environmental concern. Wood ash application may have ecological and environmental risks associated with nutrient and heavy metal leaching and increase in the rate of decomposition of soil organic matter.

Wood ash application affects chemical, physical and biological properties of forest soil. It increases soil pH, which may result in changes in the community structure of decomposers and decomposition processes of forest soil. Less is known about the response of mycorrhizal fungi or soil fauna on ash application.

The mesocosm experiment was carried out by growing two-year old nursery grown spruce seedlings in the greenhouse for five months. The mesocosms were constructed from humus and mineral soil from a spruce forest. The treatments were 0, 3000, 6000 and 12000 kg of loose wood ash ha-1 with or without earthworms in factorial design.

Main questions were if ash 1) increases Cd and DOC concentrations in run off water, 2) increases mobilization of Cd and its enrichment in mycorrhizal fine roots of spruce, 3) changes the structure of the soil food web and 4) changes the role of the earthworms in mobilization of Cd and DOC.

(# 298) Arbuscular Mycorrhizas and Soil Salinity - the Continuing Story

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Much research on the activity of arbuscular mycorrhizal (AM) fungi in saline conditions has focussed on whether arbuscular mycorrhizas ameliorate losses of plant production in saline soil. Some AM can ameliorate the effects of salinity on plant growth. However, it is not clear how this occurs. Suggested mechanisms include: (1) improved mineral nutrition; (2) influence on plant water balance; (3) influence onplant production of compatible solutes; and (4) increased sequestration of Cl^-. Central problems remain unresolved. One problem is the degree of variability between conclusions from different studies. Findings relating to one fungus or one plant/fungus combination are often not supported, or contradicted, by experiments using other combinations.

We contend that this variability is in part a function of the adaptability of AM fungi: that effects of colonisation by different fungi on the growth of plants in saline soils occur via different mechanisms. There are various arguments to support this view. First, there may be a high degree of functional specificity between these fungi in natural ecosystems, and they differ in their effects on plant growth under controlled conditions. Second, AM fungi differ in their response to salinity in controlled conditions. Third, AM fungi are opportunistic and flexible organisms. They grow when conditions are suitable and stop growing when conditions are not suitable. What is "suitable" differs between the fungi. Finally, different fungi may be active during different parts of the growing season, and these differences may be reflected in the timing of mycorrhizal promotion of plant growth. In summary, it is over-simplistic to expect a single answer to the question ‘how do arbuscular mycorrhizas influence plant production in saline soil?” Rather, there are many answers that are conditional on the type of fungus, the type of plantand the range of environmental factors in which they are growing.

(# 300) Colonization of Linum usitatissimum by AM Fungi Forms Arbuscular Pairs

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Many detailed studies have been conducted on fungal morphology and little variation has been shown in the arbuscule formation of Arum-type AM, which is characterized by longitudinal intercellular hyphaeand single terminal arbuscules within cortical cells.

Experiments have been conducted to investigate the characteristics of unusual 'paired' arbuscules colonizing Linum usitatissimum. The development and senescence of the arbuscules were followed in a time-course study. Roots were freeze-sectioned longitudinally and mycorrhizal structures visualized using nitroblue tetrazolium, a vital stain to indicate metabolically active arbuscules and intercellular hyphae, followed by acid fuchsin counterstaining. Arbuscules almost always occurred in pairs in adjacent cortical cells arising from a single, radial intercellular hypha. The individual members of a pair were often at different developmental stages, shown by different status of metabolic activity and branching structure. Structures were imaged using laser scanning confocal microscopy. The volume andsurface area of each arbuscule of a developing paired structure was measured using 3D imaging software. Logistic regression of the time-course data and measurement of arbuscular surface area indicated that there was a delay in the initiation of the second arbuscule. The pattern of arbuscule development may depend on the way in which meristematic cells of Linum divide during the development of the inner cortex.

(# 301) The indolic alkaloid hypaphorine from Pisolithus microcarpus alters gene expression in poplar roots

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Ectomycorrhizal fungi secrete several active metabolites, including auxins and derivatives. They induce substantial morphological and biochemical changes in root tissues and they likely contribute to the ectomycorrhiza development. Hypaphorine, an indole-3-acetic acid (IAA) antogonist, released by Pisolithus species, controls elongation rate of root hairs and induces a transitory root hair tip swelling [Ditengou et al., 2001], suggesting that this indolic compound might contribute to the lack of root hairs in ectomycorrhiza. Here, we have analyzed the effect of 500 µM hypaphorine or 5 µM IAA on gene expression in poplar roots, using a poplar microarray (i.e., a Unigene set of 4608 cDNAs of Populus trichocarpa x deltoides). Incubation in the presence of hypaphorine for 24h induced the down-regulation of three poplar genes, an hydroxyproline–rich extensin-like protein (x 3-fold), a nitrate-induced protein (x2-fold) and the hypothetical protein R49B06 (x 2-fold). On the other hand, IAA induced the up-regulation of these three genes, together with a proline-rich protein, whereas it repressed glutamine synthetase, a leucine-rich repeat protein and PPi-fructose-6-phosphate 1-phosphotransferase. The down-regulation of extensin expression was confirmed by northern blotting during a 12h-time course incubation. The present data suggest that the inhibition of root hair elongation by hypaphorine could bethe consequence of the observed decrease in transcripts of extensin, a cell wall protein. Whether the hypaphorine-regulated extensin is located in root hair cell walls is currently investigated.

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(# 302) Insertional mutagenesis to identify fungal genes necessary for ectomycorrhizal symbiosis establishment

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To identify fungal genes essential for the establishment of the ectomycorrhizal symbiosis, an insertional mutagenesis programme was initiated on the basidiomycete Hebeloma cylindrosporum. Using PEG-mediated protoplast transformation, 1725 hygromycin-resistant putative transformants were obtained. Screening for symbiosis-defects on Pinus pinaster seedlings allowed the identification of 22 mutants dramatically impaired in their mycorrhizal ability and of 29 true non-mycorrhizal (myc-) mutants out of which 10 integrated the transforming plasmid in their genome. Most of the tagged myc- mutants presented complex pattern of integration which may delay the identification of the corresponding inactivated genes. The co-segregation through meiosis of a particular plasmid integration with the myc- phenotype is under study. As an alternative to protoplast transformation, Agrobacterium tumefaciens-mediated gene transfer was developed for H. cylindrosporum. After optimizing the procedure, a collection of ca. 2000 transformants was constituted. All transformants had integrated the T-DNA in their genomes and 60% of them harboured a single copy. Screening of 1300 transformants allowed the identification of 11 mutants showing symbiosis defects. So far, the T-DNA border junctions of four of them were amplified by thermal asymmetric interlaced (TAIL)-PCR. The PCR products are currently used as molecular probes to identify the corresponding genomic clones in a H. cylindrosporumDNA library. In the future, both molecular characterization and gene profiling of non-mycorrhizal mutants will allow us to enlarge our knowledge on the molecular basis of ectomycorrhiza differentiation.

(# 303) Effects of Sugars on In vitro Growth of Cistus incanus Hairy Roots and of Tuber melanosporum Mycelium

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Effects of Sugars on In Vitro Growth of Cistus incanus Hairy Roots and of Tuber melanosporum Mycelium

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In vitro inoculation of hairy roots by ectomycorrhizal fungi may be used for studying interactions between the two symbionts prior to colonization. Unlike native mycorrhiza systems, in-vitro systems must be supplied with sugars via the growth medium. It is possible that the growth response of the roots to various sugars will differ from that of the mycelia, thus imposing effects that are not directly related to signal transduction between the organisms. Cistus incanus hairy roots and Tuber melanosporum mycelium were grown (separately) in Petri dishes on suitable media with different concentrations of sucrose, fructose and/or glucose. In the hairy root culture, sucrose was completely hydrolyzed during the first four weeks of growth, followed by utilization of the mono-sugars, especially glucose. For the Tuber mycelium, sucrose was the carbohydrate source of choice, followed by glucose. Fructose significantly inhibited mycelium growth. In separate experiments, hairy roots (two clones) in the growth medium were replaced with Tuber mycelium at different points in time. In these media, concentrations of reducing sugars were time dependent but similar for the two clones. Towards the end of the root growth period, one clone inhibited fungal growth (probably due to fructose in the medium), while the other supported fungal growth. These results indicate differences (quantitative or qualitative) between the two clones with respect to their effect on fungal growth. The results of this study show that the considerable effect of type and concentration of sugars on fungus growth can mask chemical interactions between mycorrhizal partners in dual cultures.

(# 304) Relationship between Arbuscular Mycorrhiza Fungi Infectivity, Soil Characteristics and Land use History

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A geographical information system (GIS) is proposed as a suitable tool for mapping the relationship between land use and mycorrhizal infectifity. A farm in south-western Australia was sampled on a 150 m grid across 14 paddocks. The composite soil samples (291) were collected for soil testing and for mycorrhizal infectivity. The ArcView and ARC/INFO packages were used to identify relationships between land use, soil test and mycorrhizal infectifity. GIS was used to analyze the relationships between variables. Both soil characteristics and mycorrhizal infectivity varied with paddock history. The crop (or pasture) one year before sampling and fertilizer use were the most important factors which were directly related to the variability in mycorrhiza infectivity. The crop (or pasture) two year before sampling also had a significant effect on the level of mycorrhizal infectivity.

(# 305) Community structure and diversity of below ground ectomycorrhiza fungi in Danish beech (Fagus sylvatica) forest with different cropping history.

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The aim of this work is to compare below ground ectomycorrhizal community in Danish beech forest sites with different cropping history. Six locations in Gribskov, Northern Zealand, Denmark were studied. A monoculture of 100 years old beech trees are growing on all six locations. Beech have naturally been growing on all the six locations for several hundred years, but at three of the locations the continuity of beech was broken from about 1830 to 1900 with Norway Spruce (Picea abias). All these six locations were replanted with beech in 1900.

The different cropping histories give us a unique chance to study, whether broken continuity after 100 years could have an impact on the ectomycorrhizal community. Previously, the under story herbal communities at these same locations have been shown to differ between the continous and non-continous plots (Flemming Rune, Danish Forest and Landscape Research Institute, unpublished data)

At late spring (May/June) and early autumn (September/October) soil cores were taken in the six plots. From the samples ectomycorrhiza fungi on the roots are sorted by a combination of morhotyping and ITS-RFLP and then identified by sequencing.

Preliminary results show that broken continuity seems to lower the diversity of ectomycorrhiza fungi. Moreover different genera were dominant in the two locations; Lactarius was dominant in the location with continuity and Russula was dominant in the location with broken continuity.The whole data set will be presented at ICOM4.

(# 306) Defoliation of Neighbour Increases Mycorrhizal Benefit of Seedlings

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We studied the functioning of mycorrhizal network connecting seedlings and an established plant in a greenhouse experiment. Specifically, we aimed to test whether the photosynthetic capacity of the established plant controls the benefits that seedlings gain from mycorrhizal symbiosis. We grew seedlings of the perennial herb Gnaphalium norvegicum (Asteraceae) with and without the arbuscular mycorrhizal fungus (Glomus claroideum). In each pot seedlings grew alone or together with a conspecific established plant. The capacity of the established plant to allocate carbon to mycorrhizal fungus was manipulated by defoliation treatments in which 0 %, 50 % or 75 % of the leaf area was removed. Thus, we had in total 8 different treatment combinations, 14 replicate pots in each. In general, mycorrhizal plants grew larger than their non-mycorrhizal controls. However, both mycorrhizal and non-mycorrhizal seedlings were of the same size when grown with non-defoliated established plant. Seedlings grown alone were larger than seedlings grown with established plant. The defoliation of established plant improved seedling growth only when plants were mycorrhizal. The mycorrhizal benefit of the seedlings increased with increasing defoliation intensity of the established plant.

(# 308) Production, application and regulation of commercial AMF inoculants in agriculture

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Some companies have partially or completely overcome the constraint of producing large quantity of mycorrhizas inoculants at an industrial level. But before achieving to a large-scale application in Agriculture, the main barriers they had or (have) to face are technical, economical, and social. A global strategy taking in consideration at least these three parameters is absolutely necessary.

Technical: AMF application is still limited because of their incompatibility with most of the plant production systems. Main parameters such as large use of fertilizers, pesticides and organic matter have been disregarded. The selection of efficient AM fungi with high capacities both to colonize root and to promote plant health is also important. Thus, the determination of optimal practical conditions of use where these products can express all their beneficial potential and the supply of standard commercial AMF products with this proven efficiency is necessary

Economical: the evaluation of the financial benefit for the grower taking into account the cost of inoculum faced to the conventional cost of inputs,

Social: ii) the control, regulation and registration of mycorrhizas product under National (or International) rules is necessary to give a guaranty to the distributors and the growers, and the education of growers to apply such bio-products

Ten years of practical trials both with technical centers and growers has permit to Biorize company to i) develop AMF applications in different plant production systems. ii) register a commercial AMF product “EndoRize” under the French rules, iii) propose a range of standard AMF products for professionals,The market is large and consists in different plant production systems. The companies producing AMF inoculum must adapt their products to each sector and conditions of use and find the best formulation to be efficient at a reasonable cost.

(# 309) Biodiversity, Population Status and Root Infection of Arbuscular Mycorrhizal Fungi in Relation to Site Factors in Highway Cut-slopes in Korea

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This study was conducted to investigate the arbuscular mycorrhizal fungal biodiversity, population status and root infection in relation to site factors in highway cut-slopes in Korea. Stabilization of exposed surfaces involved soil amendments and spraying seed mixture of three turf grass and two nitrogen-fixing shrub species. Eighteen sites were selected with varying ages (2 to 16 years), aspects and soil depths. Soils were analyzed for chemical properties, fungal diversity and spore counts. Root samples were assayed for fungal infection.

Thirty arbuscular mycorrhizal fungal species were identified, Acaulospora lacunosa and Glomus aggregatum being the two most dominant species. Of the total 37 plants inspected, 26 species had endomycorrhizal infection with an average infection rate of 18% (ranged from 1 to 67%). The same average infection rate of 22% was obtained from Festuca arundinacea and Lespedeza bicolor, the most dominant grass and woody species, respectively. Naturally-invading Robinia pseudoacacia showed higher infection rate in the old sites. The fungal spore population in north- and east-facing slopes experiencing less water stress was higher than in south- and west-facing slopes with higher water stress. Site age and the soil depth which reflected the degree of soil disturbance did not affect fungal diversity, spore population and root infection rates. The soil chemical properties - pH, N, and P contents were negatively correlated with spore number, root infection and endomycorrhizal species diversity.

Keywords: Acaulospora lacunosa, Glomus aggregatum, Festuca arandinacea, Lezpedeza bicolor, Robinia pseudoacacia, site age, aspect, soil depth, soil pH, soil N, soil P

(# 310) Characterisation of retrotransposable-like elements in the genome of Gigaspora margarita

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Repetitive DNA sequences which contribute to the large size of the glomalean genome have been poorly studied so far. The aim of this work was to isolate such sequences by screening a genomic library of the AM fungus Gigaspora margarita Becker & Hall BEG34. Amongst the clones isolated, four sequences showed a homology to retrotransposon-like elements considered to transpose in the genome via a cDNA intermediate. In order to better characterise the diversity of retrotransposons in the genome of G. margarita, reverse transcriptase genes have been partially amplified by PCR using degenerated primers and sequences belonging to different families of retrotransposons have been isolated. The distribution of these sequences in the genome has been characterised by Southern blotting and fluorescence in situ hybridisation (FISH) and their copy number estimated by dot blot hybridisations. In order to determine whether some of the gene copies are still active, their expression is being analysed at different steps of the fungal life cycle using RT-PCR. One family of gypsy-like sequences, present in 2000 copies in the genome, appears to have undergone point mutations inactivating the retrotransposon. Expression of this gene family is not detected in germinating spores and hyphae. Research is on-going for other sequences.

These retrotransposable elements, which may have played an important role in genome evolution, will provide useful molecular markers for studying AM fungal genetic diversity and for initiating a physical map of the genome.

This work is part of the european project GENOMYCA (QLRT-2000-01319).

(# 311) Contribution of Ectomycorrhizal Fungi to Plant Uptake of Ca, Mg and K and to Mineral Weathering by Tunnelling

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Circumstantial evidence points to ectomycorrhizal fungi as responsible for the formation of tunnels in weatherable minerals (feldspar and hornblende) through the excretion of organic acids. Thereby they provide a short-circuit between plant roots and the inside of mineral grains that contain Ca, Mg and K. This study aimed to quantify both processes.

Plant uptake of Ca, Mg and K from hornblende and feldspars through ectomycorrhizal fungi was measured in a pot experiment. Ectomycorrhizal P. sylvestris seedlings were grown for 2.5 years on 2-compartment pots. The root compartment was filled with quartz, the hyphal compartment (accessible by hyphae but not by roots) with quartz or quartz mixed with hornblende and feldspars. Preliminary results showed higher concentrations of organic acids, Ca and Mg in soil solution of hyphal compartments with feldspars and hornblende added than compartments with pure quartz. Concentrations of Mg and K in seedlings from pots with feldspars and hornblende were higher, but total plant uptake did not differ. Final results and implications for plant nutrition will be presented and discussed.

Contribution of tunnels in feldspars to weathering of feldspars was quantified in the uppermost mineral soil across a chronosequence. Tunnel volume was estimated from digital images of thin soil sections. Total weathering was calculated by comparing mineral content of the parent material and the uppermost mineral soil. Tunnels appeared to contribute less than 0.5% to total feldspar weathering. Surface weathering by ectomycorrhizal fungi may be more important than tunnelling.

Contribution of ectomycorrhizal fungi to plant nutrition with K, Ca and Mg and mineral weathering remains to be ascertained.

(# 313) The Paxillus involutus / Betula pendula symbiosis: Microarray analyses of gene expression during nutrient acquisition.

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Boreal forest trees are highly dependent upon symbiotic associations formed between their roots and ectomycorrhizal (ECM) fungi for nutrient acquisition, a process involving coordination between three spatially, morphologically and physiologically distinct tissues. Initial events in nutrient mobilisation and uptake occur at the advancing ECM mycelial front as individual hyphae proliferate intensively in nutrient-rich soil patches. A network of rhizomorphs distributes nutrients from such patches around the mycelium and to mycorrhizal root tips within which extensive nutrient exchange occurs between the plant and fungal partners. Nutrient uptake has been studied widely from ecological and physiological perspectives but little at the molecular level. Our study investigates nutrient-regulated gene expression in the Paxillus involutus / Betula pendula association using microarray analysis. This association was grown in semi-natural peat windows into which nutrient-rich patches of different nitrogen and/or phosphorus inorganic or organic compounds were introduced. Three cDNA libraries were constructed from mycorrhizal root tip, rhizomorph and patch mycelial tissues using pooled total RNA extracted from these tissues harvested from each nutrient treatment. Over 2000 ESTs were sequenced from each library. Alignment of these ESTs with 10,051 ESTs from three cDNA libraries representing free-living P. involutus, non-mycorrhizal B. pendula and mycorrhizal tissues growing in agar systems has currently identified a minimum of 3,200 contigs, each representing a unique transcript of plant or fungal origin. cDNA microarrays, constructed using this unique gene set, are being used in analyses of gene expression a) within patch mycelium in response to the type and quality of nutrient supplied and b) in mycorrhizal tip, rhizomorph and patch mycelial tissues actively exploiting a single nutrient resource.

(# 314) Mycorrhizas on Quercus garryana on serpentine soils

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Serpentine soils are known for the paucity of vegetation cover and for a high proportion of endemic species. The soils are relatively high in magnesium and iron and other heavy metals, but low in general fertility. Although Oregon white oaks (Quercus garryana) are not primarily found on serpentine, they do occur on scattered sites. We wanted to determine whether the mycorrhizal status of these trees was similar to that on our primary site, the Whetstone Savanna Preserve, a part of the Agate desert in southwest Oregon. The Agate Desert, with 48 cm of annual precipitation, is an alluvial fan capped with a shallow layer of clay loam over cemented hard pan and is characterized by patterned ground with mounds and vernal pools. We hypothesized that mycorrhizas would be less abundant and less diverse—parallel to the situation with green plants above ground. We sampled oak roots in at three serpentine sites in Oregon. We morphotyped the mycorrhizas and used molecular techniques to validate distinctions among morphotypes, to compare mycorrhizal tips to fungal fruitbodies and to sequence portions of fungal DNA for identification. Ectomycorrhizal diversity was greater on oak roots in serpentine soils than at the Whetstone site suggesting that lack of fertility in the serpentine soils promotes mycorrhizal formation and that the heavy metals in serpentine soils do not inhibit mycorrhizal growth. This research was funded by National Science Foundation Grant DEB-9981337 through the Biocomplexity Program and Research at Undergraduate Institutions.

(# 317) New analytical methods - ESCA for determination of phosphorus in soil.

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The amounts of soil phosphorus (P) available to plants are generally estimated by wet chemical extraction methods, where the extractants cause irrelevant reactions with soil particles during extraction. This problem is eliminated when using electron spectroscopical analysis methods, where no liquid is added to the sample before analysing it. Electron spectroscopy for chemical analysis (ESCA) has in addition the advantage of determining the chemical composition of a 10-50 deep surface layer of solids, corresponding to the depth of up to 10 molecular layers, where the majority of soil reactions take place.

Our aim was to study whether ESCA could be used to study the surfaces of soil particles and to collect information about suitable values of instrument parameters and sample handling techniques to use when studying soil with ESCA. A limed (pH 6.5) and fertilized Japanese volcanic ash soil and a not fertilised Swedish Mollisol were sampled and analysed with wet chemical method to determine bulk soil composition and by ESCA to determine element concentration at soil particle surface.

Preliminary results indicate that the concentration of Al and P increased markedly at the surface of the fertilised vulcanic ash soil. The concentration of Fe decreased slightly and Si was markedly depleted at the surface. The results clearly indicate Al as the main cause for the high P sorption capacity of volcanic ash soils, which is the main obstacle at crop production on these soils. Although the total Al content in the soil is in parity with some other soils, the large concentration of Al at the surface causes a large capacity to sorb P. In conclusion ESCA appears to be a technique possible to use in research on P and other elements on soil particle surfaces.

(# 318) Responses of tomato to infection by the root-invading fungal pathogen Fusarium oxysporum

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Fusarium oxysporum f.sp. lycopersici is a soil-borne pathogen that infects tomato. The fungus invades the plant via the roots and subsequently colonizes the xylem vessels of the stem. Ultimately, the sap stream is blocked and the plant wilts.

Upon infection the protein content of xylem sap changes dramatically during both compatible and incompatibles interactions. We identified a new member of the PR-5 family that accumulates early in both types of interaction. Other PR-proteins were found in compatible interactions only, concomitantly with disease development. The abundance of a small cysteine-rich plant protein was found to be down-regulated during infection. Proteins of fungal origin were found in xylem sap as well.

Specific resistance of tomato to isolates of F. oxysporum containing avirulence factor 2, is mediated by the product of the I-2 resistance gene. I-2 belongs to the CC-NB-LRR family of resistance genes. Using a biochemical approach we have shown that the nucleotide binding (NB) domain of I-2 is functional in both ATP-binding and ?hydrolysis. Currently we study the effect of specific mutations in the NB-domain on protein function using the Agrobacterium transient transformation assay (ATTA). Some of these mutations are predicted to abolish ATP-binding or ?hydrolysis. Initial analysis of these mutant proteins revealed that some act as constitutive-active proteins that induces an HR in the absence of the elicitor.

(# 319) Identification of ectomycorrhiza forming fungi and impact on birch and pine seedling growth in Icelandic soils.

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Iceland has suffered from severe ecosystem degradation since it's settlement in 874 and has lost more than 50% of the original vegetative cover. The cover of birch (Betula pubescens Ehrh.), the only native tree species forming forest in Iceland, has reduced greatly. Today it is the most common species used in afforestation and is extensively used in land reclamation on degraded sites. Due to low survival rates of young tree seedlings at these sites, it could be hypothesized that the lack of beneficial soil biota is hampering afforestation. A Nordic co-operation programme aims to study the beneficial microorganisms (mycorrhiza, insect pathogens). The aim of the mycorrhizal sub-project was to compare a) mycorrhiza species diversity and b) early root colonization dynamics in birch and pine seedlings grown in birch humus and soil from adjacent eroded areas. Root colonization dynamics over 3 months was followed in microcosm systems. Ectomycorrhizal diversity were assessed by morphotyping and PCR (ITS) RFLP/sequencing. Differential birch mycorrhizal development in the two test soils was characterised by heavier colonization and more diversity in humus. Birch growth in eroded soils was significantly reduced compared to humus. Similar soil-specific difference were not as apparent with pine, which supported heavy colonization by suilloid-type mycorrhizas in both humus and eroded soils. These preliminary results indicate that the requisite mycorrhizal fungal biota supporting seedling development exists in old birch stands in Iceland and the lack of specific mycorrhizal species may be a important factor contributing to high mortality of young seedlings in eroded areas.

(# 320) Development and physiological status of in vitro propagated Rhododendron plants inoculated with mycorrhiza during acclimatisation

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The effects of inoculation of in vitro propagated Rhododendron with ericoid mycorrhizal fungi at the beginning of weaning stage were studied. Inoculated and uninoculated plants were acclimatised at two light intensities (75 and 150 ìmol m-2 s-1). Biomass production and photosynthetic potential evaluated by chlorophyll fluorescence, of in vitro and ex vitro formed leaves during acclimatisation were evaluated. Survival of plantlets was 98% at low and 93-94% at high light intensity irrespective of mycorrhizal inoculation. Biomass production of inoculated plants was slightly higher than uninoculated plants. Fv/Fm ratio (variable over maximum fluorescence) indicates photochemical efficiency of PSII, which is an indirect measure of plant stress. Fv/Fm of in vitro formed leaves decreased progressively from 0.75 directly after taking out of culture to 0.60 after 8 weeks for low light intensity. Increasing light intensity from 75 to 150 ìmol m-2 s-1 had negative effect on Fv/Fm of in vitro formed leaves during acclimatisation. The highest Fv/Fm was noted for ex vitro formed leaves of plant acclimatised at lower light intensity. Inoculation with ericoid mycorrhizal fungi increased Fv/Fm of in vitro formed leaves irrespectively of light intensities and did not affect Fv/Fm of ex vitro formed leaves. Rfd value (the ratio of maximal fluorescence decrease to the steady state value) is an indicator of the photosynthetic potential of the leaves. Rfd was significantly higher for ex vitro than in vitro formed leaves irrespective of light intensity during acclimatisation. Mycorrhizal inoculation increased Rfd and the effect was the most pronounced for ex vitro formed leaves. The highest Rfd (2.68) was noted for ex vitro formed leaves at higher light intensity. Increasing Rfd value as a result of mycorrhizal inoculation indicates improved balance between the light and dark phases of photosynthesis and higher photosynthetic potential of micropropagated rhododendrons.

(# 321) The Paxillus involutus / Betula pendula symbiosis: Gene expression in ectomycorrhizal root tissue

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To obtain information on genes specifically expressed during ectomycorrhizal (ECM) symbiosis, transcript profiling in mycorrhizal root tissue was conducted. By Expressed Sequence Tag (EST) analysis, clones were sequenced from cDNA libraries constructed from ECM formed between the basidiomycete Paxillus involutus and birch (Betula pendula). In parallel, cDNA libraries from a saprophytically growing fungus and from axenic plant roots were analysed. By clustering of all ESTs obtained (10,051), 2,284 unique transcripts, either of fungal or plant origin, were discovered. From sequence homology analyses (GenBank (nr) protein database) a majority of these transcripts could be assigned putative functional and metabolic roles. This unique set of genes was further used for the construction of cDNA microarrays on which a RNA target from the mycorrhizal root tissue was compared to RNA isolated either from the free-living fungus or the plant, respectively. From analyses of biological replicates we found 103 fungal and 106 plant genes significantly (>2-fold) up or down regulated during mycorrhizal conditions. Among regulated genes there was a significant portion being putatively involved in cell rescue and defence, metabolism and protein synthesis. Nevertheless, 54% of the fungal and 52% of the plant transcripts, respectively, were orphans without any recognized cellular function and could represent a rich source of information for future exploration on mycorrhizal

(# 322) The Impact of Genotype of Norway Spruce on Mycorrhizal Fungal Community in Boreal Forest Soil

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The impact of tree genotype on the susceptibility to diseases is well established in plant pathology and widely applied in forest tree breeding programs. However, the ability of host genotype to extract certain ectomycorrhizal (EM) fungi from the broad selection of species present in boreal forest soil is unclear. The community structure of EM fungi further affects the bacteria of mycorrhizosphere and eventually the whole microbial community performing the nutrient mineralization. This, in turn, may affect the growth of the trees. The aim of our project is to investigate in situ how the genetic variation of Norway spruce (Picea abies) influence the EM species composition and soil microbial communities. We utilize a clonal spruce trial planted on the clear-cut spruce forest site situated in Central Finland. Eight healthy and normally growing clones of different genotypes have been selected to represent various growth performances since outplanting in 1994. Four clones represent fast (284 ±64 cm) and four clones slow (161±39 cm) growth rates. Each clone consists of three replicate plots supporting nine cuttings. EM communities of the clones were determined from randomly sampled root tips and different sequence types were separated by denaturating gradient gel electrophoresis (DGGE) of ITS or 18S rDNA regions. Different sequence types will be identified by sequencing. It is likely that 18S rDNA and ITS regions give different views of the fungal communities and therefore DGGE profiles of these gene regions will be tested and compared using EM isolates from boreal forest soil.

(# 324) Response of Norway Spruce Seedlings to Ectomycorrhizal Inoculation at the Nursery

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One hundred million Norway spruce (Picea abies) containerised seedlings are produced annually in Finland for forest regeneration. However, nearly one third of the seedlings die or are stunted after planting leading to considerable economical losses. The aim of the research project is to study the potential of ectomycorrhizal (EM) inoculation to promote the early development of Norway spruce seedlings. Roughly fifty fungal strains were isolated from spruce ectomycorrhizas and fruiting bodies growing adjacent to young spruce seedlings. The ability of the isolated strains to colonize spruce seedlings was confirmed by mycorrhizal synthesis and the selected strains were identified by ITS sequence analyses. Suitability of the conventional nursery growth media, nursery fertilization, and seed-orchard seed material were estimated prior to the inoculation experiment. Seedlings were inoculated with mycelia of the EM isolates and grown at the nursery. After one growing season introduced EM strains showed highly variable persistence in nursery conditions. In general, EM strains isolated from mycorrhizas were able to colonize seedlings more efficiently compared to the isolations from fruiting bodies. Growth of the seedlings prior to outplanting was not significantly affected by the different inoculums. Seedlings with higher than 30% mycorrhizal colonization by the introduced fungal strain were outplanted for testing their effect on seedlings in field conditions.

(# 325) Alleviation of drought stress on micropropagated Prunus rootstock Myrobalan 29C by inoculation with Glomus intraradices

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Propagation of fruit rootstocks by in vitro techniques is done widely and has become a standard procedure in many nurseries. In these circumstances the plantlets are transferred from sterile in vitro media to potting mixes prepared with organic substrates that lack mycorrhizal fungi and then are transplanted to the field. Early inoculation of plantlets with AM fungi has been shown to enhance growth after transplant and nematode tolerance. In Mediterranean areas drought stress is one of the most common abiotic factors affecting plant production. Micropropagated Myrabolan 29C rootstock were inoculated or not in a peat-perlite mix and after 2 months growth transplanted in 2 liter containers with a sandy soil. The study had a factorial design with two levels of watering regime, normal irrigation and controlled drought(1/3of the normal irrigation output) and three levels of inoculation: Control non-inoculated, control P-amended and inoculated with Glomus intraradices. Six months after transplant, in plants that were not subjected to drought there were no differences in growth between P-amended plants and mycorrhizal plants whilst control plants were significantly smaller. The leaf osmotic potentials were significantly bigger for control non inoculated plants compared to mycorrhizal plants. In plants subjected to stress there was a significant decrease in plant growth for the control and P-amended treatments. However mycorrhizal plants were not affected by the levels of drought imposed, achieving comparable sizes to non-stressed mycorrhizal plants. It might then be concluded that the mycorrhization affects drought alleviation in ways that cannot be solely explained by an improved phosphorus nutrition .

(# 326) Significance of arbuscular mycorrhizal fungi in the re-vegetation process in lahar area of Mt. Pinatubo, Philippines

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The violent eruption of Mt. Pinatubo, Philippines in 1991, deposited very huge amount of pyroclastic materials on and around the mountain. Until now, the deposited materials erode as lahar during rainy season and bury an extensive area. We examined the re-vegetation process in the lahar area of Mt.Pinatubo. In the experimental site in Pampanga, Philippines, more than 10 m of the volcanic deposit covered the original soil surface. Most of the area was sparsely vegetated with only a few gramineous plants, especially Saccharum spontaneum. However, some densely vegetated areas could be found in patch. These patches were characterized by co-existence of the gramineous and leguminous plants such as Calopogonium muconoides which was well nodulated. Growth of the gramineous plants in these patches was greatly favored. In both less and densely vegetated areas, high density of arbuscular mycorrhizal (AM) fungal spores were found. S. spontaneum was slightly colonized with AM fungi while the leguminous plants were highly colonized. AM inoculation experiment carried out in the laboratory involving these gramineous plants showed that these plants were not highly mycorrhiza-dependent but were able to sustain the density of AM fungi. Diazotrophic endophytic bacteria were found with high frequency from the gramineous plant shoots in the less vegetated area but with low frequency from those in the densely vegetated area. The significance of arbuscular mycorrhizal fungi in the re-vegetation process will be discussed.

(# 327) THE GROWTH RESPONSE OF MICROPROPAGATED RHODODENDRONS TO INOCULATION WITH OIDIODENDRON MAIUS AND PHIALOCEPHALA FORTINII UNDER TWO SETS OF CONDITIONS

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Ericoid ornamental species became commercially important commodity. Microplants are produced in a great amount from the tissue cultures, cultivated under controlled conditions in fertilized peat-based substrate and treated with fungicides suppressing the development of mycorrhiza. This may hamper the development of rhododendrons during their introduction to parks and gardens.

Rooted cuttings of Rhododendron cv. Belle-Heller were inoculated with two strains of Oidiodendron maius and Phialocephala fortinii, isolated from the roots of ericoid species. Cuttings were planted in two substrates (natural and commercially produced horticultural) and maintained under conditions, representing i/controlled conditions during micropropagation (sterilized substrates, cultivation in the growth chamber) ii/non-controlled conditions during horticultural cultivation (non-sterile substrates, cultivation in the greenhouse).

In controlled conditions O. maius B increased the growth of rhododendrons in the horticultural but had no effect in the natural substrate. The inoculation with O. maius C and P. fortinii strains had no effect in both substrates.

In non-controlled conditions O. maius C decreased the growth of rhododendrons in the natural but had no effect in the garden substrate. The inoculation with O. maius B and P. fortinii strains had no effect in both substrates.

The effect of the inoculation with oidiodendrons was strain-, substrate- and condition-specific, whereas P. fortinii had no growth effect, even if both strains formed microsclerotia in host roots. We conclude that compatible Oidiodendron strains can positively influence the growth of rhododendrons during early stages of their cultivation, but proper strain-selection has to be done, since also negative effects of inoculation may occur.

(# 328) Ecophysiology of Gnaphalium norvegicum: impact of fungal inoculation at two temperatures

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We aimed to investigate the role of two root associated fungi and temperature in the ecophysiology and germination of an arcto-alpine herb. Seeds of Gnaphalium norvegicum were germinated at 8° or 15°C with or without arbuscular mycorrhizal (AM, Glomus claroideum) and dark septate endophytic (DSE, Phialocephala fortinii) inocula in a climate chamber experiment. Specifically we asked if mycorrhizal growth benefit for the plant would be lower at lower temperature. We found that germination was slower at lower temperature, and P. fortinii inoculation had a positive impact on germination whereas G. claroideum had no effect. G. claroideum formed abundant AM colonization, but P. fortinii did not colonize the roots. Shoot biomasses and nitrogen concentrations were generally lower at lower temperature suggesting that plant growth was nutrient-limited. We also found that the positive effects of AM and DSE on plant growth and nitrogen acquisition were decreased at lower temperature. Consequently, mycorrhizal growth benefit for the host plant was lower at lower temperature. In addition to decreased root nutrient uptake capacity in cold soils, low saprotrophic activity and inactive mycorrhizal symbiosis probably constrain the plant nutrient acquisition in cold environments.

(# 329) United we stand- how the abiotic stressors affect mycorrhiza under the balance between tree-understorey competition and facilitation

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Under abiotic stress the balance between competitive and facilitative plant-plant interactions may change. The goal of the present study is to investigate the role of mycorrhiza in plant-plant interactions in subarctic communities experiencing environmental stress. The stress gradients included are (i) pollution (ii) altitude and (iii) seashore. The studies are conducted in Kola peninsula, NW Russia. The mycorrhizal colonization of ericaceous understorey dwarf shrubs (Empetrum nigrum. Vaccinium uliginosum, V. vitis-idaea) and Betula pubescens ssp. czerepanovii are studied at different levels of abiotic stress. Additionally, the mycorrhizal colonization levels of dwarf shrubs are compared in the presence/absence of a neighbouring tree (Betula pubescens ssp. czerepanovii). The mycorrhizal condition is studied both by microscopical examination and by estimation of fungal biomass in the roots (ergosterol analysis). The questions addressed are: 1) Does the level of abiotic stress influence the mycorrhizal condition? and, consequently, 2) Is the mycorrhizal condition of the dwarf shrubs along the stress gradients affected by the presence of a neighbouring tree? Preliminary results from pollution gradient will be reported.

(# 330) Genomic comparison of isolates of the ectomycorrhizal fungus Paxillus involutus using DNA microarray analysis

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There is a large genetic and physiological variation among different isolates of the ectomycorrhizal (EM) fungus Paxillus involutus. Some of these isolates have specific host or habitat associations. Thus the group provides a useful system for studying the evolution of host and ecological specificities in EM fungi. In order to investigate the genome variability in P. involutus, we have performed comparative genomic hybridization (CGH) using the cDNA array technology. The cDNA array contained PCR fragments of ca 1000 genes, generated from EST libraries of the "house" strain (ATCC 200175) of P. involutus. We estimate that this set covers about 13% of the genes present in the nuclear haploid genome of P. involutus. DNA was isolated, sheared and labeled from five different strains of P. involutus including the house strain and strains varying in host preferences and geographical origin. Based on the ratio of hybridization signals for the house strain ("reference" labeled with Cy3) and the other strains ("samples" labeled with Cy5) we found that all of the analyzed strains shared a set of common or "conserved" genes comprising ca 75-80% of all genes. In addition, hybridization data indicated that a fraction of the genes were highly divergent between the isolates. A majority of these genes were orphans, i.e. they did not display any significant hit to sequences found in public databases.

(# 331) Mutualistic Symbiosis between the Root Endophytic Fungus Heteroconium chaetospira and Chinese Cabbage.

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Chinese cabbage (Brassica campestris) is considered a non-mycorrhizal plant. Hence, no mutualistic fungal partners have been reported. We previously reported that a dematiaceous hypomycete, Heteroconium chaetospira, could colonize the root of the plant endophytically without causing any pathogenic symptoms. Although this fungus did not form any typical mycorrhizal structures in the plant root, it promoted overall plant growth. Therefore, we hypothesized that there is a mutualistic relationship between the fungus and Chinese cabbage. In this study, we investigated nutrient exchanges, including nitrogen and carbon, between them in vitro to prove this hypothesis. The biomass of H. chaetospira-treated plants was greater than that of the control plants when some amino acids, including valin, leucine, and phenylalanine, were amended in the rooting medium as a nitrogen source. It became clear by using a PTFE (polytetrafluoethyleneresin) compartment system that these nitrogen sources taken up by the fungus were transferred to the plants. In addition, fungal-specific carbohydrates, including mannitol, accumulated in the roots of H. chaetospira-treated plants, and the biomass of the fungus increased approximately twice compared to the control treatment. By using a 13C labeling system, we determined that the carbon taken up by the plants were transferred to the fungus. Based on these results, the root endophytic fungus H. chaetospira is mutualistic with Chinese cabbage in vitro.

(# 332) Mycorrhizas and Ecosystem Processes in Tropical Rain Forest

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Most tropical tree species form arbuscular mycorrhizas, but an ecologically important minority of taxa (including Dipterocarpaceae and Leguminosae-Caesalpinioideae pp) form ectomycorrhizas. Recent reviews, based primarily on temperate/boreal research, have concluded that ectomycorrhizal and arbuscular mycorrhizal fungi are associated with ecosystems with low and high rates of nutrient and carbon turnover respectively. In many tropical forests, where phosphorus is likely to be the limiting nutrient, ectomycorrhizal and arbuscular mycorrhizal trees co-exist. Is there niche differentiation between the two mycorrhizal types? It is difficult to get a clear answer without physiological investigation of mycorrhizal fungal species adapted to tropical forest conditions.

In forests, the potential exists for seedlings to become infected by mycorrhizal fungi originating in the roots of adult trees. The extent of seedling infection by adult-derived inoculum, and the benefits or otherwise to the seedling of such inoculum, will determine whether there is negative or positive density-dependent feedback between mycorrhizal infection and host community structure and diversity. As our ability to detect individual ecto- and arbuscular mycorrhizal fungi in the roots of both seedlings and adults improves, it has become apparent that both fungal diversity and the extent of non-random association between fungi and hosts are greater than previously thought. This could have profound implications for community processes.

(# 333) Canola Response to Nitrogen and Sulfur in Ontario

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Spring canola fertilizer recommendations in Ontario are based on data from the 1980's. Trials were initiated in 2000 as part of an effort to update the nitrogen (N) fertilizer recommendations. Other questions being addressed include: 1) are optimal fertilizer rates different for hybrids and open pollinated varieties; and 2) is supplemental sulfur (S) required in southern Ontario?

To address the first question, split plot trials with variety (OAC Summit and Hyola 401) as the main plots and N rate (6 levels) as sub plots were planted at two locations each year. In most cases there were no differences in optimal N rates between the varieties.

For the second question, split plot trials using the hybrid, Hyola 401, were planted at two locations each year. The main plots were three N rates while the sub plots were four S fertilizer rates. Some of the trials showed a response to S, especially at the higher N rates.

(# 334) Molecular detection and monitoring of fungal plant symbionts

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In natural ecosystems most plant roots interact with fungal symbionts, relation which has an important influence on the growth and health of both partners. The study of the fungal symbionts and their interaction with plants in their natural environment has for a long time been hampered by the limited number of morphological characters enabling the detection and identification, for some species, of the fungal partner in the soil or in the plant root system. These studies were mostly based on the detection and identification of the fungal spores, which did not necessarily correlate with the fungal mycelium present in the soil or in the roots.

In this last decade, important advances have been made possible by the continuous development of molecular techniques and their adaptation to the study of the plant-fungal symbionts interaction. Several molecular approaches using different target genes have been used. This has allowed to refine and extend the study of this plant-fungal interaction and to increase our knowledge on the biology of the fungus. It is now for example possible to follow a fungal inoculum in a field after transplantation of an inoculated plant. However many questions remain unanswered, and the new molecular tools that are in development based on the Polymerase Chain Reaction or DNA microarrays will allow addressing some new challenging questions.

(# 335) Enhanced N efficiency in a corn-soybean rotation under Best Management Practices

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This presentation reports N balance in a corn-soybean rotation under Best Management Practices (BMP) compared with Conventional Practices (CP). BMP included zero tillage, optimum N for corn at six-leaf stage according to NO3 test (50 kg N ha-1 in 2000), and cover cropping. CP included fall plowing and recommended N for corn (150 kg N ha-1) at planting. 15N was used to separate dynamics of fertilizer N from soil N. Corn recovered 65% of applied N under BMP compared with 24% under CP. About 70% of corn N was supplied by soil N mineralization. Post harvest residual mineral N (0-90 cm depth) after corn was 78 kg ha-1 under BMP and 142 kg ha-1 under CP. Of the residual mineral N, only 5% was derived from fertilizer under BMP compared with 24% under CP. Unaccounted fertilizer N after corn was 11% (5 kg) under BMP and 23% (34 kg) under CP. Over-winter N loss from the CP was 61 kg ha-1 of which 22 kg was originated from fertilizer. In contrast, over-winter N loss from the BMP was 17 kg ha-1 with only 3 kg from fertilizer. Nearly 50% of the over-winter N loss was by leaching. Soybean recovered < 6% of the residual fertilizer. Soybean obtained 61% of N from biological fixation under BMP compared with 41% under CP. N2O emission under BMP was 45% lower than that under CP. The results show the possibility of significant reduction of N2O emission and NO3 leaching by the adoption of BMPs.

(# 336) Fatty acid synthesis on the Glomerales: key role of the intraradical phase

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Lipids, particularly triglycerides, are the major form of carbon storage in arbuscular-mycorrhizal fungi. A series of experiments were conducted to study fatty acid synthesis of Glomus intraradices and Gigaspora rosea. 14C-Acetate and 14C-sucrose were incorporated into a synthetic culture medium to test the fate of fatty acid synthesis in germinating spores (G. intraradices and G. rosea), mycorrhizal carrot roots and fungal extraradical mycelium (G. intraradices). Germinating spores and extraradical hyphae were completely unable to synthesize 16-carbon fatty acids, but were able to elongate and desaturate fatty acids already present. The growth stimulation of germinating spores by root exudates did not stimulate fatty acid synthesis. Fungal 16-carbon fatty acids (16:0 and 16:1) were only synthesized in mycorrhizal roots. The data strongly suggests that the fatty acid synthase activity of AM fungi is exclusively expressed in the intraradical mycelium.

(# 337) The current status of the North American Proficiency Testing Program for soil, plant, and water analysis

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The North American Proficiency Testing Program (NAPT) was developed five years ago to assist soil, plant, and water analysis laboratories in improving their performance. It was formed by the amalgamation of two proficiency testing programs and seven state/provincial programs. It operates as a membership activity of the Soil Science Society of America (Committee S890). The program provides individual laboratory data to legislative mandated state/provincial certification programs.

Samples are distributed quarterly and results are statistically compiled. The NAPT program uses the median and median absolute deviation (MAD) as robust estimators of central values and variance for all data sets. Warning limits for each parameter are set at +/- 2.5 x MAD. This paper reports the results of the 4th quarter exchange completed in December 2002. A total of 167 laboratories were enrolled in this study.

Soil sample median values ranged from: pH (1:1) 5.10-7.70, NO3-N 5.0-80.0 mg kg-1 (cadmium reduction method), Olsen P (1:20) 7.5-68.7 mg kg-1, K 121-1,101 mg kg-1, DTPA-Zn 0.40-18.3 mg kg-1, TOC 0.58-9.37 mg kg-1, soil chloride 3.9-1,200 mg kg-1, and clay content 4.0-38.4%. Median values for the plant analyses ranged from: NO3-N 36-3,071 mg kg-1, Cl 0.28-1.12%, K (nitric/perchloric) 2.50-4.41%, and Zn (microwave) 18.6-86.1 mg kg-1. Generally the microwave results had the lowest MAD values. Median values for water ranged from: EC 1.15-2.88 dS m-1, Na 7.58-20.8 mmol L-1, NO3-N 0.36-1.44 mmol L-1, and P 0.02-2.41 mg L-1. Sample median value “Acid Recoverable Metals” (based on EPA methods 3050 and 3051) ranged from: As 1.49-7.99 mg kg-1, B 3.50-31.0 mg kg-1, Cu 4.3-34.7 mg kg-1, Pb 6.8-14.0 mg kg-1, S 89.0-675 mg kg-1, and Zn 16.5-180 mg kg-1.

(# 338) Effect of Ground Leaf Litter from Various Plant Species on Ectomycorrhizal Fungal Communities on Pinus rigida Seedlings

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We used transparent acrylic microcosms in which to test the effect of leaf litters of different plant species on ectomycorrhizal fungal communities of pitceh pine (Pinus rigida) and soil microarthropods. Ground leaf litter was intimately mixed with forest humic soil as the rooting medium. Two non-mycorrhizal pine seedlings were planted in each microcosm. Controls consisted of 100 % forest humic horizon material. In the remaining treatments, 75 % humic horizon was mixed with 25 % ground leaf litter from pine, oak, huckleberry or a mixture of all three. Each of these 5 treatments were replicated 6 times. The experiment was harvested after 11 months. All leaf litter species significantly suppressed plant growth, compared to controls, but the soil was significantly dryer in the controls. The total number of mycorrhizas and five of the 8 morphotypes did not differ between the treatments. The abundance of the remaining morphotypes was significantly different between treatments. Cenoccocum geophilum occurred in all treatments but was significantly more abundant in the huckleberry litter. Fresh oak litter contained higher total phenolics and tannins than the other litters. At harvest, oak had highest total organic and inorganic nitrogen content. The response pattern of different groups of soil microarthropods differed between leaf litter species. Our results suggest litter type and quality can influence both the ectomycorrhizal and soil microarthropod community composition.

(# 339) AMF management in restoration of Mediterranean disturbed area

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Previous studies have shown that arbuscular mycorrhizal fungi (AMF) are important for the establishment and maintenance of diverse plant communities. Others demonstrate that disturbance has negative impacts on AMF. So, it is mandatory the promotion of mycorrhizal fungi in restoration of disturbed systems, to allow a quickly soil and plant community rehabilitation. However, the best approach for enhancing mycorrhizal fungi that would then allow late successional plants establishment is not known. One option is to increase native AMF levels in the soil by growing Mediterranean mycorrhizal plants. An alternative approach is to add exotic commercial AMF inoculum directly into the soil. To determine which of the options is more appropriate we conducted a one year experiment under greenhouse conditions. As AMF host plants it was chosen late sucessional Mediterranean plants (Ceratonia siliqua, Myrtus communis, Lavandula luisieri), commonly used in the Mediterranean revegetation programs. We found that after six months of growth, Myrtus roots were the most extensively colonized when commercial inoculum was added compared to native AMF that were naturally present after disturbance. Furthermore, commercially-inoculated plants also gained the most biomass. However, any benefits of inoculating with commercial fungi were lost after the first year. This data suggests that native AMF are able to perform as well as commercial inoculum but required more time.

(# 340) Arbuscular Mycorrhizas in Salt Marshes: Adaptation and Plant Benefits

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Tidal flooding with salt water is one of the major factors affecting vegetation dynamics in salt marshes. Despite colonization has been found in salt marsh plants, little is known about the function of arbuscular mycorrhizas (AM) in this stressful ecosystem. This study aimed to evaluate the tolerance of indigenous AM fungi to salt marsh conditions and to investigate benefits of AM to salt marsh plant growth under tidal flooding. Infectivity experiments showed that the ability of these fungi to colonize the halophyte Aster tripolium L. (plant species with significant mycorrhizal level and with a wide distribution in salt marshes) were more influenced by high levels of salinity rather than by flooding. Increasing flooding levels did not influence fungal activity, suggesting that their functionality is not affected. The influence of AM on plant growth responses to seawater tidal flooding was investigated in two A. tripolium populations (from Dutch and Portuguese salt marshes). The growth of plants from Dutch marsh was neither affected by tidal flooding nor improved by mycorrhiza. Tidal flooding reduced considerably the relative growth rate of non-mycorrhizal plants from the Portuguese marsh, but the presence of AM fungi mitigated this reduction through higher leaf area ratio and namely, through higher net assimilation rate and nitrogen productivity. This study indicates that salt marsh AM fungi were beneficial to A. tripolium growth under seawater tidal flooding improving plant tolerance, although dependent on plant population. Furthermore, it provides evidence that mycorrhizal benefit to salt marsh plants can be environmental factor-dependent.

(# 341) Contribution of the arbuscular mycorrhizal fungus Glomus intraradices to plant uptake of uranium

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Two experiments were carried out with subterranean clover (Trifolium subterraneum L.) associated or not with the arbuscular mycorrhizal (AM) fungus Glomus intraradices. The first experiment aimed to compare the uptake of natural uranium (U) by mycorrhizal and non-mycorrhizal plants. Non-compartmented pots were filled with acid (pH 4.2) or weak acid (pH 5.6) soil, and both soils were labeled with 20 mg 238-U per kg soil. The plant growth period was 5 weeks in soil at pH 5.6, and 8 weeks in soil at pH 4.2. For the second experiment which was set up to determine the role of extraradical hyphae in U uptake by plants, compartmented pots were used to spatially separate a root compartment from a hyphal compartment. Each hyphal compartment was filled with one of the two U-labeled soils described above. U content was then measured in roots and shoots after a growth period of 6 weeks. Results from the first experiment showed that the AM fungus enhanced the U concentration in shoots and decreased the concentration in roots, for plants grown in soil at pH 4.2. No mycorrhizal effect was observed for U uptake in plants grown in soil at pH 5.6. For the second experiment, uptake of U from the hyphal compartment was significantly higher in mycorrhizal plants than in non-mycorrhizal plants for both soils. The U concentration in roots and in shoots was 1.8 to 2.4 times higher for mycorrhizal plants than for non-mycorrhizal plants. The complementary approach of the two experiments demonstrated that mycorrhizal fungi can influence U uptake by plants, and that extraradical hyphae can transport U under different pH conditions where U speciation is dominated by uranyl cation and hydroxyl species

(# 342) Endangered Wetland Plants: Infection by Arbuscular Mycorrhizal Fungi and Dark Septate Endophytes

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Wetlands are endowed with a species rich flora. Nevertheless, those habitats are often destroyed by human impact. Consequently, plant species and the micro-flora in soil are disturbed. As species diversity of arbuscular mycorrhizal fungi (AMF) in soil appears to influence plant biodiversity, this aspect needs to be taken into account for successful ecosystem conservation and restoration. Information concerning the mycorrhization of endangered plant species is still lacking. Therefore, the mycorrhizal status of four red list plants, which are Serratula tinctoria (Asteraceae), Betonica officinalis (Lamiaceae), Drosera intermedia (Droseraceae) and Lycopodiella inundata (Lycopodiaceae), occurring at two different wetland sites (peat bog and fen meadow) in the county of Salzburg, Austria, was determined by paying attention to both, AMF and dark septate endophytes (DSE). Infection intensity of AMF and DSE appeared to be higher in the fen meadow than in the peat bog. Samples taken over the vegetation period revealed that the roots of S. tinctoria and B. officinalis were heavily infected by AMF, observing vesicles and arbuscules. L. inundata showed AMF infection, too, with frequent occurrence of vesicles in spring. In contrast to the species mentioned before AMF infection intensity in D. intermedia roots was low; however, structures typical for AMF infection were observed. S. tinctoria and B. officinalis were heavily infected by DSE, while L. inundata was just slightly infected and D. intermedia did not seem to be infected by DSE at all. AMF spores extracted from sampling site soil were identified as Acaulospora laevis or A. colossica and Glomus etunicatum.

(# 343) Siderophore Release by Mycorrhizal Fungi and Phialocephala fortinii

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For almost all forms of life iron is an essential element. Under iron-limiting conditions, most fungi excrete siderophores as chelating agents which form soluble complexes with Fe3+ with very high stability constants, thus solubilizing ferric iron.

Ericoid mycorrhizal fungi produce as main siderophores ferricrocin and fusigen, respectively. Ferricrocin was also demonstrated to represent the main siderophore of the ectomycorrhizal fungus Cenococcum geophilum, some E-strain fungi forming ectendomycorrhizae, and Phialocephala fortinii as typical dark septate root endophyte. Also orchidaceous mycorrhizal fungi synthesize hydroxamate siderophores. An arbuscular mycorrhizal grass species, which showed greater iron uptake than non-mycorrhizal controls, tested positively when bioassayed for siderophores. The potential to synthesize and release siderophores into the environment will be discussed with regard to their biological significance.

(# 344) Utilization of Seafood Processing Waste as a Nutrient Source for Spelt and Soybeans

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Disposal of seafood processing waste products is of increasing environmental concern. Such wastes contain substantial concentrations of plant nutrients that may be useful in cropping programs, especially organic systems. Experimental batches of lobster and crab processing wastes were composted with sawdust and /or straw. The resulting compost was compared to direct application of the fresh seafood processing waste for soybeans and spelt production in an organic system. Fall and spring applications were also compared. Fall applications were incorporated into the soil within 2 hours of application. Spring applications were not incorporated for the spelt. For soybeans the only incorporation achieved was with the no till drill during planting. Yields of spelt were increased by application of lobster and crab wastes and yield increases were greater from fresh than from composted wastes. Yield increases were associated with increases in N uptake by the spelt. Yields of soybeans were not affected by composted waste but fresh wastes decreased soybean yields. Weed biomass in soybeans was increased by application of fresh wastes. The decreases in soybean yields with application of fresh wastes were probably due to increased competition from weeds.

(# 345) Mycorrhiza-bacteria interactions and functioning in boreal forest soils

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Boreal forest trees are highly dependent on root symbiotic ectomycorrhizal (ECM) fungi and associated bacteria for growth in low pH, lignin-rich podzolic soils. Here, I will take the opportunity to review data on mycorrhiza-bacteria interactions and activities produced in our group. In Scots pine seedling microcosm studies, extensive mycorrhizal fungal colonization of the constituent upper humus (O) and underlying mineral eluvial (E) and illuvial (B) horizons was visualised. Allocation of 14C-labelled current photoassimilate to O, E and B colonizing extramatrical mycelium has been quantified and horizon-specific ECM species identified following ITS-RFLP/sequence phylogenetics. Soil N and P mobilisation and uptake were confirmed in analyses of mycorrhizosphere compartment-specific gene and/or enzyme expression. Bacterial biofilms in O horizon mycorrhizospheres were shown to be mainly comprised of forest soil specific gram -ve bacteria, Bacillus and Paenibacillus spp. based on carbon profiling and 16S sequence phylogenetics. Novel Crenarchaeota 16S sequences were also detected. Preferential organic acid utilisation by bacteria in the external mycorrhizosphere supports mycorrhizal fungal involvement in weathering of E and B horizon minerals. Importantly, Pseudomonas fluorescens was rarely detected in mycorrhizospheres developed in the O horizon and was further confirmed in the rapid loss of marker gene tagged P. fluorescens introduced into mycorrhizal silver birch root systems. However, Scots pine mycorrhizospheres developed on petroleum contaminated soils do support catabolic plasmid harbouring fluorescent pseudomonads and increased hydrocarbon oxidation activity. Based on these data it is hypothesised that, in functional terms, the mycorrhizosphere behaves as an external rumen/gut of the host tree.

(# 346) Variation in plant responses to mycorrhizal colonization in Mediterranean prairie species

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The use of grasses and herbaceous legumes to improve soil stabilisation and soil nutrient content is one of the first steps to achieve the restoration of severely disturbed areas, where mycorrhizal propagules are scarce or inexistent. The use of AM inoculum with plants responsive to the symbiosis can speed soil recovery.The effect of Glomus mosseae(BEG 112) and G. intraradices (BEG 72), alone and in combination, was investigated on C3 grasses and legumes used in soil restoration. G intraradices was better than G. mosseae at colonising the plants root system and improving plant growth, although the mixed inoculum gave the best results.AM inoculation stimulated growth of perennial C3 grasses but reported no benefit to annual grasses. Legumes were the most responsive to AM inoculation. Thus the use of mixed inoculum and perennial grasses and legumes appears as a good strategy for soil restoration.

(# 347) Use of Arbuscular Mycorrhizae in the Control of Nematode and Fungal Root Rot Diseases in Perennial Crops

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Replanting perennial crops, particularly fruit tree and vine rootstocks is actually a dynamic activity in temperate mediterranean environments. Replant situations are more frequent than the establishment of new orchards in traditional production areas, causing high mortality and slow tree growth, and a long term reduction of the orchard productive life.

Plant parasitic nematodes, mainly root-lesion and root-knot nematode species, and soil pathogenic fungi causing white root rots, are the most important soil-borne diseases identified in relation with the orchard re-establishment of perennial crops.

The use of resistant rootstocks is essential when plant survival must be assured. Resistance is available for nematodes in some rootstocks, however, this is not the case for white root rot fungi in which nearly all commercial plant material is susceptible. Even when resistant materials can be used, they cannot be the sole alternative to be considered by growers, because of the pathogenic variability of nematodes and fungi, and because of external abiotic factors that can modify the expression of resistance.

Pre-transplant artificial mycorrhizal inoculation of young plant material is a biotechnological alternative for the induction of plant tolerance to root diseases, that is already being used and tested in natural soils. Encouraging results have been obtained with mycorrhizal fruit tree rootstocks infected with nematodes in which the symbiont enhances growth despite a high nematode build-up in the root system. Ongoing research considers the study of the potential benefits of mycorrhizal inoculation in plants infected by white root rot fungi a priority. This requires a high knowledge of the plant pathogens involved and adequate inoculation methods for assessing the symbiont-pathogen interaction.

(# 349) Application of Fertigation Technology and Oxygen Injection to Glomus intraradices Inoculum Production

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Field application of arbuscular mycorrhizal (AM) technology depends on the production of large amounts of high quality inoculum of AM fungi. Due to the obligate symbiotic characteristics of these fungi, pot culture is the most widely used system for experimental and commercial inocula production. To reduce the costs and constrains associated to this system there is a need to improve and standarise the sporulation of AM fungi achieved in pot cultures. An experiment was conducted to test if the production of Glomus intraradices (BEG 72) inoculum could be improved with the application of a fertigation program and the addition of oxygen in the nutrient solution. Two growing media, sandy soil and volcanic coarse sand, and two nutrient solution formulations were used. After four months growth, differences in inoculum production were significantly related to the substrate used. Host plants grown in sandy soil produced more spores than host plants grown in volcanic coarse sand. Increasing concentrations of K and Mg did not have a significant effect on the final number of G. intraradices spores. The application of oxygen had a stimulatory effect on the percentage of mycorrhizal root colonization but did not affect the final spore count. It is concluded that the use of an automatic program of fertigation is suitable for the large-scale production of AM inoculum.

(# 350) Field Evaluation Report of a Conference Pear Orchard in a Replant Site. Plant Inoculation with Glomus intraradices (BEG 72) is Combined with Organic Amendment and Biocide Soil Treatments

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An experimental Conference pear plantation was established in February 2002 in a replant orchard of Girona, northeastern Spain. Mycorrhizal artificial inoculation of one-year old Conference plants obtained by vegetative propagation was combined in a completely randomised block design with soil desinfection with Metham-sodium and a composted humic soil amendment enriched with microelements. A high population of the root-lesion nematode Pratylenchus vulnus was detected in the soil. There were 4 blocks with 7 trees per block for each of the six treatments considered. Glomus intraradices soil inoculum from stock plants grown under controlled conditions at IRTA Cabrils, was directly applied to the soil under the root systems at planting time. Periodical control measurements have been conducted on the trees. In June 2002, active buds were counted and in December 2002, stem diameter and shoot length were recorded and the total number of buds counted. Results after one-year growth indicate that the best treatments applied are mycorrhizal inoculation in disinfested soil and non inoculated metham-sodium soil treatment.

(# 351) galaxie – a CGI script for sequence identification through automated phylogenetic analysis

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The prevalent use of sequence data as arbiter of species identity through BLAST and similar tools implicitly assumes the target database to be of wide species sampling. This is often not the case, particularly for mycorrhizal fungi, imposing restraints on the propriety of the outcome as basis for species identification. Phylogenetic inference is known to outperform similarity searches in retrieving correct phylogenies and consequently sequence identities. galaxie is a Perl-CGI script system for sequence identification through automated web-based phylogenetic analysis. The query sequence is aligned to a dataset from a nucleotide database and a phylogenetic analysis is carried out. On a test datasets with nuclear ribosomal large sub-unit and ITS sequences from the higher fungi (Basidiomycota: Homobasidiomycetes) and both homobasidiomycetes and heterobasidiomycetes as query sequences, it proved to be a quick and accurate method of phylogenetic assignment of the query sequences. All tested homobasidiomycete and heterobasidiomycete sequences were assigned to the appropriate clades. This makes galaxie a powerful tool for approaching identities of mycorrhizal fungi and organisms in other difficult groups. galaxie was developed as complementary tool for the upcoming mycorrhizal sequence database UNITE. The scripts run in a Linux / UNIX environment through a web server and are easily adapted to specific needs.

(# 352) Community structure and genetic variation within individuals of arbuscular mycorrhizal fungi in undisturbed vegetation based on analyses of LSU rDNA

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The diversity of a phylogenetic lineage of the arbuscular mycorrhizal fungi in the genus Glomus was studied in a coastal grassland dominated by perennials. Roots of Hieracium pilosella were sampled in May, August, October and November along a 30m transect. Glomus sequences in 0.5 cm root pieces were amplified by nested PCR and sequenced. A phylogenetic analysis revealed nine lineages that could be interpreted as phylo-species. Five lineages included known species, but these species were only detected in few samples. The other three dominating phylo-species are unknown.A twinspan analysis divided the phylospecies in two clusters. The two communities were consistent with the first and the last part of the transect, whereas the harvest time did not determine the communities. The two communities were dominated by phylo-species belonging to two distinct monophyletic lineages and there was only little species over lab between the two communities. The sequence variation within the most common phylo-species was studied further, and revealed that the variation within a root fragment was the same as between different plant. Moreover, an analyses of the possible evolutionary history of the sequences indicated that the sequence variation was the result of a clonal evolution. This suggest that the sequence variation originates from the repeats in the LSU-rDNA, and that individual mycelia are homokaryotic and may extend at least 10m.

(# 353) Specific induction of coumestans in roots of Myc- mutants of Medicago truncatula.

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Four mycorrhizal mutants of Medicago truncatula (TR25, TRV25, Y6, P1) have been compared to the wild type J5 for their root content in phenylpropanoid compounds, after 30 days of inoculation by the mycorrhizal fungus Glomus intraradices. These mutants represent three different mutated genes : dmi1(Y6), dmi2 (TR25, P1) and dmi3 (TRV25).

One class of compounds, the coumestans, responded particularly to inoculation by the mycorrhizal fungus : some accumulated 2-5 times more in all Myc- mutants than in J5, and some others were induced in Myc- mutants but were not detected in J5.

One of the major stimulated compounds was coumestrol, a phytooestrogenic molecule, which is known to increase the growth of germinating hyphae of the mycorrhizal fungus Gigaspora margarita in vitro.The question rise about the biological role of coumestans in the interaction between the mycorrhizal fungus and the Myc- mutants, in particular if they are involved in the inhibition of intercellular hyphae development at the level of appressoria.

(# 354) Phylogenetic Relationship of Different Strains of the Ectomycorrhizal Fungus Paxillus involutus

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The phylogenetic relationship between different strains of the ectomycorrhizal fungus Paxillus involutus was studied. Phylogenetic tree analysis using the ITS-region was expected to separate strains of P. involutus into two major groups, a park group and a forest group according to previous studies.The aim of this study was to find out how strains with different host specificity were phylogenetically related and to find strains suitable for further genomic characterization using microarray technology (see abstract Le Quéré et al.).

Phylogenetic analysis was performed. The sequences were aligned with ClustalW and phylogenetic trees were created with MEGA 2.1. Phylogenetic trees were created with the neighbour joining method and the minimum evolution method and they had the same topology and similar support values. The trees were consistant with the former hypothesis and we showed a separation between a park group and a forest group.

The ITS-region is sufficient to separate P. involutus into the park and the forest group, but to get a better resolution within the groups variable genes are needed and these can be pinpointed with DNA/DNA micro array hybridization. This method can also be used to find genes that are controlling host specificity.

(# 356) Macroarray profiling analysis of Medicago truncatula/Glomus versiforme roots reveals novel genes regulated during the arbuscular mycorrhizal symbiosis

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Arbuscular mycorrhizas are mutualistic associations formed between fungi from the order, Glomales and the majority of angiosperms, including many of the agriculturally significant crop species. In these associations, the fungi obtain carbon from their plant hosts, while assisting them with the acquisition of phosphate from the soil. The associations form most readily when the plant partner is limited for phosphate. To gain a better understanding at molecular level about the development, functioning and regulation of the AM symbiosis, a cDNA library was prepared from M. truncatula roots colonized with the arbuscular mycorrhizal fungus, Glomus versiforme. Sequencing of the clones from the library has been conducted and 7351 ESTs have been deposited at NCBI and are also available in the TIGR M. truncatula gene index. Electronic clustering analyses performed by TIGR, indicates that 93 tentative contigs (TC) of ESTs are unique to the M. truncatula/ G. versiforme library and 4421 tentative uni-genes were also identified in this library. Using macro-arrays, the expression profiles of 2228 uni-genes have been monitored during development of the mycorrhizal symbiosis. The arrays were hybridized with 33P labeled first-strand cDNA probes prepared from M. truncatula /G. versiforme roots and mock-inoculated M. truncatula roots. Genes showing significantly altered expression patterns have been identified. Differential expression of a selection of these genes has been further confirmed by northern blot analysis and RT-PCR. The analysis of the mycorrhizal specificity of selected genes and their promoters have been initiated.

(# 357) IDENTIFICATION OF PLANT-ASSOCIATED FUNGAL SPORES AND SPORE-LIKE ORGANISMS

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Fungal-plant root symbiotic associations play critical roles in determining plant community structure, yet identification of specific fungi from soil samples remains vexing. Since species in phylum Glomeromycota do not form complex fruiting bodies, morphological species identification requires informed assessments of variable spore wall characteristics. Identifications are complicated by decomposition processes, the growth of other fungi on or within spores, or morphological similarity to organisms such as animals, protists, plant megaspores, or non-glomalean fungal spores. We are identifying unknown yet extremely common spores and spore-like structures within Wisconsin oak savanna soil samples using morphological and PCR-amplified ITS rDNA sequence characters. We present these results to detail rhizosphere diversity, and also to satisfy the curiosity of those who, like us, have wondered what these things were.

(# 358) UNITE - a molecular database for the identification of ectomycorrhizal fungi

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UNITE is a rDNA sequence database focussed on ectomycorrhizal asco- and basidiomycetes. The database initially holds only sequences from the ITS region. The sequences are generated from fruit bodies collected and identified by specialists and deposited in public herbaria. Selected species also have full descriptions and illustrations linked to the sequences.The purpose of the database is to facilitate identification of environmental samples of fungal DNA. Sequence-similarity searches against UNITE are performed using the BLAST software. BLAST outputs have links to the full database records including information on the fruit body from which the DNA was isolated (where and when collected, who collected and identified, where deposited, etc.). It is also possible to query the database by taxonomy.

Sequences generated from cultures and from soil- or root-tip samples will be accepted in future versions of the database provided they are well annotated and of good quality. We also plan to add alternative identification tools.

UNITE is a relational database built on a MySQL Linux platform. It is accessed through a Web-interface programmed with the PHP scripting language.

The development of UNITE is a Nordic-Baltic initiative and a collaboration between several research groups. The project links experts in fungal taxonomy and ecology and also forms part of a student-training network funded by the Nordic Research Council.

(# 359) Ectomycorrhizas of Gnetum africanum in Cameroon

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Gnetum is a pantropical ectomycorrhizal (ECM) gymnospermous genus. In W. Africa, Gnetum spp. are lianes that grow in secondary forest and fallow fields and the leaves are highly prized for food. In Cameroon extensive collection may threaten the wild population, and domestication is desirable. To facilitate the establishment of plantations some knowledge of mycorrhizal diversity is desirable. A field survey at 15 sites throughout Cameroon showed that ectomycorrhizas were largely confined to the top 20cm of the soil profile. Only three ECM morphotypes of Gnetum were recorded. This is unusually low mycosymbiont diversity for an ECM host. No arbuscular mycorrhizal infection was recorded. The most common ECM morphotype was formed by Scleroderma sinnamariense, a fungus which also has a pantropical distribution. Growth of this fungus in pure culture is slow on standard media, but is improved by the addition of peptone. This poster reports on methods to improve growth and to produce inoculum for experimental syntheses

(# 360) Physiological Monitoring During Early Mycorrhization Events

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Ectomycorrhizal associations have a deep effect in plant C and N metabolisms. The mycorrhiza establishment leads to an increase in the demand of carbohydrates, for fungal maintenance and growth. In addition, association with ectomycorrhizal fungi can improve nitrogen acquisition by plants, playing a key role in nitrogen nutrition of forest trees. The establishment of ectomycorrhiza, therefore, must lead to deep changes in C and N metabolisms and readjustments of the mechanisms that balance them. Although the beneficial role of mycorrhizal symbiosis has been repeatedly observed, namely on the photossystem II activity, there have been reported cases where mycorrhizal inoculation provoked first a decrease in the photochemical performance of the plant, followed by an increase to higher levels than those found prior to mycorrhiza establishment.

In this study we tried to address the question of how the readjustments in plant metabolism take place in the early stages of mycorrhiza establishment, and how they are dependent on the level of N available in the medium.

Pinus pinaster plants were grown in gnotobiotic conditions, and inoculated with Pisolithus tinctorius mycelium. Controls were inoculated with dead mycelium. The plants were fed either with 2mM or 4mM ammonium as N source. Ectomycorrhiza establishment was monitored through daily chlorophyll a fluorescence measurements, and the analysis of fast fluorescence kinetics O-J-I-P. Our results show that changes in chlorophyll a fluorescence parameters were related to the mycorrhization status, and proved to be a useful non-invasive tool to monitor physiological responses of plants during early mycorrhization events.

(# 361) Copper Adapted Suillus luteus, a Symbiotic Solution for Pines Colonising Cu Mine Spoil.

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Copper mine spoils in Central Norway are slowly colonised by trees, ericoid plants and grasses. These mine spoils offer an extremely toxic and stressfull environment both with regards to metal content, low pH and drought. Roots of pines colonising the spoils are well colonised by representatives of the "Hymenoscyphus ericae aggregate". An ectomycorrhizal basidiomycete also present in this harsh environment is Suillus luteus, a species that was previously shown to adapt to extreme Zn pollution. S. luteus sporocarps from the Cu spoils were cultured and their sensitivity towards Cu was tested in vitro. Isolates from nonpolluted areas as well as Zn tolerant isolates were included in the Cu screening. The S. luteus population from the mine spoil is considerably more Cu tolerant than the populations from unpolluted or Zn-polluted areas. In a subsequent plant experiment, the effect of sublethal Cu concentrations on pines mycorrhizal with either a Cu-adapted or a Cu-sensitive S. luteus isolate was studied. A dose response experiment was performed. Growth of the Cu adapted fungus was hardly inhibited over the Cu gradient used in contrast to the growth of the Cu sensitive strain. Nutrient uptake analyses (ammonium and phosphate) showed complete failure of P uptake at 60 µM Cu in the sensitive plant-fungus combination. In the Cu tolerant combination, nutrient acquisition of the pines was only slightly reduced. The genetic adaptation for increased Cu tolerance in S. luteus is required for its own survival and to maintain nutrient acquisition in pines exposed to high Cu concentration.

(# 362) Mycorrhizal inoculation increases growth of Rosmarinus officinalis grown at elevated CO2

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Atmospheric enrichment with CO2 is currently used in nurseries to stimulate photosynthesis of herbaceous plants that results in increased plant growth rate, shortening the production time. The effects of CO2 enrichment (ECO2) in plant production are less clear for woody species due to the different pattern of biomass allocation. Many Mediterranean woody species have been shown to be mycorrhizal, thus the importance to ascertain the interactions between mycorrhizal inoculation and CO2 enrichment. Rosmarinus officinalis cuttings were inoculated or not in a peat–perlite mix, then transplanted to 1 litre containers with a peat-perlite mix and grown in a greenhouse with fertirrigation. The greenhouse was compartmentalized in three sections one with ambient CO2 (350mm), the other with 500mm CO2 and the third one with 750mm CO2. After 2.5 months growth plants in 500mm CO2 and 750mm CO2 were bigger than plants at ambient CO2.

After 5 months growth, Non mycorrhizal plants had an increased total growth in response to CO2 enrichment at 500mm but growth was depressed at 750mm CO2. Additionally when measuring the relative growth rate (RGR) of plants under ECO2 compared to plants grown under ambient CO2, only mycorrhizal plants showed a positive RGR, resulting in a total increased growth both at 500mm and at 750mm CO2

The results confirm the importance of the symbiosis as a C-sink that would allow the continuation of the incorporation of CO2 through an increased photosynthetic rate at higher concentrations of CO2

(# 363) Potentiation of defence response induced by arbuscular mycorrhiza and systemin in tomatoes plants.

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Arbuscular mycorrhizal (AM) has been more used in the tropical agriculture by the benefits which it contributes to development of the economic import crops. However, its potential as biological control has been little studied. The AM symbiosis induce local and transient defense response, it was confine to root. The mixed used with the systemic response elicitor like systemin could allow the radical and foliate protection. In the present work we study the dynamic of chitinases and b-1,3,-glucanase activity induced by arbuscular mycorrhizal fungus (AMF), (Glomus clarum and Glomus fasciculatum) and systemin in tomatoes plants (Lycopersicon esculentum L. Mill). It was found on influence of AMF species as well as tomato variety on the induction and expression of PRs studied. In Amalia variety b-1,3,-glucanase activity was 10 time larger than the one obtained in Rio Fuego variety. Both AMF species induced in this enzymes more high level than control plants The activity induction by systemin and the potential effect on the AM was the more important result. The AM and systemin combination induced the incressed livil of this PRs, which was not observed in the other treatment. This result was confirm by the electro focusing (IEF) in which a more intensity band (pI 4.0) was obtained. An additional form relate to systemin application was observed (pI 6.2).

(# 364) Effect of the inoculation with Glomus intraradices in plant growth and water relations of Rosmarinus officinalis under drought

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Rosmarinus officinalis plantlets were inoculated or not with Glomus intraradices (BEG 72) in a peat-perlite mix. After 2 months growth plants were transplanted in a greenhouse bed filled with sandy soil. Plants were grown for 15 months with artificial irrigation simulating Mediterranean climatic conditions, with 300mm rainfall distributed through the year according to average recorded data for the last 10 years. There were no differences between mycorrhizal and non-nycorrhizal plants in the evolution of the measured water relation parameters: xylem water potential, stomatal conductance and transpiration.

However plant survival was significantly different, 100% of mycorrhizal plants survived while only 70% of non-mycorrhizal plants lasted till the end of the study At harvest mycorrhizal plants had an increased root leght, increased specific root length and increased leaf area.

(# 365) Consequences of increased nitrogen supply and altered root allocation on the ectomycorrhizal communities of a temperate deciduous ecosystem

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The impact of high inorganic nitrogen (N) deposition on ectomycorrhizal fungal communities in temperate deciduous ecosystems is not understood. In a temperate oak savanna, we examined two co-occurring consequences of elevated N deposition, increased N supply and altered root allocation, on ectomycorrhizal fungal communities in a 16 yr N addition experiment in which replicate 1000 m2 plots received 0, 5.4 (moderate fertilization), or 17 g N m-2 yr-1 (high fertilization). High fertilization more than doubled inorganic N, nearly halved oak fine root length and biomass yet doubled fine root production and turnover. In the 14th, 15th and 16th year of fertilization, total sporocarp richness was reduced by >50% in both fertilization levels while Russula spp. produced approximately five times more sporocarps with high fertilization. In the 14th and 15th year of fertilization, belowground treatment-scale species richness and species area curves were lower with high fertilization but smaller spatial scale richness, diversity indices and evenness were not. Dominant fungi colonizing roots collected in savanna and oak seedling bioassays included Cenococcum geophilum, common in all treatments, Cortinarius spp., dominant in unfertilized plots, and Russula spp., dominant with high fertilization. In contrast to Russula spp. in coniferous ecosystems, oak savanna Russula exhibit "nitrophilic" responses suggesting species-specific impacts of N increase depend on particular host plant-fungi combinations. Belowground diversity at smaller spatial scales may be constant because diversity-promoting effects of increased fine root productivity counteract adverse effects of increased N.

(# 366) DO INDIVIDUAL HOST TREES SUPPORT DIFFERENT COMMUNITIES OF ECTOMYCORRHIZAL FUNGI?

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In order to test the hypothesis that individual trees of contrasting genotype growing together in the field support different communities of ectomycorrhizal fungi, it is necessary to identify the tree to which a particular root fragment belongs. Here we describe a microsatellite-based approach to this problem, and present some preliminary data on EcM communities.

An area of native Scots pine (Pinus sylvestris var scotica) woodland was selected, characterised by chemotypic (monoterpene) variation amongst the pine trees. Five trees of known different chemotype were identified in close proximity to each other.

Soil cores were taken along transects running from a central tree to each of the surrounding four trees. Individual root fragments were extracted from the cores, coded, and the ectomycorrhizas present counted and classified into morphotypes. Representative tips from each morphotype were identified by ITS PCR combined with RFLP and sequencing. The root tip material was then used to determine the origin of the root fragment by a microsatellite approach, in which needles from the individual pine trees were first microsatellite-fingerprinted and the fingerprints were then used for linking root fragments to the individual host pines.

(# 367) The Effects of Storage Methods on Inorganic Nitrogen in Southwestern Ontario Soils.

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Large numbers of soil samples are submitted to commercial laboratories for pre-sidedress N analysis to determine N fertilizer requirements for corn. Due to the large numbers of samples and time constraints, various storage methods such as air drying, freezing and refrigeration are used to preserve samples prior to extraction and analysis. The objective was to determine if storage technique affects the amount of inorganic N extracted from these soils as compared to immediate extraction and analysis. We collected 125 soils across Southwestern Ontario and compared storage at 40C for 1, 2, 3, 4 and 7 days with freezing and air drying. Soil storage method and duration was found to alter the amounts of extractable NH4+-N and NO3--N. Air drying soils increased extractable NH4+-N and NO3--N by 76% and 6%, respectively whereas freezing increased extractable NH4+-N by 22%. There was little change in NH4+-N and NO3--N with storage up to 4 days, but there was a noticeable decrease in NH4+-N and increase in NO3--N after 7 days. Hence, soils should be stored at 40C and extracted within 4 days for NH4+-N and NO3--N. Freezing and air drying are not recommended for NH4+-N analysis.

(# 368) Diversity and spatial heterogeneity of ectomycorrhizal fungi in oak savannas

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Oak savannas are unique, spatially heterogeneous ecosystems, codominanted by ectomycorrhizal trees and arbuscular mycorrhizal prairie grasses and forbs. These ecosystems are critically endangered, with, for example, only 0.02% remaining of the original oak savannas of the Midwestern region of North America. In a series of studies, we examined the belowground ectomycorrhizal fungal diversity of oak savannas, the effect of fire on diversity, and the spatial heterogeneity of ectomycorrhizal fungi as related to distance from trees. We have found more than 130 unique RFLP-types in belowground sampling. Although belowground diversity is higher in closed-canopy forests than savanna, frequently-burned savannas contain a number of species of fungi not found in closed-canopy forests. Therefore, the combination of savanna and closed-canopy forests results in high ecosystem diversity. In-situ oak seedling bioassays have revealed that oak savannas are spatially heterogeneous in terms of seedling ectomycorrhizal infection, with 64% of root tips infected on seedlings near trees compared with 28% infection distant from trees. Based on transects at forest / field edges, ectomycorrhizal infection of seedlings remains high up to around 16 m from trees and then abruptly declines. We hypothesized that niche partitioning by ectomycorrhizal fungi along a distance gradient from trees would contribute to total fungal diversity; however, very limited evidence of niche partitioning was found. These studies document the extremely high diversity of ectomycorrhizal fungi in oak savannas, and the role of fire in maintaining this diversity.

(# 369) Effects of two cultural methods of insecticide application on soil Collembola and Mite populations in commercial potato fields on Prince Edward Island

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The effects of in-furrow and foliar insecticide applications on Collembola and Mite populations in four commercial potato fields on Prince Edward Island were examined. All four fields were ploughed in the fall and spring using a Moldboard or Chisel System. After planting, the fields received one pass of either a Rumptstad or Gruise hiller. Each field was divided into two sections: one received an in-furrow insecticide application and the other foliar sprays for insect pest control. Soil cores 8x8cm (hxd), 20 per section, were collected from each field on two sampling dates - once in the spring after planting, and once in the fall before harvest. The Collembola and Mites were extracted in the laboratory, using a modified Tullgren extractor, and counted. Results showed a significantly lower number of Collembola in the foliar-treated sections in three fields this difference was observed in both the spring and fall samples. There was no difference in the mite population between the two sections for both sample dates. Overall, in all four fields, the Collembola population was significantly lower in the fall sample; this may be because of unseasonally dry conditions experienced over the summer. The Mite population, however, showed the opposite trend with significantly higher numbers in the fall sample. Thus, insecticide application methods influence Collembola populations but have no effect on mite populations.

(# 370) Soil Organic Carbon and Management: Improving on the default IPCC coefficients for Canada

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To fulfill commitments to the Kyoto Protocol, Canada is required to provide verifiable estimates and estimates of uncertainties of soil organic carbon (SOC) stocks, and changes in those stocks over time for agricultural soils. The Intergovernmental Panel of Climate Change (IPCC) established methods for the inventory of greenhouse gas emissions from all sources. For changes in agricultural management practices for the inventory period, the IPCC has derived a simple model for estimating changes in SOC stocks. Coefficient estimates and uncertainties for the model can be derived from long-term studies that have measured differences in SOC between different management practices. We compiled published data from a total of 62 long term studies in Canada to assess the effect of agricultural management on SOC. There was a loss of 24 ± 6% of the SOC after native land was converted to agricultural land. No-till (NT) increased the storage of SOC in western Canada by 2.9 ± 1.3 Mg ha-1; however, in eastern Canada conversion to NT did not increase SOC. In general, the potential to store SOC when NT was adopted decreased with increasing background levels of SOC. Reducing summer fallow, incorporating hay into rotation with spring wheat (Triticum aestivum L.), incorporating green manures, application of N and organic fertilizers were the practices which tended to show the most consistent increases in SOC storage. Results of this analysis allow us to estimate the net contribution of agricultural management for Canada stratified by soil type and climatic region.

(# 371) Effects of stage of maturity on ensiling characteristics and ruminal nutrient degradability of oat silage

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A study was conducted to determine the effects of stage of maturity on ensiling characteristics and ruminal nutrient degradability of oat silage. Oat was harvested at the boot or soft dough stage and ensiled in mini-silos for 0, 2, 4, 8, 16 and 45 d. Two lactating Holstein cows fitted with ruminal fistulas were used to determine ruminal nutrient degradability. Regardless of stage of maturity, forages went through a rapid fermentation with a sharp decline in pH during the first 2 days of ensiling. Extensive proteolysis took place between 0 and 2 d as indicated by a reduction in true protein and an increase in non-protein nitrogen (NPN). Maturity had little or no effect on neutral detergent fiber (NDF) and acid detergent fiber content of oat silage. However, oat harvested at the boot stage contained less crude protein (CP) and more starch than that harvested at the soft dough stage. Distribution of protein fractions showed that oat harvested at the boot stage contained lower NPN, neutral detergent insoluble protein, and acid detergent insoluble protein that oat silage harvested at the soft dough stage. Results of the in situ incubation experiment indicated that oat harvested at the soft dough stage had lower ruminal dry matter (60.6 vs 66.4%), CP (81.3 vs 88.7%) and NDF (35.4 vs 42.2%) degradabilities than oat harvested at the boot stage. It was concluded that chemical composition and ruminal nutrient degradability of oat silage are significantly influenced by stage of maturity.

(# 372) Effects of cultivars and fertilization on soybean isoflavone content

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Soybean seeds contain phytoestrogens that have been reported to have numerous benefits on human health. The increasing demand for soybean products and especially for isoflavone-rich products represents a new niche market for Canadian producers. The impact of management on soybean isoflavone concentrations, however, remains poorly understood. Field experiments are conducted in Montreal, QC to determine the impact of P, K, S, and B fertilization on soybean seed isoflavone concentrations and to determine the variation among soybean cultivars recommended in Eastern Canada. Daidzein, genistein, and glycetein concentrations in seeds are determined by HPLC. Twenty cultivars were evaluated at two sites in 2002. There was significant variation in isoflavone concentrations among cultivars, total concentration ranging between 384 and 1220 ug/g. A significant site by cultivar interaction was observed; however, S08-80 consistently had the greatest isoflavone concentrations and AC Orford the lowest. The effects of P (0 to 45 kg/ha), K (0 to 150 kg/ha), S (0 to 45 kg/ha), and B (0 to 4.5 kg/ha) fertilization on soybean isoflavone concentrations were evaluated at one site. Results indicated that effects of fertilization may be limited.

(# 373) Nitrogen Deposition Effects on Mycorrhizal Communities in the New Jersey Pine Barrens

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Nitrogen deposition is increasing globally and most systems that have been studied are mesotrophic temperate forests with a relatively long history of N deposition. In these systems, mycorrhizal diversity is decreased and forests decline. In contrast, we studied oligotrophic forests in the New Jersey pine barrens. We located three forests along a transect from central (near NY city) to southern New Jersey. We expected to observe elimination of rare or sensitive species along the gradient. We also predicted that the oligotrophic pine barrens might be more sensitive to N deposition since the system is adapted to low N concentrations, therefore reaching saturation at lower levels of N input than in other forests. As predicted, there was lower richness of mycorrhizal types ($p = 0.0120$) and lower abundance of mycorrhizal root tips ($p = 0.0210$) at the northern end of the gradient. A greenhouse study corroborated this pattern. Abundance ($p = 0.0002$) and richness ($p = 0.0145$) were decreased under application of 35 and of 140 kg N ha-1 yr-1. Pitch pine seedlings were also much reduced in overall growth below ambient N controls in the 35 and 140 kg N ha-1 yr-1 additions, in shoot height ($p < 0.0001$; 23% and 30%, respectively), shoot mass ($p < 0.0001$; 57% and 65%) and in root mass ($p < 0.0001$; 53% and 67%), though shoot:root ratios ($p = 0.4632$) did not vary among treatments. These results indicate that added nitrogen may have profound effects on this oligotrophic pine barrens ecosystem.

(# 374) Succession of ectomycorrhizal fungi in Scots pine afforestations on brown coal quarry heap

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Scots pine is the most important tree used for afforestation of post-industrial areas in Poland. Performance of trees in such areas depends largely on their mycorrhizas. To investigate ectomycorrhizal fungal community of young pine trees planted on brown coal quarry in central Poland, the research project has been started in 2001. Its aim is to study spontaneous succession of ectomycorrhizal fungi as seen from above- and below-ground, and relationships between development of mycorrhiza, health status of trees, and success of afforestation practices. Observations are carried out on eight 1000 m^2 permanent plots established on 1 to 14 years old Pinus sylvestris stands. Pairs of plots differing in health status have been chosen. Fruitbodies and ectomycorrhizal communities on all plots are subject to qualitative and quantitative analyses using classical and molecular methods. Fruitbodies of nearly 70 species of ectomycorrhizal fungi were recorded. A shift in species number with pine age was observed (with exception of the oldest plot) up to 35 species on the 8 years old plot. At first 5 years of pine growth Suillus luteus and Rhizopogon luteolus were dominating species. Later they were accompanied by species of Hebeloma, Inocybe and Cortinarius. After formation of the forest-type field layer, species of Tricholoma prevailed. Mass production of carpophores of some species was noted (e.g. Rhizopogon luteolus, Hebeloma mesophaeum, Tricholoma terreum). Preliminary investigation suggests that fungal species vary in their strategy regarding production of ectomycorrhizas vs fruitbodies. It was also observed that ectomycorrhizal community differs between pine stands of different health status.

(# 375) Ectomycorrhizal Associations of Larix laricina (Tamarack) and Betula glandulosa (Scrub Birch) Growing in Wetland Ecosystems of Central British Columbia

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Uniquely characterized by having deciduous needles, tamarack (Pinaceae) is well adapted to cold climates and short growing seasons in British Columbia's central interior. Here, it often occurs in association with scrub birch (Betulaceae), in organic Sphagnum peat in lowland bogs or fens. Effective nutrient acquisition and the ability to tolerate fluctuating water tables are traits that may enhance survival, growth, and reproductive strategies in a nutrient deficient, poorly drained environment. Ectomycorrhizal relationships formed between plant roots and fungi, and the fungal linkages between hosts, may play important roles in the success of these tree species. This project addresses questions ofectomycorrhizal fungal identity and diversity, as well as possible linkages existing between tamarack and scrub birch. Young tamarack and scrub birch trees were randomly sampled from three different fen composition types within the SBS biogeoclimatic zone in the Prince George region in British Columbia. For each tree sampled, the abundance and diversity of ectomycorrhizae (200 root tips per tree) were characterized morphologically using standard light microscopy. Twenty-three fungal morphotypes were described for tamarack (24 trees) and 28 fungal morphotypes for scrub birch (36 trees). Ten morphotypes appeared common to both plant species, supporting the hypothesis of possible fungal linkages between tamarack and scrub birch. Results from abundance and diversity analysis are presented. Molecular analysis, using PCR-RFLP protocols and DNA sequencing is currently underway and will further resolve genotypic differences within fungal morphotypes, clarify linkage relationships, and extend the information gained on these mycorrhizal associations.

(# 377) Field Studies of the GPR Ground Wave Method for Estimating Soil Water Content During Irrigation and Drainage

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Knowledge of ground wave penetration depth and methods for facilitating ground wave velocity analysis are important practical aspects to consider when measuring soil water content with surface ground penetrating radar (GPR). A field study was conducted to optimize the wide angle reflection and refraction (WARR) and fixed offset (FO) methods of measuring the ground wave velocity and to find the effective ground wave sampling depth under irrigation and drainage conditions. In this study, a GPR system with 450 MHz antennas was used at a sandy loam soil site. Water contents measured with time domain reflectometry (TDR) were used to determine the sampling depth of GPR based water content estimates. Cumulative irrigation and drainage calculated with GPR were found to be more closely related with cumulative irrigation and drainage measured with shorter TDR probes, suggesting that the ground wave sampling depth was in the 0.30 ~ 0.50 m range. During the infiltration phase, the depth of the ground wave penetration was found to be in the 0.23~0.56 m range, assuming a sharp boundary between wet and dry sand. A minimum of three different transmitter to receiver offsets was needed to obtain an acceptable water content measurement with the WARR method. Comparison of water contents measured with the WARR and FO methods revealed that an antenna separation distance of 1.5 ? 2.0 m was required to obtain reasonably accurate results with the FO method.

(# 378) Identification of symbiosis-specific 'AM-fungal' genes with Geosiphon pyriformis

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Geosiphon pyriformis is the only known fungus forming endosymbiosis with cyanobacteria. Together with the arbuscular mycorrhizal (AM) fungi, Geosiphon belongs to the new fungal phylum Glomeromycota, meaning that the Geosiphon/Nostoc consortium represents a symbiosis of a glomeromycotan fungus with a photosynthetically active prokaryote. Due to this unique life style,we can use Geosiphon for the identification of fungal genes playing key roles in the AM symbiosis. Compared to the AM, this approach has the great advantage that fungal, polyadenylated mRNA can be specifically isolated from the prokaryotic mRNA. In the Geosiphon/Nostoc and AM symbioses, the symbiotic interfaces - more specifically the perisymbiotic membranes - are the sites for nutrient exchange between the partners. The mycobiont receives mainly organic compounds. Therefore, specific fungal transporters are required at the symbiotic interface and should be inducible by certain conditions. We have investigated the effects of light and darkness incubation for 72 hours (+/- photosynthesis of the cyanobacteria) on the expression patterns of fungal mRNA, expecting transporter genes and carbon-metabolism genes to be differentially expressed. Methods were established to reproducibly isolate fungal mRNA from small samples by means of magnetic beads. After reverse transcription, cDNA was amplified by 'SMART LD-PCR' and digested with Rsa-I. cDNAs corresponding to differentially expressed genes were enriched by linker adaptation, subtractive hybridisations, specific amplification by PCR, and cloning. Nylon-membranes carrying 300 blotted cDNA fragments were screened with forward- and reverse-subtracted cDNA probes. About 5% corresponded to differentially expressed genes. The results were confirmed by RT-PCR with gene-specific primers.

(# 379) Ectomycorrhizal Communities of Black Spruce (Picea mariana (Mill.) BSP) Across an Environmental Gradient in Central British Columbia

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Ectomycorrhizal (ECM) symbioses form one of the primary systems for nutrient exchange in northern coniferous forests. ECM communities consist of a diversity of fungal species that exhibit variable patterns of distribution, depending on host plant species, soil properties, and environmental factors. Using morphological and molecular (PCR-RFLP) techniques, this study describes ECM community composition and diversity of black spruce across its ecological range in BC's central interior. Black spruce habitats included Sphagnum-wetlands, characterized by cold, poorly aerated, organic soils with low nutrient availability (both pure black spruce and spruce – tamarack stands) and upland spruce - pineforests, characterized by clay-containing soils exhibiting seasonal cycles of moisture surplus and deficit. Fifteen naturally regenerating seedlings were randomly sampled from each of the three habitat types and 200 root tips per seedling were selected for morphological analysis. Using light microscopy,a total of 33 ECM morphotypes were described, 14 of which were found on three or more seedlings.Some morphotypes were detected in all habitats (generalists), while others were associated with specific habitats (specialists). Molecular analysis of 10% (n=888) of all morphotypes revealed varying degrees of within-morphotype diversity and showed some habitat-specificity of genotypes within generalist morphotypes. Results may indicate ecotypic adaptation of ECM in response to heterogeneous environmental conditions. ECM community diversity was greatest in uplands and lowest in pure spruce wetlands, possibly due to better edaphic conditions or alternate inoculum sources. This study emphasized the importance of sampling across an ecological range to describe ECM communities associated with a particular host species.

(# 380) Vegetative buffer efficiency in an irrigated pasture system

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Irrigated pastures are found within watersheds providing much of Western North America's surface drinking water supply. Vegetative buffers are often proposed to attenuate nutrient pollutants in runoff, but there is limited information on the mechanistic functioning of buffers adjacent to irrigated pastures. This study is intended to fill this gap in knowledge by examining specific vegetation, soil, and landscape characteristics controlling buffer efficiency and capacity.

At the University of California Sierra Foothill Research and Extension Center, established flood-irrigated plots with three different buffer treatments are being used to characterize the attenuation of N, P, and sediment by buffers. Stable 15N isotope tracer was applied to quantify the fate of NO3 moving through the pasture and buffers. In the first 10 days following application of the 15N tracer, 3% of the tracer was lost as runoff, 67% was taken up by grass in the zone of application, 4% was taken up by vegetation within the buffers (2% in the first 4m of buffer and 2% in the remaining 12m), 19% was stored in the A horizon of the soil, and 7% was lost via leaching. Results presented will include the effect of buffer length on nutrient attenuation, the relative importance of different N pools for NO3 retention, and the spatial variability of soil properties as a factor contributing to variation among treatments. This research will allow land managers to maximize efficiency of riparian buffers adjacent to irrigated pasture, potentially increasing the adoption of vegetated buffers as a management tool.

(# 381) Variation in Function of Arbuscular Mycorrhizal Fungi from Acidic, Alkaline and Neutral Soils

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Ecosystems that span large abiotic gradients over short geographical distances provide an opportunity to study adaptations to extreme environmental conditions. Within one thermal basin of Yellowstone National Park, plants grow across wide gradients of pH (3.5-9.3) and soil temperature (up to 55°C).We assessed effects of thermal and non-thermal arbuscular mycorrhizal fungi (AMF) on plants growingin soils ranging from acidic to alkaline in the greenhouse. We grew three species native to thermal areas (Dichanthelium lanuginosum, Agrostis scabra, Mimulus guttatus) with four AMF treatments (no-AMF, non-thermal AMF, alkaline thermal AMF, acidic thermal AMF) and three pH watering treatments (3.5, 6.5, 9.5). Plants were adversely affected by the 3.5 and 9.5 pH treatments, evidenced by reduced flowering. Additionally, plants watered with pH 9.5 solutions had less biomass. AM from acidic and alkaline thermal areas differed in their effects on host plants; plants were larger when grown with AM fungi from acidic sites, but had higher tissue P concentrations when grown with alkaline AM fungi.And while plants grown with pH 3.5 treatment were larger when associated with acidic than alkaline AM fungi, AM fungi did not consistently benefit plants grown under a pH regime similar to their origin. AMF from acidic and alkaline thermal areas significantly affected plant biomass, shoot:total biomass, and tissue concentrations of P, N, Al, and Zn. However, the magnitude and direction of the effect variedwith AMF source, plant species, and water treatment indicating functional differences between species or ecotypes within one thermal basin

(# 382) Global Warming and Drought Effects on Mycorrhizal Fungi

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Warming temperatures and altered precipitation regimes are predicted for much of the world during the 21st century. In particular, the International Panel on Climate Change predicts increased summer drying over most mid-continental land interiors with heightened risk of drought. These changes are likely to affect the community composition and diversity of host plants and their associated mycorrhizal fungi. We review and synthesize the available data on the consequences of warming temperatures and drought on the abundance and community structure of mycorrhizal fungi. In addition, we use the results of our recent studies on mycorrhizal associations with host plants in the arid southwestern United States to develop a conceptual model describing the potential interactions between drought and ectomycorrhizal fungi, incorporating likely feedbacks on host plant performance. Data so far suggest that drought stresshas variable effects on rates of mycorrhizal colonization and fungal diversity, but rapidly alters mycorrhizal community composition. Part of this community shift is a trend towards drought-induced increases in ascomycete abundance among the ectomycorrhizal fungi.

(# 383) Stratigies of Copper Fertilization of Wheat in Manitoba - Foliar Applications

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Yield responses to Cu are very much influenced by both product and method of placement. Earlier work had established broadcast and incorporation as the most efficient and in most cases the only effective method of applying Cu to soils. Unfortunately, not all copper deficiencies are identified at the time of seeding. Foliar applications may be needed to supply a quick solution to copper deficiency. The objectives of this project were to assess the effectiveness and best timing of application of two types (one sulphonic acid and one oxychloride based) of foliar products on wheat. A split-plot design with the two products (Tiger Tech 5% and Coptrel 500) as main plots and various growth stages (Feekes 2, 6 2&6 and 10 – tillering, first node visible, both at tillering and first node visible and early booting) as sub-plots were replicated six times. There was a significant ($P<0.05$) yield response to foliar Cu application in both years of the experiment. Foliar application of a sulphonic acid based Cu product provided maximum yield when applied at Feekes 6 stage (first node visible); an oxychloride product did not consistently provide maximum yield. Application of foliar products either at early or late growth stages of wheat did not provide maximum yield in both of the experiments.

(# 384) Scanning Electron Microscopy of Spore Walls of Arbuscular Mycorrhizal Fungi

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Spore wall characteristics are important determinants in the taxonomy and systematics of arbuscular mycorrhizal fungi. Interpretation of these characters is largely based on light microscopy and transmission electron microscopy. Scanning electron microscopes have been used to study the surface ornamentation of spores, but not wall structure itself. We have developed two simple techniques for observing crushed spores, providing new observations of the various layers of the spore wall and inner walls. Images of fungi from the genera Acaulospora, Entrophospora, Gigaspora, Glomus, and Scutellospora will be presented, and the results will be compared with observations at the light microscope level. Our observations will help to solidify interpretations of spore wall structure and may be useful in phylogenetic analyses based on morphological characters.

(# 385) Exploring Structural Definitions of Mycorrhizas

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The seven categories of mycorrhizas have been defined primarily on the basis of morphological and structural characteristics from the time of the pioneering work of Frank, Gallaud, Hartig and others to the present. Some of the structural characteristics revealed by light microscopy have been used as broad indicators of the establishment of functional mutualistic symbioses. For example, the presence of arbuscules in arbuscular mycorrhizas and the Hartig net in ectomycorrhizas are often cited as indicating functional symbioses. With the advent of more advanced microscopical methods (analytical transmission electron microscopy, laser scanning confocal microscopy) combined with immunolabelling and other cytochemical methods, cellular and sub-cellular characteristics of both plant and fungal symbionts in various mycorrhizas may be more indicative of function. Research on the interaction between fungal hyphae and host cell cytoskeleton and on the localization of various enzymes and other gene products is providing additional structural evidence that may be used in defining a functioning mycorrhiza. The morphological and structural information available for all categories of mycorrhizaswill be reviewed as possible criteria for defining functional mutualistic symbioses.

(# 386) SPORE INOCULATION OF PINACEAE WITH ECTOMYCORRHIZAL EDIBLE FUNGI IN MEXICO

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Mexico is known to hold seventy two taxa (the largest number all around the world) of Pinus, one of the most important ectomycorrhizal (ECM) plant genera. At the same time, the country has a high cultural diversity, which includes more than fifty ethnic groups. As a result of this particular combination of biological and cultural diversity, the country has a unique management of natural resources, which includes the consumption of more than two hundred edible mushrooms. Among them, more than 100 are ECM species. In the year 2001, a research programme started to explore the possibility to inoculate some mexican species of Pinaceae with edible ECM native mushrooms collected either from popular markets or forests. Spores, either in solutions or as dry pileum fragments, in numbers ranging from 10 to 1000 million spores per plant, were used as inoculum sources. After the evaluation of more than 15 species of ECM fungi (including species of Amanita, Boletus, Hebeloma, Laccaria, Lactarius, Russula and Suillus), the best results, in terms of plant growth and nutrient contents, were observed when pileum fragments of Suillus pseudobrevipes, Hebeloma fastibile and Laccaria proxima were used as ECM inoculum in Pinus patula. After six months from inoculation, in some cases these ECM species doubled plant growth and nutrient contents compares to controls. Additionally, synergistic effects are reported as a result of combined inoculation.

(# 387) Application of landscape element analysis to inventories of soil organic carbon.

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The objective of this research was to determine the distribution of soil organic carbon in landscape elements derived for undulating terrain. Light Detection and Ranging (LIDAR) was used to measure elevation in a 121 hectare cultivated area approximately 17.6 km north of Brandon, Manitoba, Canada. Landscape elements were defined based on relative elevation, surface curvature, and drainage. Location and area were determined for each landscape element. Concentration of soil carbon (0-60 cm) was correlated with landscape elements, using multivariate analysis. Classification schemes ranging from 4 to 15 landscape elements were evaluated. Although the concentration of soil carbon was higher in depressions relative to shoulder and back slope elements, converging and diverging surface curvature influenced the spatial distribution of soil organic carbon.

(# 388) Phosphorus fractions in a clay loam soil amended with various composts

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Various composts often used as soil amendments and fertilizers may vary in phosphorus (P) status and its transformation pathways after application to soils, which are key factors controlling P bio-availability and loss vulnerability from soil to water. We characterized compost P and assessed the changes in soil P fractions as related a compost addition in a Brookston clay loam soil under continuous corn (Zea mays L.) from 1998 to 2000. The composts investigated were yard waste compost (YWC), pig manure compost (PMC), and food waste compost (FWC). Soil P was sequentially separated into various inorganic (Pi) and organic P (Po) fractions. Regardless of the compost source, HCl-P (moderately stable P) was the predominant P form, followed by NaHCO3-Pi (labile P) and Res-P (stable P). Added composts increased NaHCO3-Pi, NaOH-Pi (moderately labile P), and HCl-Pi, in the order of PMC>>YWC>FWC, but had subtle effects on NaOH-Po. Increases in soil Pi fractions followed the order of NaHCO3-Pi>NaOH-Pi>HCl-Pi. However, added PMC significantly decreased soil NaHCO3-Po and slightly increased Res-P, while the opposite pattern was found with FWC and YWC. Changes of soil P in the plough layer accounted for 52-70% of the P applied. Effects of compost application on soil P varied with types and soil P forms, with PMC having the most significant increases in soil labile and moderately labile Pi. Downward movement of P in the soil profile may be significant in soils amended with composts.

(# 389) Are arbuscules always characteristic structures of arbuscular mycorrhiza?

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Not all vesicular-arbuscular mycorrhizal (VAM) fungi form root-borne vesicles and therefore the association is sometimes simply referred to as 'arbuscular mycorrhizal'. Recent studies have confirmed that roots of some ectomycorrhizal hosts may be colonized by hyphae and vesicles of VAM fungi. However, in many cases there is no evidence of arbuscule production and little proof of a mutualistic association. The typically ectomycorrhizal plant Cistus incanus falls into this latter group. Can this association be considered truly mycorrhizal? In vitro studies with carrot-root organs suggest that once symbiotic, VAM fungi produce an extraradical mycelium characterized by the presence of branched absorbing structures (BAS) and spores. In order to investigate whether the morphology of the extraradical mycelium of Glomus intraradices in association with C. incanus is the same as that observed with truly VAM hosts, we developed C. incanus root-organs. In the presence of these roots, the fungus forms appressoria (suggesting host root recognition), penetrates the roots, forms vesicles and subsequently forms an extraradical mycelium characterized by BAS and spores, but without forming arbuscules. From a myco-centric point of view, the fungus completes its life cycle and therefore receives all the necessary signals from the plant. However, in the absence of arbuscules can we really consider this to be a VAM association?

(# 391) Modeling Soil Water Budgets with SHAW for Seven Regions of Ontario

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The Simultaneous Heat and Water (SHAW) model is a mechanistic model capable of estimating evapotranspiration, deep drainage, and runoff from the land surface. We chose SHAW over the multitude of models currently available mainly because it can simulate the effects of soil freezing and thawing on the hydrologic budget. The model requires as input the following: daily climatic data, hydraulic properties of each soil horizon, crop growth parameters, and initial soil water and temperature conditions. The model was run for the time period 1954 - 2001 with climatic data and typical soil horizons found near Harrow, Mount Forest, Guelph, Smithfield, Ottawa, Kapuskasing, and Emo. Each site represents a unique climatic region of Ontario. Results indicate that the 48-year mean annual deep drainage exceeded runoff at all but two of the sites (Kapuskasing and Emo). Average annual evapotranspiration with corn grown continuously at each site ranged from 83% of the average annual precipitation at Harrow to 54% at Kapuskasing. Further data analyses and comparisons between the sites will be given in the poster.

(# 392) Greenhouse gas production from biological "hotspots" as influenced by Agricultural management practices

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Soil biological activity varies spatially and temporally, being more concentrated in certain biological "hotspots" such as the rhizosphere, organic residues and macro-aggregates. Agricultural management practices such as tillage, cropping systems and fertilizer sources influence the distribution of these biological hotspots and therefore production of CO2, N2O and CH4 from soils. Yet, routine procedures for measuring greenhouse gas production seldom consider soil heterogeneity. The objective of this study was to determine the influence of Agricultural management on the production of CO2, N2O and CH4 from the rhizosphere and non-rhizosphere soil under field conditions. The field experiment was conducted at the Macdonald Research Farm of McGill University at Ste-Anne-de-Bellevue, Quebec. It involved eight factorial treatments with two tillage systems (conventional tillage and no till), two crops (corn and soybeans) and two fertilizer sources (inorganic fertilizer and composted cow manure). Gas sampling tubes (0.3cm internal diameter) were installed at depths 10, 20 and 30cm in the planted row and inter-row. The production of CO2, N2O and CH4 was assessed every 9 to 14 days during the summer of 2002. Results demonstrating the effects of the agricultural management on greenhouse gas production in the rhizosphere and non-rhizosphere soil during the growing season will be presented.

(# 393) Effects of the environmental oestrogen-like endocrine-disrupting chemical Bisphenol A on the hyphal growth of Glomus intraradices

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Several synthetic environmental pollutants have been associated with abnormal sexual development in vertebrates. Furthermore, these compounds can cause homeostatic and behavioural problems, and may promote hormone-dependent cancers and reduce reproductive fitness. One such endocrine disrupter is the nonsteroidal oestrogenic compound Bisphenol A (BPA): a monomer used in the manufacture of polycarbonate plastics and resins. While its effects on vertebrates are well documented, its potential effect on other organisms is poorly understood. Under natural conditions, communication between plantroots and VAM fungi uses a series of molecules, certain of which can be classed as oestrogen-like. The potential effect that BPA could have on this symbiosis and the stability of plant communities remains unknown. In a series of in vitro studies, which aimed to link exposure to BPA with biologically relevant effects, we investigated the effect of concentrations of the contaminant BPA found in nature, on germ tube growth of the VAM fungus Glomus intraradices. At micromolar concentrations growth was stimulated, while at higher concentrations germination was inhibited. The stimulation occurred during the first week and suggests that oestrogen-like molecules are important initial stimulants, which serve to attract, and to enhance hyphal growth. After week four there was no difference between the control andstimulatory low concentration treatments. This suggests that in nature either another molecule takes over, or there is usually root contact before week four, and that what we observed was the maximal growth possible from a germinating spore. Initial experiments on the extraradical phase suggests asimilar response.

(# 395) Assessment of poplar cell suspensions to study benzene degradation

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Phytoremediation, the use of plants and their associated microorganisms for the treatment of contaminated soils, provides an ecologically and economically viable method for the remediation of petroleum-polluted sites. Several studies have indicated that plants can transform and mineralize hazardous organics; however, relatively little is known about the mechanisms involved. This study assessed the use of plant cell suspensions as a tool to elucidate plant mechanisms involved in the transformation and/or degradation of contaminants. Benzene was chosen as the model compound. Poplar cells (Populus trichocarpa x P. deltoides clone [H11-11]) suspended in Murashige and Skoog medium were incubated in a closed test system at 25oC in a dark shaker (100 rpm) for five days. Suspensions were inoculated with 50 or 125 ppm benzene, and re-incubated. Aliquots were taken at 24 hour intervals for one week, filtered with a 0.45 µm filter, extracted with carbon disulfide, and analyzed on a gas chromatograph-mass spectrometer. Preliminary results indicated that poplar cells degraded benzene, validating cell suspension as an effective method to investigate plant cell mechanisms of contaminant degradation.

(# 396) Mycorrhizal fungi from neotropical Brazilian orchids

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Anthropogenic disturbances have resulted in an increased threat of extinction for many native species of orchids from the Brazilian Atlantic Rain Forest. Considering that orchidoid mycorrhizal fungi are very important to both orchid seed germination and seedling establishment in nature, mycorrhizal fungi were isolated and characterized both morphologically and molecularly focusing the identificarion of the mycobiont associated with some threatened orchid species from Minas Gerais State, Brazil. Seven mycorrhizal Rhizoctonia-like fungal strains were isolated from roots of seven neotropical native orchid species (Epidendrum rigidum, Isochillus lineares, Maxillaria marginata, Oncidium flexuosum, Oncidium varicosum, Oceoclades maculata and Polystachia concreta). The isolates belong to the genera Ceratorhiza and Epulorhiza. The Epulorhiza isolates were identified as E. repens and E. epiphytica. RAPD analyses indicated high polymorphism between E. epiphytica and E. repens. Two isolates classifiedas Ceratorhiza were identical and may belong to the same species, while two others appear to belong to twodifferent taxa. RAPD and PCR-RFLP analyses corroborated the morphological studies indicating that these molecular tools are suitable to investigate genetic diversity within species of orchidoid mycorrhizalfungi. This was the first step to establish a collection of orchid mycorrhizal fungi for future symbiotic propagation of orchids in Brazil.

(# 398) Growth and phosphorus uptake of Eucalyptus seedlings inoculated with monokaryotic and dikaryotic isolates of Pisolithus sp.

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The ability of monokaryotic and dikaryotic isolates of Pisolithus sp. to promote the growth and phosphorus uptake of Eucalyptus grandis seedlings was studied under greenhouse conditions. Ectomycorrhiza formation, plant height, shoot dry matter production, phosphorus content, and nutrient use efficiency were determined in inoculated and uninoculated seedlings after 105 days of cultivation in sand. All the isolates tested were capable of forming typical angiosperm ectomycorrhizas with E. grandis, with a mantle layer around lateral root tips and a Hartig net limited to the epidermal intercellular spaces of the roots. The inoculation of E. grandis with any of the isolates tested significantly increased plant height and dry matter production in comparison to the uninoculated control. Phosphorus content in the shoots was consistently higher in plants inoculated with either monokaryotic or dikaryotic isolates; however, P use efficiency was always higher for the dikaryotic ones. Dikaryotic strains produced by crossings between compatible monokaryons performed better for all variables measured in comparison to the parent monokaryotic isolates. These results indicate the possibility of selecting compatible highly performing monokaryotic isolates for the production of superior dikaryotic strains.

(# 399) Altered state of arbuscular mycorrhizal fungal (AMF) activity following invasion of the non-native Vincetoxicum rossicum (Kleopow) Barbar. in ecosystems of central New York State.

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The non-native perennial vine, Vincetoxicum rossicum (Kleopow) Barbar. (pale swallow-wort), has invaded natural ecosystems of the lower Great Lakes Basin where it forms extensive, mono-specific populations in various habitats, and it displaces resident vegetation including rare native species. We investigated the role of arbuscular mycorrhizal fungi (AMF) in this invasion. Soil samples were collectedduring the 2002 growing season from three sites in central New York State where: (1) V. rossicum dominates, and (2) in adjacent areas where other species dominate. The population density and cover of V. rossicum was estimated at each site, as was the number of AMF spores in soil. The phenology of AMF structures (hyphae, arbuscules, and vesicles) in roots of V. rossicum was also examined during thegrowing season. The mycorrhizal inoculum potential (MIP) of soils from each site was determined by estimating AMF root colonization of bait plants. Sites dominated by V. rossicum had significantly lower number of AMF spores compared with adjacent areas where grasses and herbs such as Solidago canadensis dominate. Vincetoxicum rossicum readily establishes symbiotic associations with native AMF populations. High total AMF root colonization of V. rossicum was found but was not dependent upon the season. However, percentage root colonization of arbuscules was generally highest in June at the onset of the reproductive period of the plant. Soil MIP was greater in areas dominated by V. rossicum than in adjacent areas where this species was absent. Therefore, invasion of V. rossicum increases the activity of AMF in resident soils.

(# 400) Microbial Community Structure and Dynamics During Decomposition of 13C-Labeled Ryegrass Residue

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A microcosm-based study was conducted to determine how the water-soluble component of ryegrass residue affects the rate of and community composition during decomposition. Ryegrass was labeled with 13C during growth in the field and harvested for use in the lab incubation. Residue was added to soil at rates that reflect field loads. Treatments were unleached straw, leached straw, and leachate. Leachate carbon represented about 15% of the total carbon in the straw. Microcosms were incubated at 25°C. Destructive sampling took place after 0.67, 1.5, 15, 18, 50 and 80 days of incubation. Respiration measurements were made every 8 hours for the first 6 days, and then weekly for the remainder of the experiment. Community dynamics were examined using fumigation-incubation and phospholipid fatty acid (PLFA) analysis.

Respiration rate, 13C signature of the evolved CO2, and microbial biomass carbon peaked after 16 hours of incubation. The d13C of the CO2 evolved from leachate samples declined steadily, with a final value only marginally higher than that of the control, which was at natural abundance 13C. Conversely, the 13C of the CO2 from straw treatments declined slowly, and was still highly enriched after 80 days. This indicates that the microbial community degraded nearly all of the straw-derived soluble carbon added in the leachate. Removal of the soluble component resulted in a 40% reduction in cumulative evolved carbon. Preliminary analysis of PLFA data shows an increase in the fungal lipid marker, 18:2, with time.

(# 401) Hypogeous fungi associated with *Quercus garryana* in southwest Oregon

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Hypogeous fungi are found in diverse dry habitats as an adaptation to seasonal drought, e.g., with Eucalypts in Australia, and with conifers (Douglas Fir and Ponderosa pine) in the Pacific Northwest. Oregon white oak (Quercus garryana) also occurs in seasonally dry habitats and is mycorrhizal. Our primary site was Whetstone Savanna Preserve, a part of the Agate Desert in southwest Oregon.The Agate Desert, with 48 cm annual precipitation, is an alluvial fan capped with a shallow layer ofclay loam over cemented hardpan and is characterized by patterned ground with mounds and vernalpools. In three years of collecting, we found hypogeous fungi only in spring (April-May).

Genera include the Ascomycetes -Tuber, Peziza, and Genea-, and the Basidiomycetes – Zelleromyces
and Elasmomyces-. DNA was extracted from fruitbodies and ectomycorrhizal tips, amplified by PCR
and cut with restriction enzymes. RFLPs of mycorrhizas match several Tuber species—probably undescribed ones— and Peziza quercicola. Pocket gophers (Thomomys sp.) are abundant on site. These findings raise the question of the importance of small mammals in dispersal of hypogeous fungi
in oak habitats and their role in mycorrhizal inoculation of oak seedlings.

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(# 402) Effects of organic amendments to soil or soilless potting media on arbuscular mycorrhizae and their microbial associates

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Organic matter content of soilless potting media is high due to the amendment with peat moss, coir, bark,or composts, and soil may be amended with composts, mulches, manure, crop residues or cover crops. How such organic amendments affect the formation and function of arbuscular mycorrhizae (AM) was investigated. Some peat mosses added to soil inhibited AM formation and host plant growth enhancement under low soil phosphorus (P) conditions, but the effects were source- and AM species-dependent. Coir amendment to a peat-based soilless potting mix did not adversely affect AM formation at any concentration used, from 15% to 60% by volume. Several different composts amended to the potting mix at rates of 5, 10, 15, and 30% by volume depressed AM formation, presumably due to their inherently high P content, but all enhanced growth of marigold plants proportional to the concentration. In contrast, adding composts to low-organic matter soil (10% by volume) did not suppress AM formation or function. Composted grape pomace amendment to soil enhanced onion growth, an effect further increased by inoculation with AM fungi. All composts, and some peats and coirs, increased the antagonistic potential to soilborne fungal pathogens in both potting mix and soil, and also affected different functional groups of bacteria such as producers of acid phosphatase. These results indicate that organic matter can have varied effects on AM fungi, depending on the nature of thematerial and the AM fungal genotype, as well as on their microbial associates in the mycorrhizosphere.

(# 404) Changes in soil enzyme activities due to fungicide and sulfur additions

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The acidity of soils can greatly influence the proliferation of various soil flora and fauna. A container experiment was conducted to determine the effects of soil pH and fungicide addition as soil drench on various enzyme activities including acid phosphatase, arylsulfatase, and dehydrogenase. The study was set up as a three factorial-fixed variable design in which the factors of interest were: (1) sulfur additions, (2) five plant species; and (3) systemic fungicide Benlate (+ or -) for mycorrhizal suppression. Elemental sulfur at three rates was used to change the soil pH by 0.5, 1.0 and 1.5 relative to the initial mean soil pH of 6.35. The five crops included in this investigation were: thorn apple (Datura innoxia), industrial hemp (Cannabis sativa), Indian mustard (Brassica juncea), sunflower (Helianthus annuus), sweet corn (Zea mays). Half of the containers with treated with the fungicide Benlate to suppress mycorrhizal associations, the other half were used as a control. Additions of Benlate as soil drench was not found to influence any of the enzyme activities determined. The crop planted influenced any changes in enzyme activities due to the sulfur additions. Acid phosphatase activity was suppressed for some of sulfur rates in soils with corn and thorn apple; but enhanced the activity if Indian mustard was grown. Higher sulfur rates suppressed arylsulfatase activity in (soil) containers with Indian mustard. Additions of sulfur to soils enhanced dehydrogenase activity in containers with corn and thorn apple, but suppressed the dehydrogenase activity in containers with Indian mustard.

(# 405) PRELIMINARY PROTOCOLS FOR THE STUDY OF ECTOMYCORRHIZAL GENE EXPRESSION IN NORTHERN SYSTEMS

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Mycorrhizal associations present a potentially significant route of degradation for persistent organic pollutants, as mycorrhizal fungi have the potential to produce non-specific lignolytic enzymes such as lignin peroxidases, manganese peroxidases and laccases. Molecular techniques employed to assess the enzyme-producing capacity of mycorrhizal fungi are expanding our breadth of knowledge, however, most such studies are conducted on fungi grown in liquid culture rather than grown in symbiosis with the vegetative host. In instances where molecular techniques are employed to assess gene expression (e.g. RT-PCR), fungal genetic material must be sampled from an intact vegetative-fungal system in order to most accurately reflect fungal gene expression within the context of the symbiotic system. We are developing protocols designed to facilitate the non-sacrificial sampling of mycorrhizal fungal material from the roots of boreal vegetative species growing in solid media. If successful, implementation of such protocols will allow us to conduct RT-PCR analyses on intact systems, thus allowing for us to study the impact of total system conditions upon fungal gene expression.

(# 406) Effect of sodium chlorides on the growth of Japanese black pine (Pinus thunbergii) seedlings and ectomycorrhizal fungi

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To rehabilitate declining coastal stands of Japanese black pine (Pinus thunbergii) caused by Pine Wilt disease, which is one of the most devastating forest diseases in Japan, we determined effects of sodium chlorides (NaCl) on the growth of P. thungergii seedlings and ectomycorrhizal fungi in vitro. Twenty surface sterilized seeds of P. thungergii were sown in test tubes filled with vermiculite (50ml) and charcoal (1%, w/v), moistened with different concentrations of NaCl (0, 20, 50, 100, 200 mM). Pure cultures of six strains of four ectomycorrhizal fungal species were grown on liquid MMN media containing five different NaCl levels (0, 20, 50, 100, 200 mM) for 30 days. After 64 days of treatment, seedlings treated with 0 mM NaCl had significantly greater number of root tips than those with 50 mM. No significant differences were found in shoot and root dry weights, and T/R ratio among the treatments. These results indicate that the effect of NaCl on the growth of P. thungergii might firstly appear on the formation of root tips. None of the fungal strains tested were suppressed their growth even at the highest concentration of 200 mM NaCl where the germination of P. thungergii was almost suppressed. Mycelial dry weights of Pisolithus tinctorius and Rhizopogon rubesces tended to increase with the increment of NaCl concentrations whereas Suillus luteus and Cenococcum geophilum showed adecline with increasing NaCl. These results indicate that the former two species would be useful ectomycorrhizal inoculants for outplanting of P. thungergii seedlings at coastal stands.

(# 407) Monitoring inoculated AM fungi in field plants using 25S rDNA-targeted nested PCR

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Two field experiments were conducted to study colonization patterns of arbuscular mycorrhizal fungi in root of maize and cotton plants. The experiments investigated three AM fungi for their competition in root colonization and compared benefits provided to host plants. Plant seedlings were inoculated with single AMF species (Glomus mosseae, G. intraradices, S. castanea) or a mix-inoculantsbefore transplanted into fields. Mycorrhizal inoculation generally enhanced the growth of the field plants,but this beneficial contribution varies between inoculants. For example, S. castanea had less effect on maize growth than that of the two Glomus species. Plants inoculated with mixed inoculants were generally larger than plants only inoculated with a single AMF species. A nested PCR was performed on individual trypan blue-stained or fresh root fragments collected from different field plots. Universal eukaryotic primers were used for the first amplification and taxon-discriminating primers for the second. In root system from the field sites with mixed inoculants, more than one targeted fungus was detected in the majority of root fragments. All inoculated fungi were frequently detected in the same root fragment. The PCR amplification was not affected by the presence of indigenous AM fungi.

(# 410) Tillage or no tillage: impact on mycorrhizae

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Tillage is an integral part of modern agriculture. Tillage practices can modify the physical, chemical and biological properties of soil, which may affect arbuscular mycorrhizal (AM) fungi. In a no-till system, plants can follow old root channels and potentially encounter more AM fungal propagules than plants growing in soil that has been tilled. The abundance of AM fungi can be greatly reduced if the soil is tilled in fall and over-winter detached from a host plant. So while 'short term' studies suggest that it is the continuity of hyphal networks in the soil that is important, 'long-term' results may indicate that hyphal survivability and infectivity is the key factor. The various tillage practices are used in the management of soil for maximum crop production may alter AM fungal propagules. In fact, conservation tillage can increase AM fungi survival and, consequently, can improve plant P uptake and soil aggregate stability. Management of AM fungi in no-till soil is essential to provide benefits to crops. Under no-till, AM fungi survive winter better when they are close to the rows. This suggests that plants growing near the previous year's row receive more benefits. Arbuscular mycorrhizal fungi are more abundant in the topsoil and deep plowing may dilute their propagules in a greater volume of soil. Tillage practices have also influenced the AM fungal species composition. In tilled soil, certain AM species may survive and others may disappear. Tillage practices thus seem to affect AM fungi species richness, survivability and infectivity.

(# 411) Micro-analytical tools to study metal sequestration and activity of different AM fungi in polluted soils

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Micro-analytical tools related to optical and electron microscopes can significantly enhance our understanding of the interactions with the environment. The localization of elements on the cellular and subcellular level gives important data on element distribution, and by this on the role of elements in physiological processes, interactions between elements and reasons for deficiency or toxicity. It also provides the link between physiology and anatomical studies that is especially important while studyingresponses of organisms to environmental stress such as the presence of heavy metals introduced by pollution. Mycorrhizal fungi including Glomus mosseae, Gigaspora rosea and Gi. margarita grown on industrial wastes were compared using EDAX, PIXE, and a wide range of cytochemical techniques such as vitality tests and staining of the vacuolar system. The aim of this work was to optimize methods that allow to characterize individual strains and to prepare tests for the evaluation of e.g., genetically modifiedfungi.

This research is part of the GENOMYCA project and the cooperation between Poland and the Republic of South Africa.

(# 414) Carbon allocation by arbuscular mycorrhizal fungi from one host plant to two different species of introduced plants

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Carbon allocation by the AM fungus Glomus intraradices, from one host plant to two different species of introduced plants, was examined by ^{13}C labeling technique in a pot experiment. Trifolium subterraneum and Plantago lanceolata were introduced after $^{13}CO_2$ application to the shoot of the host plant T. subterraneum or P. lanceolata. Soil and plant samples were taken 4, 7, 12, and 20 days after $^{13}CO_2$ application and analyzed for ^{13}C and fatty acid 16:1w5, the AM fungal signature. Colonization of the introduced T. subterraneum was higher with T. subterraneum than with P. lanceolata as the host. ^{13}C labeling of the roots of the introduced plants was increased by the presence of G. intraradices, but not of the shoots. With T. subterraneum as the host, neutral lipid fatty acid (NLFA) 16:1w5 and phospholipid fatty acid (PLFA) 16:1w5 were increased in the soil and in the roots of the host and the introduced plants by the presence of G. intraradices. In the roots of the introduced T. subterraneum colonized by G. intraradices, NLFA 16:1w5 was increased with time. The ^{13}C labeling of AM fungal NLFA 16:1w5 was highest in both the soil and the host roots 7 days after $^{13}CO_2$ application, though decreased in the roots of the introduced plants already 4 days after $^{13}CO_2$ application. Thus, these results show that G. intraradices is involved in C allocation between plants.

(# 415) Exploring Growth and Functioning Constraints Imposed by Temperature in Arbuscular Mycorrhizal Fungi

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Climate global change will cause an increase in temperature that may modify directly and indirectly growth and functioning of arbuscular mycorrhizal fungi (AMF). Previous studies showed that low temperatures reduced growth of the extraradical mycelium to a higher extent than that of the intraradical mycelium of AMF. Further experiments carried out in both monoxenic and soil-based cultures with AMFisolates from tropical, temperate and cold regions suggest also that the optimum growth temperature of the extraradical mycelium is higher than the optimum temperature of the intraradical mycelium. There is no obvious explanation for such a differential response to temperature since both phases experience the same temperature in soil. We hypothesized therefore that 1) plant C availability or C transfer to the fungus, 2) C translocation from the intraradical to the extraradical mycelium, or 3) a physiological limitation to pack and export C from the intraradical to the extraradical mycelium might be contributing to the observed difference in temperature optima. ^{13}C transfer and translocation experiments, and confocal laser microscopy measurements of lipid body fluxes indicated that low temperatures reduced only slightly C transfer from plant to fungus and translocation of C within the fungal mycelium. We are currently investigating plant C availability and a physiological limitation to export C from the intraradical to the extraradical mycelium, using ^{13}C labelling and Nuclear Magnetic Resonance.

(# 416) Diversity of Arbuscular Mycorrhizal fungi in the formation of a functional association with a mutant tomato (Lycopersicon esculentum Mill.)

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A mutant (rmc) of tomato line 76R forms highly reduced mycorrhizal colonisation with a range of AM-fungi, but one Glomus sp. (previously reported as G. versiforme) colonises the root cortex and develops arbuscule-like structures. Phosphate uptake and benefits in terms of plant growth are reduced in this interaction compared with the interaction between the 76R wild type and Glomus sp. An experiment was designed to further study the functionality of the mycorrhizal P uptake pathway in the rmc-Glomus sp. association. The 76R and rmc plants were grown in symbiosis with the three fungi Glomus versiforme, Glomus sp. and Glomus intraradices in pots with a hyphal compartment (HC) containing ^{32}P-labeled soil. HC could only be accessed by fungal hyphae and not by plant roots. Only Glomus sp. established successfully in rmc, forming abnormal entry points followed by cortical colonisation and to a lesser extent arbuscules. Although this colonisation of rmc had no clear effect on plant growth or total P uptake, it resulted in uptake and transfer of easily detectable amounts of ^{32}P fromthe HC. This result is the first to demonstrate that the symbiotic structures in the association between the mutant tomato (rmc) and Glomus sp. represents a functional mycorrhizal P uptake pathway.Glomus intraradices and G. versiforme failed to colonise the roots and transfer ^{32}P to the rmc mutant, However, both fungi significantly influenced plant growth, suggesting that activities of mycorrhizal fungi in the rhizosphere may influence root biology even in the absence of root colonisation.

(# 417) Interactions Between Ectomycorrhizal Fungi and Ericoid Plants

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Ericaceous plants such as Calluna vulgaris and Vaccinium spp. are common understorey species in ectomycorrhizal conifer forests in the temperate and boreal zone. Their roots and their respective mycorrhizal fungi must be in close spatial proximity. The recent demonstration (Villarreal-Ruiz et al. 2002) that isolates in the Hymenoscyphus ericae genetic complex (HEGC) are able to form both ericoid (ERM) and ectomycorrhizas (ECM) raises questions about the nature of the interaction between other, perhaps more typical ectomycorrhizal fungi and the hair roots of ericaceous plants. We challenged the roots of four ericaceous species (Vaccinium macrocarpon, V. myrtillus, V. vitis-idaea and Calluna vulgaris) with isolates of four homobasidiomycete ectomycorrhizal fungi (Laccaria bicolor, Lactarius musteus, Suillus variegatus and Tomentellopsis submollis) and two ascomycetes from the HEGC (H. ericae, a typical ERMmycobiont and the Piceirhiza bicolorata isolate, previously shown to form ECM and ERM). Interactions ranged from typical ERM formed by the H. ericae and P. bicolorata mycobiont to the colonization of L. bicolor in cortical cells of hair roots of C. vulgaris. The differential effects of mycobionts on root length and shoot biomass production of ericoid plants are discussed.

(# 418) The Effect of Different AM Fungi on Water Loss from Sorghum in a Split-Root System

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After nearly 32 years of research into Arbuscular Mycorrhiza Fungi (AMF) and plant water relations, disagreement still exists about the significance of the symbiosis for host water relations, and the mechanisms involved. The aim of this work is to evaluate whether different species of AMF, Glomus mosseae (BEG 12), Scutellospora calospora (BEG 32) and Gigaspora margarita (BEG 34), affect theway roots respond to water stress in sorghum (Sorghum bicolor L. cv. Tegemeo) independent of nutritional effects. Three-week-old sorghum plants were transferred to split–root containers, containing a sterilized mixture of sand and Terragreen (50:50 v/v). Each container was inoculated on one side with one of the three AMF. Plants were grown for 5 weeks under greenhouse conditions (photoperiod 16 h; light 350 mmol m^{-2} s^{-1} PAR; temperature 23.5°C/18°C day/night and %RH 44/66 day/night). At this point, droughting was initiated, and the plants were then harvested at 0, 12, 24, 48 and 96 h after withholding water. Water loss from each compartment was recorded and the roots from the mycorrhizal (M) and nonmycorrhizal (NM) compartment were harvested. AMF species significantly affected plant height, androot length in the mycorrhizal, but not the non-inoculated compartment ($P<0.05$). The time course of water loss and water loss per unit root length were compared between plants colonised by the three AMF isolates.

(# 419) ISOLATION, CULTURE AND CONSERVATION OF EDIBLE ECTOMYCORRHIZAL FUNGI WITH MEDITERRANEAN ECOTYPES OF PARTICULAR ECOLOGIC AND ECONOMIC VALUE

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Mycorrhization with edible ectomycorrhizal fungi in forest nurseries is a suitable tool to improve performance of forest seedlings. It is known that the ectomycorrhizal association contributes to a better absortion of water and nutrients, and provides protection against pathogenic infection, thus leading to a greater survival and growth of plants. Mycorrhiza and fruit body formation are very sensitive to environmental conditions. Some mediterranean strains, living under extreme water stress and pH conditions, may be interesting ecotypes for producing mycorrhizal plants aimed to reforestation, even increasing their forest value with edible and well appreciated products.Thirty two species of edible ectomycorrhizal fungi were collected for in vitro culturing, particularly fromxeric locations (Boletus aereus, Xerocomus ferrugineus), very basic soils (Hydnum albidum, Leccinumlepidum) and/or very poor soils (Amanita caesarea), from natural and planted forests in northern Spain.Twenty species were able to grow in Petri dishes on MMN medium. The increase in colony area was Highly variable among strains. Bacterial contamination occurred frequently in Hydnum, Cantharellus, andHygrophorus cultures, preventing their use for further studies. On the contrary, Tricholoma, Boletus, Suillus, Lactarius and Amanita species, resulted suitable for isolation. Availability of these isolates will allow further research on in vitro mycorrhization and plant protection studies.

(# 422) Carbon fluxes to arbuscular mycorrhizal mycelium and the impact of Collembola

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The function of the external mycorrhizal mycelium (EMM) in nature is largely unknown because experiments typically use simplified plant:fungal systems with soils of low organic matter. In addition, the impact of abundant soil invertebrates on carbon transfers to arbuscular-mycorrhizal (AM) fungi haveoften only been studied using the readily culturable Collembola Folsomia candida, and may thus have little ecological relevance.

Here we investigate carbon fluxes to natural AM fungal communities in upland grassland using narrow mesh cores. The cores prevent in-growth of roots to a non-sterile plant-free soil compartment but allow penetration by AM mycelium. Control cores are rotated to break the hyphal connections creating otherwise undisturbed soil compartments. We used the cores to trace carbon fluxes from plants to the atmosphere via the EMM after pulse-labelling vegetation with $^{13}CO_2$ in situ. We found that carbon fluxes to the atmosphere via EMM occurred within 14h of labelling and accounted for up to 7% of the carbon initially fixed by the plants. In a second experiment, we added a population of the Collembola Protaphorura armata to half the cores and traced the flux of ^{13}C to the atmosphere. We found that P. armata reduced the amount of $^{13}CO_2$ released from the cores by 32%.

The results demonstrate the utility of the mesh core systems and confirm that carbon fluxes from plants to the EMM are significant and rapid. They also demonstrate for the first time, under field conditions that Collembola can reduce carbon fluxes from soil by disrupting AM mycelial systems.

(# 423) Mycobioindication of stress in forest ecosystems

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The effects of pollution (N, S) or different silvicultural practices on forest trees and forest ecosystems in Slovenia were estimated by comparative biodiversity and physiological studies of ectomycorrhizae (ECM). Mycobioindication included studies of: i) diversity of ECM types on Norway spruce, Picea abies (L.) Karst, or on beech, Fagus sylvatica L., in the forest stands (in situ indicators) (1, 2); ii) determination and quantification of selectively sensitive or insensitive ECM types (passive monitors) (2); iii) development of ECM on spruce seedlings, planted into the studied sites (active monitors) (3); and iv) development of ECM or specific physiological parameters in mycorrhizal spruce seedlings, tested in the experimental set-up, used ex situ as testers of substrate pollution (4, 5), or in experimentally fumigated systems. Selectively sensitive and insensitive types of ECM on Norway spruce, differences in physiological parameters and biodiversity indices in situ and ex situ have been determined. However, indices of biodiversity of the types of ECM on beech as studied in the highly diverse co-natural forests in Slovenia were controversial. A FREE-AIR CANOPY O3 EXPOSURE SYSTEM with beech trees and beech seedlings will be studied next.

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(# 424) Molecular Biology of Phosphate Transport at Mycorrhiza Interfaces

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Phosphorus (P) serves various basic biological functions and as such is an essential macronutrient for growth and development of all living organisms. Although the total amount of P in the soil may be high, the preferred form for assimilation, orthophosphate (Pi), is not easily accessible to most plants and microbes. Since the nutrient absorbing root surface area is a critical factor for plant performance, vascular plants have evolved several strategies to cope with low Pi availability, e.g. via development of extended root hairs and branched root systems, and establishment of mycorrhizal symbioses.Plants like all other organisms are able to selectively and actively accumulate Pi and other mineral nutrients in their cells. Selective transport of compounds across cellular and intracellular membranes is mediated by membrane-spanning transporter proteins with specific binding sites. To understand the molecular and biochemical mechanisms of short- and long-distance Pi transport in plants, we investigate Pi transporter genes and their encoded products in solanaceous species forming arbuscular-mycorrhizal symbiosis (1,2) and the non-mycorrhizal plant Arabidopsis thaliana (3). Molecular biological studies finally made it possible to identify and investigate Pi transporters located in the plasma membrane and a Pi translocator in membranes of organelles in more details. The presented work will give an overview of our research on Pi transporters involved in Pi acquisition at the level of mycorrhizal interfaces.

(# 425) Morphological, genetic and functional variation of ectomycorrhizal fungi in West African forests

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We examined the diversity of ectomycorrhizal fungi and ectomycorrhizas of some tree species,members of Caesalpinioideae, Euphorbiaceae and Dipterocarpaceae, growing in the humid and semi-arid tropical forests in West Africa (Sénégal, Burkina Faso and Guinea). We collected different sporocarps and ectomycorrhizas under these tree species. The three most represented orders are Russulales (57 fungal species), Boletales (22 fungal species), and Agaricales (18 fungal species). Several fungi, especially in thegenera Russula and Lactarius, were found to be undescribed species. We discovered Russula sect. Archaeinae sp. nov and Lactarius sect Plinthogali sp. nov fruiting under discrete groves of ectomycorrhizal species trees in Guinea. The taxonomic position of these fungi was confirmed by a phylogenetic analysis using a sequence database of the ML5-ML6 region of the mitochondrial large subunit rDNA gene of ectomycorrhizal basidiomycetes. We also identified the fungi from ectomycorrhizas by placing the unknown ectomycorrhizas in a phylogenetic tree, or by matching the ITS-RFLP patterns of the ectomycorrhizas with sporocarps. Our results support the hypothesis that sporocarp inventories only partly reflect the ectomycorrhizal species composition in West African forests. To determine the relative mycorrhizal dependency of indigenous trees, mycelial cultures of fungibelonging to Sclerodermatales, Boletales and Aphyllophorales were used for inoculation of seedlings growing in nursery soil conditions. Uapaca somon seedlings showed the highest mycorrhizal dependency values, reaching a maximum of 85%, while those of Anthonotha macrophylla, Paramacrolobium coeruleum, Afzelia africana, Afzelia bella and Cryptosepalum tetraphyllum seedlings were similar, reaching no more than 50%.

(# 427) Influence of arbuscular mycorrhiza on cadmium tolerance and uptake by tobacco plants with inserted metallothionein gene

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The study represents an attempt to test the interaction of arbuscular mycorrhiza and transgenic plants with application potential for phytoremediation. The responsiveness of tobacco plants (Nicotiana tabacum L. var. Wisconsin 38) with introduced modified CUP1 yeast metallothionein gene in fusion with a polyhistidine tail to arbuscular mycorrhiza (AM) and cadmium uptake was assessed. The development of AM, plant growth and cadmium uptake were compared in three 12-week experiments with the transgenic and non-transgenic tobacco plants. The first two experiments were carried out in different substrates (sand and soil) with one level of cadmium amendment, and the plants were inoculated with the heavy metal tolerant isolate Glomus intraradices PH5. In the third experiment, three levels of cadmiumamendment and two isolates were compared in soil (G. intraradices PH5 and the non-tolerant reference isolate G. intraradices BEG75).

Any difference in mycorrhizal parameters was found between the transgenic and non-transgenic plants. Both AM fungal isolates showed higher tolerance to cadmium in soil than the tobacco plants. Inoculation significantly increased the plant tolerance to cadmium, though both isolates differed in their influence on plant growth at different cadmium levels. Inoculation decreased cadmium contents in roots and shoots both in the transgenic and non-transgenic plants. The effect was more pronounced for the transgenic plants. The obtained results indicate that mycorrhizal symbiosis has to be taken into account in assessment of suitability of transgenic plants for phytoremediation purposes, as it can change the interaction between plants and heavy metals in soil.

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(# 428) Mycorrhizal inoculations for land reclamation, including contaminated soils.

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Arbuscular mycorrhizal (AM) and ectomycorrhizal (EcM) fungi have a significant potential to facilitate adaptation of plants to edaphic stress of degraded or contaminated soils. There are several aspects of application of mycorrhizal fungi in phytoremediation: e.g. a potential of sequestration or biosorption andconsequently reducing phytotoxicity of pollutants within or on the surface of the extraradical mycelium (ERM) radiating from the roots into the soil; a potential of the ERM to harbour specific bioremediating bacteria or to provide niches in the mycorrhizosphere for these micro-organisms. The major role of mycorrhizal fungi in phytoremediation and land reclamation is, however, an improvement of plant fitness in harsh environment. Mycorrhization with stress-adapted fungi can increase vegetation capability to withstand environmental stresses due to better plant nutrition or enhanced resistance to drought and pathogens. There have been numerous attempts to use inoculation with AM and EcM fungi in land reclamation and phytoremediation. Examples are given of greenhouse or field trials studying the effects of plant inoculation in substrates from spoil banks, power station fly ash deposits, waste from PVC factory, soils contaminated with heavy metals or PCB's. Results showed that the mycorrhizal fungi are able not only to develop in a wide range of degraded soils (e.g. with pH from 3 to 13) and to tolerate high concentrations of pollutants, but also to promote growth of plants in these environments. Application ofmycorrhizal fungi can alleviate or reduce some known limitation of phytoremediation processes in extreme habitats and significantly increase efficacy of land reclamation.

(# 429) Effects of cadmium and/or arbuscular mycorrhizal colonization on root ploidy levels of two pea genotypes

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The impact of arbuscular mycorrhizal (AM) symbiosis on plant responses to cadmium (Cd) was investigated by flow cytometry in roots of two pea genotypes differing in sensitivity to Cd (Pisum sativum L., Cd-sensitive VIR4788 and Cd-tolerant VIR7128). Pea roots were inoculated or not with the AM fungus Glomus mosseae BEG12 and treated or not with Cd (100 mg kg-1 substrate). Cd treatments were applied either at transplanting (Cd1) or 2 weeks after transplanting (Cd2).In control plants, without Cd and mycorrhiza, both genotypes showed nuclei with 2C, 4C, 6C and 8C DNA contents. Cd2 significantly affected nuclear proportions in both genotypes: a reduction of 2C with an increase in 4C nuclei was found in VIR4788, whilst an increase in both 6C and 8C was observed in VIR7128. The AM symbiosis differently affected the two genotypes, with a decrease in 2C and an increase in 4C and 8C nuclei of VIR4788, and an increase in 6C nuclei of VIR7128. In mycorrhizal plants, the effects of Cd2 application were only significant in VIR4788, in which an increase in 6C and 8C nuclei was observed. The possible meanings for the variations of nuclear populations in response to Cd and AM symbiosis are discussed: the Cd-induced increase in the highest ploidy levels could be explained by the high metabolic activity of root cells, actively synthesizing molecules involved in response/detoxification mechanisms towards Cd; in AM plants, the increase in ploidy may be related to AM-induced changes of DNA transcription and/or translation; finally, the responses to Cd described above depend on the genotypic variability of the two pea genotypes and their AM symbiotic status.Work supported by Italian “Ministero dell’Ambiente” (ordinanza n° 2986, 31-5-1999).

(# 431) The ectomycorrhizal network in tropical rain forests, a link within plant community

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African tropical rain forests host small communities of trees associated with ectomycorhizal fungi. The present work aims at studying the role of symbiotic fungi in the population dynamic of these plant communities.

A small portion (2000 m^2) of primary forest located in South of Guinea (west Africa) was studied. It hosted five different ectomycorrhizal tree species: Anthonotha fragrans, A. macrophylla, Cryptosepalumtetraphyllum, Paramacrolobium coeruleum and Uapaca esculenta. Each adult tree and its seedlings were first mapped and then 20 ectomycorrhizas were harvested per adult tree and seedling. Both symbiotic partners were identified from ectomycorrhizas using trnL-trnF IGS for plant and mitochondrial large sub-unit rDNA and IGS for fungus.

Forty-four different Thelephoroid strains, 18 Sclerodermataceae and 21 Boletales were identified from both adults and seedlings. Half of the Thelephoroid strains were found on all the five tree species either onadult trees or young seedlings. Most Sclerodermataceae and Boletales were found on both adult trees and seedlings for three of the five tree species.

These results indicate that the five tree species appear to be cross compatible with the same ectomycorrhizal fungi and suggest the existence of connections between plants through a common soil ectomycorrhizal mycelium network. The current study of the net transfer of carbon from adult trees to community seedlings should support the hypothesis that adult trees can supply photosynthetic compounds to young seedlings growing under light deficient canopy.

(# 432) Peat chemical and biological properties and CO-2 and CH-4 dynamics across pristine, harvested and restored Canadian peatlands

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Globally Sphagnum peatlands are sinks for atmospheric CO-2 and sources of CH-4. CO-2 sequestration occurs as plant production exceeds heterotrophic decomposition while CH-4 emission occurs as a net imbalance between microbial production and oxidation. The chemical composition of peat and the nature of the microbial community living in and utilizing this substrate thus play a large role in CO-2 and CH-4 emissions. In sites that have been commercially harvested, peat chemistry in surface regions of characteristically high microbial activity is likely altered as newer peat is removed leaving behind older more recalcitrant material, although little is known of how specific chemical properties and in turn CO-2 production and CH-4 production and consumption are altered. The effectiveness of post-harvest vegetative restoration is also not well understood in this regard. We measured anaerobic CO-2 and CH-4 production and aerobic CO-2 production and CH-4 oxidation in-vitro in peat from the surface (0-50 cm) of pristine, harvested and restored peatlands in Quebec and New Brunswick. We characterized peat organic matter using indices derived from FTIR-spectra analysis, differential lipid and organic acid extractions, and the von Post humification index. We also measured extractable inorganic nutrients and organic N and P. Microbial biomass C, N, and P were determined using a fumigation extraction method. Most notably we report that harvesting greatly increased the relative importance of recalcitrant fractions of peat, decreased microbial biomass, and decreased rates of CO-2 and CH-4 production. Also newly formed peat in restored sites produced more CO-2 and CH-4 than in pristine sites. Across all sites organic matter characteristics that we measured were good predictors of CO-2, but not CH-4 production.

(# 433) Mycelial production, spread and root colonisation of the ectomycorrhizal fungi Hebeloma crustuliniforme and Paxillus involutus under elevated atmospheric CO2

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Effects of elevated atmospheric carbon dioxide (CO2) levels on the production and spread of ectomycorrhizal (ECM) fungal mycelium from colonised Scots pine roots were investigated. Pinus sylvestris (L.) Karst. seedlings inoculated with either Hebeloma crustuliniforme (Bull:Fr.) Quél. or Paxillus involutus (Fr.) Fr. were grown at either ambient (350 ppm) or elevated (700 ppm) levels of CO2. In a first experiment, mycelial production by inoculated plants was studied after six weeks growth in perlite in pots. In a second experiment, mycelial spread from inoculated seedlings was studied after four months growth in perlite in shallow boxes containing uncolonised bait seedlings. Plant and fungal biomass were analysed, as well as carbon and nitrogen content of seedling shoots. Hebeloma crustuliniforme biomass production was significantly greater under elevated CO2. No significant effects were found on mycelial spread and extent of colonisation for either of the two fungal species, but there was a trend for greater mycelial production and colonisation of roots at elevated CO2. Nitrogen (N) concentrations and and total N amounts in plant shoots were significantly higher for inoculated plants grown in ambient CO2 levels. No differences in N were found for bait seedlings. Changes in mycelial production by ECM fungi are likely to alter their inoculum potential. Possible effects on competitiveness of individual species, and observed shifts in ECM communities associated with host plants exposed to elevated CO2 will be discussed.

(# 434) Effect of Arbuscular Mycorrhizal Fungi (AMF) on the Root Anatomy and Architecture of the Palm Species Phoenix dactylifera, P. cariensis, Brahea armata and Chamaerops humilis

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The aim of this study was to assess the impact of AMF on the root anatomy, architecture, and physiology of four palm species and to use a new colonization evaluation method given the invalidity ofthe methods based on gridline intersection for this kind of plant. For this purpose, the mycorrhizal and non-mycorrhizal palms were grown in a soil-less system with silica sand as substrate. The results show, in the case of both Phoenix species, a spatial distribution of the different structures formed by the AMF exists along the root system. There was good correlation between the anatomy of the different roots present and the presence or absence of AMF structures. Two different types of root could be distinguished: one where structures involved in nutrient exchange are formed and the other where spore production took place. The former can be visually distinguished and quantified. A different scenario existed in the case of Chamaerops humilis and Brahea armata. For these palms no visual features were distinguishable in the roots that could be correlated with their mycorrhizal status, although differences were observed at the anatomical level. All four palm species showed an Arum-type infection, though subgroups could be distinguished. In regard to plant growth, all the mycorrhizal treatments showed a clear growth response compared with the control treatments, although the mycorrhizal dependency was much higher for C. humilis and B. armata. The root systems of the mycorrhizal plants were heavier and more branched than those of the non-mycorrhizal plants for all palm species.

(# 435) Introduction of Biocontrol Fungi and Arbuscular Mycorrhizal Fungi (AMF) in the Production System of the Palm Species Phoenix canariensis, P. dactylifera, Brahea armata and Chamaerops humilis

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Palms are very slow growing plant species and every agricultural practice that leads to their increased growth represents a reduction in the palm production costs. It has already been shown that, by appropriate management of fertilizer inputs and the application of AMF, a significant growth increase of P. canariensis can be achieved in comparison with non-mycorrhizal plants (1). The aim of this study was toprove if this growth response could also be obtained for other palm species and if it could even be increased through the application of the biocontrol fungi Gliocladium catenulatum Gilman et Abbott and Trichoderma harzianum Rifai, either in combination with AMF or alone. A pot experiment with eight treatments for each of the four palm species was designed. The results cannot be generalized for all thepalms, since there seems to be optimum microorganism combination for each palm species in the conditions of this experiment. In the case of B. armata, the combination of both biocontrol fungi and AMF seems to lead to the best growth results. The same result was obtained for P. dactylifera, while P. canariensis grew better with the combination of the Glomus species with G. catenulatum. Conversely, theresults for C. humilis can be clearly divided into mycorrhizal treatments (highest growth) and non-mycorrhizal ones (lowest growth), regardless of the biocontrol fungi used. The highest mycorrhizal dependency is shown by C. humilis, followed by B. armata.

(1) Dreyer et al. (2001) In Plant Nutrition, Horst et al. (ed.), p. 648-649.

(# 436) Development of AMF strains specific primers for detection in field-grown colonized roots.

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The detection of arbuscular mycorrhizal fungi (AMF) in plant roots is a lengthy and variable process requiring staining of root tissue and subsequent microscope sessions. The objective of this study is to develop a quick and efficient method for the detection of the presence of specific strains of AMF within the roots of pre-inoculated field-grown leek plants. This method is based on the use of repetitive sequence-based polymerase chain reaction (Rep-PCR). Rep-PCR primers have been used for repeated elements in prokaryotic genomes and have been shown to amplify inter-repeat sequences of some fungal genomes but so far have never been tested as a molecular tool for AMF. Three strains, Glomus intraradices, G. versiforme and G. sp., grown under root organ culture were used as pure starting inoculum for pre-inoculation of leek plantlets and targeted for the development of strain specific primers.DNA extracted from each individual strain was amplified using BOX, ERIC and REP primers. Following analysis of the banding pattern of the Rep-PCR products, bands which readily distinguished the strains from one another were excised from the agarose gel, purified and sequenced. The sequences obtained were used as a template to design primers specific for each strain, these were then tested on field-grown leek roots.

(# 438) Development and characterization of simple sequence repeat (SSR) markers to survey the introduction of a Laccaria bicolor strain

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The ectomycorrhizal fungus Laccaria bicolor (Maire) Orton has been described as an appropriate speciesfor use in the reclamation of saline-alkaline sites (Kernaghan et al., 2002). At the same time, molecular tools are needed for monitoring the persistence of inoculant strains on root tips of seedlings and studying their effects on indigenous fungal populations. A selected strain of L. bicolor #8232, was usedto inoculate nursery-grown seedlings of Populus tremuloides, Pinus banksiana and Picea glauca. The seedlings were then introduced into a saline-alkaline site of the oil-sand mining company Syncrude Ltd. (Alberta, Canada). To monitor the introduction of the strain, we have isolated and characterized several SSR (single sequence repeat) markers from a L. bicolor genomic library enriched for (TC)n and (TG)n di-nucleotide motifs. Selection of the most variable markers have been conducted on different L. bicolor strains. The selected set of SSR markers should be of a great value to monitor the introduction of the L. bicolor strain #8232 into the mining site and, more generally, for surveying and monitoring L. bicolor populations.

(# 439) Effect of two strains of Pisolithus tinctorius on Physiological Responses of Pinus Halepensis Plants under Different Soil Water Conditions

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The purpose of this paper was to evaluate the effect of different levels of soil humidity on the response of Pinus halepensis plants associated with two fungal strains of Pisolithus tinctorius (30 AM and 3SR) in order to evaluate the influence of this mycorrizal symbiosis on growth, water relations and gas exchange parameters. The strain 3SR has previously been reported as a good candidate for large scale inoculation programmes in nurseries in Spain. Inoculated and uninoculated plants were subjected to two irrigation treatments; control treatment (maintained at sufficient water supply) and deficit treatment (one third of the control) for three months (stress period). Then, irrigation was increased in deficit treatment to reach the control condition for three months (recovery period). By the end of the stress period, the water deficit had reduced root mycorrhizal colonization in both mycorrhizal associations, but this reduction was more pronounced in 30 AM. All plant types showed similar growth patterns, but stressed plants had lower values of root hydraulic conductivity (Lv), more negative leaf water potential values (øl) and lower water relative content (WRC) than control plants. Stomatal conductance (gs) and chlorophyll content (SPAD) decreased in stressed plants. After the recovery period, stressed plants presented similar øl, WRC and SPAD values to those of the control; however, Lv and gs did not recover. At the same time, mycorrhizal colonization (3SR) was seen to have improved plant water status (higher øl and WRC values). The total content of inorganic solutes was not changed by the presence ofmycorrhizae. Nevertheless, a slight increase of phosphorus in 3SR stressed plants was observed.

(# 440) Multivalency of AMF root-organ culture in research and development.

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The root-organ culture propagation of arbuscular mycorrhizal fungi (AMF) on excised root has opened in the early 1990's a new and promising era for original and valuable investigations in the domain of mycorrhizal symbiosis. The AMF root-organ culture technology allowed studies in fungal morphology, physiology, and biochemistry, not accessible when using the in vivo traditional mode of propagation. For now, several dozens of AMF strains are propagated on root-organ culture, many of them accessible for research through the Glomales in vitro collection (GINCO). The purity of cultures allows reliable molecular biology works dedicated to taxonomy, phylogeny and detection using strain specific primers. In situ ongoing observations on hyphal elongation and ramification processes, spore ontogeny, spore senescence, and anastomose between AMF strains generate unique informations on the strain species vitality, growth potential and identity. Testing the direct effect of nutrients, pesticides, and hydrocarbons on the mycelium behaviour and root colonization capacity permits to improve efficacy of time-consuming field tests. The pre-evaluation, under in vitro growing conditions, of sporulation, hyphal expansion, and root colonization rates for a specific strain or a mix of strains permits to predict its mycorrhizal potential once field grown, helping to pursue more efficient selection of high quality mycorrhizal inoculum.

(# 441) Competition between mycorrhizal fungi: commercial inoculum vs. greenhouse contaminants

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Preliminary greenhouse trials were conducted to investigate whether the use of a commercially available mycorrhizal inoculum could enhance growth and subsequent percentage survival of out-planted seedlings used for the revegetation of oil sand tailings in northern Alberta. The commercial inoculum used comprised a cocktail of endo- and ectomycorrhizal fungi, and was tested on three tree species: paper birch (Betula papyrifera), green alder (Alnus crispa), and aspen (Populus tremuloides). These initial tests highlighted a problem of competition between the ectomycorrhizal fungi which constituted the commercial inoculum and the spores of ectomycorrhizal fungi present in three greenhouses. Four inoculum concentrations (2, 5, 10 or 12% v/v) were compared with non-inoculated controls. The fertilizer and watering regimes aimed to maximize mycorrhizal formation. Biomass, mineral content and percentage root colonization by endo- and ectomycorrhizal fungi were monitored. Although the results differed amongthe three greenhouses, there was always an important colonization by the indigenous ectomycorrhizal fungi.The possible reasons behind the high level of contamination are discussed.

(# 442) Regulation of phosphate transport in the arbuscular mycorrhizal symbiosis

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Arbuscular mycorrhiza (AM) is the most widely spread plant-fungus symbiosis throughout the world. Formation of AM allows the plant to overcome the problem of low availability of phosphorus in the soil due to fungal activity. The mycorrhiza-specific phosphate (P) transporter StPT3, cloned from mycorrhizal potato roots, was the first transporter described which was expressed at the plant-AM fungus (AMF) interface1. The presented work is a continuation of the study of StPT3 expression aimed at a better understanding of the regulatory mechanisms of StPT3 expression in mycorrhizal roots. In our research, we combine traditional pot cultures with monoxenic cultures of AMF and plant hairy roots. To investigate spatial and temporal patterns of StPT3 expression as well as localization of the StPT3 protein in plant tissues colonized by AMF mycelium, we generated transgenic plants and hairy roots harboring constructs consisting of promoters or coding regions of plant mycorrhiza-specific P transporters fused to appropriate reporter genes. These approaches allowed us to answer some open questions of AM biology, concerning (1) the specificity of StPT3 expression in various plant-fungus associations, (2) the degree of conservation of the signaling pathway leading to the induction of mycorrhiza-specific P transport between evolutionary distant plant species, (3) co-localization of StPT3 expression and AMF mycelium development in Arum- and Paris-type AM, and (4) possible involvement of different fungal structures other than arbuscules in the process of P transfer at the plant-fungus interface. Current result of this work will be presented.

(# 443) ECM community dynamics in boreal Québec

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Relationships between ECM community structure and stand characteristics are being assessed in the southern mixed-wood and northern black spruce dominated boreal forests of Québec. We are using a combination of anatomical and molecular characters to determine ECM diversity and species composition in plots representing various overstory compositions (mixtures of Abies balsamea, Picea glauca, P. mariana, Populus tremuloides, P. balsamifera, Betula papyrifera and Pinus banksiana.), diversities and ages (58, 82, 87 and 132 years post fire), but situated on similar mineral soil deposits. Other salient environmental factors, including soil nutrient status, understory vegetation and available light have also been measured. Host roots were sampled randomly or in a manner that enabled their separation into species on the basis of wood anatomy. Roots identified to species were quantified either manually or digitally using MacRHIZOTM software. Shannon diversity indices and species identifications of ECM fungi, determined microscopically or by RFLP analysis and sequencing of cloned rDNA, are related to stand and edaphic characters by multiple regression and canonical correspondence analysis. We have demonstrated a positive relationship between overstory tree diversity and ECM diversity, which appears to be due to fungal host specificity. The overstory composition of mixed stands also appears to play an important role in determining local ECM diversity and composition, with some host combinations supporting highly variable ECM communities and others supporting more distinct fungal assemblages.

(# 444) Are phosphorus fertilizers necessary for asparagus establishment?

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Phosphorus (P) fertilizers are often applied to increase crop yields, but there is growing awareness that high rates of P fertilization can contribute to eutrophication of lakes and rivers under some conditions. Moreover, P fertilizers will not necessarily increase yield. In soils with a low P content, arbuscular mychorrizal fungi (AM) can efficiently translocate P to the plant, thus reducing the need for fertilizers. A study is underway in Sainte-Anne-de-Bellevue and Saint-Liguori, Quebec, to determine if P fertilizer increases the growth of asparagus, a perennial crop. Soil test P levels (Mehlich –3P method) at these sites were 147 mg P/kg and 138 mg P/kg respectfully. Triple super phosphate was applied at 5 rates : 0, 78 ,116, 155 , 310 P_2O_5kg/ha. In the second year of growth, asparagus production was estimated by counting the number of shoots and their diameter. The percentage of AM colonization was estimated by counting the number of roots colonized using the grid-line intersect method. The number and diameter of asparagus shoots was not affected by the amount of P fertilizer applied. The AM colonization under different phosphorus treatments will also be discussed. Our results suggest that P fertilizer recommendations in Quebec may be excessive for soils that contain high soil test P levels.

(# 445) Self and non-self regulation by AM fungi and rhizobia colonizing alfalfa in a split-root system

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Legumes form symbiotic associations with arbuscular mycorrhizal fungi (AMF) and rhizobia. Both of these groups of micro-organisms exhibit autoregulation, whereby a certain level of colonization by the symbiont inhibits further colonization on other parts of the root system. We used alfalfa (Medicago sativa) in a split-root system to ascertain whether these similar autoregulation patterns act independently. The symbionts Sinorhizobium meliloti and Glomus mosseae were tested. When both symbionts were used separately, we observed that pre-inoculation of one half of the root system caused a reduction in colonization levels on the other half. Moreover, when the two symbionts were confronted, we observed a non-self regulation, whereby pre-inoculation of one half of the root system with one of the symbionts, reduced the capacity of the other half of the root system to establish a symbiosis with the other symbiont.

(# 446) Arbuscular mycorrhizal fungi spores in soils from a phytoremediation field trial

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Arbuscular mycorrhizal fungi (AMF) influence plant communities in many ecosystems, but especially in disturbed soil systems. Phytoremediation technologies aimed at organic contaminants employ plants and their associated rhizosphere microorganisms to sequester or degrade the contaminant in situ. This study assessed AMF spore numbers and viability in soils from a phytoremediation field trial. The site consisted of petroleum-contaminated soil from a buried flare pit (mean TPH concentration = 8 000 ppm). Four treatments were imposed on the contaminated field site: (T1) unfertilized and unplanted control; (T2) fertilized and unplanted control; (T3) fertilized and planted with a mix of 15% perennial ryegrass, 25% Rambler alfalfa and 60% creeping red fescue; and (T4) fertilized and planted with a mix of 28% tall wheatgrass, 28% Nuttal's salt-meadow grass, 28% Altai wildrye and 16% Rambler alfalfa. After three months, shoot biomass on treatments T2 and T3 was 964 and 1844 kg/ha, whereas root biomass (0-30cm)was 491 and 659 kg/ha, respectively. The AMF spore density ranged from 245 to 870 spores per 100 g in the unplanted controls (T1 and T2, respectively) and 1850 to 2390 spores per 100 g in the planted treatments (T3 and T4, respectively). Spore viability as assessed by vital staining was low across all plots (T1 = 0; T2 = 11%; T3 = 12%; T4 = 10%). These results indicate that AMF populations are active components of the phytoremediation system. Current research is directed at determining the identity and function of AMF in these soils.

(# 448) Endomycorrhizae and phytoremediation

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In Canada, there are thousands of sites contaminated by heavy metals. Excavation and landfill are the most common and costly strategies used to remediate these type of sites. On the other hand, some plants growing on soils contaminated by heavy metals accumulate these metals in large concentrations (phytoremediation or phytoextraction) and in this matter contribute to the remediation in a more sustainable manner. The main objective of this research is to determine if endomycorrhizae fungi could enhance the heavy metal extraction by indigenous plant species in Canada. Two (2) greenhouse experiments were set up in 2001 and 2002 with the following treatments: a mix of four (4) plant species: Festuca rubra, Festuca eliator, Agropyron repens, and Trifolium repens. Four (4) mycorrhizae species developed by Premier Tech Ltd in Rivière-du-Loup (Québec): Glomus intraradices, Glomus mossae, Glomus etunicatum, and Gigaspora gigantea. Four (4) types of heavy metals : Arsenic (Na_2HAsO_4 $7H_2O$), Selenium (Na_2SeO_4 $10H_2O$), Zinc (ZnN_2O_6), and Cadmium (CdN_2O_6). In general, there is a greater heavy metal extraction by the colonised plants, especially Glomus intraradices (120 µg of Cd and 6500 µg of Zn) versus the controls (70 µg of Cd and 3000 µg of Zn). These greenhouse results were also confirmed in field trials performed in parallel on heavy metal contaminated sites in the Montreal region. Mycorrhizae can enhance the extraction of soil heavy metals by plants.

(# 449) The association of culm anatomy with lodging resistance in spring wheat cultivars.

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Selection for superior lodging resistant cereal lines is difficult due to the complexity of screening for this trait under natural field conditions. The identification of easily measurable traits related to lodging resistance may ease the selection process. The present study was conducted to determine if differences in morphological and anatomical characteristics exist among wheat genotypes differing in lodging resistance. From a two year field study conducted in Edmonton, AB examining genotypic differences to artificial lodging treatments, morphological culm analyses was conducted on 13 spring wheat cultivars using visual observations and an environmental scanning electron microscope. Cultivar differences ($P<0.05$) were found for total culm length, basal internode lengths and the number of internodes per culm. At the second basal internode, cultivar differences were observed for culm diameter, culm wall thickness, and the number of vascular bundles. No differences were found for the lumen diameter and the sclerenchyma ring thickness. A lodging resistant semidwarf New Zealand bread wheat cultivar, Sapphire, had a wide culm diameter, thick culm wall, a large number of vascular bundles, and the lowest number of internodes in the cultivars studied. Of all plant characters examined, plant height remains one of the most important for lodging resistance in the wheat germplasm studied.

(# 450) Composting sheep carcasses.

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Because of scrapies, rendering companies no longer collect sheep carcasses, which aggravates the disposal problem. Since composting has been used for the disposal of poultry and hog carcasses, this process presents an interesting potential. Consequently, an experiment with none, one, and two ewes plus lambs per layer were composted in a six-cell unit with sheep manure as the C source. Each cell was isolated by walls, was roofed, and had a cement floor equipped with a drain permitting leachate collection. In each cell, three layers of carcasses were sandwiched between two layers of manure, allowed to compost for three months, turned, and matured for another three months. Results indicated that temperatures generally rose to 65 0C; that, except for the bones and some wool, the carcasses had disappeared after three months; that there was considerable leachate which was not always dependant on loading rate; and that for most variables, the compost and leachate composition were unaffected by loading rate. However, variables were often affected by season. Therefore, composting is an interesting on-farm carcass disposal method.

(# 451) Effect of the interaction between AMF Glomus manihotis and plant growth promoting bacteria (PGPB) from Bacillus genus on micropropagated banana plantlets.

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Despite the well-known advantages provided by micropropagation, one of the main inconvenient is the lack of beneficial microorganisms of plants obtained by this technique. The establishment of a rhizosphere microbiota has been described as an important point for the survival and development of microplants during post vitro hardening phase. Beneficial microorganisms like AMF and PGPB can contribute to plant adaptation to autotrophic conditions by enhancing development and health. However, an effective combination of both microorganisms is not always easy, since microbiota relationships are under a great specificity. In this trial, micropropagated banana plants from 'Grande Nain' cultivar, firstly mycorrhized with G. manihotis were inoculated with a 108CFU/mL suspension of Bacillus spp. consortium. Four harvest moments at 30, 85, 135 and 185 days after bacteria inoculation were made. According to temporal evolution, the optimal response of the co-inoculation was registered at 135 days, where the 80% of parameters measured showed significative differences. Plants inoculated with both microorganisms showed increments in biomass production and development comparing to those without any organisms. Foliar contents of P and N were also higher in plants inoculated with the combination of AMF and bacteria. No negative effect of bacteria on AMF colonisation was observed.

(# 452) Effect of AMF Glomus mosseae and plant growth promoting bacteria (PGPB) Pseudomonas fluorescens strain 817 on micropropagated banana plantlets infected with root-knot nematode Meloidogyne javanica.

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The individual use of arbuscular mycorrhizal fungi (AMF) and plant growth promoting bacteria (PGPB), has been described as biocontrol strategies against plant pathogens. They both are able to improve plant health and development. Due to the high degree of specificity involved in soil microbiota relationships, the effectiveness of each one does not mean a guarantee of the combined use of them. The effect of the interaction between an AMF and a PGPB strain on nematode reproduction in banana has been studied in this trial. Micropropagated banana plantlets ('Grande Nain' cultivar) were treated with G. mosseae or P. fluorescens 817 and the combination of both organisms. A suspension containing 10,000 nematodes/mL was applied 15 days after bacteria inoculation. Analysis took place 135 days after nematode inoculation. Plants infected with M. javanica and inoculated with any of the beneficial organisms or both of them, showed weak increments in development. Nitrogen foliar contents were higher in plants inoculated with G. mosseae or P. fluorescens 817 or their combination. Nematode reproduction was reduced in all treatments with both AMF or bacteria. No negative effect of bacteria or nematode on AMF colonisation was detected. In the same way, G. mosseae colonisation or M. javanica infection, does not reduce bacteria populations in roots.

(# 453) In vitro studies of the interaction between Trichoderma sp., Pisolithus tinctorius and Phytophtora cinnamomi

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The saprotrophic fungus Trichoderma sp., the mycorrhizal fungus Pisolithus tinctorius and the pathogenic fungus Phytophtora cinnamomi were tested in vitro in order to study their interaction.Two different culture media were used (PDA and MMN). Each fungus was inoculated alone and in combinations of two and three in Petri dishes. The growth rates were measured every 48h and the contact time of the fungus growing together was registered. The behaviour of the fungus after contacting with each other was also recorded.Trichoderma sp. and P. tinctorius grow better in PDA while P. cinnamomi grows better in MMN. When growing together, Trichoderma sp. spatially inhibits P. tinctorius growth and grows over P. cinnamomi either in MMN or PDA media. P. tinctorius also grows over P. cinnamomi inhibiting its growth. An inhibition effect, other than spatial, seems to exist between P. tinctorius and P. cinnamomi while Trichoderma sp. seems to act mainly by spatial inhibition.In vivo assays are in course in order to assess the role of Trichoderma sp. as a biofungicide against P. cinnamomi, and its interaction with mycorrhizal fungi.This work was supported by the Project PRAXIS MESOCASMIC.

(# 455) Zone Tillage and Nitrogen Placement Strategies to Reduce Fuel Consumption, Decrease Nitrous Oxide Emissions and Improve Soil Quality.

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A three year field study was established on a wheat-corn-soybean rotation on a Brookston clay loam soil. The tillage treatments following winter wheat involved fall moldboard plow tillage, fall transtill and no-tillage, The N placement methods evaluated were sidedress N placement at 2 cm depth (shallow) and at 10 cm depth (deep). The objectives were to evaluate the feasibility of using zone tillage and nitrogen fertilizer placement technology to reduce fossil energy consumption (fuel and N fertilizer requirements) and nitrous oxide emissions. Fuel consumption was reduced by 67% with zone tillage (6.74 L/ha) compared to conventional moldboard plow tillage (20.4 L/ ha). Averaged over all three tillage systems, shallow N placement methods decreased nitrous oxide emissions from the soil by 25% compared to deep N placement. Further, when deep N placement was used, no-tillage resulted in 19% lower nitrous oxide emissions (4.46 kg N/ha) than conventional moldboard plow tillage (5.52 kg N/ha) and zone-tillage resulted in 38% lower emissions (3.43 kg N/ha) than conventional moldboard plow tillage. Corn grain yields similar with conventional and zone tillage in 2000 and 2002, however yield reductions were observed with zone tillage during 2001 under drought conditions. Zone tillage was found to be a promising technology as it reduced fuel consumption and draw bar energy and it was also environmentally friendly as nitrous oxide emissions were reduced compared to both conventional moldboard plow and no-tillage.

(# 458) Networks of Power and Influence: The Role of Mycorrhizal Mycelium in Controlling Plant Communities and Agro-Ecosystem Functioning

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The external mycelia of mycorrhizal fungi are the "hidden half" of the symbiosis but provide one of the most powerful influences upon biogeochemical cycling, the composition of plant communities and agro-ecosystem functioning. These mycelial networks are empowered by receiving 10-30% of the net photosynthate of their host plants and are the most dynamic and functionally diverse components of the symbiosis. Through their inter-connections between roots of different plants and their abilities to access nutrients that are, by reason of chemistry or spatial location, unavailable to plants, mycorrhizal mycelial networks have major effects on nutrient cycling and below-ground carbon-fluxes. As the costs and functional 'benefits' of mycorrhizas differ greatly between fungal species and, through reasons of physiology and varying host-specificity, are not shared equally amongst plants, mycorrhizas have a major influence on plant community composition and ecosystem functioning. This paper will review recent advances in our understanding of the multi-functionality of mycorrhizal mycelial systems in agro-ecosystems and assess their potential contribution to the maintenance of biodiversity. The importance of carbon and nutrient fluxes through mycorrhizal networks, the nature and extent of their interactions with other trophic groups of organisms, and the adverse effects of pollution, intensive cultivation and forestry practices on their functioning will be considered. The future, in which increasing use of genomic and post-genomics technologies will at last enable fine-scale resolution of thelargely hidden but dynamic spatial and temporal activities of mycorrhizal mycelia in soil will be appraised.

(# 459) Analyses of transgene expression in the ectomycorrhizal fungus Pisolithus tinctorius

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The roots of most vascular plants are colonized by specific root-inhabiting symbiotic fungi and this relationship is termed mycorrhiza. In the present work, the genetic transformation of the ectomycorrhizal fungus Pisolithus tinctorius is reported and the transgene expression was also analyzed. This fungus has been extensively used in forestation programs, because P. tinctorius has a broad tree-host range andis distributed throughout most of the world. We developed the genetic transformation as a tool for the study of the microorganism-plant interaction. The stable transformation was carried out by microprojectile bombardment and Agrobacterium-mediated transformation, this last method was found to be very efficient. Southern blot analyses of transformed fungi by biolistic revealed that the integrationof the transgenes occurred in two different places in the genome. In situ hybridization analyses of the transcript localization showed an important accumulation in extraradical mycelia. Interestingly, a strong signal was also detected in cortical cells of the plant symbiont. These results are discussed in terms of the macromolecular trafficking between the symbiont interfaces.

(# 460) The Effect of Two Microbial symbionts, Glomus intraradices and Frankia sp. on the growth of Alnus glutinosa in Extremely Alkaline Anthropogenic Sediments

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Interest in the use of plant-microbe based systems for the remediation of degraded soils and sediments has been increasing in recent years. Black alder (Alnus glutinosa (L.) Gaertn.) is known not only to form actinorhizas with nitrogen fixing Frankia, but also mycorrhizas with arbuscular mycorrhizal fungi. The presence of actinorhizas and arbuscular mycorrhizas may reduce stresses caused by lack of nutrients and extreme soil pHs. A greenhouse experiment was conducted using A. glutinosa seedlings inoculated either with Glomus intraradices BEG163, Frankia sp. or both symbionts in a sediment with an extreme pH 12-13 from the waste from an acetylene and polyvinylchloride factory. After a six-month growth period, plants inoculated with both symbionts had significantly greater total leaf surface areas, shoot heights and dry weights, root collar diameters and total biomass when compared with the uninoculated controls, the Frankia sp. alone and the G. intraradices treatment alone. The total dry weight of Frankia nodules andthe total number of nodules were significantly greater in the treatment where both symbionts were present. The length and activity of the extraradical mycelium of G. intraradices was also significantly greater when a dual inoculation was performed. In general, the inoculation with Frankia sp. alone was shown to improve A. glutinosa growth, whereas G. intraradices alone generated a neutral to slightly negative response under these environmental conditions. However, when the two symbionts were inoculated together a synergistic effect was observed resulting in a greater benefit for the plants. The remediation model using A. glutinosa together with inoculated stress tolerant bacterial and fungal symbionts is proposed for the phytorestoration of such anthropogenic stressed sediments with extreme pHs.

(# 461) Metal leaching behavior under NaCl and tap water from three artificial soil substrates of urban trees

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Urban tree pit soils are often exposed to de-icing salt accumulation, nutrient deficiencies, and compaction. Three urban tree soil substrates were leached with tap water after adding 4 levels of NaCl solution to compare their nutrient retention, reaction to de-icing salt, Na+ leachability of the different substrates as influenced by leaching and salt. The tested soil substrates were loam (L), a mix of ¾ loam and ¼ peat by volume (LP), and a mix of 80% acid-washed silica passing a 4 mm sieve with 20% clay by mass (SS). After the substrates were wetted to saturation, 50 ml four levels of NaCl solution containing either 0, 12.5, 25.0 or 37.5 mg NaCl /column) were applied on the first day. Afterwards, the soils were leached with tap water. Na loss rates were in the order L > SS > LP. The loam substrate had the best Na leachability while LP retained more Na. When leached with tap water alone, L and LP had similar K loss rates of about 37%, while SS had a higher K loss rate of 62%. When different levels of Na+ were added, a higher Na levels caused greater Ca and Mg losses. These losses changed little over time within a given Na+ level. Net losses of Ca and Mg were in the order L>LP>SS. Na+ increased K+ loss from L and LP only slightly but by 13 to 18% in SS compared to tap water. Fe loss with tap water was similar in all soils. After applying NaCl, a higher Na+ concentration caused a higher Fe loss in the order SS > L = LP.

(# 462) Spatial Variability of Soil Test Phosphorus, Potassium, and pH in Ontario Soils

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One of the most frequently used methods for establishing management zones for the purpose of site-specific application of nutrients is grid soil sampling. Geostatistical procedures are then used to estimate values between sample locations. A requirement of geostatistics is that samples be taken at a close enough spacing so that they are correlated to one another. An evaluation of the scale of variability of soil test Phosphorus (STP), soil test potassium (STK), and soil pH for Ontario soils was conducted using autocorrelation analysis of 25 Ontario farm fields which were grid sampled at a 30 m spacing. Autocorrelation analysis indicated that, for each of STP, STK and soil pH, 13 of the 25 farm fields would require a grid spacing of less than 30 m to adequately assess their spatial variability. For only one site was the commonly used 100 m grid spacing adequate for the assessment of the spatial patterns of STP and STK. It was concluded that the commonly used grid sampling spacing of 100 m was too great to assess the spatial variability of STP, STK, and soil pH in Ontario and that a spacing of 30 m would be required in most cases to meet the minimum requirement of geostatictics. Soil sampling using a 30 m grid, however, would require approximately 11 times as many soil samples as the 100 m grid which is likely to make the cost prohibitive.

(# 463) Fine scale genetic structure analysis of Cenococcum geophilum reveals putative cryptic species

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Cenococcum geophilum (Cg) is one of the most commonly encountered and widely distributed mycorrhizal fungal species. A significant amount of genetic and genotypic diversity has been detected in populations of Cg, despite the fact that this fungus is not thought to reproduce by meiotic or mitotic spores. Previous studies have concluded that a finer sampling scheme was needed to adequately describe the genetic structure of Cg. Therefore, we chose to sample at a fine scale within a Blue oak (Quercus douglasii) dominated California woodland. Three subpopulations of Cg were sampled within approximately 10 to 15 m of each other on a spatial scale of less than 4 square meters per subpopulation. Up to 18 soil samples were taken from each subpopulation and over 100 cultures were recovered from viable sclerotia. Amplified fragment length polymorphisms (AFLP) detected a substantial amount of diversity within and among each subpopulation. Genome wide variability based on AFLP and preliminary phylogenetic analysis of the ITS region and a group I intron, located between ITS 1 and the small subunit of rDNA, of representative isolates from one subpopulation is consistent with cryptic species of Cg coexisting at fine spatial scales. The hypothesis of cryptic species within Cg is being further tested on other subpopulations of Cg using AFLP and phylogenetic analyses of additional genetic loci.

(# 464) MYCORRHIZAE ALTER FRUIT QUALITY BY REPRESSING RIPENING GENES IN TOMATO

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Tomato plants (Lycopersicon esculentum Mill) were grown from seeds and inoculated at transplant withGlomus fasciculatum to determine the effect of mycorrhizal fungi on fruit quality. Two different levels of phosphate were evaluated (22 or 44 ppm). Quality of tomato fruits was measured by determining size (weight, length and diameter), color (L*, a*, b*, C*) and texture or firmness (penetration force) at three different stages of ripening. Phosphate applied influenced the percentage of successful plant colonization by AM (arbuscular mycorrhizae) and photosynthetic rate as well. Fruit quality was improvedin AM-treated plants. Fruits from mycorrhizal plants with 22 ppm phosphate were bigger and more homogeneous in size than fruits from control plants. Likewise AM-treated fruits presented a brighter red color than control fruits. Fruit firmness at red stage was also improved by fungi inoculation, since AM-treated fruits showed higher penetration force than those control fruits did. To look closer at the mycorrhizal effect on the fruit quality, mRNA levels of two enzymes were examined during fruit ripening, polyglacturonase and ACC oxidase. Polygalacturonase is involved in fruit softening (related to texture) and ACC oxidase is an enzyme involved in ethylene biosynthesis, the main accelerator of fruit ripening. A dramatic decrease in the abundance of the mRNAs for the two enzymes was observed AM-treated plants in comparison to control plants.

This work shows for the first time that mycorrhizal colonization have a significant effect on fruit quality and that this effect is reflected in changes in gene expression in the fruit.

(# 465) Effects of Nitrogen Fertilization on Yields and Effective Components of Chrysanthemum boreale M. (Compositae)

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Chrysanthemum boreale M., a perennial flower, has been historically used as a natural medicine in East Asia. With increasing interest in concerns for health-improving foods, the demand for C. boreale M. has increasedbecome higher than ever. However, the amount of wild C. boreale M. collected from mountainous areas is not enough to meetcover all current demands. We investigated the effects of nitrogen application on plant growth and effective components of C. boreale M. to develop an efficient cultivation system of nitrogen fertilization. C. boreale M. was cultivated in a pot scale (1/2000a scale), and nitrogen applied at the equivalent of six rates (with rate of 0, 50, 100, 150, 200, and 250 kg ha-1). Maximum yield (whole plant and flower) was achieved at 226 to 246 kg ha-1 N. Proline was the most abundant amino acid in the flower of C. boreale M. and the contents of amino acids in flowers increased with increasing nitrogen application rate. Nitrogen recovery efficiency was more than 41% for all nitrogen treatments and reached 61.8 % at 100 Kg N ha-1. In the flower, contents of cumambrin A, a sesquiterpene compound known to reduce blood-pressure, decreased with increasing nitrogen application. However, the amount of cumambrin A in flowers increased as nitrogen rate increased, because of increasing flower yield. In conclusion, nitrogen fertilization increases yields and enhances overall quality.

(# 466) A comparison between the fungal community found on ectomycorrhizal roots and the fungal community found as fruiting bodies in a mature stand of Blue Oak (Quercus douglasii)

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Few studies of ectomycorrhizal (EM) community ecology have examined xeric, Quercus-dominated woodlands and savannas, despite the abundance of these vegetation types in the Northern Hemisphere. In this study we compare the EM community from roots under a mature stand of Blue Oak with EM fruiting bodies from the surrounding forest. We collected EM fruiting bodies in a 500x500m plot yielding epigeous, hypogeous, and resupinate forms. We identified specimens based on morphology and ITS sequences. In March 2003 we sampled EM roots from a 32x32m hierarchical grid. DNA was extracted from 100 bulked EM roots per core. The ITS region and part of the ribosomal large subunit were amplified and then cloned. 30 clones were sequenced using ITS-1F and sequences of root tips were compared with a sequence database from fruiting bodies. We hypothesize that EM fungi dominant on root tips are different from those producing abundant epigeous fruiting bodies. We expect fungi from the Russulaceae, Thelephoraceae, and other resupinates to be common on roots. However, contrary to the results found from many ecosystems, we also expect that ascomycetous fungi and fungi that produce hypogeous fruiting bodies will be common on root tips.

(# 467) Exploring functional definitions of mycorrhizas: are they always mutualisms?

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Fifty years ago Melin showed that hyphae of ectomycorrhizal (EcM) fungi can absorb nutrients and translocate them to plant hosts; this has subsequently been demonstrated for arbuscular mycorrhizas (AM). We also know that carbon is transferred from mycorrhizal plants to fungal symbionts, leading to the well-established idea that bi-directional nutrient transfer is the main basis of mycorrhizal mutualism. The obligate nature of AM in terms of vegetative growth and sporulation and of EcM for fruit-body production, leads to the assumption that fungal fitness is completely dependent on carbon supplied by the plant. However, for the plants results are remarkably diverse in terms of growth and P uptake and effectiveness of the fungi. When there is no whole-plant response to mycorrhiza formation it is assumed that the fungi make no contribution to nutrition and that mutualism (if any) must have another basis. Recent results with AM (refer to abstract ___) show that this is a serious oversimplification and that some fungi are responsible for 100% of plant P uptake, even when there is no change in total P uptake or growth. Does this constitute mutualism at the cellular level? How is plant fitness affected by fungal dominance of P uptake if there is no response at the whole plant level? How does the marked diversity in plant and fungal 'performance' observed in pot experiments affect plant fitness and competitive success in complex ecosystems? Our presentation will discuss these questions in the light of recent experiments at the physiological and ecological levels.

(# 468) Effects of Lime Application on Terpene Contents and Yields of Chrysanthmum coronarium L. (Compositae)

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Chrysanthemum coronarium L. has a long history of cultivation in East Asia as a vegetable and a herbal medicine. Previous research has shown that terpene compounds such as cumambrin A (CA) and dihydrochrysanolide (DC) can be isolated from C. coronarium L. and can play roles in cancer prevention and blood-pressure reduction. We investigated the effects of calcium on terpene contents and yields of C. coronarium L., with a long term view to the development of an effective production system for this crop. About 16 kg of dried soil was packed into each pot (1/2,000 field size), and slaked lime was applied at rates of 0, 1, 2, 3 and 5 Mg ha-1. The maximum yields following lime application were equivalent to 2.2 Mg ha-1. Sesquiterpene lactone (SL) contents and yields in the flower of C. coronarium L. were increased by increasing lime application rate, as were CA and DC. The correlation coefficient between SL contents and calcium contents in the flowers was strong (r=0.604*). Thus, SL cyclase or synthase were increased relatively with increasing calcium application up to 2 Mg ha-1. Essential oils, including sesquiterpene compounds such as cyclohexadin and ¥á-Longipinene, were highest at 3.0 Mg ha-1 lime. A relationship between essential oil content and calcium content in the leaf was not detected. In conclusion,increasing the calcium concentration in the soil cultivation can lead to improved yield and medicinal properties of C. coronarium L.

(# 469) Impact of Arbuscular Mycorrhizal Fungi on Soil Microorganisms, N and P Cycling and Crop

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Arbuscular mycorrhizal (AM) fungi are fundamental to plant growth and soil quality, but the mechanisms subtending such effects are not fully understood. AM fungi physically assist root in takingup water and nutrients, and directly enhance plant growth and C in soil-plant systems. It is less clear how AM fungi influence soil bioprocesses. AM fungi can reduce, stimulate or have no effect on different taxonomic and functional microbial groups and individuals of the rhizosphere and of the bulk soil. More insight into the AM fungi - soil microorganisms' interactions could help us clarify the impact of AM fungi on N and P cycling. AM fungi can directly mobilize P from the organic and the inorganic fractions of soils through the release of phosphatase enzymes and of organic acids, and through a shift in equilibrium created by the powerful inorganic P-scavenging ability of arbuscular mycorrhizae. However, the effect of AM fungi on P release from soil can also proceed through the influence of the symbiosis on other soil organisms. The amount of labile P held within AM fungal biomass seems important to reduce P fixation in soil and to facilitate P uptake by plants after hyphae death. AM fungi can influence mineralization, nitrification and denitrification, through their effect on soil microorganisms. Symbiotic nitrogen fixation in legumes is usually enhanced by concurrent AMF colonization in a way that cannot always been attributed to better plant P nutrition.

(# 470) IMPACTS OF TIMBER HARVESTING ON SOIL MICROBIAL COMMUNITIES TESTED BY A NEW DISTRIBUTION-FREE STATISTICAL TEST

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Impact from timber harvest machinery may cause a drop in soil organic matter content and in soil porosity. In turn, these changes will affect key ecosystem properties and processes such as water and nutrient storage capacity, soil structure and nutrient availability. Most of the earlier work examined the impact of forest harvesting on soil physical properties and tree growth. The objective of this study is to investigate the effects of soil compaction and soil organic matter removal on soil microbiological properties and processes. Samples were collected from the following five treatment (with three replicates) from the LTSP site in the Dawson Creek Forest District: 1) intact mature aspen forest; 2) stem only harvest, no compaction; 3) stem only harvest, heavy compaction; 4) whole tree harvest plus forest floor removal, no compaction; and 5) whole tree harvest plus forest floor removal, heavy compaction. For the mineral soil and the forest floor (when not removed), we determined microbial community-level catabolic profiles (using Biolog® ECO plates), basal respiration, microbial biomass, and nitrogen and phosphorous availability. Preliminary data analysis on the community data showed that whereas soil compaction produced only a non-significant trend, forest floor removal reduced markedly the degradation intensities of most of the C-sources used, suggesting a reduction in soil organic matter mineralization capacities, which may lead to nutrient deficiencies for plant growth. Available tests to verify ANOVA assumptions showed lack of power with our data set. We proposed here a new distribution-free analysis to test multivariate response in multifactorial ecological experiments.

(# 471) Compost applications increase water-stable aggregates in conventional and no-tillage systems.

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Agricultural practices that alter the soil organic matter (SOM) content are expected to cause changes in soil stability and aggregation. The objective of this study was to evaluate short-term (<2 year) changes in water-stable aggregates (WSA) in a silt-loam soil under different management regimes. The interactive effects of tillage (no-till and conventional tillage), crop rotations (continuous corn, corn-soybean rotation) and composted cattle manure applications (0, 15, 30 and 45 Mg (wet weight) ha-1) on WSA were assessed in a factorial (tillage x crop rotation)-split plot (compost) experiment. The proportion of WSA >4 mm was greater in compost-amended than unamended soils within one year, and the mean weight diameter (MWD) of aggregates increased with increasing compost application rates. By the second year of the study, no-till soils under continuous corn and the soybean phase of the corn-soybean rotation had more WSA >4 mm and a greater MWD than any crop rotation in conventionally-tilled soils. Increasing the C input to soil increased the MWD of aggregates. The MWD of aggregates was related to the C content of soils under no-till, but not conventional tillage, suggesting more physical stabilization of organic matter (OM) in no-till than conventional tillage agroecosystems. Our findings indicate rapid improvements in aggregation of a silt-loam in the first two years after compost application and the adoption of no-tillage practices.

(# 472) Ecology and function of arbuscular mycorrhizal fungi (AMF) in subsistence agriculture in the semi-arid tropics – a comparison with temperate mesic agroecosystems

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Most terrestrial plant species form arbuscular mycorrhiza. The mycorrhizal fungus provides a large absorptive surface, which often results in increased P uptake. In agroecosystems that experience wet, freezing winters, winter cover cropping and the avoidance of tillage can significantly increase mycorrhizaactivity, resulting in increased cereal yield and legume N_2 fixation rates. Could cover cropping and no-tillage practices promote mycorrhiza activity in the semi-arid tropics where the primary stress is drought? This could benefit subsistence farmers that lack the means to purchase fertilizers.

Field experiments in an alfisol and vertisol in Zimbabwe showed that P limited growth and N_2 fixation of Lablab purpureus. In a greenhouse experiment, the addition of AMF inoculum to the non-sterile alfisol increased nodule P content, nodule mass and shoot N concentration. Adding AMF inoculum to the vertisol did not have significant effects.

We investigated the effect of a mycorrhizal cover crop (Cajanus cajan) and winter tillage on mycorrhiza inoculum potential in an alfisol, vertisol and a granite sand. In all three soils the cover crop significantly reduced the fallow period. Contrary to our predictions, however, there were no significant effects of cover cropping or tillage on inoculum potential. We hypothesize that the low moisture levels in the soilsdid not have a significant negative effect on mycorrhizal inoculum potential, and that during drought, tillage and the lack of a host plant do not represent significant impediments to maintaining a high inoculum potential. We conclude that soil freezing and drought have different effects on AMF.

(# 473) Mutualism in the earthworm gut: evidence from microbial PLFA biomarkers

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In North America, earthworm populations ingest several tonnes ha-1 of soil and plant residues each year. Soil and organic residues passing through the gut are transformed both by earthworm secretions and by microorganisms, but surprisingly little is known about the types and functions of microorganisms inhabiting the earthworm gut since only culturable microorganisms (1 to 10% of the total microbes present in the gut) have been identified so far. The purpose of this study was to quantify the changes in microbial community diversity and biomass in the gut of Lumbricus terrestris L. and bulk soil using phospholipids fatty acid (PLFA) biomarker analysis. Phospholipid fatty acids (PLFAs) were extracted from three parts of the earthworm gut and analyzed by GC-FID. The total PLFA content was about 200 times higher in the earthworm gut than the bulk soil, and the biomass of specific biomarkers was 400- to 800-fold higher for bacteria and 100- to 275-fold higher for fungi. In addition, the biomass of biomarkers for protozoa was twice as great in the hindgut than in the other parts of the gut, and 100 times greater in the earthworm gut than bulk soil. This is the first report of protozoan growth in the earthworm gut; further study to determine their role in earthworm digestion is warranted. These results, together with recently published data from other studies, suggest that metabolic activity in the earthworm gut may involve obligate relationships between closely related syntrophic microorganisms.

(# 474) Local Arbuscular Mycorrhizal Fungal Diversity is Strongly Coupled to Regional Diversity in an Urban Ecosystem

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Local diversity at an experimental landscape plot was compared to the regional diversity of arbuscular mycorrhizal fungi (AMF) in an urban ecosystem in the arid Southwestern USA. To assess local diversity, fifty soil samples were collected at an experimental landscape plot located at the Desert Botanical Garden, Phoenix, Arizona. To assess regional diversity, three soil samples were collected at 40sampling sites in the Phoenix metropolitan area. AMF species in each soil sample were identified from trap cultures, and species richness and relative frequency of each species was calculated. Twelve species were detected at the experimental landscape site and close to 20 species were detected in the regional survey. There was a strong overlap of species composition on the local and regional scale with ten of the species detected in the local community also detected in samples in the regional survey. The four most frequently detected species in the local communities were the most frequently detected in the regional survey and the rarely detected species were similar. Species composition in urban sites was alsosimilar to that previously reported for the surrounding Sonoran desert. This type of overlap between local and regional diversity suggests large-scale historical processes may be important in determining local community structure. Preston-type plots of the relatively frequency also indicate broad dispersal of AMF species. These results appear to indicate that the local community sampled is strongly coupled to the metacommunity

(# 475) Carbon, ash and organic matter relationships for feedlot manure composts

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Manure composting has gained increased acceptance by the beef feedlot industry in southern Alberta. To understand organic matter dynamics during composting, it is essential to distinguish mineral constituents (likely to persist) from organic constituents (potentially susceptible to decomposition). At the Lethbridge Research Centre, data for 3051 manure/compost samples have been acquired during six years of beef feedlot manure composting trials. The samples included raw manure and manure at various stages of composting where cereal straw or wood chips had been used as bedding. Routine analyses included total carbon (TC) in finely-ground (< 150 µm) sub-samples (8 mg), and ash in coarsely-ground (< 2 mm) sub-samples (5 g). Total C content was determined by automated combustion-gas chromatography at 1000 ºC (Carlo Erba, Milan, Italy). TC values ranged from 6.9% to 50.1%. Ash content was determined by manual combustion in a muffle furnace at 650 ºC for 24 hr. Approximate organic matter (OM) or volatile solids was calculated as (100% - ash content). The relationship between OM and TC was defined by the equation OM = 3.1+1.8(TC) with an R^2 value of 0.96. For the same data, the average ratio of OM to TC was 1.917, slightly higher than the conventionally-used van Bemmelen factor of 1.724. Additionally, the regression analysis demonstrated that (1) ash content could be estimated from TC, eliminating the need for time-consuming ash determinations and (2) the mass balance of TC could be used instead of ash-free dry matter to describe organic matter losses during composting.

(# 476) Evidence for mycorrhizal host-races in two non-photosynthetic orchids

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Evidence is accumulating for specialized yet evolutionarily dynamic associations between orchids and their mycorrhizal fungi. However, the phylogenetic scales of changes in specificity in orchids are largely unexplored. In other words, do changes occur close to speciation (evidenced by differences in specificity in sister species or genotypes)? Or, in contrast, do changes accumulate during the course of divergence long after speciation (evidenced by differences in specificity among families or genera, but not among sister species)? We address these questions in two genera of non-photosynthetic orchids using culture-independent molecular-phylogenetic analyses of the fungal symbionts. In the Hexalectris spicata complex, we find that different floral variants in the southwest associate with different, but closely related jelly fungi in the Sebacinaceae. In the Corallorhiza maculata complex, we find that 1) the associations of particular genotypes are narrower than expected by chance based on permutation tests, 2) four of six genotypes associate with discrete clades of fungi in the Russulaceae based on AMOVA analyses, and 3) these distinct associations are consistent over thousands of kilometers. The most striking result is that differently specialized genotypes within each orchid species maintain their distinct mycorrhizal specificity when growing in close sympatry. We suggest that these subspecialized orchid genotypes are analogous to host-races in phytophagous insects. Host-race formation can drive speciation in insects, especially when host-choice is related to mate-choice. It is unclear how specialization on different fungi could promote reproductive isolation between orchid genotypes, but differences in flowering phenology have been noted among some of these genotypes.

(# 477) Ectomycorrhizal inoculation of containerized Pinus montezumae seedlings with spores of three different fungus isolates

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In Mexico, there has been increasing interest for large scale nursery applications of ectomycorrhizal fungi as a result of the necessity to improve survival and growth of tree seedlings on a variety of sites. For the above reason, some nurseries include the presence of mycorrhiza as another criterion to evaluateplant quality. The goal of this study is to compare effects of three different fungus isolates, two of mexican origin (Pisolithus tinctorius and comercial inoculum of Scleroderma texense) and one of north american origin (comercial inoculum of Pisolithus tinctorius) upon percent of mycorrhizal colonization and seedling growth.

Two weeks old pine seedlings were inoculated with water suspensions of each fungus at the dosage of ten million spores per seedling. Seedling height, stem diameters, oven dry weight of tops and roots and mycorrhizal root colonization of 40 randomly selected seedlings from each treatment replication were recorded at 5, 15, 30 and 45 weeks after inoculation. Control seedlings were contaminated with mycorrhizal fungus present in the greenhouse environment. No significant differences were detected among any inoculation treatment and controls. However, it is interesting to notice that the standard deviation decrease with time. Sporocarps of the "early colonizer" Laccaria appears in containers of all treatments. The final and most important test to evaluate effectiveness of any mycorrhizal fungi is to assess how seedlings perform after outplanting. Continuing efforts to select mexican beneficial fungi adapted to outplanting sites is currently in progress.

(# 478) Colonization preference and morphologies of arbuscular mycorrhizal fungi among different plant species

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In this study, we tried to elucidate whether plant or arbuscular mycorrhizal (AM) fungi control the morphologies in tested plants. Cucumber, tomato and Clethra barbinervis were grown in pots containing soils from 7 different vegetation sites. Percent of AM colonization was different among the plant speciesand the vegetation sites. Cucumber and tomato showed both Arum- and Paris-type morphologies while C. barbinervis showed the only Paris-type throughout vegetation sites. DNA was extracted from the sample soils and roots and PCR was conducted using AMF genus-specific primers (VANS1 and VAGLOfor Glomus, VANS1 and VAACAU for Acaulospora and Entrophospora, VANS1 and VAGIGA for Gigaspora and Sctellospora). DNA was amplified similarly in tomato, C. barbinervis and soils among the sites using primer sets except the case with VANS1 and VAACAU primer pair in cucumber. Root compartment system was used in order to observe the morphologies of AM fungi through different plant species and the type of AM fungi colonizing each plant. Cucumber or C. barbinervis was grown in a compartment with an adjacent compartment containing Paris-type forming C. barbinervis. Cucumber showed both type of morphologies while C. barbinervis showed Paris-type only. DNA was amplified with all primer pairs from C. barbinervis but not from cucumber. Higher colonization was observed using single plant species as receiver within the system compared to using two species.

(# 479) Use of mycorrhizal inoculum in propagation of the Australian native Epacris impressa Labill. (Ericaceae)

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Fungus EI-1-1 isolated from Epacris impressa roots was used as an inoculum along with three other treatments in a clonal propagation trial. Previous trials have demonstrated significantly improved growthin axenically grown E. impressa. A fungus plug was placed in sterile potting mix with added sugar solution and grown until hyphae were visible. E. impressa tip cuttings were taken in Spring 2001. Cuttings were placed in one of four treatments as follows: 1) potting media alone, 2) potting media alone plus stem dipped in IBA, 3) potting media plus site soil and IBA dip, 4) potting media plus fungal inoculum and IBA dip. Stuck cuttings were placed in a fog house and hand-watered. After twenty weeks roots were harvested and examined for mycorrhizas. No mycorrhizal fungi were observed in any roots examined and there was no statistically significant difference between treatments. This may suggest that mycorrhizal inoculum showing promise in vitro may not confer benefit in situ. Additional trials will be performed over the next two years to examine the use of mycorrhizal inoculum in clonal propagation of this species. This study has been partially funded by a grant from the Australian Flora Foundation and by the Maroondah AFF Group.

(# 480) The arginine translocation hypothesis: Advanced mass spectrometry for studying the uptake and assimilation of NH4+ in Glomus intraradices

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Arbuscular mycorrhizal (AM) fungi can transport considerable amounts of N supplied as ammonium or nitrate. Arginine is present in substantial levels in AM fungi and has been suggested to play a major role in mycelial N translocation in AM fungi (Bago et al., New Phytol, 149, 4-8, 2001). This was further evaluated by applying mass spectrometry technology in a time-course study of $^{15}NH_4$ incorporation by G. intraradices grown in root organ culture. External hyphae were sequentially harvested from a root free compartment containing 5 mM $(^{15}NH_4)2SO_4$ over a 96 h period. The nitrogen content as well as ^{15}N abundance in hyphae and roots were determined using an elemental analyser interfaced to an isotope ratio mass spectrometer. The free amino acids were extracted using the chloroform/methanol/water procedure. The amino acids were directly analysed by ion-pair chromatography and were quantified by electro-spray ionisation using an ion trap mass spectrometer. The labelling of the individual amino acids was obtained from the isotopic pattern. The positional labelling was derived using MS/MS strategies.The ^{15}N abundance in the hyphae rapidly approached that of the nutrient substrate whereas the ^{15}N abundance in the roots remained much closer to the natural abundance. Apparently, the NH_2's of the guanidium moiety and the a-amino group were predominantly labelled. The novel results on the biosynthesis of arginine in Glomus intraradices will be discussed based on the detailed labelling experiments as well as results obtained for the amino acids in the glutamine and urea cycles.

(# 481) Compensation by arbuscular mycorrhizal fungi for lack of root hairs in barley

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Improved P uptake by mycorrhizal plants is usually explained by extension of root-external hyphae beyond the P depletion zone close to the root surface. Root hair length influences the width of this depletion zone and hence appears to influence the mycorrhizal P uptake dependency of plants. However,this hypothesis is based on comparisons of different plant species or cultivars and not on comparisons of a single host with contrasting root hair formation. This study uses a spontaneous root hair deficient mutant in Hordeum vulgare cv Pallas to obtain more direct evidence for the root hair effect. Both the mutant and its wild type were grown with or without mycorrhizas at a range of soil P levels. Phosphate uptake of the two plant types was similar at high P levels, but was depressed at low P levels in the mutant. In contrast, P uptake of the mutant was much increased by mycorrhizas and one fungus fully replaced root hairs in P acquisition at low P levels. Roots of the mutant contained typical colonisation structures and a radioactive tracer confirmed P transport from the extraradical mycelium . A limited P uptake response in the wild type at increasing soil P levels was unaffected by mycorrhizas, indicating that the fungi did not utilise less available P sources.

This is the first direct evaluation of the relative effectiveness of root hairs and mycorrhizas in terms of P uptake. It is also the first proof that an efficient mycorrhiza can substitute root hair P uptake.

(# 483) Effects of an AM fungus and two fluorescent pseudomonads on tomato growth, root development and phosphorus accumulation

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The increasing public concern about food and environment quality has resulted in research on alternative agricultural practices characterized by low chemical inputs. It is well known that microbial inoculations could contribute to improve plant growth and health. Among beneficial microorganisms proposed for plant inoculation, arbuscular mycorrhizal fungi (AMF) and fluorescent pseudomonads received large attention. However, information on the effects induced by AMF and rhizobacteria, as single or mixed inoculants, on plant growth and root architecture is scanty. We have focused our attention on the impact of an AM fungus (Glomus mosseae BEG12) and two strains of Pseudomonas fluorescens (92rk and P190r), alone or in combination, on tomato growth, root development and phosphorus (P) acquisition. The AM fungus and the two bacterial strains, inoculated alone or in combination, increased plant growth and showed a synergistic effect. Root architecture was also strongly influenced, depending on the inoculum combination. Plants inoculated at the same time with G. mosseae BEG12 and the two fluorescent pseudomonads showed the highest values of total root length, total root area and volume, number of tips and root branching degree. Moreover, P. fluorescens 92rk hada mycorrhization helper effect. Leaf P content was enhanced by the AM fungus and the bacterial strainsalone and in combination; the highest leaf P content was recorded in plants inoculated with the three microorganisms at the same time.In conclusion, our results support the use of microbial mixed inocula and represent a promising approach for the development of a more environment-friendly agriculture.

(# 484) Ectomycorrhizal fungi on beech coarse woody debris and correlation to some CWD characteristics

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Coarse woody debris (CWD) is an important part of the forest ecosystem as a habitat for plants, animals, bacteria and fungi (1), which use the substrate as a source of nutrients and as a place for fructification. We mapped fruitbodies of ectomycorrhizal (EMF) and lignicolous fungi (LF) on 211 dead beech trees (of different decay phases and diameter classes) in two virgin forest reserves in southern Slovenia (2, 3, 4). In 60 of the trees also nutrients (C, N, S, P, K), pH, wood density and moisture contents were determined (3). The highest influence on occurrence of EMF showed the decay phase and its contact with soil. Most EMF prefer most decayed logs. High percentage of the contact of the log with the soil seems to be necessary for colonisation of the log with mycelium. The calculated response curves (CANOCO) for frequently occurring EMF also showed the preference for higher decay phases. We conclude that CWD is not only important for LF but also for EMF which return a part of the nutrients from the decaying wood through the mycelium back to living ectomycorrhizal plants in the forest ecosystem.Ref.: 1) Amaranthus M., Trappe J., Bednar L., Arthur D., 1994. Can. J. For. Res. 24:2157 – 2165. 2) Piltaver A., Matoèec N., Kosec J., Jurc, D., 2002. Zb. Gozd. Les. 69: 171 - 196. 3) Kraigher H., Jurc D., Kalan P., Kutnar L., Levaniè T., Rupel M., Smolej I., 2002. Zb. Gozd. Les. 69: 91 – 134. 4) Grebenc T., Piltaver A. 2003. In: Kraigher & al. NAT-MAN WP6 Report: Slovenia.Acknowledgements: The study was co-financed by the 5FW EU project NATMAN (QLRT1-CT99-1349) and the Ministry of Education, Science and Sport through the research programme P0404-501 and the young researchers scheme (for TG).

(# 485) BIODIVERSITY, PRODUCTIVITY AND N, P CONTENTS OF CHESTNUT MYCORRHIZAL ASSOCIATED MUSHROOMS

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In Portugal chestnut (Castanea sativa Mill.) tree orchards have been studied in different ways since the start of their decay during the last decades of the XXth century, due to Phytophtora cinnamomi. We started some work on mushroom inventory in these agroforestry systems, in order to get information on mycorrhizal fungi biodiversity. Since most of the mycorrhizal mushrooms are edible species and these are mostly collected and commercialised, an important output of nutrients can be due to the edible species. For these mushrooms, we intend to know how many N and P can be removed from the system and how can the macrofungi contribute for nutrient recycling.

In order to do so, in 2002, 3 plots 100 m^2 were selected in a chestnut orchard (not plough). All the mushrooms were collected, dried and weight. For some of the edible species, namely Hydnum rufescens,Boletus edulis, Cantharellus cibarius, Tricholoma acerbum, Xerocomus chrysenteron and Clitopilus prunulus, quantification of N and P were made. The nitrogen (ammonium and nitrate) concentration was determined by Kjelldahl analysis and the phosphorus by the molybdenum blue method (John, 1974). Nineteen edible mushrooms were recovered and N and P contents were determined either in terms of dry and fresh weights. Taking into account the productivity of each species per plot, the output of these nutrients was calculated. The results were allocated to the hectare.

(# 486) Evaluation of the biodiversity and relative abundance of mycological flora in chestnut trees, Castanea sativa Mill., in the Northeast of Portugal: preliminary results

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The Northeast of Portugal is the main principal chestnut producing region of Portugal and one of the most important of world. The area associated with chestnut tree is 2 9101 ha in Portugal from which 2 4426 ha in the northeast of the country. This work aims: to evaluate the biodiversity and relative abundance of mycological flora associated with chestnut tree; to calculate the ratio of mycorrhizal and non mycorrhizal mushrooms; to analyse the occurrence of mushrooms along the harvesting season; and to discuss their ecological value and endangered species. The experience was carried out in Autumn-Winter of 2002 in a chestnut orchard Castanea sativa Mill. (not ploughed), in the region of Bragança (UTM PG8937). Three 100 m^2 plots were selected. The mushrooms species were collected, separated and counted weekly. They were identified by genera or species.Sixty eight species were recovered belonging to 20 genera. Inocybe and Russula were the genera with the greater number of species (13). Followed by the genera Amanita and Lactarius (6); Tricholoma, (5); Boletus and Cortinarius (4); Xerocomus (3); Hebeloma and Laccaria (2); and the genera Cantharellus, Clitocybe, Clitopilus, Collybia, Entoloma, Gyroporus, Hydnum, Hypholoma, Lycoperdon and Macrolepiota with the least number of species (1). The species belonging to the genera Inocybe and Russula were the most abundant in the number of fruiting bodies, 226 and 133, respectively. 91% of the total number of species are mycorrhizal and 9% are non mycorrrhizal.

The evolution of the number of species, along time, increased until the end of October, and then decreased until the end of November. Some of the species recovered in the study area, namely Amanita caesarea, Boletus aereus, Cantharellus cibarius and Gyroporus castaneus are registered in the European red list.

(# 488) Biodiversity of Mycorrhizal Fungi in the Mycoheterotrophic Orchid Limodorum abortivum

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Because of the limited storage molecules in their seeds, orchids depend on endophytic fungi for the uptake of organic carbon during early developmental stages. In several species, either partially or completely lacking photosynthesis, dependency on the mycorrhizal fungus as a carbohydrate source (mycoheterotrophy) is extended into adulthood. Limodorum abortivum (L.) Swartz is a partially mycoheterotrophic orchid common in the Mediterranean area. We have investigated the biodiversity of mycorrhizal fungi associated with adult plants growing in different environments and plant communities in France and Italy. DNA extracted from L. abortivum roots was PCR amplified with primers specific for fungi (ITS1F/ITS4), followed by cloning and sequencing of the amplified DNA fragments. Phylogenetic analyses demonstrate that all sequences clustered within the genus Russula, in three separate groups. Ectomycorrhizal root tips were sampled from surrounding plants, and ITS sequences were obtained from the different ectomycorrhizal morphotypes. In at least three cases, ectomycorrhizal sequences were found that clustered with those obtained from L. abortivum. These data confirm the specific association of mycoheterotrophic orchids with fungal endophytes capable of forming ectomycorrhiza.

(# 489) Within-Field Spatial Variability of P Saturation Indicators in Horticultural Fields

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The within-field spatial variability of soil P indicators has to be understood to design variable rate application of P fertilizers and for planning smart management of organic residues. The objective of this study was to analyze the intensity and the structure of organization of selected soil P saturation indicators in 16 fields (2.5-11.9 ha) used for horticultural production (cereal-hay-crucifer-carrot rotation) in Orleans Island (QC, Canada). A 30 m x 30 m unaligned grid was used for sampling soil surface layer (0-20 cm). Mehlich-3 extractable P (M3P) and Al (M3Al), and degree of soil P saturation (DSPS=M3P/M3Al) were measured. M3P and DSPS showed high within-field spatial variability, as indicated by the median CV values of 50% and 47%, respectively. The mean within-field M3P values ranged from 15 to 403 kg P ha-1, rating soils as "poor to excessively rich" in P according to fertilizer requirement tables used in Quebec for crucifers and carrots. Fifty percent of the studied fields exceeded 250 kg P ha-1 while 7 of 16 fields had a DSPS over 10%, indicating potential risk of P losses to the environment, particularly on sloping area. Between field and within-field variability are mostly related to different soils and crop management histories. Well defined spatial structure has been found in several fields for M3P and DSPS, with a mean correlation distance value near 45 m. This indicates that a denser sampling grid (>4 samples per ha) than the "one sample per ha" grid currently used is needed for deriving reliable P fertilizer prescription maps in this farming system. Managing P fertilizers and organic residues by homogeneous soil zones could be an economic alternative to variable rate or uniform application strategy.

(# 490) Using Digital Image Analysis to Locate and Describe Organic Matter in Soil Thin Sections.

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Digital Image Analysis (DIA) is increasingly being used for micromorphological studies of soil thin sections. The goal of our investigation is to study the transformation of organic matter from fresh remnants to several brown humified stages and amorphous components. This work examines the ability of DIA to quantify different organic matter in 3 soil profiles (15 horizons) of Brookston Series Gleysolic Soils from S.Ontario: soil under rotation corn/alfalfa and added fertilizers; soil under corn with no fertilizers, and a 100-yr old Oak forest. The images are collected by high resolution digital camera using of red, green and blue filters under plane polarized, circular polarized and reflective lights. Each thin section is characterized by a set of classes including: pores, different matrix types, concretions, carbonates and organic matter. Pedofeatures are visually identified using a petrographic microscope and these recognizable pedofeatures are related to classes obtained by an unsupervised classification algorithm within PCI Geomatica. Organic natter classes are described in terms of humification degree, association with mineral matrix and proximity to other classes, i.e. to soil matrix or pores. Organic matter classes are quantified and are considered as properties dependent on the soil depth and land management regimes.

(# 491) Soil-Specific Management of Agricultural Inputs using Soil Electrical Conductivity.

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Managing agricultural inputs by homogeneous soil zones could be an economic alternative to variable rate or uniform application strategies. Measuring soil electrical conductivity (EC) has been proposed instead of expensive soil survey procedures for delineating within-field management zones (MZ). The objective of this project was to assess the usefulness of a soil EC survey in delineating homogeneous and contrasting MZ in 16 fields used for horticultural production in Orleans Island (QC, Canada). A 30 m x 30 m unaligned grid was used for sampling soil surface layer (0-20 cm) while soil electrical conductivity mapping was performed using Geonics EM-38 on a 15 m x 15 m grid. Organic matter (OM), buffer pH (pHsmp), Mehlich-3 extractable P, K, Ca, Mg, and Al (M3P, M3K, M3Ca, M3Mg, and M3Al) were analyzed. The fuzzy k-means classification algorithm (FuzME) was used with the soil EC dataset for defining MZ. Two to three within-field MZ were found optimal in this farming system for implementing soil-specific management of agricultural inputs. This field stratification can reduce the variance of soil fertility indicators to about 60-80% of the within-field variance. M3Mg, M3Al (P sorption capacity), pHsmp (lime requirement), and M3P (P fertilizer requirement) were the most discriminating soil fertility indicators. M3K, M3Ca, and OM were less often implied in MZ differentiation. Subdividing the studied fields into four to six MZ resulted in an additional gain of about 10-20% of variance reduction. However, MZ discrimination was not well-marked. Farmers have to choose the precision level appropriate to their farming system budget.

(# 492) Investigating Plant Sucrose Breakdown in Response to Arbuscular Mycorrhizal Fungi

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Arbuscular mycorrhizal (AM) fungi consume 10-20% of the carbon fixed by their host plants. AM fungi utilize hexose sugars that are released from sucrose, but it is not known which plant enzyme is catalyzing this reaction. Sucrose synthase is the main sucrose breakdown enzyme in plant sink tissues, including the root nodule. However, we hypothesize that another enzyme, cell wall invertase, is breakingdown sucrose for AM fungal metabolism. Cell wall invertase exists in the apoplastic space with the AMfungi. In contrast, sucrose synthase is a cytosolic enzyme. Hexose sugars resulting from sucrose synthase cleavage would require transport into the apoplast, but no plant hexose transporters are known to export hexose sugars into the apoplast. Instead they work in the opposite direction, moving hexose into the cytoplasm. Although it appears that sucrose synthase transcripts localize to plant cells containing mycorrhizal structures, we hypothesize that this enzyme works antagonistically against cell wall invertase, directing carbon to plant and nodule metabolism. We are characterizing the transcript and protein levels of both enzymes in root and nodule tissues as well as performing immunolocalization in response to mycorrhizal infection.

(# 493) Mycorrhizal dependency of Chihuahuan Desert plants is influenced by life history strategy and root morphology

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Arbuscular mycorrhizal (AM) fungal infection was assessed for dominant Chihuahuan Desert annual and perennial plant species during the summer of 2000. Annuals were determined to have significantly less AM infection than their perennial counterparts. Additionally, annuals were shown to have significantly smaller fine root diameters than perennials. Within fifteen of the seventeen species examined, the presence of AM hyphae in a root segment was not a significant determinant of root diameter, indicating than in most plant species mycorrhizal infection is not directly promoting root diameter increases. The results of this survey show that the dominant plant species of the Chihuahuan Desert group into two categories: (i) short-lived annuals with thin roots and low AM dependency, (ii) longer-lived perennials with thick mycorrhizal roots.

(# 494) New Model for Soil Gaseous flux estimation using closed chambers

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Soils represent a major source of greenhouse gases such as N2O, CO2, CH4. Therefore, developing an effective method of flux estimation of these gases from soils will greatly aid the policy-making process. Although, several methods have been developed over the years to quantify these fluxes, the soil chamber methods remain the most frequently used owing to their attributes of low cost, portability and ease of use. In the closed chamber method, the major limitation has been how to control and correct for the non-linearity of concentration build-up in the chamber headspace. The most commonly used models are the linear model, which does not correct for non-linearity and the Hutchinson and Mosier (H-M) model (1981) which does. Although the H-M model is plausible in many ways, it assumes a constant gas concentration in the production zone of the soil even after chamber placement, a point that has raised many doubts in subsequent studies. The objective of he study was to developing a more plausible and model based on the hypothesis that, by using integrals of diffusion from the chamber in the absence of flux, non-linearity on the field can be corrected. The results of flux estimates from the Linear, H-M and the Integral Model will be presented.

(# 495) Interactions between AM fungi and soil nitrogen impact prairie community composition

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Responses of communities of plants and arbuscular mycorrhizal (AM) fungi to soil nitrogen (N) and atmospheric CO2 were examined in a two-year factorial experiment. Mesocosms were planted with 14 plant species that varied in their level of mycotrophy and included grasses, legumes and forbs, with both C3 and C4 photosynthetic pathways. Treatments included +/- AM fungal inoculum, +/- N, and +/- CO_2. Plant communities responded most to the AM and N treatments, both individually and interactively. The second year of the experiment CO_2 was not a significant main effect; however, CO_2 by AM, and CO_2 by N did affect plant community composition. In general, C4 species benefited most from +AM, and C3 species benefited most from +N and +CO_2 treatments. Mesocosms with +N treatments had the highest total biomass, but lowest species diversity. Two invasive non-mycotrophic annual forbs were more dominant in the +N and -AM mesocosms, and had less dominance in +AM mesocosms. Mycotrophic perennial plants benefited most from the +AM treatment. AM spore communities changed significantly from 2001 to 2002, indicating that sporulation had occurred. Several AM species significantly increased abundance with +N, including Glomus fasciculatum and Scutellospora erythropa. These results indicate that soil N enrichment impacts the composition of plant and AM fungal communities and that AM fungi may help ameliorate the impact of non-native plant invasions in N enriched environments.

(# 496) Hydraulic lift: transfer of water and fluorescent tracers between plants connected by common mycorrhizal networks

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Common mycorrhizal networks (CMNs) play an important role in facilitating water redistribution and uptake during drought. Shallow-rooted plants that share a CMN with deep-rooted individuals conducting hydraulic lift may derive the greatest benefit from this process. The ability of CMNs to directly transfer significant amounts of water between plants was evaluated in the obligate mycorrhizal species coast live oak (Quercus agrifolia). Mycorrhizal (EM and AM) oak seedlings were grown in microcosms comprising two adjacent compartments separated by air gaps and mesh barriers that could be crossed by hyphae but not by roots. Watering was withdrawn from both compartments during experimental drought, but oak seedlings in one of the compartments had access to a taproot chamber with unlimited supply of water and conducted hydraulic lift. Isotopic data obtained after injecting deuterium-labeled tracers into the taproot chamber showed that neighboring droughted seedlings received water from the donor plants through CMNs. The pathway for such transfer was assessed and described by using fluorescent dyes. Data on the relative allocation of transferred water to the mycorrhizosphere soil, roots, stems, leaves and transpiration flux of the receiver plants will be presented.In turn, the ecological implications of this process for the functioning of natural plant communities in drought-prone ecosystems will be discussed.

(# 497) Arbuscular mycorrhizae and fungal pathogen interactions and their impact on asexual propagules of Allium vineale

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It has been proposed that, in addition to increased P uptake, mycorrhizae may play an important role in protecting host plants from pathogens. We planted asexual propagules of Allium vineale in the presence and absence of both mycorrhizae and Sclerotium cepivorum (white rot), a soil fungal pathogen specific to the genus Allium, using a factorial design. The order of encounter was varied, with the plantsencountering either the pathogen or the mycorrhizal inoculum first. Three plant genotypes were used. There was a significant three-way interaction (mycorrhizae*pathogen*genotype) for leaf length after 2 months. The three genotypes differed in their susceptibility to the pathogen, and this susceptibility varied with the mycorrhizal treatment as well as for order of encounter for genotypes B and C. These interactions shifted at the final harvest one year later, as there were still significant differences among the genotypes in their susceptibility to the pathogen, but susceptibility was no longer altered by the presence of mycorrhizae. Overall these results support the hypothesis that mycorrhizal associations play a role in mediating plant-pathogen interactions, and that this role varies over time.

(# 498) Functional genomics of arbuscular mycorrhiza: decoding the symbiotic cell programme

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The fact that reciprocal compatibility systems between arbuscule-forming fungi and primitive land plantshave been acquired by new plant species appearing during evolution means that the symbiotic root-fungal interactions should be based on widespread mechanisms within the plant kingdom. Over the last decade research into the molecular bases of cell programmes in arbuscular mycorrhiza has progressed rapidly with the advent of transcriptome technologies. It is evident from plant gene expression information initially based on molecular probes identified for other biological systems or metabolic processes that plant-fungal interactions are characterised by uncoordinated defense responses, overlapping genetic programmes with nodule symbioses and activation of specific transmembrane transport processes. More extensive insight into plant genes involved in the mycorrhizalsymbiotic programme is presently being achieved by global approaches with principal aims of discovering novel genes or subsets of genes which are essential to cell programmes in the different steps of plant-fungal interactions in arbuscular mycorrhiza. The strategy of functional genomics based on large scale differential RNA expression analyses (DDRT-PCR, electronic Northerns, suppressive subtractive hybridisation, DNA chips) will be presented, with a focus on P. sativum and M. truncatula. The most recent knowledge about gene consortia that are modulated in roots during arbuscular establishment and functioning will be discussed.

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(# 499) Mycorrhizal colonization enhances plant defences against aphids in tomato

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Plants have direct and indirect ways to defend themselves from insect herbivores. Direct defences contrast colonization and, later on, development and reproduction of invading insect. Indirect defences include the production of volatile semiochemicals that are attractive towards natural enemies (predators and parasitoids) of herbivore insect. The effect of arbuscular mycorrhizal (AM) symbiosis on plant-herbivore and plant-herbivore-parasitoid interactions have been investigated in tomato plants colonized by the AM fungus Glomus mosseae BEG 12.

AM colonization affects negatively the development of the aphid pest Macrosiphum euphorbiae (Thomas). In particular, the reproductive rate of this sap feeder was significantly lower on mycorrhizal tomatoes than on control ones. Moreover, mycorrhizal tomatoes were significantly more attractive than control plants towards the braconid wasp Aphidius ervi (Haliday), the most effective natural enemy of M. euphorbiae. The latter result was obtained with plants that have not been infested by aphids and thus the active compound(s) involved in these multitrophic interactions are supposed to be entirely related to the mycorrhizal symbiosis. Finally, only after having been infested with M. euphorbiae, did control tomatoes become as attractive towards A. ervi as mycorrhizal ones.

These results confirm our preliminary observations and suggest that AM symbiosis, along with positiveeffects against many plant pathogens, can affect both direct and indirect plant defences against herbivores. The mechanisms involved are worth to be investigated thoroughly in order to promote sustainable strategies of crop protection.

(# 500) Nuclear size in arbuscular mycorrhizal tomato: the role of ploidy and chromatin decondensation

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In order to better understand the mechanisms of nuclear size variations, and more precisely, to clarify why nuclear hypertrophy does not always follow genome increase, biological techniques combined witha sophisticated and strict mathematical approach have been applied to study the nuclei of root cortical cells of an arbuscular mycorrhizal (AM) plant, as fungal colonization is known to strongly affect nucleusorganization and ploidy. Tomato, with its three ploidy levels (corresponding to 2C, 4C and 8C DNA content) represents an optimal biological system for the study of nuclear variations related to ploidy. Quantitative and qualitative nuclear changes have therefore been analyzed in mycorrhizal (colonized by Glomus mosseae BEG 12) and non-mycorrhizal roots of Lycopersicon esculentum Mill cv. Early Mech, by means of microscopy, immuno-labelling of histone H1 and flow cytometry. The results, clearly showed that increased ploidy is necessary, but not sufficient, to explain nuclear hypertrophy, in which chromatin decondensation, related to cell metabolic activity, is also involved. In addition, colonization by AM fungi showed to be a useful tool for the investigation of basic and general biology phenomena.

(# 501) Gene expression in the ectomycorrhizal basidiomycete Laccaria bicolor under various nitrogen concentrations

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Recent reports indicate a decline of the ectomycorrhizal fungal diversity in Europe in the 20th century, which has been attributed to enhanced atmospheric nitrogen deposition in forest ecosystems through air pollution. The physiological mechanisms, which underlie the depression of ectomycorrhizal fungal development by enhanced nitrogen availability, are largely unknown. The aims of the present study were (1) to identify genes which are differentially expressed in the ectomycorrhizal basidiomycete Laccaria bicolor by altered soil nitrogen concentrations, and which, therefore, may help to delineate the physiological adjustments of this species to enhanced nitrogen (2) to test an approach to study gene expression in ectomycorrhizas in the field. For these purposes, a simplified symbiotic system with greenhouse-grown ectomycorrhizal seedlings of Douglas fir (Pseudotsuga menziesii) and two genotypes of L. bicolor was used. The regulation of genes in the fungus was assessed through gene expression profilings (transcriptomics). As a prerequisite, a cDNA library from RNA expressed in free-living L. bicolor mycelium was constructed. Approximately 1500 randomly sampled cDNA clones were sequenced, functionally annotated, and deposited on nylon arrays. The cDNA array technology was applied to investigate the expression of a large number of genes simultaneously and to identify groups of genes having a coordinated expression. First results of these studies will be presented and discussed.

(# 503) Role of Glomalin in Sequestration of Heavy Metals

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Bioremediation, specifically biostabilization, is a promise alternative for remediation of soils contaminated by potentially toxic elements (PTEs). This alternative involves the use of microorganisms and bioproducts to stabilize and ameliorate toxic effects of these elements to the plant-soil-environment system. Evidence show that arbuscular mycorrhizal fungi (AMF) may have an important role in polluted soils, such as an increment in plant tolerance and sequestration-accumulation of PTEs. It has been reported that arbuscular hyphae are involved in the sequestration and accumulation of PTEs, at the cell wall level. However, the mechanisms used to withstand PTE are not very well understood. An exploratory study in order to evidence the possible participation of glomalin, glycoprotein produced by all AMF, in sequestration of PTEs was performed. Glomalin was extracted, from two polluted soils containing high concentrations of total and (DTPA)-available PTEs, by two autoclaving cycles using 50mM citric acid pH=8.0. Bradford total proteins (BTP) and inmunoreactive glomalin (IRG) and yield glomalin (YG) were determined from the extracts. The PTE-content in glomalin was measured by AAS. In the soil 1 (with higher available PTEs) lower BTP (0.49 mg protein g soil-1), IRG (0.18 mg protein g soil-1) and YG (2.35 mg glomalin g soil-1) were observed in comparison to the soil 2 with 1.18, 0.67 and 6.4 mg g soil-1 of BTP, IRG and YG. Glomalin under natural condition sequestered different PTEs from the polluted soil. Sequestration was higher by glomalin extracted from soil 2 (4.29 mg Cu, 1.12 mg Pb and 0.08 mg Cd g glomalin-1) than this from soil 1 (1.55, 0.62, 0.02 mg g glomalin-1, respectively), while Mn-sequestration was similar by glomalin from both soils. Glomalin sequestration and stabilization of these elements is interesting because of the toxicity of these PTE to the soil-plant system.

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(# 504) Use of stone-soil mix ('structural soil') for improved growth of urban sidewalk trees: a trial in southern Quebec

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In traditional sidewalk tree-pits, roots are unable to extend beyond the confines of the planting pit without damaging the sidewalk. Soil volume within the pit, often less than 2 m3, is highly inadequate for healthy tree growth, and tree mortality is very high. An approach developed by Bassuk and Grabosky at Cornell University is currently being tested in the Montreal area, in a project involving McGill University and the City of Montreal's Parks Service. In this system, paved areas such as sidewalks are underlain by a stone-soil mix designed to permit tree roots to extend underneath the pavement, greatly increasing potential rooting volume. The crushed stone provides structural support while leaving sufficient pore-space to permit air and water movement and root growth, even when the mix is highly compacted to meet engineering requirements. Research in the US indicates that tree roots grow deeper with such systems, reducing risks of sidewalk heaving. An outdoor trial was established near Montreal in 2001 to monitor performance of trees transplanted into such a mix. A range of mix proportions and physical properties was tested prior to trial establishment. The mix used included a 4:1 ratio (mass basis) of angular crushed stone and clay loam soil, and small amounts of hydrogel. It was blended off-site, then used to fill trenches excavated 60-70 cm deep. It was compacted to standard Proctor density (2 Mg/m3) in four lifts, then paved except for 1.5 x 1.5 m openings around each tree. Trees were centred 3 m apart.

(# 505) Soil Management Zones Delineated by Soil Electrical Conductivity for Potato Production.

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Using soil electrical conductivity (EC) data for delineating homogeneous soil management zones (MZ) looks more and more promising in many precision agriculture applications. The general objective of this project was to evaluate the efficiency of EC for defining and delineating MZ related to soil quality and potential productivity for potato cropping. An intensive unaligned grid soil sampling (9 samples per ha) was conducted on a 13.8 ha commercial field under potatoes (Solanum tuberosum L) production. For each sample point, the soil surface layer (0-20 cm) was sampled and analysed for physico-chemical properties. Soil profiles were described at each point. Soil EC was measured using a very intensive unaligned grid sampling design (43 samples per ha) with the Geonics EM 38 technology. The k-means clustering algorithm was used for delineating management zones using the soil EC kriged data matrix. Two MZ were found optimal for implementing soil-specific potato management in this field. These two MZ showed significant differences in potato yields (5.9 Mg/ha) and in some soil physico-chemical properties (v.g. organic matter, P extracted by Mehlich-III, pH water). The highest potato yields were observed with the highest soil EC and vice versa. Soil properties most linked to the MZ are directly related to the soil water regime (thickness of sand deposit over the clay substratum, water table depth, drainage, water holding capacity, etc.). This study shows that soil EC has the potential to be used efficiently for delineating within-field MZ showing contrasting soil properties and potential productivity.

(# 506) Molecular changes in Pisum sativum L . roots during arbuscular mycorrhiza development and cadmium stress

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Molecular responses related to detoxification pathways vis-à-vis cadmium (Cd) pollution were studied inGlomus intraradices-colonised and non colonised roots of Pisum sativum L. cv. Frisson, grown in soil/sand pot-cultures in the presence and absence of 2-3 mg kg-1 bioavailable Cd. Real-time RT-PCR showed that the stress-related gene encoding a heat-shock protein (hsp70) was activated following mycorrhiza formation and/or Cd-stress. Transcripts of a chitinase gene (cht) increased under Cd-stress and levels were highest in mycorrhizal roots exposed to the heavy metal (HM), whilst a chalcone isomerase (chi) was only up-regulated by Cd. A gapdh gene was slightly activated in mycorrhizal roots in the absence or presence of Cd, but levels were considerably higher in roots of nonmycorrhizal Cd-treated plants. Expression of a metallothionein-encoding gene (PsMTA) increased in mycorrhizal roots and more strongly in roots of Cd-treated plants. Genes encoding the enzymes g-glutamylcysteine synthetase (gsh1) and glutathione synthetase (gsh2), responsible for the synthesis of glutathione (GSH), the precursor of phytochelatins (PCs), showed an increased expression in response to Cd treatment. A homoglutathione synthetase (hgsh2) gene did not appear to be affected by Cd alone but it was activated in mycorrhizal roots both in the absence and in presence of Cd. Finally, transcript levels ofa glutathione reductase gene (gr) were increased by HM stress, but to a lesser extent in presence of mycorrhiza. Accumulation of GSH and thiol groups in roots of cv. Frisson was more affected by Cd stress than mycorrhiza development. In Cd-treated nonmycorrhizal and mycorrhizal plants levels of thiol groups significantly increased, suggesting synthesis of PCs. Results are discussed in relation to tolerance to Cd in pea and protection of plants by arbuscular mycorrhiza vis-à-vis Cd stress.

(# 507) Toward an understanding of the molecular mechanisms underlying phosphate transport in the AM symbiosis

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The majority of the vascular flowering plants, including most agriculturally important crop species, are able to establish symbiotic associations with arbuscular mycorrhizal (AM) fungi. The symbiosis develops in the plant roots where the AM fungus colonizes the apoplast and cells of the cortex and also establishes an external mycelium in the rhizosphere. In many, but not all, AM symbioses, the fungus mediates the transfer of phosphorus from the soil to the plant. One of our research goals is to understand the molecular mechanisms underlying phosphate transport in the AM symbiosis. Using a genetically tractable model legume, Medicago truncatula, and an AM fungus, G. versiforme, we have initiated the cloning and analysis of phosphate transporters that may mediate phosphate transport between symbionts in this AM symbiosis. Motif searches of the M. truncatula EST collections enabled the identification of a mycorrhiza-specific EST predicted to represent a novel phosphate transporter gene. The corresponding gene (MtPT4) was cloned and shown to encode a mycorrhiza-specific phosphate transporter. MtPT4 is expressed exclusively in the cortical cells containing arbuscules and the protein is located in the peri-arbuscular membrane, particularly in the areas surrounding the fine branches of the arbuscules. Analyses of both the membrane targeting and the in planta role of MtPT4 are in progress.

(# 508) Effect of arbuscular mycorrhizal fungi and Bacillus inoculation on growth of Carica papaya plants growing in vermicompost

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Dual effect of mycorrhizal arbuscular fungi (MAF) and plant growth promoting rhizobacteria (PGPR) inoculation was evaluated on the papaya plant development growing in soil enriched with 40% earthworms casting (vermicompost) under greenhouse and field conditions. Root colonization of MAF was 17% with bigger influence on the plant development. Bacteria inoculation had and effect on the MAcolonization, but is speculating their has on spore germination during the 30 days). In the first growth phase (64 days), the MAF and MAF+Bacillus pumilus caused a greater plant growing. At 115 days, plants inoculated with two microorganisms becoming more growth and had 5 flowers by plant, showing a higher development. Nutrient disponibility and mutualist association of MA fungi and MAF+bacteria had a positive effect on the absortion of P and Zn, as well, the juvenility phase was lesser, from 160 to 115 days. In the flowering step the content of P was 50% less than plants in full growing. This results ibdicate that the energetic expenses of this process. The MAF favored the growing of rhizobacteria in the root plants, showing evidence of mutualistic asociation. Papaya plants grown in soil with vermicompost inoculated with MAF and bacterias always overcome growing that in vermicompost non-inoculated.

(# 509) Control of whitefly with Verticillium lecanii on mycorrhizal (Glomus intraradices) common bean plants in greenhouse

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In the context of microbiological pest control, fungi have a high potential in the control of certain insects. For this reason the population of the whitefly Trialeurodes vaporariorum (Westwood) inoculated with the entomopathogenic fungus Verticillium lecanii (Zimmerman) in bean plants (Phaseolus vulgaris L.), was evaluated. Plants were mycorrhizal (Glomus intraradices Schenck and Smith)and nonmycorrhizal. Bean plants were submitted to the following treatments in the greenhouse: 1) control plants, 2) G. intraradices, 3) V. lecanii, and 4) V. lecanii + G. intraradices. All the plants were infested with the whitefly. The results showed that the plants treated with V. lecanii + G. intraradices had the lowest density of total eggs and nymphs of the whitefly (2.37 leaf-1, versus 5.15 leaf-1 on the control plants). This dual inoculation of beans with both V. lecanii and G. intraradices was significantly different from the control plants in terms of the lowest density of whitefly T. vaporariorum eggs and nymphs, 2.3 leaf-1, followed by the treatment of G. intraradices (3.8 leaf-1), the control (5.1 leaf-1) and finally the plants treated with V. lecanii (7.1 leaf-1). The integrated use of the entomopathogenic fungus V. lecanii and the endomycorrhizal fungus G. intraradices may become an interesting strategy for whitefly control under greenhouse conditions.

(# 510) Visualization of Polyphosphate in Cryo-Fixed Fungal Cells: a Dark Septate Fungus, Phialocephala fortinii and an Arbuscular Mycorrhizal Fungus, Gigaspora margarita.

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Polyphosphate is a storage compound in fungal cells and plays an important role in phosphorus supply to host plants in mutualistic relationships. Polyphosphate in fungal cells is thought to be localized in vacuoles, either in a dispersed form or as granules. To understand localization of polyphosphate in hyphae, cryo-techniques, coupled with freeze substitution with either osmium/acetone or acetone only were applied for a dark septate root endophyte, Phialocephala fortinii, and for germ tubes of an arbuscular mycorrhizal fungus, Gigaspora margarita. Semi-thin sections stained with DAPI for viewing polyphosphate by epifluorescence microscopy; polyphosphate appears as yellow deposits under UV irradiation. To analyse phosphorus distribution at the ultrastructural level, electron spectroscopic imaging (ESI) and parallel electron energy-loss spectroscopy (PEELS) were conducted by energy filtering TEM. In P. fortinii hyphae, various sizes of spherical and tubular vacuoles were located centrally, whereas in G. margarita germ tubes most of the volume was occupied by spherical or tubular vacuoles. In both fungal hyphae, DAPI staining showed that polyphosphate is distributed in vacuoles in dispersed form and sometimes brightly stained bodies were closely attached to them. The net distribution of phosphorus in P. fortinii using ESI showed higher accumulation in vacuoles than in cytosol even though phosphorus was in a dispersed form. Spectrum analysis by PEELS confirmed the presence of phosphorus in vacuoles. In contrast, in G. margarita germ tubes ESI and PEELS showed a lower contrast of phosphorus distribution between vacuoles and cytosol than that in P. fortinii.

(# 511) Host Microtubules Present in The Hartig Net Region of Both Ecto- and Ectendomycorrhizas.

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Previous studies have shown that in two endomycorrhizas (arbuscular mycorrhizas and orchid mycorrhizas) fungal hyphae trigger dramatic changes in the organization of host cell cytoskeleton but in both cases microtubules (MTs) and actin filaments (AFs) remain in colonized cells. In ectomycorrhizas, however, it has been reported that both MTs and AFs disappear in host cells adjacent to Hartig net hyphae. We have studied MT organization in two conifer species (Pinus banksiana; Picea glauca) colonized by two fungal species, the ascomycete, Wilcoxina mikolae var. mikolae and the basidiomycete,Laccaria bicolor. W. mikolae forms ectomycorrhizas with P. glauca but ectendo mycorrhizas with P. banksiana. Ectendomycorrhizas are characterized by the presence of intracellular hyphae in addition to a mantle and Hartig net. L. bicolor forms ectomycorrhizas with both conifer species. Immunolabelling for MTs in conjunction with confocal microscopy showed cortical MTs and MTs associated with the nucleus in uncolonized root meristem, cortical, and vascular parenchyma cells of both mycorrhizas. In ectomycorrhizas, cortical MTs and MTs associated with the nucleus were observed in root cells adjacent to the Hartig net. A similar situation occurred in the P. banksiana/W. mikolae ectendomycorrhiza at a developmental stage at which Hartig net hyphae only were present adjacent to root cells. However, at a stage at which both a Hartig net and intracellular hyphae had formed, MTs were closely associated with the latter hyphae and with the host cell nucleus. In both ecto- and ectendomycorrhizas, MTs were present within fungal hyphae.

(# 512) Determination of an Observable Humus Form Classification Scheme in a Northern Quebec Boreal Black Spruce-Feathermoss Community

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Black Spruce (Picea mariana (Mill.) B.S.P.)-feathermoss communities are generally associated with large accumulations of partly decomposed organic matter. This humus is of great importance to long-term sustainable management and site productivity in forest ecosystems as a key source of nutrients, and a contributor to soil structure and moisture retention. A better understanding of Boreal humus forms is important to predicting forest ecosystem response to harvesting, and post-harvest site productivity. We are interested in determining if an observable humus form classifications can be used as an indicator for nutrient availability and forest sustainability. The objectives of this study are to develop a humus classification based on observable field characteristics; and to correlate each humus class according to nutritional status. Field observation of 450 profiles in six cutovers in the northern Abitibi claybelt region indicated that the presence or absence of three master humus horizons, and subordinate humus horizons, could be used to visually differentiate nine humus form classes. Further research will examine the nutrient status of each humus horizon and humus form class and the relationship of these organic profile features to stand productivity. Such relationships will allow the productivity potential of cutover sites to be evaluated by field inspection of humus profile characteristics.

(# 513) Carbon and Nitrogen Dynamics Along Post-wildfire and Post-harvest Chronosequences for Jack Pine-dominated Sites in Northwestern Ontario

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The objectives of the study are: 1) to develop natural disturbance benchmarks for important ecological processes (i.e., C sequestration and N mineralization rates) utilizing a jack pine-dominated chronosequence, and 2) to compare C and N soil reserves, microclimate conditions, and N mineralization rates for recently logged (full-tree harvest), burned (wildfire), and salvage logged (wildfire followed by full-tree logging) sites. A total of 15 sites, ranging in age since disturbance from 5 to 125 years, were selected from a broader plot array for the determination of C and N pools. A subset of these sites (6) were used for the in situ N mineralization experiment. The soils for all the study sites represent well-drained, outwash sands, with well-developed Orthic Humo-Ferric Podzolic profiles.

As expected, total carbon storage increased substantially with stand age (140 to 300 T/ha), largely the result of carbon accumulations in tree biomass (0 to 90 T/ha) and CWD (70 to 105 T/ha). Soil carbon reserves also increased with stand age (60 to 100 T/ha), due primarily to the build up of the forest humus layer (16 to 56 T/ha). For the most part, nitrogen pools followed the pattern depicted for carbon. When comparing the total C and N pools for the recently (5-yr-old) burned, harvested, and salvage logged sites, the wildfire site reserves were higher than the other two treatments. This difference was almost exclusively the result of the large CWD pool, particularly the standing dead component, that remains after a wildfire. On the other hand, the low values for the salvaged logged sites were the combination of fire consumption / volatilization (forest floor and crown material) and stemwood removals during the salvage operation.

Chemical analysis of the KCl extractions obtained from the in situ mineralization experiment (30-day, buried-bag incubations) are currently underway and will also be presented.

(# 514) Arbuscular Mycorrhiza and Plant Water Relations - From Drought Acclimation to Acclimatization of Tissue Culture Produced Plantlets

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Arbuscular mycorrhizal (AM) symbiosis can enhance crop water relations by increased phosphorus uptake. However, when phosphorus levels are comparable among treatments during drought acclimation, AM can also affect plant water relations via greater extraradical hyphae development, osmotic adjustment, lower abscisic acid (ABA), and morphological changes including greater carbon (C) partitioning to roots (resulting in higher root-shoot ratios) and higher leaf cuticle development. Subsequently, higher photosynthetic rates (A) and stomatal conductance (gs) can occur resulting in greater plant biomass. This paper reports selected mechanisms of AM enhancement of drought-acclimated plants. AM seedlings of the neem tree (Azadirachta indica) or chile ancho pepper (Capsicum annuum) do not have greater water-use efficiency per se than NonAM plants, as indicated by stable isotope discrimination, gas exchange or carbon gain.

Little is known about the role of AM on physiological changes of micropropagated plantlets during acclimatization and post-acclimatization. Plantlets of C. annuum had low A and poor initial growth during acclimatization. Relative water content (RWC) decreased during the first days after transfer from tissue culture containers to ex vitro conditions. Consequently, transpiration rates (E) and gs declined, confirming that in vitro formed stomata were functional and able to respond ex vitro to partial desiccation — thus avoiding excessive leaf dehydration and plant death. AM plantlets had lower leaf ABA and higher RWC than NonAM plantlets during peak plant dehydration (6 days after plant transfer) — and a higher A and gs as early as days 5 and 7. During post-acclimatization [after day 8, when RWC increased and stabilized], A increased in all plantlets; however, more dramatic changes occurred with AMF plantlets.

(# 515) Effect of Arbuscular Mycorrhizal Fungi and Organic Fertilizer on Photosynthesis, Growth, Nutrient Uptake and Root Phosphatase Activity of Ipomoea Carnea subsp. Fistulosa

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A greenhouse study was conducted to determine the effect of arbuscular mycorrhizal fungi (AMF) inoculation and organic fertilizer on the physiology, growth, and phosphatase activity of Ipomoea carnea subsp. fistulosa. The AMF treatment consisted of a commercial isolate of Glomus intraradices (MycorisePro®) and a noncolonized (NonAMF) control. Organic fertilizer (Nitrell® 5N-3P-4K) was applied at 10%, 30% and 100% of the manufacturer's recommended rate, which were respectively 1.2 kg m-3, 3.6 kg m-3 and 12 kg m-3. AMF enhanced the growth index, height, stem diameter, root, leaf, shoot and total plant dry mass of I. carnea at the different organic fertilizer rates. In addition, AMF increased leaf number, leaf area, leaf area ratio and net photosynthesis. Leaf uptake of N, P, K, Fe, Cu and Zn were higher in AMF plants. Colonization levels of AMF inoculated plants ranged from 27 to 79%. The commercial AMF isolate was effective in enhancing growth and mineral ion uptake even at the 100% organic fertilizer rate. Enzymatic root activity of acid phosphatase (ACP) and alkaline phosphatase (ALP) increased in AMF plants. The correlation between ACP activity and total P uptake in AMF plants was higher than NonAMF plants. A higher correlation between ACP and ALP activity was found in AMF than NonAMF plants. This research suggests that AMF inoculation with an organic fertilizer source increases mineralization of organic nutrients, in part due to an enhancement of root phosphatase activity (ACP and ALP) -- thus enhancing nutrient uptake, increasing photosynthetic levels and improving overall plant growth.

(# 516) Effect of tillage and crop sequence on sugar beet, soil conservation and weeds

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A large percentage of the land in southern Alberta has been devoted to row crop production. Despite the fact that much of the irrigated area is subject to strong chinook winds most of this land is intensively cultivated. The objective of this research was to develop cropping systems that maximize sugar production in cropping sequences that include sugar beet after wheat or dry bean while protecting the soil from erosion and managing weeds. Sugar beet yield and quality were similar after conventional (included moldboard plow, vibrashank cultivator, harrow and packer), minimum (double disc and harrow in fall, glyphosate in spring), and no tillage after dry beans. However, the no tillage dry bean system left less than 1,000 kg/ha of residues on the soil surface which are not enough to protect the soil from erosion. After wheat, sugar beet yield and quality were similar following minimum and conventional tillage but no tillage yields were lower. Minimum and no tillage systems left more than 2000 kg/ha of residues which are considered sufficient for erosion protection. A heavy wheat residue cover reduced redroot pigweed density. Sugar beet yield was lower after no tillage establishment after wheat compared to the other tillage methods for the following reasons: 1) Poor seed to soil contact in no tillage ; 2) Up to 10 C lower daily maximum soil temperatures, 3) Less available soil N.

(# 517) Arbuscular Mycorrhizal Fungi Enhances Phytoremediation of Chromium in Sunflower

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Chromium (Cr) is a heavy metal risk to human health, and a contaminant found in agricultural and industrial sites. Phytoremediation relies on phytoextraction of Cr with biological organisms. The ability of the arbuscular mycorrhizal fungus (AM), Glomus intraradices, to enhance Cr uptake and plant tolerance was tested on the growth and gas exchange of sunflower (Helianthus annuus L.). AM and non-inoculated (Non-AM) sunflower plants were subjected to two Cr species [trivalent cation (Cr3+) {Cr(III)}, and divalent dichromate anion (Cr2O7--) {Cr(VI)}]. Both Cr species depressed plant growth, decreased net photosynthesis (A) and increased the vapor pressure difference; however, Cr(VI) was more toxic. Chromium accumulation was greatest in roots, intermediate in stems and leaves, and lowest in flowers. Greater Cr accumulation occurred with Cr(VI) than Cr(III). AMF enhanced plant tolerance and hyperaccumulation of Cr. At higher Cr levels greater mycorrhizal dependency occurred, as indicated by proportionally greater growth, higher A and reduced visual symptoms of stress, compared to Non-AM plants. AM plants had greater Cr-accumulating ability than Non-AM plants at the highest concentrations of Cr(III) and Cr(VI), as indicated by the greater Cr phytoextraction coefficient. Mycorrhizal colonization was more adversely affected by Cr(VI) than Cr(III), however high levels of colonization still occurred at even the most toxic levels. Arbuscules had the greatest sensitivity to Cr toxicity. Higher levels of both Cr species reduced leaf tissue phosphorus (P). While tissue P was higher in AM plants at the highest Cr(III) level, tissue P did not account for mycorrhizal benefits observed with Cr(VI) plants.

(# 518) Effect of Shac natural feed additive on the characteristics of cattle feedlot manure

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Cattle feedlot operations continue to increase in size, generating a large amount of manure and associated odours. The objective of this research is to assess the effects of the Shac® natural feed additive on manure characters. Shac is a lignite-based by-product from the coal mining industry. For this study, eighty steers were randomly divided into four groups (cattle housed individually) and fed with a barley grain and barley silage-based finishing total mixed ration containing 0, 0.5, 1.0 or 2.0 L of Shac per tonne of dry matter for 150 days (including the first 25 day background period when the cattle were gradually introduced to the new diet). Wood chips were used as the bedding material. Manure samples were collected on days 25, 55, 81, 109 and 150. For samples collected on day 25 and day 52, pH, EC, and NH4/NH3-N content of manure and the rate of NH3 emission decreased significantly with the Shac content in the feed. On the other hand, nitrate/nitrite-N, TN, TC and VFA were not affected by feed treatment on any sampling date. In addition, manure moisture, total VFA and NH4/NH3 content, and the NH3 emission rate all decreased as sampling period increased. But N2O emission was only detected for manure samples taken on the last two sampling dates. The observed lower NH4/NH3 content in manure and NH3 emission earlier in the experiment suggest that the Shac could possibly play a role in reducing gaseous ammonia N emission to the atmosphere. Further studies are needed to examine the response of NH3/NH4 in manure, to determine whether the reduction is due to changes in amount of urea produced or the inhibition of urea hydrolysis to NH3/NH4 in manure when Shac is used as a feed additive.

(# 519) AM fungi and carbon transfer between sugar maple saplings and forbs

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The possibility of nutrient transfer between different host plants connected by arbuscular mycorrhizal fungi (AMF) under natural conditions has received little attention. In the present field study, we investigated the possible transfer of C between sugar maple saplings (Acer saccharum) and the spring ephemeral forb, Erythronium americanum, by means of AMF. One sugar maple sapling, three E. americanum plants and one ectomycorrhizal yellow birch (Betula alleghaniensis) were planted together inpots buried in a maple forest. The following spring, during leaf expansion of sugar maple saplings, the leaf of one E. americanum was labelled with $^{14}CO_2$. Seven days after labelling, radioactivity was detectedin the leaves, stem and roots of sugar maples. Specific radioactivity in sugar maples was 13-fold higher than in yellow birches and 17-fold higher than in the leaves of non-labelled E. americanum plants. This suggests a direct transfer of ^{14}C between the labelled E. americanum and the sugar maple saplings via AMF. The quantity of ^{14}C transferred to sugar maple saplings was negatively correlated with the percentage of ^{14}C within the bulb of E. americanum, indicating that this species exports C once its own carbohydrate requirements have been met. In a second labelling, sugar maple leaves were treated during autumn, the active growth period of E. americanum roots. Radioactivity was detected in E. americanum roots but not in the yellow birch. These results suggest that AM fungi connecting different understoreyspecies can act as reciprocal C transfer bridges and that this could be linked with plant phenology.

(# 520) Diversity of Glomalean Fungi in Selected Brazilian Ecosystems

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Diversity and distribution of arbuscular mycorrhizal fungi (AMF) in brazilian agroecosystems, natural ecosystems (sand dunes, cerrado, tropical forest) and degraded lands were evaluated based on 27 scientific papers published in the last two decades. A total of 79 AMF species was identified to species level which represents ca. 50% of the total number of AMF species. The highest number of species have been detected in agroecosystems (64) followed by forest (42) and cerrado (40). Most studies concentrated in the Southeastern region of the country whereas the North and Central West have gone unsampled. Scutellospora and Acaulospora are co-dominant in agroecosystems and degraded lands, while the former dominates on the cerrado and sand dunes and the latter on forest. Dominance at family level follows that of genus. Based on frequency of occurrence, no prediction can be made on the distribution of a given species in a ecosystem, nevertheless, the six most frequent species detected overall were A. scrobiculata, G. etunicatum, A. spinosa, S. pellucida, Gi. margarita and A. morrowiae. In all studies, mycorrhizal community, based on spore counts, was dominated by 2-4 species which accounted for more than 50% of spores produced. These results reinforce a necessity to strength the AMF research program in Brazil and places the country as a major center of AMF biodiversity which deserve defined conservation policy

(# 521) Arbuscular mycorrhizal fungi (AMF) associated with bromeliads in the Brazilian Atlantic Rain Forest

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A research program is being carried out to study the mycorrhizal association with several species of bromeliads. In this study we evaluated mycorrhizal colonization and occurrence of AMF species in bromeliads species, Vriesea ensiformis, Tillandsia gardneri and Nidularium innocentii, occurring with habit epiphytic and epilithic in a secondary tropical forest at Morro Geisler in South Brazil. Bromeliads epiphytes occurred on forked branches or on the stem of Myrcia pubipetala and Gymnanthes concolor (Myrtaceae) and epilithics formed dense mat of roots over large boulders. After staining, roots were scored for the percentage of mycorrhizal colonization. Specimens of Vriesea ensiformis and Tillandsia gardneri had only 1,5% of root colonized by mycorrhizal fungi with most of the colonization occurring asexternal mycelium. Epiphytic Nidularium innocentii had on average 27% of root colonization (range 9-43%) while the same species as epilithic had on average 20.5% of colonization (range 18-23%). External mycelium accounted for the great majority of arbuscular mycorrhizal fungi detected on the roots of Nidularium (20%) although vesicles were present in few roots. In order to verify AMF species associated with these species, root pieces were inoculated on a sterile soil:sand (1:2) mix and trapped using Sorghum as the host. Trap cultures are currently growing in greenhouse. Our preliminary results indicate that habit of bromeliads influence on the development, and possibly, function, of the mycorrhizal association

(# 522) Populus clones and cultivars differ in ectomycorrhizal and arbuscular mycorrhizal colonization rate when grown in uniform soil conditions

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Fine roots of Populus species and hybrids may have both ectomycorrhizal (ECM) and arbuscular mycorrhizal (AM) associations. In some cases ECM were found to be the predominant form, whereas in others, both EM and VAM were observed in the same root system. Generally, it is considered that the type of colonization depends primarily on the soil conditions, however the mechanisms of the dual colonization of the plant roots are not well understood. In this study one-year-old cuttings of 16 clones and cultivars of Populus were potted in soil taken from the upper soil horizon (0-15 cm) at a plantation of Populus alba and cultivated in uniform conditions. The cultivars were selected from a collection of the Institute of Dendrology in Kórnik, Poland, as fast growing and tolerant to pesticides genotypes. After one growing season all the cultivars studied developed both, ECM and AM, however high variability in the degree of colonization was recorded. The total ECM colonization varied between 2 and 80% of the root tips, depending on the Populus genotype and one to three ECM morphotypes were found at the root systems. The degree of AM colonization was contained between 3 and 50% of roots. A negative relations between ECM and AM fungi were found in most of the cultivars, however in some of them a balance between the two types of mycorrhiza was observed. The results suggest that the type of mycorrhizal symbiosis is dependent mostly on the Populus genotype.

(# 523) Nutrient Efficiencies and Yield Response to Rotations and Fertility Treatments

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A two year no-till field experiment was conducted in Truro, NS to evaluate the effects of fertility treatments (three rates of liquid dairy manure, a rate of inorganic NPK, and a control with no fertilizer application) and rotations on nutrient uptake and productivity of corn, soybeans, and spring wheat. A split plot experimental design was employed, where the whole plots were the rotations and the subplots were the fertility treatments. Since the data presented consists of the first two years of a long term rotation, rotational effects were not statistically apparent for either crop. In the first season (2001), manure rate 2 (48.1 t/ha) provided higher yields for both soybean and corn compared to other treatments. Interestingly, the highest manure rate 3 (64.3 t/ha) reduced yields for all three crops compared to manure rate 1 (32.1 t/ha) or rate 2 in the first season. Fertility treatments did not significantly influence wheat yields in 2001 and in general for soybean, the manure treatments resulted in lower % nitrogen than either the control or the NPK treatments. In the second season there were no differences in yields for corn, however soybeans showed higher yields when grown under the manure treatments. Wheat yields for all fertility treatments were higher than the control in 2002. These are only a few of the preliminary results for this experiment.

(# 524) Characterising the diversity of AM fungi in an upland grassland - links to plant species and spatial scales

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We are investigating the diversity of AM fungi colonising different plant species which co-occur in an upland grassland ecosystem. There is increasing evidence of non-random associations between plant species and AM fungal taxa but little is known of the scale at which these interactions occur. By combining a molecular method of plant species identification with AM fungal community analysis of root fragments which co-occur within a cubic centimetre, we are able to map below ground plant community structure and associated microbial diversity at a fine spatial scale. Terminal Restriction Fragment Length Polymorphism (TRFLP) of the small subunit (SSU) ribosomal RNA gene was used to generate molecular fingerprints of AM diversity and abundance. Our high intensity sampling of roots from spatially referenced core samples will allow powerful analyses of plant/microbe associations. We will use this data to address the question 'is there evidence for specific interactions between plant species and AM fungal taxa?'

(# 525) Abiotic and biotic soil properties related to Sclerotinia stem rot disease in soybean and bean fields under different management practices

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Sclerotinia stem rot disease (SSRD) caused by Sclerotinia sclerotiorum is a major disease of legumes in Quebec. This project investigated the influence of soil factors and management practices on the development of SSRD in soybean and bean production systems. Soil samples were taken twice during the growing season from 10 bean and 40 soybean fields south-west of Montreal. The incidence of SSRD, management practices and selected soil properties were measured in each field. Most fields (33 of 50 fields) had a very low percentage of disease incidence (0-10 % of disease incidence). There tended to be more SSRD incidence in no-till (NT) fields than for conventional tillage (CT) fields, suggesting that the higher soil moisture and lower surface temperature in NT than CT systems favours SSRD emergence. Disease incidence was significantly correlated with glomalin, a marker of mycorrhizal fungi presence, in conventional fields (r = 0,456**, n=33) and in fields cropped with bean (r=0,695*, n=10). However, further study of the microbial community by lipid analysis is need to better understand these preliminary results. This study provides an in-depth understanding of the ecological factors related to SSRD emergence. Such information is needed to define soil health indicators for disease suppression in bean and soybean production systems.

(# 526) Selection of test sites for field pea variety trials in Alberta

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We analyzed the yield data of field pea variety trials tested in different sites over the four geographical regions of Alberta for the period of 1987 to 2001. There was considerable site-to-site variation within each region. Our analysis was able to group the test sites into relatively homogeneous but geographically non-contiguous ¡¥mega-environments¡¦. Such grouping provided a basis for determining how many and which sites to be used in the future testing. It also provided a test for adequacy of the current practice that uses regional averages for recommending varieties to pea producers across the province.

(# 527) Mycorrhizal inocula for agricultural systems: achievements and perspectives

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Considerable advances in methods for the commercial production of inocula of arbuscular mycorrhizal fungi have been achieved in the past few years. However, the inability to produce these fungi on a large scale in pure culture still considerably hampers the development of applications. In order to circumvent this difficulty, producers of inocula have to use laborious cultivation technologies leading to products that make the registration processes and marketing development arduous and difficult to achieve. This results in an expensive product which is limited in its area of use and consequently has a restricted market potential. Because of this, the development of mycorrhizal products unavoidably requires the development of links and feed-backs of mycorrhizal biotechnology to fundamental science. Essential elements include the understanding of the molecular basis of the obligate biotrophy of arbuscular mycorrhizal fungi, new molecular techniques for detection and monitoring of inocula in plant roots and soil taken from the field, increased knowledge on the ecophysiology of arbuscular mycorrhizal fungi and on their interaction with other microorganisms and with the environment.

In addition, other aspects that are also essential for the development of this industrial activity necessitate (i) the establishment of widely recognized methods for evaluating the quality of mycorrhizal inocula, (ii) the promotion of a certification programme for producers in order to concord with the legal and ethical aspects of inoculum use as well as national and international regulation, and (iii) the promotion of educational and training programmes aimed at making public aware of using arbuscular mycorrhizal inoculum for sustainable development of agricultural plant production systems.

(# 528) Assessing Local Diversity of Arbuscular Mycorrhizal Fungal Species: The Impact of Spatial Patterns

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Local diversity and small-scale spatial patterns of arbuscular mycorrhizal fungal (AMF) species were quantified in two experimental xeric landscaped plots in Phoenix, Arizona, USA. AMF species at 25 regularly-spaced sampling points in each 9.2 x 9.2 m plot were assayed using trap cultures. A total of 12 species was detected, with 7 species in one plot and 11 in the other. Sampling effort curves and jackknifeestimates indicate that a limited number of species was still undetected. No single species was dominantin either plot, although 2 to 4 species were detected in over half the sampling points in each plot. A rank-frequency plot reveals a log-normal species distribution at the site. The number of AMF species was not correlated with proximity to plants. Despite the patchiness of plants in the plots, the number of species detected per point exhibited spatial structuring only at the smallest sampling scale in a single plot, and only a single species in each plot was non-randomly distributed. The results indicate that the traditional sampling technique of collecting a limited number of samples in proximity to plants underestimates species richness at local sites.

(# 529) Concise Descriptions of North American Ectomycorrhizae

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Following the 9th North American Conference on Mycorrhizae, a poll of the ecotomycorrhizal research community and discussions in two workshops of the BC Ectomycorrhizal Research Network (BCERN), a standard system describing the key morphological and molecular characteristics of ectomycorrhizae was developed. In 1996, the results of this effort were published as a manual "Concise Descriptions of North American Ectomycorrhizae" (CDNAE) with information on how to prepare and describe morphological and anatomical features; and characterize the DNA RFLP patterns. As of 2003 five folios of 24 descriptions have been published. A Database of Descriptions of Ectomycorrhizae (DDE) was completed in 2000 and includes data from different publications and allows for searches on all features. A web version of Matchmaker: Mushrooms of the Pacific Northwest (MMPNW) with over 2000 sporocarp descriptions was completed in 2001. Links between DDE and MMPNW provide researchers with a quick reference to the features of both the sporocarp and ectomycorrhiza of fungal species described in DDE. The editors encourage contributions to the CDNAE manual, as wide participation willincrease its usefulness as an aid in the study of ectomycorrhizae. For CDNAE we are most interested in publishing descriptions of distinctive ectomycorrhizae with known ecology and preferably which have not been described previously. The DDE web site was revised in 2002 to increase its search capability and allow researchers from throughout North America to add additional published or unpublished descriptions. For DDE we are interested in developing a more extensive database of descriptions and welcome all contributions.

(# 530) Mycorrhizal networks: their extent, function and importance

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It is well known that, in the laboratory, a single mycorrhizal fungal isolate will colonize different host plant species, will form linkages between them and will provide a conduit for transfer of carbon, nutrients and water between plants. Thus, it would appear plausible that these connections are extensive and they are important in elemental transfer between plants under field conditions. Nevertheless, our knowledge of networks in the field has been hampered by the complexity of the belowground system and by our lack of ability to directly observe, in situ, hyphal connections and their associated functions. In the future, isotopic tracers and morphological observations will continue to be useful in furthering our understanding of these networks. These techniques, along with new microsatellite and fluorescent dye methods, will likely provide needed information concerning the extent to which these networks exist,the extent to which they transfer elements between plants, and the relative importance they have on plant growth and overall ecosystem functioning. In this presentation we will highlight our current knowledge of mycorrhizal networks, the major gaps in knowledge in this area and those scientific approaches that will increase our understanding of this controversial subject.

(# 531) Arbuscular Mycorrhizal Fungi can Dominate Phosphate Supply to Plants Irrespective of Growth Responses

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We have shown that, depending on the fungus/plant combination, AM fungi vary greatly in ability to transfer P to plants, and that P can be supplied exclusively via the AM fungal pathway whether or not a plant responds positively to colonization. We grew Linum usitatissimum (flax), Medicago truncatula (medic) and Lycopersicon esculentum (tomato) separately in pots with low P soil. ^{33}P was supplied in small, buried compartments accessible only to fungal hyphae. Compared with uninoculated (NM) plants,flax grew better, but to different extents, when colonized by each of the three fungi tested (Gigaspora rosea < Glomus caledonium < G. intraradices). Medic responded positively to both Glomus species but Gi. rosea decreased growth. Tomato did not respond positively to any of the fungi. We calculated that G. intraradices delivered all the P taken up by all three plant species. Likewise, G. caledonium delivered all the P to flax and medic, but only about 70% to tomato. Gi. rosea delivered little Pto flax (despite the positive growth response) or tomato, but delivered up to 40% of the P taken up by medic (despite the growth depression). The results show that direct plant P uptake can cease completely and provide strong evidence for considerable functional diversity in AM symbioses, particularly differences in 'cross-talk' that must influence expression of fungal and plant P transporters in different AM partnerships. They also have implications for the search for ways of improving 'P uptake efficiency' in crop plants that show small or no AM responsiveness.

(# 532) Competitive Interactions between a Mycorrhizal-Defective Tomato Mutant and its

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Plant mutants with impaired levels of colonisation by arbuscular mycorrhizal fungi (AMF) have proven valuable in the identification of key stages in the development of AM. One such mutant is the mycorrhiza-defective tomato rmc. To date the potential of these mycorrhiza-defective mutants in ecological studies has not been realised. The role of AMF in plant competition at the genotype level between mycorrhiza-defective plant mutants and their wild-type progenitors is analogous to interspecific competition between mycorrhizal and constitutively nonmycorrhizal plant species. Competition between rmc and its wild-type progenitor (76R) offers a particularly exciting opportunity because the two genotypes grow at similar rates when at low density and 76R is not then highly responsive to colonisation by AMF.

We conducted a replacement series experiment in which rmc and 76R were grown in competition, either uninoculated or inoculated with Glomus coronatum. When uninoculated, rmc and 76R had similar growth rates. When inoculated, 76R benefited from colonisation at the expense of rmc, presumably due to more efficient resource acquisition (e.g. P) via the AMF. Thus, although 76R is not responsive to AMF when grown in monoculture, colonisation gives 76R a competitive advantage when competing with the non-mycorrhizal rmc. 76R then appears positively responsive to AMF, and rmc appears negatively responsive; in other words, mycorrhizal responsiveness becomes a "community-based" parameter. Our approach provides a useful simple model "artificial ecosystem" that allows mechanistic studies and comparisons with the much more challenging work on competition between plants that are colonised (or not) by different AMF in natural communities.

(# 533) The effects of plant density on yield and maturity of silage corn in central Alberta

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New corn (Zea mays L.) hybrids have been developed for short season environments that are capable of achieving silage maturity in central Alberta. To maximize productivity and evaluate potential of this new cropping option agronomic evaluation of new hybrids is needed in this environment. Field experiments were conducted at three locations in central Alberta in 2002. Silage yield, maturity and quality response was evaluated for four short-season Pioneer hybrids varying in maturity from 2000 to 2250 Corn Heat Units. Increasing plant density from ~50 000 to ~124 000 plants/ha-1 delayed silking by 8 days. Silage dry matter percentage at harvest ranged from 35% to 31% DM from low to high density respectively. Yield showed a significant linear ($P < 0.05$) response to increased plant density. Both yield and maturity must be considered when determining variety and density recommendations for producers. Lower corn heat unit varieties showed a greater adaptation to the region achieving higher yields as plant density increased and acceptable (>30%) dry matter percentages for ensiling. Higher corn heat unit varieties displayed less adaptation to central Alberta, exhibiting decreased yield at higher plant densities and unacceptable dry matter percentage (< 30%) for ensiling

(# 534) Responses of the non-host plant, A. thaliana, to arbuscular mycorrhizal fungi

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Unlike most herbaceous plants, Brassicaceae do not undergo symbiosis with mycorrhizal fungi. Elucidating the reasons for the lack of this interaction will likely give important insights into the genetic determinants that control the communication between plants and mycorrhizal fungi. In order to test whether Arabidopsis is at all able to respond to mycorrhizal fungi, we performed expression profiling using the Affymetrix 24K oligonucleotide array. We found that Arabidopsis roots respond to inoculation with Gigaspora rosea with an increased expression (x2.5-10) of 12 genes, but a decreased expression (x2.5 to >35) of about 100 genes, at 24 hours p.i.. Among the down-regulated genes are homologues of genes that are associated with symbiosis in legumes, as well as genes putatively involved in signalling, such as phosphatases and transcription factors. Therefore our data seem to indicate that Arabidopsis does respond to mycorrhizal fungi and shuts down a symbiotic program upon contact with the fungus. Comparison of these data with those obtained with host plants may reveal genes that are a) upregulated in host plants but downregulated in non-host plants, b) constitutively expressed in host plants but downregulated in the non-host. The latter class of genes may fulfil important functions in mycorrhiza formation, but cannot be identified through expression profiling in the host plant. Together, our work revealed new candidate genes that may play a role in mycorrhiza formation.

(# 536) Influence of weed control, irrigation and fertilization on /Tuber melanosporum/ colonization of /Quercus ilex/ plantation seedlings.

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Establishment of black truffle (Tuber melanosporum) plantations requires 5-10 years of field management in order to support the growth of healthy host trees and proliferation of the ectomycorrhizal symbiont prior to production of the highly profitable truffles (underground sporocarps). Despite the 30 years passed since inoculated-seedlings became commercially available there is great variability in plantation success with unanswered questions regarding cultivation practices during the pre-productive years. In 1998 we established a factorial study with T. melanosporum inoculated nursery seedlings of Quercus ilex in order to evaluate the influence of fertilization, irrigation and weed control on seedling growth and abundance of the desired mycorrhiza in the developing root system. After 4 years we removed whole plants from 3 blocks and found that weed control significantly improved plant total dry wt., root length, root depth and lateral expansion. Moderate irrigation and weed control both contributed to increased fine root production and increased T. melanosporum mycorrhizae. Although there is a clear positive relationship between total fine root tips and tips colonized by T. melanosporum, we observed a decline in the proportion of T. melanosporum mycorrhiza in the seedlings with the highest levels of fine root production. Fertilization did not affect root growth although the high fertilization treatment reduced T. melanosporum colonization.

(# 537) Assessing the infectivity and effectivity of commercial mycorrhizal inoculants in plant nursery conditions

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The industry of mycorrhizal inoculum production is expanding around the world. However, the infectivity and effectivity of the products on the market has not always been tested in standard nursery practices. Horticultural crops are usually grown in soilless potting mixes containing perlite, vermiculite, peat moss and composted forest products, and the effects of these artificial mixes on mycorrhizal colonization is not well understood.

We examined the infectivity of several commercial mycorrhizal inoculants in different potting mixes. Corn plants were grown in a soil-based medium and in two different soilless substrates, a potting mix prepared with redwood bark, pine sawdust, calcined clay and sand, and the commercial Sunshine # 5 mix, mainly composed by Canadian sphagnum peat moss. The different commercial mycorrhizal inoculants were applied at the moment of transplanting at the rate recommended by each producer. Plants were grown for 50 days and the shoot height, total dry mass and percentage of mycorrhizal colonization was recorded.

The percentage of mycorrhizal colonization obtained with the different mycorrhizal inoculants ranged from 0 to 50%. This variation might reflect rate effects (different propagule numbers) as well as the difference in content and type of infective propagules (mycorrhizal roots, hyphae or spores).The infectivity of each mycorrhizal inoculant varied widely among the different potting mixes. Mycorrhizal colonization was not related to plant growth. Plants grown in Sunshine mix were the tallest and had the greatest dry mass independently of their mycorrhizal status.

(# 538) Correlation and causation between plant diversity and the diversity of arbuscular mycorrhizal fungi

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Is there a consistent relationship between the diversity of AM fungal species and the diversity of their plant hosts? The apparent functional redundancy of AM fungi, as supported by the low levels of specificity of association, would suggest little interdependence between plant and AM fungal diversity. However, there is accumulating evidence that AM fungal species are ecologically distinct and these differences in ecology could generate a causal interdependence between the diversity of plants and fungi. For example, host-specific differences in AM fungal effects on plant growth could cause plant diversity to depend on the diversity of AM fungi. Alternatively, host-specific differences in AM fungal growth response to plant hosts could cause AM fungal diversity to depend on the diversity of plant hosts. Either way, we would expect a positive correlation between plant and AM fungal diversity. We test this relationship using a data set compiled from published reports of plant and fungal diversity combined with our unpublished data. When looking across sites located over several continents, we find a positive correlation between the diversity of plants and AM fungi. This pattern also holds within regions and within a single community. The consistency of this pattern provides support for a causal interdependence of plant and AM fungal diversity. Additional support for this causal interdependence was found from patterns of local diversity within a single community, as the level of plant diversity in one year was significantly dependent on the diversity of plant species in the previous year and vice versa.

(# 541) Mutational analysis of Sbcdc42, a Suillus bovinus gene that encodes a putative GTP-binding protein

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Cdc42 is an important member of the Rho family of RAS-like small GTPases. The Members of the Rho GTPase family are key regulatory molecules that link surface recpetors to both the organization of cytoskeleton and gene expression in eukaryotic cells in response to various signals (1,2). Cdc42 plays an essential role in polarized growth in many eukaryotic cells including yeast , mammalian cells and human pathogenic fungi, Candida albicans. The biological function of Cdc42 has been extensively studied in Saccharomyces cerevisae. In this budding yeast, Cdc42 activity has been implicated in polarized growth and bud emergence (3). We have isolated the Suillus bovinus Sbcdc42 by using the primers specific for cdc42 and by screening the S. bovinus cDNA library (4). The complementation experiments show that Sbcdc42 cDNA is functionally equivalent to S. cerevisae CDC42. In order to elucidate the role of the Sbcdc42 gene product, we have generated mutations cdc42G12V and cdc42D118A in Sbcdc42 by using site-directed muatgenesis. Genetic transformation of the fungus S. bovinus with the binary plasmid vectors carrying the mutations has been performed using the transformation system developed in our laboratory using Agrobacterium tumefaciens (5). The mutations will provide clues to the function of the Sbcdc42 gene product in the ectomycorrhizal fungus S. bovinus.1. Matozaki et al 2000 Cell Signal 12:515, 2. Raudaskoski et al 2001 NATO Sci Ser 328: 123, 3. Johnson 1999 Microbial Mol Biol Rev 63:54, 4. Grofer et al 2001 MPMI 14:135, 5. Hanif et al 2002 Curr Genet 41:183.

(# 542) Root and ectomycorrhiza development and Scarecrow gene expression in Pinus sylvestris

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The formation and function of ectomycorrhiza represent always a two way signalling in which the both partners influence each other´s development. In our research project on the development of Suillus bovinus – Pinus sylvestris ectomycorrhiza we have long been interested in the factors regulating the changes in the root and fungal growth patterns at the formation of ectomycorrhiza, although the actual signalling molecules and their receptors still remain to be identified. The present work presents the cloning and characterization of the SCARECROW (SCR) gene from P. sylvestris and the use of PsSCR as a tool for research on the differentiation of the short roots and ectomycorrhiza in P.sylvestris. Arabidopsis thaliana SCR gene is a putative transcription factor and RNA expression pattern determined by in situ hybdridization localizes the SCR expression in endodermis and in the Quiscent Center (QC). This is also the case in P. sylvestris roots and in dichotomous and coralloid roots induced by the fungus S. bovinus at the formation of ectomycorrhiza. The development of the latter roots requires the differentiation of a new QC and endodermis, which is of special interest and can be visualized with the help of in situ localization of PsSCR transcripts. A useful tool for induction of dichotomous and coralloid short roots without fungal partner is the application of the auxin transport inhibitor NPA (N-1-naphthylphthalamic acid).

(# 543) Evidence that suilloid fungi have a unique functional role for pines establishing in the absence of mycorrhizal networks.

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Pinus contorta establishes in a sand dune ecosystem under primary successional conditions on the coast of Oregon, U.S.A. Seedlings have established at least 100 meters from local forests and are not directly interacting with any below-ground ectomycorrhizal networks. Isolated seedlings up to 5 years old were primarily colonized by 6 'suilloid' species: Suillus brevipes, S. tomentosus, Rhizopogon fuscorubens, R. occidentalis, R. vulgaris, and R. subcaerulescens. In contrast, 240 root samples taken from local pine forests revealed a pattern typical of mycorrhizal networks associated with undisturbed forest communities including high EMF species richness and high frequency of EMF in Russulales and Thelephorales. Over 100 species of EMF observed fruiting in surrounding pine stands could serve as spore inoculum for the isolated seedlings. Microhabitat in the isolated areas as well as the below ground carbon allocation by the seedlings may prevent most fungi from becoming established in the isolated areas. However, we believe deer are in part responsible for the observed pattern in that they eat primarily suilloid fungi and disperse propagules over long distances in their feces that can remain dormant for at least a year. Our results suggest that in contrast to typical plant communities where Russulales, Thelephorales and other EMF groups dominate belowground, conifer seedlings growing in the absence of mycorrhizal networks benefit from a species poor fungal community dominated by Suillus and Rhizopogon. Comparison of these data to those generated from secondary successional pine communities recovering from fire will be made.

(# 544) Suillus sp.: A potential ectomycorrhizal species for ecological restoration in the arid mountain regions of western China

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The vegetation of Da Qin Mountain, which is located in Yellow River upper basin, is one of the most threatened ecosystems in north-western of Inner Mongolia of China, with 5% or less of their original stand presently existing. To assess the mycorrhizal status in this degraded barren region, root of native species, most belong to secondary growth species, were collected throughout the year under different stands. Major host genus are Pinus, Larix, Populus, Betula, Tilia, Quercus, and Ostryopsis. Major fungal genus are Amanita, Boletus, Cenococcum, Hebeloma, Lactarius, Paxillus, Rhizopogon, Russula, Scleroderma, and Suillus. However the most frequent species are Suillus sp. and Cenococcum geophilum. More than 40 ectomycorrhizal strains were isolated from mycorrhizal tissue and rarely from sporophores. Selection of the most efficient ectomycorrhizal strains has been carried out in laboratory, nursery and field experiments. Assessment of seedling growth showed that the Suillus sp. was superior for ectomycorrhiza formation and for ease of inoculum production. Seedling height was increased to 80.3% in nursery trials. Survival rate increased to 26% and total stem height increased to 139.5% at the end of third season in the field trials. Therefore inoculation with this strain of Suillus sp. shows great potential for vegetation reconstruction in these degraded barren regions of western china.

(# 545) Proteome analysis of plant-microbe symbioses: current achievements and future prospects establishment.

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Extensive insight into up and down-regulated genes and proteins at different developmental stages of the AM symbiosis is being gained from untargeted approaches in the model plant species Medicago truncatula. Among them, proteomics has proved its high efficiency for identifying AM symbiosis-related proteins (SRPs) (1). Results of the comparative proteomics of the AM symbiosis with Glomus mosseae and the nitrogen-fixing symbiosis with Sinorhizobium meliloti will be presented (2). To extend the identification of AM-SRPs, our research was then targeted in the following directions. First, we developed sub-cellular proteomics of the arbuscular M. truncatula symbiosome to reveal membrane proteins that could be involved in nutrient transport. Second, for the early stages of the AM symbiosis, we developed methods in order to get comparative information at the transcriptomic and proteomic levels (3). Third, 2-DE patterns from in vitro transformed roots inoculated or not with an AM fungus were confronted to those obtained from plants routinely grown into soil substrates. Finally, in order to determine the origin of the SRPs (plant or fungus) we began the proteomics of an AM fungus using an in vitro two-compartment system with mycorrhizal Ri T DNA-transformed roots. Results dealing with all these topics will be presented in order to highlight the interest of proteomics to study plant-microbe symbioses.

(1) Dumas-Gaudot, E, Bestel-Corre, G and Gianinazzi, S (2001). Recent Research Developments in Plant Biology, Research Signpost 1: 95-104.
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(3) Dumas-Gaudot, E, Amiour, N, Wiedmann, S, Bestel-Corre, G, Valot, B, Lenogue, S, van Tuinen, D, Gianinazzi-Pearson, V, Gianinazzi, S. Proteomics (submitted)

(# 546) Proteomics of the early stages of Medicago truncatula arbuscular mycorrhizal symbiosis

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Proteins are the functional outputs of the cells and their analysis provides substantial information, particularly when interpretation of their expression is related to that of the genes. Proteomics together with transcriptomics have emerged as powerful approaches to get insight into protein/gene expression and regulation within the arbuscular mycorrhizal (AM) symbiosis (1, 2). Researches are focused on well-defined key steps of Medicago truncatula AM symbiosis: the late and the early stages. Proteomics was firstly undertaken on the late stages, for which root material availability was not limiting (3). Unlikely, for the early stages corresponding to the first contacts between roots and fungi (appressoria stage), only very limited amounts of root material are available, making proteomics a difficult task. A protocol has been designed allowing to (i) extract enough proteins from low amounts of roots and (ii) carry out transcriptomics/proteomics on the same samples (4). Based on this protocol, we have extended our investigation to another AM fungus, Glomus intraradices (Gi) in its early interaction with M. truncatula roots. Following inoculation or not with Gi, 2DE profiles of a wild genotype (cv. Jemalong J5) were compared to both an AM symbiosis deficient mutant (TRV25) and a hyper-mycorrhizal mutant (TR122). These results allowed characterising and identifying, by mass spectrometry, some genotypic specific modifications in response to Gi inoculation. To have an integrative view, these proteomic data will be then compared to the transcriptomic ones, which are currently carried out on the same root samples.

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(2) Journet, E.P., van Tuinen, et al., 2002, Nucleic Acids Research 30 : 5579-5592
(3) Bestel-Corre, G., Dumas-Gaudot, E., et al., 2002, Electrophoresis 23 : 122-137.
(4) Dumas-Gaudot, E., Amiour, N., et al., 2003, Proteomics (submitted).

(# 547) Use of in vitro grown Glomus intraradices to sensor the effect of agricultural amendments

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Because of their high contents in mineral nutrients and organic matter, sewage sludges have been propelled as farm fertilizers. However, their spreading onto agricultural lands is of great concern, since they may contain pathogens, heavy metals and organic chemicals, leading to disturbances in soil microbial communities. In particular, the arbuscular mycorrhizal (AM) symbiosis is highly exposed [1, 2, 3]. Together with proteomics, we used the dual-compartment system [4] to investigate how an AM fungus responds to sewage sludges. Our aims were to determine the impact of lixiviates of agricultural amendments experimentally enriched or not in pollutants: (i) on the AM fungal development and (ii) on the G. intraradices proteome. Water and acetone sewage sludge lixiviates were added to the minimal (M) medium, on which G. intraradices mycorrhizal Ri T-DNA carrot roots were grown for 8 months. The impact of these lixiviates on extraradical growth evaluated by image analyses will be presented. In the meantime, the 2-DE reference map of non treated in vitro cultured G. intraradices was established and preliminary identifications were realized for proteins of the extraradical fungus and Ri-T-DNA carrot root mycorrhiza, through tandem mass spectrometry. Out of the 450 well-resolved proteins, amino acid sequences were obtained for ten proteins, some of which presented homologies with known enzymes of the central cell metabolism. Further research will aim at going on the identification of fungal proteins and at determining the impact of lixiviates from sewage sludges on the G. intraradices extraradical proteome.

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(# 548) Magnesium By-Products as a Substitute for Dolomite in Fertilizing Forage Crops

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Magnesium (Mg) by-products from the industrial extraction of Mg could supply Mg to crops but their efficiency is not well documented under the growing conditions of Québec. We determined the effect of these Mg by-products on forage yield and Mg uptake, and on Mehlich-3 soil Mg content in a 3-year experiment conducted from spring 1999 at three locations. Three Mg by-products [Actimagtm (11.9% Mg), 80-20 (14.6% Mg), BPEFh (16.0% Mg)], Epsom salt (10.5% Mg) and dolomite (11.4% Mg) yearly applied at 200 kg Mg/ha were compared with no Mg application. Averaged across the nine site-years, the application of Mg did not affect forage yield but it increased forage Mg uptake except for dolomite. The increase in forage Mg uptake with the application of the Mg by-products did not differ from that of the Epsom salt. The forage Mg uptake was 32% greater with the Mg by-products than with no Mg or dolomite applications and this effect was significant at five out of the nine site-years. The Mg by-products ncreased Mehlich-3 soil Mg content compared with no Mg application or dolomite by 67% and this effect was significant at eight out of the nine site-years. The Mg Mehlich-3 soil content was greater with Epsom salt (651 kg Mg/ha) than with the Mg by-products (471 kg Mg/ha) and this effect was observed at six out of nine site-years. We conclude that the Mg by-products from the industrial extraction of Mg are a good source of Mg for forage crops compared with dolomite.

(# 549) Detection of DNA from Tuber melanosporum Vitt mycelium in soil samples

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Abundance and spatial colonization of Tuber melanosporum mycelium in soil from field conditions is currently undocumented. The aim of this work is to develop a molecular tool for the detection of black truffle mycelium in soil. Soil samples from nurseries, experimental and natural truffle beds were tested. Direct isolation of DNA was assessed through an adapted CTAB protocol followed by purification of the coextracted contaminants. PCR with T. melanosporum-specific primers and restriction analysis were carried out. This procedure allowed us to check the occurrence of T. melanosporum in soil, which should provide a better understanding of the ecology of this fungus. Further quantitative PCR analysis will be applied to quantify the amount of mycelium DNA on a forest or plantation scale.

(# 551) Tillage and substrate effects on the production of biogenic gases

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The objective of this study was to determine how tillage-induced environmental conditions and substrate quality affect the mineralization rate of simple compounds and subsequent production of biogenic gases. Simple C compounds with and without nitrogen were applied to soil cropped to corn under no-till and moldboard plow systems. Biogenic gases (CO2, N2O, and CH4) were measured from the soil surface (fluxes) and within the profile (concentration) at 10-, 20-, and 30-cm depths (i.e., within, at the bottom of, and below the plow layer) for several days after application. The sucrose had a different isotopic 13C signature than the corn and this allowed us to distinguish the sources of C in the soil respiration measurements. Temperature appeared to be the dominant soil environmental factor affecting the rate and extent of decomposition. Preliminary assessments of the data indicate that, in general, surface fluxes of CO2 and N2O were greater in soils amended with glycine than with sucrose and were greater under till than no-till. The soil respiration and 13C measurements showed that there was an increase in mineralization of endogenous soil organic matter (i.e. priming) in both tillage systems after application of the substrates.

(# 552) Early recognition stages in mycorrhiza initiation in M. truncatula: from transcripts to proteins

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Magnesium (Mg) by-products from the industrial extraction of Mg could supply Mg to crops but their efficiency is not well documented under the growing conditions of Québec. We determined the effect of these Mg by-products on forage yield and Mg uptake, and on Mehlich-3 soil Mg content in a 3-year experiment conducted from spring 1999 at three locations. Three Mg by-products [Actimagtm (11.9% Mg), 80-20 (14.6% Mg), BPEFh (16.0% Mg)], Epsom salt (10.5% Mg) and dolomite (11.4% Mg) yearly applied at 200 kg Mg/ha were compared with no Mg application. Averaged across the nine site-years, the application of Mg did not affect forage yield but it increased forage Mg uptake except for dolomite. The increase in forage Mg uptake with the application of the Mg by-products did not differ from that of the Epsom salt. The forage Mg uptake was 32% greater with the Mg by-products than with no Mg or dolomite applications and this effect was significant at five out of the nine site-years. The Mg by-products increased Mehlich-3 soil Mg content compared with no Mg application or dolomite by 67% and this effect was significant at eight out of the nine site-years. The Mg Mehlich-3 soil content was greater with Epsom salt (651 kg Mg/ha) than with the Mg by-products (471 kg Mg/ha) and this effect was observed at six out of nine site-years. We conclude that the Mg by-products from the industrial extraction of Mg are a good source of Mg for forage crops compared with dolomite.

(# 553) Diversity of Arbuscular Mycorrhizal Fungi in the Dry Deciduous Forest

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This study was carried out to identify arbuscular mycorrhizal (AM) fungi forming mycorrhizal symbioses with the root systems of tropical dry deciduous forest of the Mexican Atlantic Coast. We collect the rhizosphere samples in three dry deciduous forest patches of Veracruz, Campeche and Yucatan, Mexico, in november 1999. Soil samples were placed in plastic pots sown with Jacaratia mexicana, Zea mays and Dactylis glomerata L. as host plants. Pots of all sites were maintained in a greenhouse to obtain adequate rates of fungi population growth. After six months the AM spores were extracted from each pot culture by wet sieving and decanting followed by centrifugation in a 20-60% sucrose density gradient (Daniels and Skipper, 1982). Permanent slides of a minimum of 20 spores (broken and unbroken) were prepared in polyvinyl alcohol-lactic acid-glycerol (PVLG, Koske and Tessier, 1983) and/or PVLG + Melzer's reagent (1:1 v/v). Detailed spore characteristics such as shape, size, color, spore wall structure, and hyphal attachment were recorded. Nikon FX-35W photographs of spores were taken. Species were identified using standard taxonomic keys (Schenck and Perez 1990), INVAM web information and literature references highly specialized. Voucher specimens were deposited in the ENCB herbarium. A total of six morphospecies were identified: Entrophospora infrequens, Sclerocystis sinuosa, Glomus intraradices, G. etunicatum, Glomus sp. 1 and Glomus sp. 2. Although S. sinuosa and G. intraradices were common in this tropical deciduous sites, the last one was most dominant in Veracruz (90.13%), Campeche (71.91%) and Yucatan (97.24%).

(# 554) The effects of free-air enrichment of carbon dioxide and ozone on ectomycorrhizal fungal sporocarp production in aspen stands

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Humans are dramatically altering atmospheric chemistry at regional and global scales. Elevated carbon dioxide has the potential to increase, and ozone has the potential to decrease, plant C fixation and allocation belowground. The impacts of these gases on mycorrhizal fungal communities are poorly understood. We have initiated work at the AspenFACE site in Rhinelander, Wisconsin, USA to examine how mycorrhizal fungal communities are altered by these gases. Factorial carbon dioxide and ozone treatments have been applied to stands there in an open-air system since 1997. As a first phase of this work, we are examining treatment effects on sporocarp production. We hypothesized that sporocarp production would reflect differences in C fixation and belowground respiration. Initial results of this work from aspen stands suggest that late-season sporocarp production is significantly reduced in response to elevated ozone. In addition, there appears to be an interaction of elevated carbon dioxide and ozone. Elevated carbon dioxide alone reduces sporocarp production relative to controls, whereas elevated carbon dioxide in combination with ozone increases sporocarp production in comparison with ozone alone. The lack of a positive effect of carbon dioxide alone on sporocarp production suggests the need for a more complex model of C allocation to sporocarps. Ozone treatment caused the complete disappearance of sporocarps of strongly rhizomorphic taxa (Leccinum and Cortinarius), but not of less rhizomorphic taxa (Inocybe, Hebeloma, Laccaria). Whether these effects on sporocarp production are consistent from year to year, and are reflected belowground, remains to be seen.

(# 555) DIVERSITY AND ABUNDANCE OF ARBUSCULAR MYCORRHIZAL FUNGI IN COFFEE AGROECOSYSTEMS DISTURBED BY EROSION

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We evaluate the arbuscular mycorrhizal fungi (AMF) diversity in undisturbed coffee agroecosystems and others with signs of erosion. This study was carried out in the municipality of Teocelo located in the coffee belt of central western Veracruz, Mexico. Twenty-five morphotypes of endophytic fungi were identified belonging to 3 genera: sixteen in Glomus, five in Gigaspora and four in Acaulospora. This morphotypes were Glomus geosporum (Nicolson and Gerdemann), G. intraradices (Schenck and Smith), G. versiforme (Karten) Berch., G. microagregatum (Koske, ET al.), G. etunicatum (Becker and Gerdemann), G. constrictum (Trappe), G. clarum (Nicolson and Schenck), Glomus sp. 1, Glomus sp. 2, Glomus sp. 3, Glomus sp. 4, Glomus sp. 5, Glumus sp. 6, Glomus sp. 7, Sclerocystis dussii (Gerdemann and Trappe, 1974) and Sclerocystis sp.; Gigaspora gigantea (Gerdemann and Trappe, 1974), Gigaspora sp., Scutellospora sp.1, Scutellospora sp. 2 and Scutellospora sp. 3; Acaulospora rugosa (Morton, 1986), A. mellea (Schenck and Spain, 1984), A. foveata (Janos and Trappe, 1982) and Acaulospora sp. A greater diversity, richness and abundance were detected in non-eroded agroecosystems soils and smallest quantity in highly eroded agroecosystems soils

(# 556) Current situation of the mycorrhizal research in Mexico

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In Mexico the first studies related with arbuscular mycorrhizal fungi (AMF) were reported in the 1970´s and 80´s a strong current in this area was evident. National Mycorrhizal Meetings began in 1997 when the Universidad Veracruzana observed an increasing awareness among scientists belonging to different institutions that AMF interactions play a key role in natural communities. Several topics were discussed and from then on progress in activities of working groups has been carried out. Until the moment three AMF memoirs and two books have been published. Also the Mexican Society of Mycorrhizal Symbiosis (Sociedad Mexicana de la Simbiosis Micorrízica) was founded in march 2003 to allow us a bigger linking among mexican and foreign investigators. The largest amount of research works are related to arbuscular mycorrhiza (AM) and to a lesser extent to ectomycorrhiza (EM). The generality of AM works are focused to their effectiveness and role in supporting the productivity and stability of agroecosystems. 38.64% are physiological, 32.86% ecological and 21.51% biotechnological reports evaluating fruit plants (44.0%), vegetables (15.81%), gramineous (14.10%) and leguminous (11.11%). The remaining 6.99% has been carried out in taxonomic, biological control and molecular areas. The majority of reports are carried out in greenhouses (61.83%) and they are scarce studies in natural ecosystems. More than half of those (56.71%) are published in memoirs of the National Symposiums, 20.04% in specialized books and only 8.10% in indexed magazines.

(# 557) Response of Juncea Canola to Stresses at Different Development Stages

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Heat and water stresses often cause Brassica crops flower abortion and low seed yield in the semiarid Canadian prairie. A growth chamber study was conducted to determine the effect of short periods of high temperature and water stress at different developmental stages for different Brassica species. Two Juncea canola (Brassica juncea L.), a canola (B. napus L.) and a mustard (B. juncea L.) were grown under 20/18 °C day/night temperature. High (35/18 °C) and low (28/18 °C) temperature stresses were imposed for 10 days at bolting, flowering or podding stages. Low (90% available water) or high (50% available water) water stress was imposed for each of the temperature treatments. Temperature stress affected yield components more intensively than did water stress. Compared to control, the high temperature stress reduced pods main shoot-1 by 75%, seeds pod-1 25%, and seed weight 22%, causing mainstem yield reduction as high as 87%. Delaying stress exposure to pod formation stage reduced the probability of the plant to recover from the stress. Plants grown at low water stress expressed better recovery than plants at high water stress. Under high temperature stress, Juncea canola expressed recovery by increasing pods, while napus canola maintained better seed filling. Juncea canola may recovery from stress better than conventional canola in fields where interplant competition may limit conventional canola from producing sufficient pods.

(# 558) Residual Value of Various Sulphur Sources

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A three-year study was carried out between 1999 and 2001 on two Gay Wooded soils to assess the residual effect of ammonium Sulphate, three sources of elemental sulphur (S) and an experimental product (ExS) that consisted of ammonium sulphate and elemental S. Elemental S sources as well as ExS were blanket applied in 1999 at a rate of 30 kg ha-1, whereas ammonium sulphate was superimposed yearly at twelve rates (0 to 55 kg S ha-1) in 5 kg S ha-1 increments. Enough space was allocated per product to allow new ammonium sulphate rate applications each year of the experiment, whereas ammonium sulphate rates from the previous year(s) were assessed for residual effects. A crop rotation of canola-barley-canola was adopted. Elemental S was surface broadcasted during the seeding operation in 1999. Ammonium sulphate rates were surface applied each year of the experiment. Maximum yield of canola in the first year was obtained with 30 kg ammonium sulphate-S ha-1; elemental S had no effect and ExS provided maximum yield at 55 kg S ha-1. Barley in the second year did not respond to any S sources. Maximum yield of canola in the third year was obtained with 30 kg S ha-1 either from the application of elemental S and ExS in the first year or from all annual applications of ammonium sulphate. Thus, all forms of sulphur had the same residual effect after three years, but use of any elemental S form by itself resulted in a lost opportunity of an average of 1,500 kg canola seed ha-1.

(# 559) Compost, Manure and Gypsum Application to Timothy/Red clover mix on Dykeland Soils

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A two-year field experiments were conducted on Nova Scotia dykeland soils to evaluate the effect of Source Separated municipal solid waste (SS-MSW) compost, solid manure, commercial fertilizer and gypsum on (1) timothy/red clover productivity (2) nutrient and trace element availability and uptake, (3) distribution of nitrate and ammonium in 0-80 cm soil profile, and (4) soil microbial biomass. Treatments consisted of 2 rates of SS-MSW compost, two rates of solid manure, and two rates of NPK fertilizer in combination with three levels of sulfur as gypsum. Rate one and two of the SS-MSW compost, manure, and fertilizer were calculated to provide 95 and 190 kg of total N/ha respectively, while gypsum was calculated to provide 0, 20, and 40 kg total S/ha. In the second cropping season, forage yields from the first cut were highest in the compost treatments, lower in manure and NPK treatments, and lowest in the control. Forage yields from the second cut were higher in all fertility treatments and lower in the untreated control. Addition of sulfur increased both first and second cut forage yields in the unamended control. Sulfur addition did not influence yields. Both rates of SS-MSW compost provided high yields and may completely substitute commercial fertilizer application on timothy/red clover mix on dykelands. In addition, compost and manure improved physical, chemical, and biological properties of the soil.

(# 560) Effect of Liquid Manure and Benlate on Soybeans and Spring Wheat Yields, Nutrient Uptake, and Mycorrhizae Associations

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Two container experiments were conducted to evaluate the effect of five fertility treatments (three liquid manure application rates, commercial NPK fertilizer, and unfertilized control) and mycorrhizae suppression (- and + Benlate) on yields, nutrient uptake and mycorrhizae root colonization of soybeans and wheat. In addition, a mycorrhizae root colonization study was conducted on soybeans and wheat from field experiments following the same five fertility treatments but without the Benlate treatments. Results from the container experiments show that both soybeans and wheat yields were highest in the NPK treatment and lowest in the unfertilized control. Suppression of mycorrhizae with the addition to Benlate did not affect the yields of the two crops. Addition of Benlate at a rate of 25 mg a.i. /kg soil as a soil drench suppressed % RLM (Root Length infected by Myccorhizae) of both crops. The % RLM on soybeans in week 7 was 1.5-6.3 for Benlate treated vs. 47-59 for non-Benlate treated plants. However, the % RLM in week 13 was 20-27 for Benlate treated and 47-49 for non-Benlate treated plants. Within wheat, the % RLM in week 7 was 21-32 for Benlate treated vs. 45-59 for non-Benlate treated plants. Wheat plants in week 13 had % RLM 44-51 for Benlate treated vs. 72-76 for non-Benlate treated plants. Fertility treatments did not significantly affect % RLM of the two crops. Total and available concentrations of 15 nutrient and trace elements in soils and total concentrations in plant tissue were measured and are tabulated.

(# 561) Identifying Tracers to Characterise E: coli 0157 Transport Through Disturbed and Undisturbed Columns

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Transport of E. coli 0157 from cattle manure through the soil has the potential to contaminate water sources with serious human health consequences. Understanding of E. coli 0157 transport is limited because it cannot be released in the natural environment. The purpose of this study is to evaluate E. coli 0157 tracers in order to ascertain a greater understanding of E. coli 0157 flow mechanisms. In the first of a two part study, tracers will be evaluated in the laboratory through disturbed and undisturbed columns, for both a clay and loam soil. The existence of preferential flow paths will first be examined by determining breakthrough curves (BTC) for pulses of different sequentially applied conservative tracers. While flow is still in steady state, E. coli 0517 will be applied along with fluorescent latex spheres of various size and charge and a surrogate pathogen. Analysis of these indicators in the effluent will lead to determination of dispersion coefficients and adsorption constants, leading to a representative tracer for E. coli 0157. Results from this experiment will provide an understanding of transport mechanisms for E. coli 0157 and the effect of different textures. These results will be later applied to field experiments. This information will aid in minimizing health risks associated with manure application to soil.

(# 562) Runoff and erosion monitoring and management for reduced nonpoint contaminant export in agricultural watersheds.

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The overwhelming majority of water quality problems in southern Quebec watersheds results from agricultural nonpoint sources of pollution. The overall goal of a watershed rehabilitation network initiative within Montérégie and Beauce regions in Québec is to evaluate the effectiveness of riparian zone and surface runoff management on agricultural nonpoint source pollutants export. The project follows a paired watershed design (control and treatment), where the quantifiable relationship in nonpoint contaminant export between paired watersheds during the calibration period will be compared to their relationship following treatment implementation. From hydrometric and water quality monitoring data collected during calibration period (2001-2003), the phosphorus (P) and sediment transfer system within the small agricultural watersheds network (6 X 3-6 km2) were described and enabled the description of significant relationships between paired watersheds in their response to runoff events. Episodic P and sediment loads temporal distribution remain largely associated with peak streamflow events, when overland runoff conditions develop from snowmelt and precipitation on thawing or saturated soils in late-winter/early-spring. A detailed watershed diagnosis enabled the localization of critical sources areas of runoff and phosphorus export. Aerial multi-spectral imagery, surface flow paths modelled from precision elevation models, as well as springtime GPS-survey of runoff and erosion activity were spatially integrated within user-friendly TNT-Atlas software, in order to support implementation of best management practices and structural runoff management.

(# 563) Removal of pinegrass and forest floor during site preparation: effects on lodgepole pine growth and ectomycorrhizae

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After logging, site preparation alleviates the effects of pinegrass (Calamagrostis rubescens) interference on regenerating conifers in British Columbia, but little is known about interference mechanisms and appropriate site preparation methods for steep slopes. In this study, lodgepole pine (Pinus contorta) was planted into pinegrass controls and small (90x90 cm) and large (180x90 cm) patches where pinegrass was removed (a) alone using glyphosate or (b) along with forest floor using an excavator. Treatments were followed for nine years. We found that removal of the forest floor reduced ectomycorrhizal diversity and richness, decreased the relative abundance of E-strain mycorrhizae, and increased MRA mycorrhizae during the first 16 months post-treatment. At the same time, forest floor removal reduced soil and foliar nutrients, increased bulk density and soil water availability, and decreased porosity and aggregate stability. These changes were not observed in the chemical patches. Pine diameter growth was depressed by mechanical forest floor removal during the initial four years, but it caught up to the chemical treatment where the forest floor was retained after nine years. This convergence in diameter growth among treatments corresponded with pine root growth outside the boundaries of the patch treatments with time. After nine years, pine survival and growth were higher in all treatments relative to the control. Our results show that pinegrass can suppress early pine performance, and large chemical patches that retain forest floor are best for conserving the ectomycorrhizal community, relieving the multiple environmental stressors, and enhancing early survival and growth of pine seedlings.

(# 564) Variations in Grain Nitrogen Removal from Corn Production

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Information of nitrogen (N) removed by corn grains from the cropping system is not only required for proper soil N management, but also is a prerequisite for environment risk assessment. The objective of this study was to quantify the variations of corn grain N removal in relation to weather and agronomic practices. Corn grain samples from several experiments including different hybrids and fertilizer N levels under different environments were determined. Quantitative relationship of grain yield and grain N removal was established. In general, kernel N removal is a linear function of grain yield with a slop of 0.8 (i.e. 0.8 lb N/ac was removed for each bu/ac grain yield produced). Large variations in the slop (0.58-1.12) existed among years and hybrids. Level of fertilizer N application had less effect on the yield-grain N removal relationship. Implications of variations in grain N removal to the establishment of N index and impact on environment safety will be discussed.

(# 565) Organic Carbon in Wetland Soils: Insights on Structure and Transformation Processes using K-edge XANES and NMR Spectroscopy

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X-ray absorption near edge structure (XANES) and nuclear magnetic resonance (NMR) spectroscopy were used to characterize organic matter in several wetland soils in Saskatchewan. NMR analyses indicate that the organic matter in the soils consists of predominantly aliphatic structures such as carbohydrates and long chain poly(methylene) units. Carbon XANES spectroscopy shows that the surface (~ 10 nm level) layer of particulate organic matter has a structure dominated by aromatic, carbohydrate and carboxylic acid-like material apparently derived from partially degraded lignin and cellulose polymers. The aliphatic structures remaining in this surface layer are probably recalcitrant (poly)methylene units. At a depth of ~ 100 nm, the aliphatic content significantly increases suggesting the presence of more labile structures. The presence of these more labile aliphatic compounds may be due to slow decomposition rates in the wet, often cool environments present and to the protective action of the more refractory components present at the surface (~ 10 nm) of the organic matter. Drying of the wetlands, either by draining or as a result of climate change, is likely to result in the rapid decomposition of these labile organic structures releasing carbon dioxide.

(# 566) Arbuscular mycorrhizal fungi colonize decomposing leaves of Myrica parvifolia, M. pubescens and Paepalanthus sp.

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We found hyphae and vesicles of arbuscular mycorrhizal fungi (AMF) within the decomposing leaves of Myrica. parvifolia, M. pubescens and Paepalanthus sp., and found hyphae, vesicles, and arbuscules within scale-like leaves of the rhizomes of Paepalanthus sp. We divided the litter found in the vicinity of these species' roots into three decomposition layers, and found the greatest AMF colonization in the most decomposed leaves which were in close association with roots. In contrast, we did not find differences in AMF colonization of roots present in the different decomposition layers. AMF decomposing leaf colonization did not differ between two closely related species, M. parvifolia and M. pubescens, nor between two sites (Guatavita and Zipacón, Colombia) of different soil fertility. AMF vesicle occurrence in decomposing leaves was correlated with the abundance of AMF extraradical hyphae among those leaves. We propose that AMF enter decomposing leaves mechanically through their vascular tissue. In consequence, AMF are well positioned to obtain and efficiently recycle mineral nutrients released by decomposer microorganisms before loss by leaching or immobilization in soil.

(# 568) Chromium effect in the arbuscular mycorrhizal colonisation and the growth of tomato (Licopersicum esculentum) plants.

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Heavy metals are extremely toxic for crops, and among other things, they inhibit the mycorrhizal formation and affect the phosphorus nutrition in the host plant. Chromium, particularly, is a potentially toxic metal for micro-organisms and plants, and due to its industrial use it has become a serious pollutant.

The main objective of this work was to determine the arbuscular mycorrhizal effects in the development and colonisation of tomato (Licopersicum esculentum) plants, treated with different chromium concentrations. For this purpose plants were inoculated with AM fungi, and then were irrigated with a Long Ashton solution, low in phosphorus containing different chromium concentrations (1000, 3000 and 6000 ppm).

Results showed that mycorrhizal colonisation increased in the plants treated with higher chromium concentrations (3000 and 6000 ppm), which points out a possible plant strategy to associate and establish symbiosis with AM fungi, and this way resist in a better way the chromium deleterious effects.

In plants treated with 6000 ppm of chromium, the surviving was 4 times higher (80%) when the plants were inoculated with AM fungi, related to the non- inoculated plants (20%). This suggests that AM fungi establish an efficient protection system for the plants.

Plants treated with AM fungi that survived the transplant and were treated with 6000 ppm reached a size and weight similar to the plants treated with lower chromium concentrations (1000 and 3000 ppm).

(# 569) Calcium Uptake into Potato Plants and Tubers

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The uptake and translocation of calcium into potato plants was examined using test solutions containing 5 % safranin dye and the radiotracer 45CaCl2. In greenhouse-grown minitubers suspended in test solution for up to 5 days, safranin diffused into the outer pith tissues while 45Ca2+ occurred throughout the pith. Ca2+ is apparently taken up directly by tubers from the soil via a slow diffusion process. In micropropagated plantlets, each with one microtuber attached, 45Ca2+was found well ahead of the safranin dye-front in all plantlet stems. 45Ca2+ in plantlet shoot tips was significantly greater than in microtubers. 45Ca2+ was translocated into the microtubers while safranin did not. Greenhouse-grown plants with minitubers attached were used to determine the relative uptake by basal and stolon roots. Basal root feeding contributed significantly more 45Ca2+ to shoot tips and tubers than stolon root feeding while combined feeding gave the greatest shoot tip and tuber 45Ca2+ levels.

(# 570) Identification of Ca-Packing Potato Genotypes Through In Vitro Screening and Tracer Technique

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Potato micropropagation, microtuberization and plantlet tissue calcium contents were compared for six potato cultivars (Alpha, Bintje, Green Mountain, Kennebec, Russet Burbank and Shepody) grown in media (Murashige-Skoog basal salt medium) containing low (5 mM) or high (15 mM) Ca2+ level. All aspects of growth improved when medium Ca levels were greater. For example, microtuber induction occurred earlier at 15 mM medium Ca2+ level, leading to improved microtuber yield and greater microtuber tissue Ca2+ content. Micropropagated potato plantlets placed in test solutions containing the ratiotracer 45CaCl2 showed improved 45Ca2+ uptake when medium calcium levels were greater. Cultivar Bintje was the most efficient genotype at accumulating Ca2+ from growth media or test solutions containing high or low Ca2+ levels. It was identified as a calcium-packer using both in vitro screening and liquid scintillation counting.

(# 572) Successful mature pine inoculation with Tricholoma matsutake

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We demonstrate for the first time that roots of mature trees can be successfully inoculated with an ectomycorrhizal fungus, here the Japanese matsutake (Tricholoma matsutake).Despite numerous worldwide attempts, cultivation of the valuable matsutake (Euro 100 per fruit body) was still looking out of range. While seedlings could be infected in vitro, the infection failed to spread after transplantation in nursery or forest sites. We hypothesized that inoculating aged trees with matsutake known to fruit only in mature forests should be a way to overcome this deadlock by providing a suitable rhizosphere environment.

Mycorrhiza-free roots were generated from root systems of 50 year-old Pinus densiflora trees in Kake (Hiroshima prefecture) and inoculated 12 months later with pieces of 4 week-old T. matsutake thalli. Four and a half months later, dense nets of hyphae extended from the inoculation points into the soil. After staining, typical Hartig net palmettis were observed in colonized root tips. A two-steps nested PCR (fungal ITS primer pair followed by re-amplification using matsutake specific ITS primers) confirmed the presence of T. matsutake hyphae in colonized root tips and in soil micro-aggregates.These results open the way toward matsutake, and other late-stage ectomycorrhizal fungi, cultivation in mature forests where fruiting could be expected only few years after inoculation.

(# 573) Influence of sterol biosynthesis inhibitor fungicides on arbuscular mycorrhizal symbiosis

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Sterol biosynthesis inhibitors (SBI) fungicides are frequently used in all crop production for the control of fungal diseases. Repeated doses or soil accumulation of these fungicides could have detrimental effects on plant growth by limiting the functioning of Arbuscular Mycorrhizal (AM) symbiosis.

The effect of SBI fungicides on the fungal growth, sporulation, and root colonization of AM fungi has been investigated in several laboratories. However, the results obtained are often not comparable due to the lack of a standardized and reproducible method (diversity of formulation of these compounds, difference of sensitivity of fungal or/and plants, diversity in the modes of application and concentrations of fungicides).

In this work, a standardized, reproducible easy-to-use monoxenic culture system was used to test the impact of SBI fungicides on the non-targed AM fungal symbionts.

Two SBI fungicides with different enzymatic targets were studied. Active molecules were tested at various concentrations (0.2; 2; 20 and 200 mg/l): fenpropimorph (D8,7 isomerase and D14 reductase inhibitors) and fenhexamid (C4 demethylase inhibitor). The impact of these compounds on spore germination, root colonization and sporulation of G. intraradices was evaluated by growing the AM fungus on media containing the SBI fungicides at these various concentrations.

Preliminary results showed that fenpropimorph and fenhexamid, at concentrations above 20 mg/l, clearly inhibited germination, colonization and sporulation of G. intraradices.

These preliminary results suggests that SBI fungicides may have different effects on the non-target AM fungal symbiont and may affect diversely the survival, reproduction and functioning of these key organisms involved in the soil-to-plant continuum.

(# 574) Establishment of monoxenic culture between the arbuscular mycorrhizal fungus Glomus sinuosum and Ri T-DNA-transformed carrot roots

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We report for the first time the establishment of an arbuscular mycorrhizal association between Glomus sinuosum (= Sclerocystis sinuosa) and transformed Ri T-DNA carrot (Daucus carota L.) roots in monoxenic culture. The G. sinuosum sporocarps survived not as single spores, but as sporocarps in the environment. The mode of germination of G. sinuosum was by extension of hyphae around the sporocarp. Numerous vegetative spores, arbuscules and vesicles were produced after the roots were infected by the hyphae. New mature sporocarps started to form after four months in the culture system. Forty-seven sporocarps were produced on average in each culture dish after six months, and these newly produced sporocarps were capable of germination in the growth medium.

Keywords: Arbuscular mycorrhiza, transformed carrot roots, monoxenic culture, Glomus sinuosum, Sclerocystis sinuosa, sporocarps

(# 576) Surface-disinfection of AMF spores and relationship with the external spore wall ornamentation

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In vitro root-organ culture (ROC) of arbuscular mycorrhizal fungi (AMF) provides access to pure, non-contaminated spores and mycelium, essential for germplasm collections such as GINCO. Disinfection process is the first critical step to succeed in ROC, requiring the surface disinfection of spores of AMF, without killing the fungi. Many methods failed to link complete spore surface-disinfection and high germination rate of AMF spores. To investigate the relationship between surface-disinfection and germination, experiments were conducted on two groups of spores: surface-smooth AMF spores from the genus Glomus and surface-ornamented spores from the genus Scutellospora. Two disinfection protocols were tested on both type of spores: (1) the surface-disinfection of spores in a solution of chloramine T (10%) for a period of 10 min followed by a 10 min bathing of the spores in a mixture of antibiotics (Gentamycin 100 mgl-1 and Streptomycin 200 mgl-1) and (2) a more rigorous disinfection process, with a long period of exposure in chloramine T (10 min twice) and antibiotic solution (10 min twice). With protocol (1) 50% of the Glomus sp. spores germinated among which 14% remained uncontaminated, while with Scutellospora sp. germination was 18% among which 50% remained uncontaminated. With protocol (2), 7% of the Glomus sp. spores germinated and each remained uncontaminated, while with Scutellospora sp. germination was 38% among which 52% remained uncontaminated. These results shows that disinfection process could be oriented towards the type of spore, in order to optimize the disinfection process with the percentage of uncontaminated germinating spores.

(# 578) Is Partner Benefit Symmetric in Mycorrhizal Symbiosis?

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In growth experiments with AM and EM monocultures, it has been shown that the host plant gains different growth benefits depending on the identity of symbiotic fungi. However, it is not known whether the symbiotic benefit gain is symmetric to both partners. Furthermore, it is not known whether maximal symbiotic benefit gain is reached with one partner, or whether symbiont diversity increases symbiotic benefit gain. To answer these questions, a literature survey was conducted. Plant growth was taken as the plant benefit measure and the amount of fungi in the root (fungal colonization intensity x root size) as the index of fungal benefit. Data on plant growth and fungal colonization intensity were extracted from papers investigating the effect of environmental factors that impair plant photosynthetic carbon gain (ozone, defoliation) and from those that potentially improve carbon gain (elevated CO2). Systems in which one or several plants were grown with one or several fungal symbionts were compared. The results will be discussed in the context of evolution of cooperation in mycorrhizas.

(# 581) Species composition and significance of mycorrhizas in young oak plantations of Q.petraea and Q.robur.

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The mycorrhizal symbiosis is a crucial factor in forest tree health. Quercus robur and Q. petraea are two the major forest tree species in central Europe. Oak decline is not completely new phenomenon in Europe, but the production of the healthy oak seedlings for restauration of forest areas is serious problem in recent years.

The presence of ectomycorrhizal species on young oak seedlings has the significant effect on its quality and physiology. We compared the ectomycorrhizal community of young oaks (from seedling to 3 years old plants) in nursery plantations and natural oak forests. The comparison and evaluation of ectomycorrhizal species was based on occurrence of macrocarps, mycorrhiza morphotyping and by using molecular methods PCR-RFLP ITS rDNA of mycorrhizas and macrocarps. The coincidence between of macrocarps and mycorrhizas occurence was compared. The occurence of mycorrhizas in nursery plantations is affected by many environmental factors. Natural mycorrhization of seedlings during first year of plantation varied from 1 to 5 species during season. We identified two of them as: Coenococcum geophilum, Scleroderma sp. We found the same species composition in the oak forest, but number of mycorrhizal tips per root length was significantly higher. The mycorrhizal species did not correlate with macrocarps species during the season. The variability of mycorrhizas increased in second and third year of plantation. In nature, the species composition showed to be more rich and variable than in planting fields.

The molecular methods showed that (i) more than one species of ectomycorrhizal fungus were often present in a single morphotype, (ii) mycorrhizal species of oak produced macrocarps rarely on plant fields, (iii) results of molecular analyses revealed higher diversity of mycorrhizal species than morphotyping.

(# 582) Premier Tech Research Report: In situ efficacy experimentation

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By using a technologically advanced production process, Premier Tech Biotechnologies has developed and manufactured a line of mycorrhizal-based products for home garden use. To demonstrate the beneficial use of these commercial mycorrhizal inoculants in field applications, Premier Tech conducts field testing on a regular basis, in collaboration with Universities and Research Centers. During the summer of 2002, field tests were performed to evaluate the effects of two commercial soil inoculants on plants species commonly cultivated by gardeners. Application of MYKE® TREE AND SHRUB soil inoculant resulted in a statistically significant growth increase in this first season for five tree and shrub species: Cedar, Dogwood, Green Ash, Norway Maple, and Juniper. Annual and perennial plants inoculated with MYKE® ANNUAL AND PERENNIAL soil inoculant under conditions simulating established planting beds, showed a significant reduction of transplant shock (Coleus), faster growth (Salvia) and an increase in flowering (Coleus, Daylily). These results demonstrate the beneficial effects of commercial inoculants on annuals, perennials, trees and shrubs in home gardens. They also contribute to show the value of using mycorrhizal inoculum under in situ field applications.

(# 583) Host-plant mediated mycorrhiza effects on the spider mite Tetranychus urticae

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Both herbivorous arthropods and mycorrhizal fungi may significantly affect plant performance and fitness. Studies on the effects of either herbivores or mycorrhiza on their host plants are numerous, whereas topics such as the combined effects of above-ground herbivores and mycorrhiza on the host plant and/or the interaction between the two organisms have rarely been addressed. We studied the effects of the arbuscular mycorrhizal fungi Glomus mosseae on selected life history parameters of the two-spotted spider mite Tetranychus urticae mediated by the host plant Phaseolus vulgaris. Both, T. urticae and G. mosseae are globally distributed and occur on numerous host plants relevant in agricultural ecosystems. Mycorrhiza had a positive effect on the oviposition rate (eggs/female/day) but not juvenile developmental time (egg to adult period) of the spider mites. Furthermore, when given a choice adult spider mite females tended to preferentially colonize and oviposit on leaves from mycorrhiza colonized plants than on leaves from uncolonized plants. We discuss the potential consequences of this outcome to the community level.

(# 584) Community Structure of AM Fungi Colonizing Roots of Different Varieties of Hordeum vulgare

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The host dependent population growth rates of AM fungi are explained as a possible mechanism for the maintenance of fungal species diversity. In the present study we are investigating the influence of different genotypes of one plant species on the AM fungal community in various soils. Twenty one varieties of Hordeum vulgare from the gene bank of Latvia were analyzed concerning their influence on the community structure of AM fungi colonizing their roots. The mean colonization varied widely between the different Hordeum varieties. The oldest variety Vairogs from 1930 had a mean mycorrhizal colonization of 32% and the variety Ansis, selected in 2001, had a mean colonization of 54%.Are these differences in mycorrhizal colonization explained by changes in the composition of the fungal community in the root system in response to the different plant genotypes? This problem has been evaluated using a nested PCR approach based on 25S rDNA polymorphism and taxon specific primers. In addition we analyzed the distribution of AM fungi in the field with respect to the different varieties.

(# 585) Mycorrhizal inoculum potential of tailings and spoils from a Canadian oil sand industry

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Seedling bioassays were used to assess the mycorrhizal inoculum potential of seven different tailings and spoils originating from an oil sand plant site (Syncrude Canada Ltd.), near Fort McMurray, in northeastern Alberta: composite tailings (CT), tailing sand (TS), deep overburden material (OB), peat muskeg (MK) and three reclaimed sites (R99, R88, and R82). Jack pine, hybrid poplar and red clover plants were grown in soil cores under greenhouse conditions for 8 wks. The CT materials were deprived of mycorrhizal propagules, and characterized by alkalinity and a low level of nutrients. Ectomycorrhizas (ECM) were observed on pine and poplar in MK and in the two oldest reclaimed sites (R88 and R82). Using morpho- and molecular (ITS-RFLP) typing tools, four ECM species were identified as Laccaria proxima, Thelephora americana, E-strain (Wilcoxina sp.) and Tuber sp. (probably the I-type fungus). Two other putative ECM species, Sebacina sp. and Peziza sp., were identified by sequencing the ITS region. Laccaria proxima. and Wilcoxina sp. were the most frequently observed species. In all substrates containing organic matter (MK, R99, R88, R82), arbuscular mycorrhizal fungi were observed on root systems of clover and poplar. Pine roots were also colonized by vesicle forming hyphae of an unidentified endophyte.

(# 586) Is the Pinus banksiana - Laccaria bicolor mycorrhizal system salt tolerant?

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In the boreal forest of northern Alberta, oil sand mining industries are producing vast areas of saline, sodic and alkaline material. This material is revegetated with indigenous salt tolerant forest trees such as Pinus banksiana Lamb. Common reclamation practices rarely take into account soil micro-organisms but salt tolerant ectomycorrhizal strains could potentially help alleviate this stress. Using salt tolerant myco- and phytobionts, we performed a greenhouse trial to evaluate the physiological effects of increased salt concentrations on the Pinus banksiana-Laccaria bicolor symbiosis. A complete random block design was set up using one year old, inoculated and non-inoculated, nursery grown tree seedlings. Two weeks after budbreak, the seedlings were exposed to different NaCl concentrations (0, 0.5, 1, 2.5 or 5g Na/pot) or a saline-alkaline solution from sand tailings (1g Na/pot). Measurements of chlorophyll a fluorescence, net photosynthesis, morphological parameters, and water potential were performed to monitor plants physiological response. A significant decrease in all parameters was observed for the two highest NaCl application rates (2.5 and 5g Na/pot). Laccaria bicolor did not alleviate plant stress for these treatments. Nevertheless, photosystems and some morphological features were positively influenced by the presence of Laccaria bicolor at the lowest NaCl concentrations (0.5 and 1g Na/pot).

(# 587) AM FUNGI IN PAH-POLLUTED SOILS, FROM LABORATORY TO FIELD EXPERIMENTS

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Many industrial soils are polluted by a mixture of pollutants including metallic and organic pollutants such as polycyclic aromatic hydrocarbons (PAH). These compounds represent a group of persistent and toxic soil pollutants that are of major public concern due to their mutagenic and carcinogenic property.

Phytoremediation is the use of plant and their associated microorganisms for remediation of polluted soils. Because most plant species are mycorrhizal on industrial soils, we investigated the effect of AM fungi on the fate of PAH in the rhizosphere of plants, and showed that they enhanced survival, plant growth in PAH contaminated soils, and the biotransformation or biodegradation of PAH, although the effect differed between soils. A rhizosphere and mycorhizosphere gradient of PAH concentrations was observed. Different microbial communities were found in the rhizosphere of AM and nonmycorrhizal plants, suggesting that AM could affect PAH degradation by changing microbial communities. To confirm these laboratory results in situ, an industrial site (Homécourt, North East part of France) contaminated with PAH was chosen to set up a field experiment where a mixture of alfalfa and ryegrass were inoculated with two AM fungi (Glomus mosseae P2 and Glomus intraradices). After one year, a lower Zn accumulation was found in shoots of alfalfa inoculated by G. mosseae P2 whereas G. intraradices was, using a PCR-TGGE technique, the only inoculated fungus present in the roots. The results obtained during the second year will be presented and discussed during ICOM4.

(# 588) Diversity of arbuscular mycorrhizal fungi associated with two different plants on heavy metal polluted soils

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Arbuscular mycorrhizas are ubiquitous rhizosphere microorganisms and key components of the soil-plant systems. Because they are at the interface between soil and roots, they directly affect the fate of the pollutants, and their transfer to plants. Using compartment devices, the contribution of AM fungi to the transfer or reduced transfer of heavy metal, such as Cd and Cs, to roots has been shown.

Although their occurrence in heavy metal polluted soils has been often shown, AM fungi diversity on such sites has rarely been considered. Further, different plants may have different tolerance to metals and be more or less dependant on AM fungi for metal tolerance.

We studied the diversity of AM fungi in the roots of two plants, Arrhenaterum elatius, in the north of France (Mortagne du Nord), and Viola calaminaria, a metallophyte plant, in the North of France and in Belgium (Auby and Plombières), both growing on Zn polluted soils. Soils and plants were collected and heavy metals analysed, and diversity was estimated using TGGE and T-RFLP after PCR on DNA extracted from roots. Results showed that AM diversity was relatively low, differed with sites and plants, and for A. elatius was not correlated with heavy metal concentration in soil and plant.

Nonmycorrhizal fungi were also found in roots, whose role in soil-plant systems in poorly known.

(# 589) Shift in community composition of arbuscular mycorrhizal fungi may slow pasture recolonization by a tropical forest tree

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Tropical forest conversion to pasture was first hypothesized to result in changes in the arbuscular mycorrhizal fungi (AMF) community by Janos nearly 25 years ago, yet our understanding of changes in AMF communities following tropical forest clearing and their role in limiting pasture recolonization by forest plant species remains incomplete. I characterized AMF communities of forest and pasture soils at three adjacent sites in Coto Brus, Costa Rica, using both spores collected from the field and trap cultures in the greenhouse. Concurrently, I inoculated seedlings of the tropical forest tree species Terminalia amazonia with either forest or pasture soil from these sites, planted the seedlings in forest and pasture, and compared survivorship, growth, abiotic characteristics of inocula and root colonization by AMF.

AMF community composition differed between forest and pasture. Three of the most common species in pastures --an undescribed Entrophospora sp., Glomus hoi, and Scutellospora calospora-- were not observed in the forest. Seedlings inoculated with forest soil experienced lower mortality, higher initial growth rates, were more heavily colonized by AMF, and were less likely to be colonized by Scutellospora than seedlings inoculated with pasture soil. Changes in AMF community composition following forest conversion to pasture may slow pasture recolonization by T. amazonia. Proximate causes for the shift in AMF community composition and its consequences for forest regeneration in pastures need to be examined.

(# 590) Early Prediction of Nitrogen Requirement for Corn in Eastern Ontario

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Nitrogen (N) amendment is poorly correlated with soil mineral N content pre-planting in the humid conditions of eastern Ontario. A field experiment was conducted in Ottawa for three years to improve the precision of N application to corn using crop-based indicators. Two hybrids were grown with 8 N treatments as either starter or combinations of starter and sidedress between V6 and V8. Leaf chlorophyll content and canopy reflectance were simultaneously measured from V5 to V12 stages. Prior to N sidedress, plant total N and soil mineral N concentrations were determined. Our data showed that in all years, Leaf chlorophyll and canopy reflectance measured at pre-sidedress stage determined plant N status, but these measurements did not correlate with final grain yield ($r<0.40$). While the measurements at post-silking stages were strongly correlated with grain yield (r ³0.70), soil or plant N concentrations at pre-sidedress were not correlated with grain yield. The two hybrids did not differ in the response to N treatment in all years. Significant yield differences due to N treatment were observed in 2000 and 2002. In both years, yields were significantly greater in all N treatments than in 0 and 40 kg N ha-1. The results indicated that environment conditions after N sidedress had large impact on grain yield, and early measurement of leaf and canopy greenness cannot predict grain yield under stressful conditions, but reliably indicate the plant N status for N amendments. Implication of this study on corn N management will be discussed.

(# 591) Effects of post-emergence papermill sludge and liming by-product applications on soil properties and crop yields.

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Agricultural use of papermill sludge and liming by-products (K, Ca, Mg) is increasing in the province of Quebec, Canada. However, little information is available about their simultaneous post-emergence application on crops. The objective of this study was to determine their effects on soil properties and crop yields with annual blends application for three consecutive years (2000-2002). Three types of papermill sludge (PS1, PS2–mixed papermill residues and PS3- de-inking papermill residues) were used on three different sites. Eight treatments were tested: Biosolids 0, 30 and 60 Mg ha-1 and biosolids 30 Mg ha-1 blended with 3 Mg ha-1 of each liming by-product. Liming products were, commercial lime (CL), lime sludge (LS), wood ash (WA), magnesia dissolution by-product (SPD), and foundry electrolyse by-product (SPEF). The SPEF largely modified soil nutrient dynamics. Decreases in yields could be mainly explained by Cl and Na high content of SPEF. Biosolids PS1 and PS2 were identified as nutrient sources that increased crop yields after one and two years of application respectively. The PS1 significantly improved yields when combined with WA or CL. On the other hand, when combined with LS, PS1 tended to reduce yields. Finally, PS3 immobilised nutrients to the detriment of crop yield after the first year of application with an increasing negative effect in the following two years. This study indicated that mixed papermill residues-liming product blends are an effective source of nutrients for crops. However, environmental consequences of their repeated applications have to be addressed.

(# 593) Why are so diverse the Scutellospora at La Gran Sabana, Venezuela?

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Glomalean fungi are able to form arbuscular mycorrhizas (AM), the mycorrhizal type most frequently found in nature, for which a new Phyllum (Glomeromycota) has been erected recently. This group of fungi seems to have low taxonomic specificity and in contrast with the majority of organisms, there is not an increase in Glomalean biodiversity from the poles to equator. Scutellospora is one of the genus within Glomales, and it is characterized by the presence of large spores (100-500 mm), several internal layers, a germination shield and a bulbous suspensor. During several travels to La Gran Sabana (LGS), Venezuela, we have found a relatively large number of Scutellospora morphotypes that are new for science. In this work we presented the evidences to support the existence of a high diversity of Scutellospora spp. in LGS and we speculate about the possible explanation for this fact. Upper soil (0-20 cm) from savannas, shrublands and forests from LGS were collected and the spores were isolated, catalogued and deposited at IVIC Glomalean Herbarium. In different ecosystems from LGS and covering an area of 1.5 ha or less, a total of 12 non-described Scutellospora were collected. The majority of them possesses ornamentations that conspicuously show that they have not been collected before. As to the present only 30 Scutellospora species has been described around the world, the species reported here mean an increase of 40 % to all Scutellospora known to the present. Possible reasons for the high diversity of Scutellospora at LGS are discussed.

(# 594) Interactions between mycorrhizal status, temperature and nutrient fertilisation on growth and nutrient status in a spring ephemeral, Erythronium americanum

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The interactions between mycorrhizal status, temperature, and nutrient fertilisation were studied in Erythronium americanum, an abundant spring ephemeral in deciduous forests of North America. A first group of root-free bulbs of E. americanum was collected in the field in early September as non-mycorrhizal (NM) plants and a second group was collected in November (after completion of root growth) as mycorrhizal (M) plants. Both groups of plants were then submitted to a low temperature regime (5°C) simulating the hypogeous growth of E. americanum, under three fertilisation treatments: 1, 10 and 50% Hoagland's. This was followed by the epigeous growth period where two temperature regimes were tested: an early spring (12/10°C) and a later spring condition (17/15°C). At the end of the hypogeous growth period, root elongation was higher in NM than in M plants which translated into lower dry biomass and starch concentration in the bulb. No fertilisation effects were apparent at that stage. Final bulb biomass, following completion of the epigeous growth period, was higher in M plants than in NM plants. It was also higher under the lower temperature regime, and the intermediate fertilisation treatment. M plant better growth did not seem to be related to a better mineral nutrition as nutrient concentrations were similar between M and NM plants and only total nutrient content differed in accordance with the difference in biomass. These results suggest that both E. americanum and its arbuscular mycorrhizal symbionts, are adapted to better perform at the low temperature regime typical of early spring.

(# 595) UV light and Vitamin D-Regulated 45Ca2+ Uptake into Micropropagated Potato Plantlets

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In vertebrates, UV light elicits vitamin D synthesis that regulates Ca2+ absorption from the gut and Ca2+ metabolism. In plants, UV also elicits vitamin D synthesis. However, few studies exist on UV elicitation of vitamin D in plants or the effect of vitamin D and its metabolites on Ca2+ uptake into plants. In this study we used micropropagated potato plantlets to investigate the effect of exogenously applied vitamin D or UV elicitation of endogenous vitamin D. Plantlets exposed to 10 mgl-1 exogenous vitamin D3 or UV light for 24 hours had significantly increased 45Ca2+ uptake compared with untreated control plantlets. It seems apparent that UV exposure elicited the synthesis of vitamin D3 in leaves which facilitated 45Ca2+ uptake into the roots in the same manner as exogenous vitamin D3 treatment. An indirect assay for endogenous vitamin D was developed based on 45Ca2+ uptake into plantlet shoots from test solutions.

(# 596) Use of LEACHM to Simulate Water and Solute Transport Through a Clay Loam Soil Under Long-Term Cropping and Fertilization

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Computer simulation modeling can be very useful for identification of nitrate leaching mechanisms, and for development of agricultural practices that reduce nitrate contamination of surface and ground water resources. LEACHM (Leaching Estimation And Chemistry Model) was used to predict water transport and nitrate leaching from four tile drained plots on a Brookston clay loam soil (Orthic Humic Gleysol) that have had consistent crop and soil management for forty-four years. Crop management included fertilized and unfertilized continuous corn (Zea mays L.), and fertilized and unfertilized rotation corn (corn-oats (Avena sativa L.)-alfalfa (Medicago sativa L.)-alfalfa). Soil management included fall moldboard plowing (15-cm depth) and secondary spring discing before planting. Tile discharge, volumetric soil profile water content, nitrate concentration in tile drainage water, and nitrate concentration in soil pore water down to 2 m depth were measured. The total quantity of water and nitrate leaving the root zone were also calculated, and partitioned into that intercepted by tile drainage and that entering the groundwater. These data were analyzed using LEACHM to elucidate nitrate leaching mechanisms and loss characteristics.

(# 597) Residual soil nitrate as affected by N rates and soil classes in corn production

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Nitrogen (N) management in corn production (Zea mays L.) is important from both production and environmental perspectives. We evaluated the effect of N fertilization and soil classes on residual soil nitrate conntent (RSN) at corn harvest. The study was conducted on a 15-ha field near Montreal, Quebec, Canada, for three years (2000-2002). During each spring, soil samples (n = 150) were collected on a 30 m x 30 m grid. Six N fertilizer rates (0-250 kg N ha-1) were applied at the 6-8 leaf stage. The RSN were measured in the 0-0.20 m layer in Fall 2000, 2001, and 2002. In addition, RSN was evaluated to 0.60 m in 0.20-m increment in 2002 in three treatments (0; 150; and 250 kg N ha-1). In general, RSN varied largely with years screening climatic conditions variation and N uptake. Nitrogen has a significant effect on RSN only in 2002 in the 0.40-0.60 m layer ($P < 0.01$). Thus, RSN increased from 16 kg NO3-N ha-1 in the unfertilized treatment to 49 kg NO3-N ha-1 when 250 kg N ha-1 was applied. The RSN content within the surface (0-0.20 m) was significantly related to the NO3-N content to a 0.60-m depth. The effect of soil classes was only significant in 2002 ($P < 0.01$) where RSN ranged from 61 to 89 kg NO3-N ha-1 in the fine sandy loam and clay classes, respectively. From these results, it can be concluded that there is a potential of N losses after corn harvest in Montreal lowlands. Variable rate N application according to soil texture and yield potential can reduce environmental risk.

(# 598) Distribution and plant interaction of endomycorrhizal fungi along a saline soil gradient, in a temperate semiarid environment

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Salinity is a worldwide phenomenon constraining plant productivity, that converts productive soils into wastelands. Mycorrhizal status of wild plants species as well as the AM fungi natural distribution in a Mediterranean semiarid climate were investigated along a saline soil gradient with an electric conductivity range of soil past extract (EC) of 1 ≤ EC ≤11 dS.m-1. Data showed that soil salinity level affected the distribution and the diversity of both AM fungi and host species. Glomus spp. occurred all along the saline gradient and thus salinity appeared without affect on the survival of this fungus. Sclerocystis spp. and Acaulospora spp. were only found in the non-saline soil (EC ≤1 dS.cm-1) and appeared to be intolerant to the salinity. In contrast, Gigaspora spp. and Glomus spp. occurred in the soil having salinity EC of 11 dS.m-1 and then exhibited a great tolerance to salinity. The floristic composition seemed to be markedly more dependent on the mycorrhizal status rather than the salinity level. AM fungi contribution to plant diversity appeared quite significant, in this saline ecosystem by favouring the establishment of mycotrophic species. Even if the salinity was responsible for a reduction the of mycorrhizal infective propagules density in the soil - from 77 to 58 propagules.kg-1 soil -, the relative abundance as well as the rate of mycorrhizal plants were rather more positively influenced by the soil density of AM propagules than negatively affected by the salinity level. Thus, the AMF play a crucial role in plant composition of saline ecosystems.

(# 599) The physiological response of Acacia tortilis-AMF symbiosis to drought is fungus

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Effect of three arbuscular mycorrhizal fungal (AMF) species on the growth and water status of Acacia tortilis was investigated under three watering regimes - maximum water holding regime (WHC), mild drought (1/2 WHC) and severe drought (1/3 WHC) -. Measurements were performed at four stages named pre-drought (one day before imposing water deficit), early-drought (30 days after imposing water deficit), mid-drought (60 days after imposing water deficit), and late-drought (90 days after imposing water deficit). Under maximum water holding regime, Glomus sp. was more infective than G. deserticola and G. intraradices. Predawn water potential (PWP) was analogous for both mycorrhizal and control treatments whilst midday water potential (MWP) was lower for control than for AMF treatments. Under mild and late drought, G. deserticola and G. intraradices were more infective than Glomus sp. Seedlings inoculated with G. intraradices had the highest PWP and MWP. Mid-morning and midday stomatal conductance were similar and higher in seedlings inoculated with G. deserticola and G. intraradices. Under severe and late drought, infectivity was comparable and higher for both G. deserticola and G. intraradices. Seedlings inoculated with G. intraradices displayed the highest growth, MWP, stomatal conductance and relative water content. Seedlings inoculated with Glomus sp. and the controls had lost their leaves at -4 MPa water potential. The interspecies difference between AMF in host response to water deficit that seemed to be related to the intensity and duration of drought. Consequently, inoculation of A. tortilis with G. intraradices improved plant growth under severe and sustained drought.

(# 600) Nitrate Leaching in a Clay Loam Soil after 44 Years of Consistent Soil and Crop Management

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Management of water resources in areas susceptible to nitrate contamination can benefit from knowledge of long-term, or "baseline", nitrate leaching losses below the crop root zone. The objective of this study was to characterize nitrate loss from twelve tile drained plots on a Brookston clay loam soil (Orthic Humic Gleysol) which have had consistent agricultural management for forty-four years. The treatments included conventionally tilled fertilized and unfertilized continuous corn (Zea mays L.), continuous Kentucky bluegrass (Poa pratensis L.), and a conventionally tilled corn-oats (Avena sativa L.)-alfalfa (Medicago sativa L.)-alfalfa rotation with each crop in the rotation grown every year. Tile discharge, nitrate concentration in tile drainage water, and total nitrate loss through tile drainage water were measured in twelve plots. Nitrate concentrations in soil pore water down to 2 m depth were also measured in four of the twelve plots (fertilized and unfertilized continuous corn, and fertilized and unfertilized rotation corn). The fertilized continuous corn (CC) and rotation corn (RC) treatments produced 4-year (1999-2002) flow weighted mean nitrate concentrations in tile drainage water of 15.0 and 20.3 mg N/l, respectively, both exceeding the Canadian drinking water guideline value of 10 mg N/l. Mean nitrate concentrations in the soil pore water below tile depth were also greater than the guideline value for these two plots. Over the 4-year period, total cumulative nitrate losses in tile drainage water were large at 131.6 kg N/ha for fertilized RC and 79.7 kg N/ha for fertilized CC. In contrast, cumulative nitrate losses in tile drainage were very low for unfertilized bluegrass (4.4 kg N/ha), fertilized bluegrass (6.6 kg N/ha) and unfertilized CC (7.5 kg N/ha). Hence, crop management practices can have a profound effect on both nitrate loss from the crop root zone and nitrate contamination of tile drainage water.

(# 601) Heritable variation in growth response of Plantago lanceolata to the soil community

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A number of factors contribute to the competitive advantage (or disadvantage) that one plant experiences in relation to a neighbor, even a neighbor of the same species. In order to examine the effect of relatedness on neighbor growth, we planted five Plantago lanceolata plants of differing degrees of relatedness in live soil (containing mycorrhizal fungi) and sterile soil, and measured aboveground biomass after five months. We found evidence of heritable variation within the Plantago lanceolata population in growth response to live soil, but the number of related individuals in a pot did not affect plant growth. During the experiment plants were infected with mildew and grazed by insect herbivores. The degree of mildew infection was dependent on the genotype of the mother, but not the genotype of the father, therefore likely due to maternal effects. The degree of herbivory experienced depended upon the degree of relation of neighbors and soil inoculation. As the degree of relatedness increased, the amount of herbivory on related individuals increased in live soil. Our results do not support earlier results suggesting positive frequency dependence between related and unrelated Plantago lanceolata plants.

(# 602) Phosphate Metabolism in the Association between Medicago truncatula and the Arbuscular Mycorrhizal Fungus Glomus intraradices Studied by in vivo 31p NMR Spectroscopy.

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We have utilized the potential of in vivo ^{31}P nuclear magnetic resonance (NMR) spectroscopy for studying phosphate (P) pools and their dynamics. The aim was to characterise the incorporation of inorganic P (Pi) into various P pools within Medicago truncatula roots in symbiosis with Glomus intraradices. First, steady state uptake was measured at two Pi levels, with $CaHPO_4$ at two concentrations (high and low P) mixed into the soil before planting. Second, a short time-course of polyP and P accumulation and disappearance was performed after P addition at two concentrations 1, 3 and 6 days before harvest.

(# 603) Interactions of Mycorrhizal Mutant Plants with Different Members of the Glomeromycota: Insights into Phylogeny

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The phylogeny of fungi that form arbuscular mycorrhizas (AM), and close relatives such as Geosiphon pyriformis, has recently been re-evaluated using molecular sequence data and the group is now recognised as constituting a new monophyletic phylum, the Glomeromycota. Within the phylum four orders are recognised, and within them several taxa formerly at the level of genus are now raised to family status. Unfortunately, although the molecular phylogeny appears well supported, useful distinguishing morphological characters for these structurally simple organisms are often lacking; the taxonomy remains 'difficult' and does not have much predictive value with respect to symbiotic attributes. Concurrent with phylogenetic re-evaluation has come the realisation that far from being a functionally uniform group, AM fungi are highly diverse and that the fungal genome plays an important part in symbiotic cross-talk with plants. There is probably more plant-fungus specificity and more diversity in colonisation pattern than appreciated previously and the outcome of symbiosis is very different in different plant-fungus combinations. Do any of these fungal characters align with molecular phylogeny? Does the new taxonomy have increased predictive value with respect to the biology of the fungi and their symbiotic effectiveness? We examine these questions using interactions between AM fungi from different orders and families of the Glomeromycota with different host species, including a mycorrhiza-defective mutant of tomato which shows different colonisation patterns with different AM fungi.

(# 606) Hydroponic evaluation of wastewater from anaerobically digested organic waste as a fertility source for selected turfgrass and woody species

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Modern societies continue to generate increasing volumes of a variety of organic wastes including agricultural wastes (animal manures, crop processing residues), food processing wastes, municipal solid wastes, sewage biosolids, papermill biosolids and other industrial organic wastes. The organic constituents of these wastes are known sources of environmental problems, but represent 'lost' resources if not re-used. Anaerobic digestion offers a potential solution to this widespread problem, producing biogas (used directly for energy production), a peat-like organic residual (used by the horticultural industry as a fertile potting amendment) and a nutrient-rich wastewater. A pilot-scale anaerobic digester has been built in Guelph, ON, and is currently operating and receiving organic wastes from a wide range of sources. Previous research has evaluated the peat-like product for re-use in the horticultural container industry, while current research is focussing on re-use of the wastewater for turfgrass production. In greenhouse hydroponic trials, Poa pratensis, Agrostis palustris, Forsythia suspensa and Weigela florida were used to evaluate the wastewater as a fertility source in comparison to several common fertility sources. Preliminary results have indicated that the intra-process wastewater is suitable, at recommended nitrogen levels and with minor chemical adjustment, for re-use as a soil fertility amendment in turfgrass production due to its high nutritive content.

(# 607) Field evaluation of wastewater from anaerobically digested organic waste as a fertility source for selected turfgrass species

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Modern societies continue to generate increasing volumes of a variety of organic wastes including agricultural wastes (animal manures, crop processing residues), food processing wastes, municipal solid wastes, sewage biosolids, papermill biosolids and other industrial organic wastes. The organic constituents of these wastes are known sources of environmental problems, but represent 'lost' resources if not re-used. Anaerobic digestion offers a potential solution to this widespread problem, producing biogas (used directly for energy production), a peat-like organic residual (used by the horticultural industry as a fertile potting amendment) and a nutrient-rich wastewater. A pilot-scale anaerobic digester has been built in Guelph, ON, and is currently operating and receiving organic wastes from a wide range of sources. Previous research has evaluated the peat-like product for re-use in the horticultural container industry, while current research is focussing on re-use of the wastewater for turfgrass production. In field trials, Poa pratensis and Agrostis palustris were used to evaluate the wastewater as a fertility source in comparison to several common fertility sources. Preliminary results have indicated that the intra-process wastewater is suitable, at recommended nitrogen levels and with minor chemical adjustment, for re-use as a soil fertility amendment in turfgrass production due to its high nutritive content.

(# 608) Inoculum's Production for Teak Seedlings

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Inoculating seedlings is one of the silviculture strategies to efficient fertilizing and to prepare seedlings when replanting in the field. Some VAM have been isolated and nowadays we try to produce in mass scale to fulfil inoculums for teak seedlings. There are Glomus manihotis, G. etunicatum, that were explored from Ngawi, Cepu, Jember, and Madiun. Compatibility and effectively to teak seedlings have been tested (height; girth; leaf area; dry weight).

Method to produce these inoculums is using Sorghum sp as host plants to produce mass inoculums. Periodically, keep being maintained and fertilzed with minimum phosphor. Spore production of these inoculums between 100-260 in one gram medium; infected root between 60-100%. After harvesting (3 months old), inoculums are packaged in water resistan plastics, and store in cold storage. This condition will be available to inoculating, help teak seedlings gain optimum growth up to 5 times compared uninoculated teak seedlings.

(# 609) Glomus mosseae BEG 12 and Pseudomonas fluorescens A6RI overcome growth depression and root morphogenetic modifications induced by Rhizoctonia solani in tomato plants

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Public concern about the use of pesticides potentially dangerous for human and environmental health is driving the interest of scientist towards more environmentally friendly methods to control plant diseases. The ability of arbuscular mycorrhizal fungi (AMF) and a number of fluorescent pseudomonads to promote plant growth is well documented. Moreover, both AMF and fluorescent pseudomonads could antagonize fungal phytopathogens, thus representing an alternative to chemical fungicides. In this work we investigated the effects of the AM fungus Glomus mosseae BEG12, the plant growth promoting rhizobacterium Pseudomonas fluorescens A6RI, and the phytopathogenic fungus Rhizoctonia solani 1556 on tomato growth and health. In addition, as roots represent one of the key means whereby plants and soil microorganisms interact, root system morphology was also studied. R. solani 1556 reduced fresh root and shoot weight and influenced root architecture: the root systems of infected plants showed a significant decrease in total root length and number of tips, as well as other modified root parameters, in comparison to the controls. The growth depression and the negative effects on morphometric parameters induced by the pathogen were partially overcome by the presence of the beneficial microorganisms. The pathogen infection was significantly reduced by these microorganisms, and R. solani 1556 only reached the central cylinder when inoculated alone.Our results show a clear reduction of the R. solani disease induced by G. mosseae and P. fluorescens A6R1 in tomato plants. The possible causes at the base of this tolerance will be discussed.

(# 610) Specific increase of 24-Methyl/Methylene sterols in arbuscular endomycorhizal roots grown *in vitro*

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Several biochemical methods have been proposed for estimating the presence of arbuscular mycorrhizal fungi (AMF). Lipids are especially abundant in both spores and vesicles of AMF. They typically contain high contents of fatty acids C16:1w5 and C18:1 w7 as well as polyinsaturated 20 carbon fatty acids. C16:1 w 5 has been proved suitable for estimating the biomass of AM mycelium in soil laboratory systems and in roots. Although little attention has been paid to sterols. Ergosterol, the predominant sterol of most fungi, was proposed as a potential indicator of AM fungal biomass inside colonized roots. But ergosterol was not detected in AMF grown in vitro. 24-Methyl and 24-Ethyl cholesterol were predominant sterols of spores isolated from pot cultures and monoxenic cultures. This present study established that the increase of 24-Methyl/Methylene sterols was an appropriate indicator of AM colonized transformed carrot and chicory roots. The specificity and the origin of this indicator of the endomycorrhizal stage were also investigated.

(# 611) Types of ectomycorrhizae in the canopy gaps in mixed beech-silver fir forest

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The community of ectomycorrhizal fungi (ECF) can reflect the natural or human-influenced changes in the forest ecosystems. In our study the influence of the new felled gap (30m diameter, no natural regeneration) in the mature beech-silver fir forest stand was compared with the naturally occurring gap of about the same size and with abundant regeneration in a virgin forest reserve. The abundance of types of ectomycorrhizae (ECM) and the presence of sporocarps of ECF have been studied for two years. The ECM root tips were analysed by the anatomical method, PCR-ITS-RFLP and sequence analysis for determination of ECF. 67 different morphotypes were found, 23 of them were identified to the species level after morphological identification. 10 identifications were confirmed with PCR-ITS-RFLP analysis. Other types were not clearly linked to RFLP pattern of any of the sporocarps in database. Sequencing of part of ITS region was used for identification to the genus level after comparing with GenBank database (there is not enough data for identification to the species level). Sequencing turned out to be necessary for molecular identification of genus Cortinarius. Exploration types (after Agerer 2002) were correlated to the position in a transect line through the canopy gap

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(# 612) Ectomycorrhizal fungal community dynamics on Scots pine bait seedlings before and over four years after a boreal forest clear-cut

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Ectomycorrhizal (ECM) fungal communities are diverse and of central importance for establisment and growth of boreal forest tree species. Here we report a 5-year assessment of mycorrhiza forming ECM fungal diversity on Scots pine bait seedlings in un-cut, interface zone and clear-cut areas of a pine dominated boreal forest in southern Finland. A first set of seedlings were transplanted in June 1997, a year before the clear-cut, and a second seedling set transplanted in June 1998 into the descibed zones after the February clear-cut. Seedling survival was continuously monitored until 2001 and seedlings sampled yearly in October for biomass, mycorrhiza morphotype and ITS-RFLP analyses. Totally, approx. 800 seedlings were harvested, 60000 mycorrhizas morphotyped and 500 RFLP-patterns from representative morphotypes obtained.

Seedling biomass was significantly increased in interface and clear-cut areas compared to the un-cut control forest. Seedling survival rate stabilized to approx. 50% after 1-2 growth seasons. Simpson's diversity indices for morphotypes showed statistically significantly increases in the interface zone while control and clear-cut area were statistically similar. The total number of different morphotypes observed was also highest in the interface zone, the difference becoming more clear after three growing seasons. The relative occurrence of rhizomorph forming morphotypes on seedlings increased in the control but decreased in the clear-cut area. The RFLP-taxa data supported the increasing diversity in the interface zone compared to other treatments. Approx. 35 RFLP-taxa, including e.g. Suillus variegatus, Cenococcum geophilum and several Cortinarius- and Russula- species, were recognised which will discussed in the presentation.

(# 613) Effect of Varieties and Seeding rates on Internal Green Shoulders(GS) in Carrots (Daucus carota Var. sativus)

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Green shoulder (GS) is a physiological disorder in carrots indicated by chlorophyll accumulation at the crown. GS not only affects root appearance but also makes it unfit for consumption due to its bitter taste. The objectives of this study are to evaluate genotypic and phenotypic variation and to monitor the effect of plant population densities on the occurrence of internal GS and establish a relationship between canopy volume and GS. Thirty four varieties were field evaluated at Great Village, Nova Scotia using a randomized complete block design (RCBD).Slicer (Caro Choice) and dicer (Red Core Chantenay) varieties were grown with five different seeding rates as treatments at Great Village, Nova Scotia using a RCBD.Leaf area index (LAI)($p=0.0001$) differed significantly but the percentage length of the internal greening ($p=0.0550$) of the varieties did not differ significantly. A weak correlation was seen between the two ($r2=0.46$). Although LAI differed significantly in slicer and dicer varities, there was no significant difference in the percentage length of the internal greening in the dicer ($p=0.569$) and the slicer ($p=0.375$) varieties. A weak correlation was seen between the LAI and the slicer and dicer varieties indicating that the canopy volume does not completely control GS. It is possible that the GS may perhaps be induced even prior to canopy development. Since, exposing hypocotyls to light increased greening during early seedling emergence, GS may be a phenomenon that the young seedlings encounter in the field which may have attenuated until after maturity. Early greening of the seedlings needs to be controlled to prevent GS in matured plants.

(# 614) Challenges in commercializing AM inocula in the retail market

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In the early 1980's university scientists and researchers from Agriculture and Agri-Food Canada, demonstrated the potential of endomycorrhizal fungi to benefit plants in various ways. Following the screening of several isolates, they identified an arbuscular mycorrhizal (AM) fungus which performed exceptionally well in experimental trials resulting in growth improvements as well as disease and drought tolerance. The aforementioned researchers convinced Premier Tech to invest in this technology and to integrate this beneficial organism into growing media in order to create a new and improved generation of peat based mixes. Since that time, Premier Tech has made important R & D investments related to an industrial-scale inoculum production process, greenhouse and field testing as well as mycorrhizal product development. From a growing media supplement, to stand alone concentrates and innovative growing kits, the company has succeeded in developing and commercializing AM inoculants in the retail market. However, several challenges were encountered and some issues remain hurdles to the future development and commercialization of mycorrhizal products. The presentation will highlight some of these challenges including inoculum production and formulation, regulatory issues, AM quantification methods and marketing issues.

(# 615) An evaluation of the use of electromagnetic induction to delineate leaching patterns in tile drained fields.

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Subsurface drainage is widely used in areas that experience poor local water infiltration or a seasonally high water table. Such installations result in the soils immediately above the tile line experiencing enhanced drainage, and exhibiting a more oxidized environment than the soils found midway between the lines with poorer drainage. This introduces systematic alterations in the local hydrology. Many studies have examined the influence of subsurface drainage on the transport of agrochemicals, bacteria and other contaminants through the soil profile. Frequently, what is not determined is the lateral extent of enhanced drainage around the tile drains. The current research is examining the utility of surveys of electrical conductivity and magnetic susceptibility measured with electromagnetic induction meters (EM38, Geonics Ltd.) to delineate the zones of enhanced drainage. Results are being correlated with chemical and mineralogical analysis of bulk and intact soil samples. The study site, located at the University of Guelph's Elora Research Station (near Elora Ontario), had subsurface drainage installed since the 1960's at 15m intervals and at approximately 60cm depths. Three transects, each under a different management practice (till, no-till, grass) and covering three tile lines are being examined.

(# 616) Tile Drainage Water contribution to Nitrous Oxide loss from agricultural fields.

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Nitrous oxide (N2O) emission from agricultural land to the atmosphere is considered to be a major environmental issue, especially with the growing concern over climate change, and Canada's signing of the Kyoto Protocol. Limited research has been conducted on N2O emissions from tile drainage water. Field trials were initiated in 2000 at Charlottetown, Prince Edward Island, to examine the concentrations and losses of N2O in tile drainage water during winter and spring thaw, as influenced by timing and source of manure application. The soils at the experimental site are Charlottetown sandy loam with some Malpeque sandy loam at the lower elevations. The size of the plot ranges from 0.21 ha to 0.28 ha with two-tile drains/ plot. The experiment consists of four fertility N treatments, replicated three times and applied at different timings to supply 120 kg available N ha- 1.The treatments are solid swine manure (fall, 2000), ammonium nitrate (spring 2001), liquid swine manure (spring, 2001) and solid swine manure (spring, 2001).

Based on the initial survey of 12 sampling dates during February to May 2002, N2O losses in tile drainage water from these experimental plots ranged between 0 to 1456 g N2O - N ha- 1day - 1.This preliminary data indicates the potential for significant N2O loss via tile drainage in relation to surface flux and should be included, when calculating a N2O budget. Statistical analysis of the data for the events measured shows that, N2O concentrations were not significantly affected by manure treatments. The magnitude of losses were influenced by plot location and may reflect hydrologic differences. This study is ongoing.

(# 617) Root morphometric analysis and soil AM inoculum potential evaluation in three different herbaceous communities (NW Appennines, Italy)

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Mycorrhizal symbiosis is an important factor determining competitive interactions among plants and, consequently, plant community biodiversity and dynamics. AMF are also involved in the formation of soil aggregates. For these reasons their status needs to be evaluated whenever an assessment of plant community or soil quality is requested.

Plant and soil samples have been collected in three herbaceous communities (Val Borbera, NW Italian Apennines) characterized by different past and present agricultural management: mowing, cattle grazing, abandonment. Morphometric parameters of root samples elutriated from soil cores have been determined using the Mac RHIZO Images Analysis program. AM-inoculum potential of the soil has been determined by growing Trifolium repens cv. Huia as bait plant in soil samples.

Plant communities and soils are best structured, in terms of protection against erosion provided by hypogeal plant systems and biological activity (AM inoculum potential) where low impact management is still practiced. Roots in mown meadows and in pasture are very fine and form a thick thatch through the first 10 cm of soil profile. Plant species in the meadow resulted heavily colonized by AMF and soil inoculum potential was significantly higher in meadow and pasture than in abandoned fields.

(# 620) Influence of the growth medium on hyphal morphology of Tuber spp.

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Truffles are ectomycorrhizal ascomycetes belonging to the genus Tuber many of which have edible ascocarps of great economic value. Truffle cultivation involves raising infected plants in greenhouses and then planting these into suitable sites. The technology for large scale production of ectomycorrhizal plants involves the use of pure isolates in axenic-mass culture under controlled conditions. However, truffle infected plants are usually inoculated with spores because it is difficult to growth them in pure culture. In our lab, the mycelia of different Tuber species (T. borchii, T. melanosporum, T. macrosporum, T. brumale, T. rufum, T. maculatum) were isolated and characterised by morphological and molecular methods on mWPM containing sucrose as sugar source (Iotti et al. 2002). Studying the best growth conditions for these species, we noted that the hyphal morphology varied depending on the substrate characteristics. In particular, for all the tested species, the pH values and the carbohydrate source influenced the hyphal growth unit and the hyphal diameter while agar concentration didn't affect the mycelial morphology. In the majority of species, the highest hyphal diameter and the lowest value of hyphal growth unit occurred in the substrates containing simple sugars like glucose, mannose, fructose or the disaccharide sucrose. On the contrary, polysaccharides produced a loose mycelium with low branched and thin hyphae. Hyphal diameter increased also with the reduction of medium pH value.

(# 621) Arbuscular mycorrhizae and phosphorus induce endopolyploidization Allium porrum root cells

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Endopolyploidy is a common phenomenon in plants, it may occur in any cell type during differentiation and it is very frequent in cells of plants with small genomes. The physiological significance of endoreduplication is poorly understood: it is related to increases in cell size and metabolic activity, to gene expression regulation and it is modulated by the levels of plant growth regulators. Up to now only in Lycopersicon esculentum, a multiploid species with a small genome, nuclear polyploidization has been clearly demonstrated following arbuscular mycorrhizal (AM) colonization. In Allium porrum plants (a species with a large genome) only a little increase following colonization, mainly depending on increased in phosphorus nutrition, was shown.

The aim of this work was to get deeper insight on the effects of AM colonization on nuclear ploidy of A. porrum during differentiation. As AM fungi are known to improve phosphorus nutrition, the effects of this parameter was evaluated too. Adventitious root segments, at increasing distance from the apex, were analyzed by flow cytometry and chemical techniques. The analysis of the different root zones showed that P concentration and the percentages of 4C nuclei increased with both P nutrition and mycorrhization; the former parameter decreased in all treatments from the apical to the basal zone of the roots, whilst the latter increased. However the percentage of 4C nuclei increased in the zones close to the apices, more in mycorrhizal plants than in controls, suggesting a direct involvement of the mycorrhizal fungus on the process of polyploidization.

(# 622) Ectomycorrhizal fungal community structure across a bog-forest ecotone in southeastern Alaska

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We examined the ectomycorrhizal fungal community across a bog-forest ecotone in southeastern Alaska. The bog and edge were both characterized by poorly drained Histosols and a continuous layer of Sphagnum species, ericaceous shrubs, Carex species, and shore pine (Pinus contorta Dougl. ex Loud. var. contorta). The forest had better-drained Inceptisols and Spodosols and a tree community including western hemlock (Tsuga heterophylla (Raf.) Sarg.), yellow cedar (Thuja plicata Donn ex D. Don.), Sitka spruce (Picea sitchensis (Bong.) Carr.) and shore pine, with an understory of ericaceous shrubs and herbs. Ectomycorrhizal root tip density (ECM tips cm-3) was significantly greater in the forest (6.04) than the edge (1.92) or bog (0.05), and ectomycorrhizal colonization was significantly different in all three plant communities (bog 53, edge 88 and forest 99%). The below ground ectomycorrhizal fungal taxa were analyzed using molecular techniques (PCR-RFLP and nucleotide sequencing) and the taxa observed are characteristic of boreal forests worldwide. Three ECM fungal taxa, Suillus tomentosus (Kauffman) Singer, Cenococcum geophilum Fr.:Fr, and a Russula spp differed in relative frequency, yet were among the four most frequent in all three plant communities. Although differences in ECM fungal richness were observed across plant communities, comparisons were confounded by unequal sampling of ECM roots due to root density and colonization differences. Using resampling procedures for creating taxa-accumulation curves as a function of sampled ECM roots revealed similarities in cumulative richness across the ecotone.

(# 623) Short-rotation forage crops affect subsequent barley yield and quality

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Perennial forage crops are not traditionally grown in crop rotations in the semiarid prairies for several reasons: i) they are slow to establish; ii) they require intensive tillage to terminate; and iii) they reduce yield of subsequent crops. Short-lived perennial forages that possess rapid establishment characteristics could be used for 3 years of hay production with easier rotation to an annual crop. An experiment seeded in 1998 at Swift Current with three short-lived grasses grown in monoculture or with two alfalfa cultivars was terminated by herbicide or tillage in May 2002, and subsequently seeded to barley. Visual observations prior to stand termination indicated that slender wheatgrass (SWG) and Dahurian wildrye (DWR) ground cover had declined but intermediate wheatgrass (IWG) was generally over 90% of the original. Barley grain yield was 1140 kg/ha on plots previously in IWG compared to 1750 and 1880 kg/ha on plots previously in DWR and SWG, respectively. IWG reduced straw yield, harvest index, and test weight compared to SWG and DWG. Grass mixtures with Beaver alfalfa yielded 2020 kg/ha compared to 1410 and 1280 kg/ha for Nitro alfalfa and grass monocultures, respectively. Barley grown on previously Beaver alfalfa mixtures also had higher straw yield, harvest index, and test weight compared to that grown on plots from the other two mixtures. These preliminary results suggest that short-lived grasses (DWR and SWG) may fit in crop rotations better than longer lived species (IWG) and that inclusion of alfalfa may, in fact, increase subsequent barley yields in this semiarid region.

(# 624) Soil test calibration databases for research and education

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In spite of a long history and large volume of soil test calibration research, the relevance of the fertility recommendations it derives is often questioned. More systematic organization, analysis, and dissemination of the data could facilitate improved interpretation of soil tests by practitioners. This study examines the application of such organization and analysis to the existing database supporting phosphorus and potassium recommendations for corn and soybean crops in Ontario. Implications of the spatial distribution of data sources, and degree of representation of particular soils will be considered. The soil test calibration database supports the calculation of response probabilities as a function of soil test level. It forms an educational tool that illustrates the need for flexibility in agronomic recommendations derived from soil testing. Applying a spatial perspective to calibration data gives new insight on the limitations of general recommendations and identifies gaps for future research.

(# 625) Nod Bj-V (C18:1, MeFuc) Production by Bradyrhizobium japonicum (USDA110, 532C) at Suboptimal Growth Temperature

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Lipo-chitooligosaccharides (LCOs) act as bacteria-to-plant signal molecules that modulate early events of the Bradyrhizobium japonicum - soybean symbiosis. Sub-optimal rhizosphere temperatures suppress plant-to-bacteria signaling by decreased production of flavonoid signals, particularly genistein, resulting in poor nodulation and lower amounts of fixed nitrogen. Addition of appropriate flavonoids to soybean inoculants partially compensates for the impact of low soil temperature in the early growing season, however, the effect on bacteria-to-plant signaling is unknown. Thus, the objective of this study is to evaluate the effects of low growth temperatures on the production of Nod factor (LCO) by the microsymbiont. Two strains of B. japonicum, 532C and USDA110, were tested for ability to synthesize LCO at three growth temperatures (15, 17 and 28°C). The greatest amounts of the major LCO, Nod Bj -V (C18:1, MeFuc), were produced/excreted by the two strains at 28°C. At 5 µM genistein, the highest concentration of LCO was produced by B. japonicum 532C. Low incubation temperatures decreased LCO concentrations extracted from USDA110 and 532C cultures. At 15 and 17° C, the LCO production efficiency of B. japonicum 532C and USDA110 was markedly decreased with the lowest LCO concentration per bacterial cell occurring at 15° C. No variations in the LCO production per cell were detected among tested strains at 15 and 17° C. The biological activity of the extracted LCO was tested. The data from the present study corroborates earlier work showing the inhibitory effects of low temperatures on nod gene expression in Bradyrhizobium japonicum.

(# 627) Effect of Medium Nitrogen Level on Potato Microtuber Protein Concentrations

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Nitrogen is an essential nutrient for plant growth. In potato crops grown in the field optimum nitrogen fertilization is important to maximizing yield. However, it is not known to what extent nitrogen availability affects protein concentration of tuber tissues. This is more readily evaluated in a tissue culture system than in the field. Nitrogen level was varied in Murashige and Skoog medium to determine its effect on the total protein content of microtubers of four potato cultivars with a range of seasonalities. These included Norland, Shepody, Green Mountain and Russet Burbank. Microtubers were generated from layered micropropagated plantlets using a two-step method. For all cultivars, both the mean number and size of microtubers per container were greater when medium nitrogen levels were increased. However, there were no clear trends relating medium nitrogen level to microtuber tissue protein concentration. Low medium nitrogen level tended to reduce the protein concentration in cultivars Shepody and Norland while high medium nitrogen level tended to increase the protein concentration only in Russet Burbank. These results confirm that nitrogen fertilization can promote tuber yield but suggest that tissue protein concentrations are genetically determined.

(# 628) Discrimination of Soil Solid Phases using Axial X-Ray Tomography

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Currently available computerized axial x-ray tomography systems permit the rapid acquisition of 3D digital imagery of soil and geological samples, with spatial resolutions below 10 micrometres. This , combined with recent advancements in digital imagery analysis software, present new opportunities for evaluating the spatial configuration of soil components. The major limitation with the technique remains the challenge of distinguishing among solid phases; especially when they exist in sizes smaller than the resolving capacity of the instrumentation, leading to voxels of mixed composition. The present work looks at the x-ray attenuation of a variety of solid materials naturally encountered in soils, as well as selected anthropogenic materials.

(# 630) Effects of Landscape Variability on the Rate and Maximum 2,4,-D Degradation

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The herbicide 2,4-D [2,4-(dichlorophenoxy) acetic acid] is the most widely used pesticide in Canada for the post emergent control of broadleaf weeds. Therefore, the knowledge of 2,4-D degradation is a critical component in maintaining environmental integrity within the Canadian agricultural ecosystem. The heterogeneous nature of agricultural fields necessitates further investigation into the behavior of 2,4-D in agricultural soils in which the physical, chemical, and agrometeorological conditions vary spatially. Physical and chemical properties of soil organic matter, moisture, temperature, and pH vary with respect to landscape position, and thus are integral components in modeling the behavior of 2,4-D. The objectives of this study are to quantify the spatial distribution of soil characteristics in landscapes and their impact on the rate and maximum amount of 2,4-D degradation. Degradation has been assessed in laboratory microcosm incubations, using (14C)-labeled 2,4-D. Degradation has been measured by trapping the evolved 14CO2 in sodium hydroxide and further quantified by Liquid Scintillation Counting. Preliminary results show extensive variation in the biodegradation rate and total degradation coinciding with landscape position.

(# 631) Nitrogen and Phosphorus Transport in a Snow-Dominated Mountain Stream

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Lake Tahoe, on theCalifornia-Nevada border, is experiencing eutrophication in part due to loading of N and P from its tributaries. Few studies have simultaneously monitored these nutrients in the streams and in the soils, yet soils likely have important biogeochemical effects of either mitigating or exacerbating nutrient inflows, especially during snowmelt. A field study was conducted to investigate the losses of NO3-, NH4+, soluble reactive P (SRP) and dissolved organic P (DOP) during the snowmelt period in a small watershed in the Lake Tahoe basin. At sites with contrasting vegetative cover (open area, forested and shrub covered), mixed-bed resin bags were buried at three depths. In the stream, a water sampler was used to collect four samples per day. For a given depth, resin bags sorbed the same amounts of SRP and DOP across vegetation types (ratio 1:1) and only SRP was retained as water percolated through the deeper portion of the soil mineral horizons. Resin bags buried in the organic layer of riparian sites sorbed significantly ($p < 0.01$) more NO3-N than the other sites. In stream water, the SRP concentrations were significantly higher ($p < 0.01$) than DOP and NO3--N concentrations declined over time. This study supports the hypothesis that the spring pulse of NO3- in stream water is due to winter accumulation of NO3- beneath riparian sites only if the bulk of snowmelt volume flowed through the organic and not the mineral layer. We consider this to be unlikely and speculate that the NO3- in stream was due to the melting of the snowpack.

(# 633) USING NEMATODES TO IDENTIFY MANAGEMENT EFFECTS ON SOIL FOOD WEBS

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Terrestrial life depends upon the processes arising from the complex array of feeding relationships among the organisms that constitute the soil food web. Knowledge of feeding relationships among organisms provides insight into important processes including decomposition, nutrient cycling, and pathogen/pest suppression. Reliable and efficient biological indicators are invaluable tools for determining food web condition and function, particularly as affected by agricultural management. One useful indicator group is the soil nematode fauna. Nematodes are ubiquitous in the soil environment; they occupy many trophic nodes; they constitute functional guilds whose members respond similarly to environmental enrichment, degradation, and stress. Nematode faunal analysis, based on functional guilds, provides a two-trajectory description of the soil food web. The Enrichment Trajectory is the weighted abundance of individuals in opportunistic guilds whereas the Structure Trajectory measures larger, slower-reproducing omnivores and predators. Nematode faunal analysis of numerous Manitoba soils representing a range of agricultural intensifications demonstrates the abundance of enrichment indicators is high in soil receiving large quantities of readily-degraded materials. Conversely, the abundance and diversity of structure indicators is low in disturbed and heavily-managed agricultural sites. Nematode faunal analysis as a tool to identify management practices having beneficial effects on soil food webs is discussed.

(# 634) Development of Compost as an Inoculant Carrier for Rhizobia

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Six composts were compared to inoculant quality peat for physical, chemical, microbiological and phytotoxic characteristics. Three composts were developed into powdered seed-applied and granular rhizobial inoculants for pea and lentil and evaluated for viability and nodulation ability after storage and effectiveness in inducing symbiotic nitrogen fixation in growth chamber and field experiments. All but one of the composts exhibited characteristics generally similar to peat. Sterilization with gamma radiation prior to inoculation improved long-term storage. Growth chamber experiments performed under both near-sterile and non-sterile conditions indicated the composts performed nearly as well as commercial control products. Together the results indicate a good potential for development of compost into a carrier for rhizobial inoculants.

(# 635) Sediment, carbon and dentrification potential distribution in a upland-wetland transition, Saskatchewan, Canada

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Our knowledge of soil distribution and greenhouse gas dynamics in small, ephemeral wetlands is very limited but these element are known to be greatly influenced by management changes in the surrounding catchment. We intensively sampled an hummocky til agricultural landscape near St. Denis, SK to determine the spatial distribution of sediment, organic and inorganic carbon, and denitrifying enzyme activity (DEA). Distinct sediment types and carbon ranges exist for five wetland landscape elements: cultivated wetlands, pond centers, tree rings, sediment tongues, and grass strips. The location of the wetland elements depends in large part on the morphology of the surrounding catchment. Values for DEA of fall, 2003 samples were highest for the pond center sediments and lowest in the upland soils. The DEA results did not show a clear relationship with total carbon or nitrogen levels. This analysis has been used to develop a landscape-scale sampling program for nitrous oxide and methane measurements.

(# 636) Quantifying N2O Fluxes Associated with Agricultural Practices in Non-Level Prairie Landscapes

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This study was conducted to assess N2O emissions from major agricultural uses (i.e., conventional cropping, no-till, forage, and fallow) using both conventional N-fertilization and swine manure as a nutrient source on a hummocky surface. Due to the drought experienced in 2001 and 2002, N2O emissions were generally low. Nevertheless, we did observe a significant effect of N source and of landform position on the N2O flux. In general, the N2O flux increased in the sequence: upper slopes < backslopes » lower slopes, which followed a trend similar to that for soil moisture (i.e., soil moisture was generally greatest in the lower slope positions and least in the upper slope positions). Also striking was the effect of N source; i.e., the greatest source of emissions was the liquid swine manure. In 2002, for example, N2O emissions (averaged across the growing season) increased in the order: wheat-fallow plots (457 ng N2O-N m-2 min-1) » forage plots (511 ng N2O-N m-2 min-1) < fertilized plots (841 ng N2O-N m-2 min-1) » manured plots (944 ng N2O-N m-2 min-1). Moreover, at both the 1´ and 2´ application rates, the manured plots yielded the highest N2O emissions. The lowest emission rates were observed in the uninoculated, fertilized (1´) forage plots.

(# 637) Upscaling of Chamber-based Estimates of Nitrous Oxide Emissions at Snowmelt

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Upscaling of point-based measurements of trace gas emissions is very difficult due to the extraordinary variability of emissions in time and space. Our project was designed to compare estimates of nitrous oxide emissions from chambers and from aircraft-based sensors during snowmelt in 2003 for a township of agricultural land near Laird, Saskatchewan. Chamber measurments were made at twelve fields selected to represent crop types and management practises in the area. Ten chambers were used per site, and measurements were taken on seven days during the melt. Emissions varied greatly between sites and were not readily explainable by controlling soil and climate factors. Cumulative emissions during snowmelt differed among crop residue types: cumulative emissions were 69, 54, and 32 g N2O-N ha-1 for wheat, pea, and canola residues respectively. A single manured site had cumulative emissions of 254 g N2O-N ha-1. A crop area-weighted estimate for cumulative emissions from the chamber-based measurements was 58.7 g N2O-N ha-1. The chamber-based results were very similar to those from the aircraft-based sensors. The emissions are low compared to other studies in western Canada due, in part, to the very dry soil moisture conditions in the fall of 2001.

(# 638) The fungal hypaphorine reorganises the actin cytoskeleton and abolishes the calcium gradient in Eucalyptus root hairs

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Eucalyptus globulus roots associate with fungal mycelia of Pisolithus tinctorius to form ectomycorrhizae. The development of this symbiotic association involves a series of early mechanisms of recognition initialised both by root and fungal signalling molecules. It has been shown that the mycelium of Pisolithus tinctorius accumulates an indole compound identified as hypaphorine, the betaine of tryptophane. Hypaphorine is then secreted to the host plant. We do know that hypaphorine induces an inhibition or arrest of root hair elongation in Eucalyptus globulus, in Populus and also in Arabidopsis.

The objective of this study was to understand the early mechanisms involved in response to hypaphorine.The inhibition of root hairs induced by 1 mM of hypaphorine is correlated to a change of cyto-architecture. Since cyto-architecture and plant cell elongation both depend on the actin configuration, we decided to study the organisation of actin. From confocal images, we quantified the actin configuration and we revealed clearly shift from fine F-actin to F-actin bundles in the sub-apex of the hair during 20 mn with hypaphorine. So, root hairs exposed to 1 mM of hypaphorine rapidly remodel their actin cytoskeleton.

Like tip growing cells, root hairs show a cytosolic gradient of calcium, which is implicated in actin dynamic. So we investigated the calcium distribution in root hairs after hypaphorine application. Our work showed that the calcium gradient is abolished after an application of hypaphorine, suggesting that hypaphorine modifies calcium fluxes.

This work is supported by the Lorraine district

(# 639) Oxidative stress enzyme activities on Castanea sativa Mill. roots along mycorrhizal association with Pisolithus tinctorius.

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Castanea sativa Mill. in vitro mycorrhizal plants with Pisolithus tinctorius and four strains of Hebeloma cylindrosporum, two of which are IAA overproducer mutants, were studied along the mycorrhizalprocess in terms of oxidative stress enzyme activities. Determinations performed ten days after root contact with the fungus show that roots mycorrhizal with P. tinctorius (Pt) have lower PO activities than non-mycorrhizal ones, these differences being still maintained 270 days after contact. Roots mycorrhizalwith H. cylindrosporum (Hc) also present lower PO activities, either mycorrhizal with the wild types of this fungus or with the IAA overproducer mutants.

PO and other oxidative stress enzymes were studied in C. sativa roots 1h, 3h, 5h, 10h, 24h, 48h, 72h, 5 days and 10 days after mycorrhizal induction with P. tinctorius in order to realise the effect of a mycorrhizal fungus on the stress enzyme activities of the host during the contact - recognition process. Preliminary results are presented and compared with the already known processes of pathogenic fungi.

(# 640) Factors Responsible for Vigorous Emissions of Nitrous Oxide from Thawing Soil

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The effect of anthropogenically derived gases emitted to the atmosphere is of major concern for the state of our environment. The greenhouse gas, nitrous oxide (N2O) destroys ozone in the stratosphere and accounts for about 10% of the radiative-forcing of gases emitted to the atmosphere in Canada. Agricultural soils account for the majority of nitrous oxide (N2O) emitted by anthropogenic sources. Most emissions occur during a brief period (1-3 weeks) in which soil frozen in winter thaws in spring. To identify the factors driving emissions during thawing of soil a series of laboratory experiments were conducted. Newdale Soil (Black Chernozem of loamy calcareous glacial till and of the tall-grass prairie region) was packed into rings, moistened to 90% water-filled pore space, placed for 2 days at -20oC and then placed into 1.5 L sealer jars at room temperature to determine N2O emission rates over a 7-day period. Control treatments were treated similarly except were placed at 5oC for 2 days prior to placement at room temperature. The first factor examined was bulk density (1.1, 1.2, and 1.25 g cm-3) because its impact on N2O emissions from thawing soil has not been detailed. Frozen soil had 2 to 5-fold greater emission with rates decreasing at higher bulk density. The results imply that N2O consumption in thawing soil is enhanced at higher bulk density effectively decreasing the N2O:N2 ratio and reducing emission rates. Also to be discussed is the effect of water-filled porosity, available C and nitrate on N2O emissions from thawing soil.

(# 643) Enrichment of atmospheric CO2 and soil nutrients mediates mycorrhizal benefits

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Anthropogenic enrichment of atmospheric CO2 and soil nutrients is likely to affect mycorrhizal functioning. It has been hypothesized that CO2 enrichment should increase mycorrhizal benefits because as carbon limitation is reduced, mycorrhizal uptake of soil nutrients should become increasingly important. This hypothesis has not yet been carefully tested. This study examined interactions among the availability of CO2, nitrogen and phosphorous and the symbiotic effects of four different isolates of arbuscular mycorrhizal (AM) fungi in four different plant species. We grew Koleria cristata (C3 grass), Schizchyrium scoparium (C4 grass), Lespedeza capitata (C3 legume) and Achillia millifoliea (C4 composite) with Glomus spp., Gigaspora spp., and no AM fungi at ambient and elevated CO2 and at low and high nitrogen and phosphorus. Three sets experiments were replicated six times. We found that enriched atmospheric CO2 influenced the symbiotic outcome of interactions differently in different combinations of plants and AM fungi. In some cases CO2 and nutrient enrichment decreased plant benefits from AM symbioses and in other cases these factors increased AM benefits. Understanding how mycorrhizae and soil fertility mediate plant responses to CO2 enrichment is important for accurately predicting plant community responses to the anticipated anthropogenic changes to our atmosphere.

(# 644) Temperate Grassland Ecosystems

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Temperate grasslands comprise a major terrestrial biome that accounts for the majority of arable lands. Grassland patterns and processes are evolutionarily and ecologically linked with arbuscular mycorrhizae.Late successional prairie plants often have coarse roots and are highly mycotrophic. This suggests that, in stable grasslands, there is a selective advantage to being incorporated into a mycorrhizal hyphal network. Experiments have shown that mycorrhizae influence the outcome of plant competition and plantcommunity structure. Furthermore, the diversity of AM fungal communities can impact the productivityof grassland communities. Mycorrhizae are also important in grassland pedogenisis. Hyphae and glomalin produced by AM fungi help generate soil aggregates and provide substrates for other soil organisms. Mycorrhizae directly affect the biological fertility of soils by enhancing plant uptake of nutrients and they indirectly affect soil fertility by influencing decomposition. Mechanisms of AM enhancement of nutrient uptake have been well studied, but little is known about their influence on decomposition. Humans impact grasslands through fertilization, irrigation, tillage, air pollution, and grazing. There is evidence that these perturbations alter mycorrhizal structure and function, which in turn may impact grassland community composition and ecosystem function.

(# 645) EFFECTS OF CONVENTIONAL AND NATIVE AMERICAN AGRICULTURAL PRACTICES UPON MYCORRHIZAL INOCULUM POTENTIAL IN SOUTHWESTERN USA.

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Arbuscular mycorrhizal fungi (AMF) form symbiotic associations within the roots of most crop plants. These associations improve water relations and enhance nutrient uptake to the host plant. The goal of this study was to compare the mycorrhizal inoculum potential (MIP) in soils with different crop histories and different management practices. Soils were collected from sites managed with high-input conventional practices, low-input Native American practices, and non-managed wild lands. It was predicted that the MIP would be lower under high and low-input agricultural practices as compared to non-managed wild lands. Results show that MIP of high-input cornfields was significantly lower (P= .02) than adjacent non-managed wild lands. Furthermore, the MIP of low-input cornfields was also significantly lower (P= .006) than adjacent non-managed wild lands. However, the mean MIP?s of low input and high input cornfields were not significantly different from one another. It was also hypothesized that crop history and duration of crop management would have a significant effect upon the MIP of conventional agriculture fields. Results show that increased duration of management increases a crops susceptibility to changes in MIP for corn (P= .02) and alfalfa (P=. 01) rotations. These data show that 1) agriculture management practices reduce the MIP of soils from their native vegetation state, and 2) overtime, high input agriculture practices reduce the resistance of AMF to changes in MIP.

(# 646) Determination of the regenerative natural capacity of inoculated Alnus acuminata H.B.K. subsp acuminata with native mycorrhizas in eroded soils of the Colombia Andes.

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Alnus acuminata, an alder, is a species that presents mutualistic symbiosis with Frankia, arbuscular mycorrhizas (MA) and ectomycorrhizas (ECM), is of utility in protection of hydrographic river basins, and soil restoration. Alders grows in slopes and eroded soils. However, alders are not commonly used in reforestation programs in Colombia, due in part to their high mortality rates after being transplanted. The objective of this study was to compare the development and natural regeneration of alders that presented high symbiosis with Frankia, MA and ECM (with percents of colonization of 20-25% for MA, and 25-30% for ECM), versus alders that presented low symbiosis levels (Frankia, 3-5% for MA and 5-10% for ECM, respectively). They were planted in eroded soils of the Tomine region (Colombia). After 6 years, the number of surviving trees, the number of trees naturally regenerated from those originally planted, the number of other plant species associated with the trees, and the levels of MA and ECM were determined.

It was found that trees planted with high symbiotic levels of MA and ECM had greater survival rates (above 75%) compared to low symbiotic trees that had only a 15% survival rate. On average, both groups of trees showed four natural regenerated trees around each originally planted tree. In addition, around established trees, 3 to 5 different plants were associated to the trees. Further, the lowsymbiotic trees that survived presented increase percent of mycorrhizal colonization (above 40% for MA and ECM) in their roots. These results indicated that the presence of mycorrhizas in high levels favour the survival of alders in eroded soils, thus increasing the regeneration of soils and biodiversity restoration of the region.

(# 648) Ectomycorrhizal fungal diversity of variously disturbed northern hardwood forests of the Adirondack State Park, NY, U.S.A.

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Biodiversity may be negatively correlated with disturbance. Some ectomycorrhizal fungi in the Pacific Northwest are primarily found in old growth temperate rain forests. We are comparing ectomycorrhizal fungal diversity in forests that have experienced different levels of disturbance in temperate northern hardwood forests of the north-eastern U.S. Four stands of three management histories were sampled: old growth (some trees at least 200 yrs old), even-aged maturing (from fires ~100 yrs ago), and recently cut forests (partial cutting of trees within the past 20 years) were sampled for sporocarps of ectomycorrhizal (EM) fungi and EM root tips. Preliminary results suggest that differently disturbed forests of the Adirondack State Park have similar patterns of EM fungal richness with differing species compositions in each stand. Variability of sporocarp collections within the three management histories was as great as the difference between the three management histories. Molecular data for root tips will be compared with collected sporocarps. These data will be compared with diversity of plant species in each plot, measures of heterogeneity within each plot, and diversity of saprophytic fungal species in each plot. Sampling procedures will be compared for assessing diversity of EM fungi in northern hardwood forests.

(# 649) Mycorrhizae and Exotic Plant Invasion

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Invasive species are characterized by superior competitive abilities, in part due to enhanced nutrient uptake. Because of their potential to affect both inter-specific interactions and nutrient uptake, arbuscular mycorrhizae (AM) could contribute significantly to the success of invasive species. Comparisons between invasive exotic species and non-invasive native species show, in some studies, that the invasive species is better able to take advantage of its fungal symbiont to access soil nutrients. For example, the Eurasian forb Centaurea maculosa, which is invasive in North American grasslands, has higher tissue P concentration and more biomass when growing with native grasses and forbs in pots with mesh vs. membrane dividers. Mesh barriers allow hyphal but not root access to the opposite side of the pot, and membrane barriers exclude both roots and hyphae. Native plants did not show a similar increase in biomass. C. maculosa also produces larger quantities of extraradical hyphae at greater distances from the host plant than does the native grass Festuca idahoensis. Mycorrhizal enhancement of nutrient uptake is in part because of extraradical hyphae, which access parts of the soil inaccessible to the roots. The carbon cost to the host plant of increased extraradical hyphae production may be relatively lower for species with physiological characteristics associated with some successful exotic species, including higher photosynthetic rates and rapid growth. The relationship between host plant physiological traits and AM function needs to be addressed in future studies, comparing function across host plants, including fast and slow-growing exotic and native plant species.

(# 650) Field-Scale Methods for Identifying Management Units on the Basis of Residual Nitrogen and Soil Structure

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Soil strength indicators, such as cone penetration resistance (PR), integrate soil structure, texture, bulk density, water content, and organic carbon in their measures. It is well known that these soil attributes have a measureable impact on N use efficiency and crop growth. Therefore, soil strength indicators have potential to help define N fertilizer management zones at the field scale. Under the hypothesis that crop response and N use efficiency in clay loam soils in eastern Ontario will be constrained more strongly in soils of higher strength, relative to those of lower strength, corn yield response was examined for relatively "lower" and "higher" PR zones within a field and stratified on the basis of three fertilizer treatments (0, 150 and 300 kg N/ha). Irrespective of fertilizer treatment, corn grown in "higher" PR zones had consistently lower yields than corn grown in "lower" PR zones. Increasing fertilizer application improved mean yields in both PR zones, however, crops grown on "lower" PR zones responded with a significantly higher gain in yield. For "higher" PR zones under fertilizer rates of 300 kg N/ha, the mean yield was similar to that obtained in the "lower" PR zone with a fertilizer rate of 150 kg N/ha.

(# 651) Modeling symbiosome-associated protein complexes in the arbuscular mycorrhizal cell

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Plant and fungal genes expressed during the arbuscular mycorrhizal symbiosis are involved in establishing and maintaining fundamental mycorrhizal processes. These include host subcellular accommodation of the fungal partner, e.g., interfacial matrix and peri-arbuscular membrane synthesis and reorganization of cytoskeletal and endomembrane components. Other processes include nutrient exchange and transport, induction or suppression of host defence responses, signal transduction and inter-symbiont communication. In this investigation, a total of eleven symbiosis-related cDNAs (seven plant and four fungal) were cloned using subtractive hybridization of cDNA libraries from in-vitro mycorrhizal (Daucus carota/Glomus intraradices) and non- mycorrhizal carrot root tissue. Isolated plant cDNAs encoded several novel proteins, including a CC-NB-LRR (coiled-coil/nucleotide-binding/leucine-rich repeat) disease resistance (R) protein with an N-terminal membrane-spanning region and zinc-binding site for a zinc-dependent metalloprotease. This is the first report of an R gene expressed in arbuscular mycorrhizae, and the only cloned R gene to date which contains a zinc metalloprotease domain, suggesting a role for R proteins in symbiotic as well as disease resistance processes.

Additional plant cDNAs encoded for a polygalacturonase-inhibitor protein, a cell wall polysaccharide precursor, and several transmembrane proteins including zinc and nitrate transporters and two receptor protein kinases. Fungal cDNAs encoded a polyketide synthase, a phosphoglycerate kinase, a transmembrane ammonium transporter, and an anaphase-promoting protein. All seven plant cDNAs were predicted to localize to either the plasma, mitochondrial or endoplasmic reticulum membrane, suggesting that these proteins may comprise a symbiosome-associated protein complex in the mycorrhizal cell. A hypothetical model was developed using bioinformatic sequence analyses.

(# 652) Adaptation of high-protein lupins in western Canada

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Narrow-leafed lupin (Lupinus angustifolius) is a commercial pulse crop in Australia, northern Europe and other parts of the world. Lines tested in Alberta in 2002 produced impressive yields under severe drought conditions. Grain analysis has indicated high levels of crude protein (38.3-42.7%). The feed industry in western Canada imports millions of dollars of soy meal as a protein source for livestock. We will report on the growth and productivity of lupins under various pH levels, and discuss genetic differences observed in seed vigor. If grain yields of 3-4 tonnes can be consistently grown in western Canada, lupin could become another Canadian pulse crop success.

(# 653) Gene expression pattern related to host preferences in the ectomycorrhizal interaction between birch (Betula pendula) and different strains of Paxillus involutus

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The aim of this study was to investigate the different forms of interactions between roots and ECM-fungi. Betula pendula and three strains of Paxillus involutus, differing in their ability to establish a mycorrhizal interaction with birch, were selected as model systems. Two strains (May,H) were able to build a functioning mycorrhizal interphase while the non-mycorrhizal strain (Nau) formed no Hartig-net and no inhibition of lateral root growth after 14 days of the interaction was observed. Additional differences in physiological interaction like the accumulation of H_2O_2 and activity of plant peroxidase aswell as laccase were detected. For investigating the molecular background of differences between these strains in establishing a mycorrhizal interphase, a cDNA microarray approach was chosen. The microarray used in this study contained 2200 probes of plant and fungal genes taken from a cDNA library. In total 2284 unique transcripts from birch roots mycorrhized with P. involutus (H) as well as fromsaprophytic grown fungi(H) and axenic grown plants were discovered. RNA isolated from birch roots after two weeks of root-fungal interaction with May, H or Nau was used for comparing all fungi with each other. Preliminary results of microarray analysis show differences in gene expression among strains and provide evidence that several genes are differentially expressed depending on the fungal host. For further investigations, we selected candidates from these genes which may be important for a different mycorrhizal plant-fungal interaction.

(# 654) The ectomycorrhizal communities of pinyon pine are influenced more by host genetics than herbivory by the moth Dioryctria albovitella

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The negative influence herbivores exert on their host plants, and the positive influence of mutualistic mycorrhizal fungi have been extensively studied. Less well known is the relationship between herbivores and mutualists that share a common host. Herbivory. using molecular approaches We examined whether pinyon pines (Pinus edulis) that were naturally resistant to a shoot-boring moth (Dioryctria albovitella) differed in their ectomycorrhizal fungal community composition from trees susceptible to moth. To determine whether differences were due to herbivory or to tree genetics associated with resistance, we also examined the ectomycorrhizal community composition of susceptible trees from which the moth had been removed for 10 years. Resistant and susceptible trees did not differ in richness or evenness of ectomycorrhizal fungal species. Preliminary results from the moth removal trees, however, show a two-fold increase in richness but similar evenness, possibly a result of greater representation by rare species. Of note was a significant increase in the number of ascomycetes sampled on susceptible and moth removal trees compared with resistant trees. These results demonstrate that moth resistant and susceptible trees differ in the community structure of their ectomycorrhizal symbionts but these differences may be due to host tree genetics rather than the direct effects of herbivory. The enhanced species richness seen in moth removal trees could reflect increased carbon allocation belowground as trees are released from paying a cost of resistance.

(# 655) ROLE OF ARBUSCULAR-MYCORRHIZAL FUNGI IN MEDIATING INVASION OF THREE NON-NATIVE PLANTS INTO NATIVE ECOSYSTEMS IN ALABAMA.

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Invasion of non-native plants is seriously affecting the functioning and integrity of many ecosystems of the world. This study focuses on three aggressive invasive non-native plants in the southeast USA: Kudzu (Pueraria montana (Lour.) Mer. var. lobata (Willd.) Maesen & S. Almeida) (Fabaceae) a perennial vine, Chinese privet (Ligustrum sinense Lour.) (Oleaceae) a perennial thicket-forming shrub, and Mimosa (Albizia julibrissia Durazz) (Fabaceae) a small tree that prefers open spaces. Two invading fronts of the Privet and Kudzu in a native forest were selected within the Arboretum at Troy State University, Troy, Alabama. The mycorrhizal inoculum potential (MIP) of soils collected across invading fronts of Kudzu and Chinese privet were determined by estimating AMF root colonization of bait plants. The overall objective of this project was to assess the role of AMF in the invasion process of these aggressive non-native plants. All three non-native invasive plants established symbiotic associations with native AMF populations. Soil MIP was significantly higher in sites dominated by Chinese privet than in adjacent forest understory were the native chain fern (Woodwardia areolata (L.) Moore) dominates. Thedisturbed site where Kudzu was invading had significantly higher MIP than soils were grasses were dominating but Kudzu could also be found. The second highest MIP level was found on a site dominated by Kudzu, while no MIP was found in soil of the adjacent non-disturbed forest. This information is important for conservation and restoration projects that aim at halting the invasion of non-native plants.

(# 656) Shaft-soil interaction on penetrometer probes as a measure of soil-cone friction

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Cone index or penetrometer resistance includes a friction component which is unknown, variable and soil dependent. Plant roots entering the soil are able to avoid friction. An estimation of the magnitude of the friction component of the cone index would enhance the value of the penetrometer for assessing soil rooting conditions. A combination penetrometer measuring both cone index and water content can be equipped with an additional force sensor at the top of the shaft to estimate friction as well. A series of equations representing force components on the cone, the lower force sensor and the water content sensor were solved in iterative sequence to estimate the friction coefficient between soil and cone. Soil columns (0.15 m diam. x0.45 m high) having three layers, each at bulk density of approximately 0.9, 1.0 and 1.1 kg m–3 and water content 0.1 to 0.2 m3 m–3 were packed in the laboratory. Force sensor data from the upper two layers were used to calculate friction coefficient profiles within the upper 0.3 m depth of soil. A consistent pattern of increasing friction coefficient with depth in the upper layer and higher coefficients in the denser layer was shown from four soils. Although these results are very promising, additional measurements at different water contents must be compared to independent estimates of soil to cone friction.

(# 657) Effects of spore inoculum on the ectomycorrhiza diversity of Douglas-fir seedlings.

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Ectomycorrhiza diversity helps stabilize below-ground processes after disturbance. In addition, EM diversity can increase tree's competitive abilities. Nursery grown seedlings often have low EM diversity and the EM species may be poorly adapted to out-planting sites. Harsh sites tend to have low EM inoculum potential. Hence, applying spore inoculum of EM species that vigorously colonize roots may increase growth and survival of out-planted stock. In a pilot project, we experimentally address two questions: 1) Does spore inoculation at the time of out-planting affect survival and growth? 2) Do the inoculated fungi affect EM diversity? During out-planting, we inoculated Pseudotusga seedlings with Rhizopogon spores. Preliminary results suggest that Rhizopogon EM increased on some sites. To improve statistics, replication will be increased from 5 to10 in future studies. Regardless of growth response, successful inoculation of out-planted seedlings has the potential to impact the broader soil ecosystem. Because the EM species that may be established via inoculation are aggressive colonists, they have the potential to alter the biodiversity of ectomycorrhizal fungi on a wide scale. The knowledgegained by this study will allow forest managers to improve planning for reforestation projects and may be particularly valuable when considering ecosystem management and restoration projects.

(# 658) Arbuscular mycorrhizal fungi biodiversity of natural and disturbed savannas in La Gran Sabana (Venezuela).

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Although approximately 80% of terrestrial plants belong to typical mycorrhizal families, we know little about the role of biodiversity of arbuscular mycorrhizal fungi in the functioning of natural ecosystems. In this work we describe the effect of superficial soil removal on mycorrhizal infective potential and species composition of arbuscular mycorrhizal fungi in La Gran Sabana, Venezuela. Our results show a strong lost of the infective potential in disturbed savannah along the year. Accordingly, spore density, richness and diversity index of disturbed savannah were lower than in natural condition. Higher dominance concentration in disturbed savannah indicates abundance of few species in this condition. An interesting particular case was the dominance in disturbed savannah of Acaulospora tuberculata, a species totally absent in natural savannah. In both situations (natural and disturbed) the dominant genus was Glomus, with 69 and 75 % of total diversity, respectively. Remarkably, the absence of Gigaspora and Scutellospora genera was observed, as well as the concomitant increase of relative abundance of Acaulospora in disturbed conditions. This suggests the existence of AM-species with higher susceptibility of disturbance and the presence of others adapted to disturbed conditions. The last group of species could participate in different way in the functioning of this ecosystem.

(# 659) Application of micromorphology and image analysis to study soil genesis in northern Iran

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Field observations are often not sufficient for process-based interpretations of soil genesis and classification, particularly when the soils form part of aggradational pedocompexes within alluvial successions. Under such condition micromorphology can provide temporal and spatial information on pedofeatures, which are related to genetic processes. The current study focuses on the presence of a) illuvial gypsum (in soils of arid, semiarid climates and poorly drained or saturated soil of semiarid climates), b) secondary carbonates (in soils of arid, semiarid and sub humid climates), and c) illuvial clay (in soils of well-drained semiarid, as well as subhumid and humid climates) in northern Iran. Specific attention is given to the utilization of computerized analysis of high-resolution digital imagery of soil thin sections, to provide quantitative spatial information of pedofeatures.

(# 660) Nutrient and water management of high density sweet cherry

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Lapins sweet cherry on dwarfing Gisela 5 (Prunus cerasus x Prunus canescens) rootstock were planted in April 1998 at a spacing of 4m (within row) x 4.5m (between rows). Commencing the year of planting, eight annual irrigation/nutrition treatments were established with 6 replicate, 4-tree plots in a randomized complete block design. Treatments included micro-sprinkler irrigation with (1-3) three concentrations of fertigated N (42, 84, and 168 ppm), applied 8 weeks past full bloom as calcium nitrate; the medium N rate was also applied with (4) P fertigated in early spring or (5) K fertigated in June; (6) N, uniformly broadcast at 75 kg ha-1 in June in a 1m-wide strip centered on the tree row ; also (7) broadcast N followed by the medium rate of fertigated N, applied 4 weeks postharvest (August) and (8) the medium N rate but drip-irrigated. Irrigation was scheduled according to atmometer-measured evaporation.

The dominant effect was reduced size of drip-irrigated, relative to sprinkler-irrigated trees, as Idicated by smaller trunk cross-sectional area and pruning weights. This growth restriction has been attributed to a decrease in soil moisture content towards the tree alley in drip-irrigated plots. Reduced tree size did not affect initial yield for this treatment, although fruit size was reduced and fruit maturity delayed in 2001. A range of leaf and fruit N concentrations has been produced by the different rates of sprinkler-fertigated N although effects on crop performance have been minimal. In contrast P and K nutritional status have not been affected by P or K fertigation. Low leaf K concentration of drip-irrigated trees implies that these trees are susceptible to the development of K-deficiency.

(# 662) The role of plant root exudates in peat decomposition

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Globally northern peatlands are important sinks for atmospheric CO2, though climate change leaves their role in the carbon cycle uncertain. In order to better understand potential changes, predictive models of CO2 flux need improvement. Statistical models are useful for predicting photosynthesis with environmental factors, while ecosystem respiration, both heterotrophic microbial and autotrophic, responds differently to environmental stimuli and thus is more difficult to predict with simple statistical relationships. In many other ecosystems, respiration has commonly been partitioned into only 2 components, where heterotrophic respiration refers to mineralization of residual soil organic matter and mineralization of root exudates is effectively considered to be a portion of autotrophic root respiration. This simplification is useful considering that root exudates are mineralized rapidly and do not usually perpetuate as soil organic matter. If interactions between rhizodeposition and decomposition of residual organic matter exist, however, this simplification may not be relevant. We added organic compounds designed to mimic root deposition to peat in-vitro and quantified subsequent C mineralization over 21d. Addition levels at or below "calculated realistic" rhizodeposition on one sunny day stimulated 14x more C to be mineralized than the initial addition. In all treatments, microbial biomass and dissolved organic C increased. This preliminary experiment draws the conclusion that as characterization and modelling of respiration in peatlands progresses to differentiate autotrophic and heterotrophic components, mineralization of root exudates cannot be effectively characterized as a portion of autotrophic respiration, but rather a link between vegetation and decomposition dynamics.

(# 663) Effect of seeding rate and fertilizer on performance of Fenugreek (Trigonella foenum-graecum).

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Fenugreek (Trigonella foenum-graecum) is an annual legume adapted to dryland conditions. In parts of Asia the young plants are used as potherbs and the seeds as a spice or as herbal medicine. The species name "foenum-graecum" means "Greek hay" indicating its use as a forage crop in the past. Effect of seeding rate was determined in experiments conducted under irrigated and dryland conditions at Lethbridge using selected forage type fenugreek lines. Under irrigation 20 kg ha-1 seeding rate produced significantly higher biomass than 10 or 15 kg ha-1. Biomass production under dryland conditions for these genotypes was not affected by the three seeding rates used in the test. Forage quality parameters estimated on the samples collected at the time of dry matter determination were not influenced by seeding rate in these tests. In another set of experiments, effect of P on forage and seed production was determined. Only under irrigated conditions P treatments appeared to have significant effect on biomass production. Effect of seeding rate and P on fenugreek seed yield was inconclusive as the plots were damaged by hail before harvest. These agronomy studies will help production of forage type fenugreek cultivars in western Canada.

(# 664) Arbuscular mycorrhizal status influences rate and source partitioning of belowground respiration in sunflower microcosms

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Colonization by mycorrhizal fungi causes plants to reallocate photosynthate from sinks such as root respiration, tissue and exudates to fungal sinks. The net effect of this redistribution on the residence time of carbon in soils remains unknown. Using high resolution belowground respiration measurements and isotopic analyses, we devised an experiment to assess the mycorrhizal influence on belowground C processing rates. We grew sunflowers (Helianthus annuus) under four inoculating conditions: with Glomus intraradices (Gi), with Gigaspora gigantea (Gg), with desert grassland soil inoculum (DG), and without mycorrhizal inoculum (NM). Plants were enclosed in airtight respiration chambers (50 cm height x 15 cm diameter PVC cylinders) where an automated respiration monitoring system recorded bihourly belowground CO2 production measurements from 64 pots. The remaining 80 plants were harvested at three timepoints (3, 6, and 12 weeks) and used to compare growth rates among treatments and to establish allometric relationships between root and shoots. At 2 weeks, sunflowers inoculated with Gg showed a 3-day pulse of respiration but shortly converged with the other treatments. At 6 weeks, Gi-inoculated belowground systems sustained respiration rates over 54% greater than NM plants, despite having 38% lower root mass. Carbon-13 analyses reveal that roughly half of the respired carbon is plant-derived at this point, the other half originating from soil organic matter. Further isotopic tracing and respiration measurements of microcosms after shoots have been killed and physiological respiration eliminated will allow us to address mycorrhizal influence on the total decomposability of plant derived products.

(# 665) Effects of a CO2-enriched atmosphere on EMF communities in a temperate eastern USA pine forest

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Ectomycorrhizal fungi (EMF) are dominant members of the soil fungal community in temperate forests, and will therefore be an important determinant of carbon sequestration capabilities and forest productivity in these ecosystems, as atmospheric CO_2 concentrations rise. Because elevated CO_2 increases fine root production and root exudation, EMF community diversity may be altered by greater substrate availability. Alternatively, increased demands by host trees for mineral nutrients at higher CO_2concentrations may lead to changes in the EMF with which they associate, eliminating or reducing the abundance of some fungal species. To test these hypotheses we used a sequence-based approach to compare community diversity and structure between elevated and ambient CO_2 plots at the Duke Forest Free Air CO_2 enrichment (FACE) experimental forest. Fruiting bodies and colonized root tips samples were collected and ITS sequences were generated. This method proved highly effective for determining species identity from root tips. Species richness is extremely high; 778 samples yielded 135 EMF species with little congruence between fruiting body and root tip samples. Thelephoraceae and Russulaceae species were dominant mycorrhizal associates obtained from belowground samples. Significant differences in community structure between elevated and ambient CO_2 plots were not detected, but candidate "CO_2 responder species" were identified. Results from non-parametric diversity estimators indicate EMF community diversity is lower in the elevated CO_2 plots, possibly due to competitive interactions between EMF species, or selectivity by hosts for particular EMF species. Implications for long-term EMF community stability and monitoring in temperate forests will be discussed.

(# 666) Impact of tillage erosion on the spatial and temporal variability of herbicide sorption by soil

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Soil is one of the essential components in supporting the functionality and sustainability of agricultural ecosystems. Soil is not only the support system for plant growth, but also allows for breakdown and recycling of chemicals (fertilizers, pesticides) that are applied in agricultural production. Therefore, understanding processes occurring in soil is of critical importance for providing adequate food production and minimizing environmental contamination risks.

This ongoing research program aims to quantify how soil characteristics and herbicide sorption by soil may change over time due to the influence of tillage operations and tillage erosion. This understanding is used to test and modify existing soil distribution erosion models for predicting the long-term (decades) effect of tillage operations on the risk of surface water and groundwater pollution by pesticides.

Four calcareous soil-landscapes were grid-sampled for a total of 40 to 300 samples in each field. Soil analyses included determinations of 137Cesium content, soil organic carbon content, soil pH, soil texture, carbonate content, and herbicide (2,4-D) sorption and desorption parameters. The soil-landscapes were delineated into upper, middle, lower, and depressional landform elements with the use of a landform description model. Multiple correlation and regression analyses were done on this data and combined with tillage erosion models for estimating the impact of tillage practices and operations on the spatial and temporal variability of soil properties and herbicide sorption by soil. Selected results are presented.

(# 667) Comparison of forage yield and quality of PC rye, fall rye (Secale cereale) and barley (Hordeum vulgare) when harvested for silage.

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The first North American cultivar of PC rye (ACE-1) was compared with barley (Duke) and fall rye (AC Rifle) for biomass production and quality when harvested for silage. PC rye was established in fall of 2000, fall rye was established in fall 2000 and fall 2001 while barley was established in spring of 2001 and 2002. Seeding rate for all crops was 90 kg ha-1. Experimental plots were protected from broad leaf weeds by spraying Banvel and 2,4-D in the spring of each year. Nitrogen was adjusted in all plots to 100 kg available N ha-1. Tests were seeded with 18 cm spacing under irrigation and 36 cm spacing under dryland. All three crops were harvested at the soft dough stage. Under irrigation over two years PC rye produced about 30 and 20 % more dry matter yield than fall rye and barley, respectively. When harvested at soft dough stage PC rye silage contained less protein and more fiber than barley. It is therefore suggested that PC rye be harvested at an earlier growth stage than soft dough stage for optimizing forage quality.

(# 668) Soil Solution as a Tool for Environmental Monitoring Program

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Monitoring of soil liquid phase is considered to be a powerful approach for assessing the cumulative impact of natural factors and management practices on agroecosystem sustainability and environmental quality. It is suggested that soil solution composition could be used as an early environmental indicator for evaluating the potential leaching of nutrients. Suction cup lysimeters were installed beneath pasture and fallow plots at depths of 2, 4 and 6 ft (0.61, 1.22 and 1.87m) at Florida A&M University Research & Extension Center, Quincy, Florida. Soil solution, surface water and groundwater samples were taken biweekly and were analyzed for pH, Ec and major nutrients. The results showed that the properties of the soil solution (pH, Ec, P, K, NO3-N, NH4-N, Ca, Mg, Na and Si) have different susceptibility to the combine impact of natural factors and management practices. The soil solution from Orangenburg loamy fine sand soil (Ultisols) has neutral to slight alkaline reaction (pH 7.04-7.35) and a calcium-nitrate composition. A significant decrease of Ca and Mg is observed with increasing soil depth for both goat and cattle pastures. The content of P and K in the soil solution is not significantly affected by different land use but a gradual decrease in the 1.22-1.83m layers is observed. There is significant difference in nitrogen content when comparing pasture and fallow land. The data of this study show that soil solution composition can be used in monitoring program of livestock production. The preliminary results show that extensive and semi-intensive pasture management is a practice which ensures maximum inclusion of nitrogen and non-nitrogen elements in the biological cycle of nutrients and prevents excessive leaching through soil profile.

(# 669) Evaluating Soil Management Practices in Agroecosystems of Malawi: Taking the Biophysical Heterogeneity into Account

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Smallholder farming systems of sub-Saharan Africa are characterized by their biophysical heterogeneity and the diversity of management practices used by farmers. The purpose of this study was to determine whether the ability of management practices to improve soil quality was affected by the biophysical characteristics of agroecosystems located in a micro-watershed of Malawi. Information on management practices, soil quality indicators and biophysical characteristics were collected on a series of observational plots located in farmers' fields. Management practices included application of green and animal manure, crop residues and inorganic fertilizers, and the use of tree hedges and contour strips. Soil quality indicators included pH, exchangeable cations and P, basal respiration, qCO2, available N, and various properties of the floating fraction of organic matter. Biophysical characteristics included slope, plot age, depth, erosion signs, color, texture, organic matter content, rockiness, and presence of single trees. First, observational plots were grouped into six clusters of similar biophysical characteristics using a fuzzy-k means analysis. For each cluster, the total variation in soil quality indicators was partitioned into the fraction explained by management practices, the fraction explained by biophysical characteristics and their confounded effect using partial redundancy analysis. In older plots located in flatter areas a positive effect of management practices on soil quality indicators was observed. In plots located in recently opened fields, on degraded soils or on steeper slopes, however, the effect of management practices was either very small or highly confounded by the effect of biophysical

(# 670) Effect of land application of wood ash on total biomass and grain yield of barley and canola

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Wood ash has a high pH which can be used to neutralize acid soils and a nutrient content with potential to supplement growth of agricultural crops. In a greenhouse study up to 50% increase in dry matter was observed when barley was grown in acidic Brunisolic and Luvisolic soils supplemented with up to 10% (w/w) wood ash, equivalent to about 200 t ha-1. In a subsequent three year field study in Central Alberta, Canada, the effect of single applications of 0.25, 0.5 and 1.0% (w/w) (equivalent to 6, 12.5, and 25 t ha-1) wood ash were studied on barley and canola. Significant increases in total dry matter and grain yield of barley and oilseed yield of canola were observed in all wood ash treated plots compared to the untreated plots. Under field conditions, barley dry matter yield increased up to 72%, barley grain yield increased up to 50% while canola oilseed yield increased up to 70%. Our results show that land application of wood ash has a beneficial effect on field crops and that there is no significant benefit to applying wood ash at rates greater than 10 t ha-1 (0.5% w/w). These results indicate that land application of wood ash can provide forest companies with a viable alternative to landfill disposal of this by product.

(# 671) Fate of 2,4-D as affected by landscape position, and soil depth.

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Understanding the behaviour of herbicides in agricultural fields is important for improving weed control strategies and minimizing the risk of environmental contamination. This poster outlines a study that quantified the spatial variability of 2,4-D mineralization and movement in soil within a landscape. Soils were sampled from 72 slope positions along a field transect in southwestern Manitoba. Samples were taken to depth, and segregated by soil horizon. Quantification of biodegradation and sorption processes served as key indicators of 2,4-D fate within the landscape samples. Both parameters were found be highly variable, and were correlated with slope position and soil depth. Results from this study could lead to changes in producer management techniques for optimizing 2,4-D efficacy and limiting environmental contamination.

(# 672) Variability of 2,4-D sorption in agricultural fields as affected by

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Knowledge of herbicide sorption processes in soils is key in quantifying herbicide persistence and mobility in agroecosystems. Sorption is a function of various parameters, including soil physical, chemical and biological characteristics, herbicide chemical and molecular properties, and climatic conditions. Soil organic carbon levels are arguably the most important factor of all soil characteristics in determining herbicide fate. Soil organic carbon varies from region to region due to the influence of climate on pedogenic processes, and within landscapes due to surface morphology and hydrology. It is unknown whether the variability of herbicide fate is greater at the regional scale or at the landscape scale.

This study determined the variability of 2,4-D sorption as it varies among regions and their respective landscapes. Soil samples were collected from three landscape positions at each of forty-one benchmarks sites in various ecodistricts within the province of Alberta. These samples were analyzed for soil organic carbon content, soil pH, soil texture, and herbicide (2,4-D) sorption by soil. Multiple correlation and regression analyses were done to quantify the dependency of herbicide sorption on soil properties. Spatial patterns of herbicide sorption among ecodistricts will be presented. Implications of this study will aid producers when making management decisions and contribute to a national pesticide indicator model.

(# 673) Foliar application of NOD factors to one soybean leaf stimulates photosynthesis in remaining, non treated leaf.

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Nod factors are bacteria-to-plant signaling molecules synthesized by number of symbiotic rhizobia upon perception of plant-secreted flavonoids. Previous results indicated that foliar application of LCO is beneficial to number of host and non-host plant species and increases photosynthetic rates. In this study we investigated whether those increases are invoked in the LCO-treated leaves only. LCO application to one soybean leaf resulted in an increase in photosynthesis (CO2 uptake) in that leaf 24 hours after application. However, immediate measurements (2 hours after LCO application) revealed that there is a slight decrease in the photosynthesis rate in the LCO treated leaf as compared to untreated leaf on the same plant or to control plants. Such decreases were observed 3 times during the course (96 h) of experiment and were correlated with low light intensity during cloudy, winter days in the greenhouse. During sunny days, when light intensity was high, photosynthesis rates in LCO treated leaf were at the same level as in non-treated leaf, and those were 21% higher than control plants. This indicates a systemic translocation of LCO (and / or its induced signal) from leaf to leaf within plant. The increase was sustained during the course of experiment, however, it diminished slightly to 11% at 96 h after treatment. Our findings indicate a dual LCO role in photosynthesis: causing increases in photosynthetic rates at high light intensities and further decreases at low light intensities. The mechanism of LCO regulation of photosynthesis is unknown and requires further investigation.

(# 676) Transfer Rates of 15Nitrate and Analogs of Phosphorous, Potassium, and Calcium through a Common Mycorrhizal Grass Network.

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Arbuscular mycorrhizal fungi infect the majority of plant species found within the oak/savannah woodland ecosystem of the California foothills. These fungi have the potential to form underground networks which link the roots of individual plants and/or species of plants. A common mycorrhizal network (CMN) may function as an efficient transport mechanism for the movement of nutrients betweenplants. An experiment was designed, as part of an on-going study, to examine transfer rates of macronutrients between plants restricted to mycelial connections. Specialized growth containers, designed to separate plants with double root restrictive screens and an air-gap, were used to prevent diffusive and bulk flow of nutrients via soil or root pathways. In these growth containers, nutrients can only move in or along hyphae. Tracers applied to the foliage of donor plants were analyzed for tracer concentration in receiver plants. Selected plant nutrients or nutrient analogs were examined for movement through the CMN. ^{15}Nitrate was used to trace nitrogen movement. Arsenic, caesium, rubidium, and strontium were used as tracers for phosphorous, potassium, and calcium respectively. Rates of tracer transfers were estimated by harvesting 1, 3, 7, 14, and 21 days after tracer application to the donor plants. Three species of arbuscular mycorrhizal grasses, common to a California Sierra foothills research site, were selected for the experiment. All treatments contained all three selected species in equal quantities. A mix of species was chosen to represent a more complex system. Positive transfer of ^{15}N, As, Cs, and Rb was found in this system.

(# 677) Differences in ectomycorrhizal infection of conifer seedlings across an alpine-treeline ecotone: relative importance of variation in soil properties and microclimate.

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The importance of mycorrhizae to plants in stressful environments, such as for conifer seedlings above the upper limits of forest, is not well known. Lower infection rates may contribute to lower seedling survival in harsh alpine environments. Over 90% of naturally occurring Engelmann spruce (Picea engelmannii (Parry) Engelm.) and subalpine fir (Abies lasiocarpa (Hook.) Nutt) seedlings showed signs of ectomycorrhizal infection, yet the morphology of the dominant fungal symbiont lacked the characteristic mantle of hyphae. We then addressed the potential role variation in infection rates may play during the critical establishment phase immediately following germination. Seeds of Engelmann spruce were sown into soils that were reciprocally transplanted among three sites ranging in sky exposure from closed canopy forest (38%) to exposed alpine meadow (89%). Three seedlings from each combination of site and soil were harvested and examined for percent of root tips infected biweekly throughout the growing season. Mean infection rates at the end of the growing season were significantly different for seedlings in the forest (29.46% ± 5.73%), treeline (13.10% ± 3.86%), and alpine soils (0.0% ± 0.0%). However, infection rates were not significantly different for individual soil types located among the three different sites (P = 0.9239). These results indicate that conifer seedlings may be less likely to establish an ectomycorrhizal association in treeless alpine meadows compared to the more sheltered forest sites. Moreover, site differences in infection appear more attributable to variation in soilproperties, possibly inoculum availability, than to microclimate and corresponding effects on seedling physiology.

(# 678) Exploring mycorrhiza phylogeny: mutualism or reciprocal parasitism?

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We have traditionally thought of mycorrhizas as mutualistic associations between fungi and plants. This concept implies that the symbiotic partners are co-evolving to provide greater benefit to their partners. However, much of what we observe in terms of mycorrhizal fungal diversity and co-evolution is in conflict with view: if natural selection is benefiting genotypes that provide more benefits, then we should see lower diversity, and we would not expect a pattern of multiple gain and loss of mycorrhizal associations in plant groups. In this talk we explore whether the paradigm of reciprocal parasitism, where each partner is under selection to gain maximum benefits for the least cost, is more appropriate for explaining the diversity and phylogeny of mycorrhizal associations.

(# 679) INFLUENCE ON ARBUSCULAR MYCORRHIZAL FUNGI AND PHOSPHOROUS ON DISEASE SEVERITY BY Phoma costarricencis IN COFFEE PLANTS

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Effect of arbuscular mycorrhizal fungi (AMF) inoculation or phosphorous fertilization and Phoma costar- ricencis in coffee plants (Coffea arabica L.) was studied. This study was divided in three experiments: thefirst one was conducted under greenhouse conditions and plants were inoculated with native AMF MTZ-1, and/or received 1600 ppm Kg-1 of phosphorous addition. The second experiment was carried out under nursery conditions: plants were inoculated with AMF MTZ-1 and/or received 1600 ppm Kg-1 in sterilized and not sterilised soil. In both experiments, inoculated plants showed a tendency to decrease disease severity index. It was not confirmed if phosphorous addition contribute to a decrease of disease severity. A third experiment involved AMF inoculated or phosphorous fertilised plants, which received 500 conidia ml-1 of Phoma costarricencis Echandi, under controlled conditions. Disease severity index was estimated at 10, 15 and 20 days after pathogen inoculation. Gas exchange pattern was also measured. Results showed that plants inoculated with AMF and pathogen had the lowest disease index (35%), plants with phosphorous and pathogen inoculation average index (44.8%) and control being the highest index (60%). Plants with AMF inoculation showed the highest levels for transpiration, stomatal conductance and CO_2 assimilation. These results suggest that inoculation with mycorrhizal fungi, improves plant respiratory efficiency, which might explain the tolerance to pathogen.

(# 680) Anthropogenic nitrogen input enhances mycorrhiza mediated nitrogen acquisition by plants

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Arbuscular mycorrhizal (AM) fungi play a significant role in plant nutrient acquisition. Sporadic evidence suggests that anthropogenic nitrogen (N) inputs may detrimentally impact AM development and function. Using ^{15}N as a tracer, we examined the direct N transport by mycorrhizal fungal hyphae as influenced by mineral N inputs in a microcosm experiment. Two compartments (HOST and TEST) of eachmicrocosm were separated by a 20 µm nylon mesh that allowed AM fungal hyphae but not roots to passinto the Test compartment. Wild oat (Avena fatua L.) was planted in the HOST compartments, inoculated with either a single species of AM fungi, Glomus etunicatum, or a mixture of AM fungi including G. etunicatum. Both inoculums originated from agricultural soil. Tracer amounts of ^{15}N (3 mg Nkg^{-1} soil) were applied to the TEST compartments. Glomus etunicatum alone increased plant biomass by16%, total plant N by 25%, and plant ^{15}N by 105%, and the AM mixture increased the parameters by 91%, 100%, and 280%, respectively. The single AM species and mixture reduced soil extractable N by 20% and 70%, respectively. Compared to the control, applications of mineral N (NH_4NO_3 at 25 mg N kg^{-1}soil in total) to the HOST plants enhanced plant biomass by 187% and mycorrhiza mediated N acquisition by 40%. These findings demonstrated that low to moderate N inputs can significantly enhance mycorrhiza mediated N acquisition by plant, thus improving its N nutrition and biomass production.

(# 681) Soil and corn response to compacted surface soils under variable N fertilizer application

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The relative role soil physical properties and soil nutrients play in crop growth is difficult to precisely determine. For compacted surface soils, potential N availability to plants may be inhibited and crops may suffer. Adding additional fertilizer to lower yielding compacted areas, may not offset yield losses resulting from compaction induced soil physical constraints on plant growth. This study evaluated soil physical and corn crop properties over preferentially compacted and non-compacted clay loam soils under 150 and 300 kg N ha-1 fertilizer treatments. Cursory findings indicate that doubling fertilizer rates over preferentially compacted soils may not fully offset yield losses due to compaction. Corn root properties suggest that compaction impeded optimal root growth, and therefore, reduced nutrient uptake potential by affected corn plants.

(# 682) The Impact of Nitrogen Amendment on Glomalin Content in Soils in three Forest Communities in Lower Michigan, USA.

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Increased use of anthropogenically fixed nitrogen has led to concerns about possible long-term impacts on terrestrial ecosystems. Previous studies in forests have demonstrated the potential of nitrogen fertilization to influence mycorrhizal fungal community structure. Glomalin is a protein produced in quantity by arbuscular mycorrhizal fungi, has been implicated in the formation of soil aggregates and potentially represents a significant store of soil carbon and nitrogen. To determine the possible impact of N-amendment on stores of glomalin we examined glomalin levels over two growing seasons in three forest types receiving background N deposition (controls) or treated with 80 Kg N ha^{-1} yr^{-1} as $NaNO_3$. Three sites of each of three forest types, sugar maple-basswood (SMBW), sugar maple-red oak (SMRO) and black oak-white (BOWO), in the Manistee National Forest in Michigan were selected for study. Nitrogen amendments were made at monthly starting in spring 2001 with sampling conducted four times during each of the 2001 and 2002 growing seasons. Easily extracted (EG) and total glomalin (TG) were extracted from air-dried soils with citric acid and measured by the Bradford method. Analysis of variancerevealed significant differences related to season and forest type in easily EG and TG. A statistically significant effect of N amendment was not observed, however, in 2001 N addition increased EG by 10% relative to controls in SMRO and 14% in BOWO soils. For both seasons glomalin levels were greatest inSMBW and lowest in BOWO; EG as a fraction of TG displayed the opposite pattern. Glomalin levels generally increased from May to October with seasonal increases in EG being higher in N-treated than control plots. Across all forest types and dates, N amendment was associated with a 2-3% increase in relative contribution of EG to TG.

(# 683) Can AM-mycorrhizas re-start plant succession in severely disturbed soils?

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Several authors have suggested that arbuscular mycorrhizas (AM) play an important role in plant succession and the rehabilitation of degraded ecosystems. The recruitment of propagules caused by shrubs used as nurse plants, would start the plant succession in severely degraded soils from which arbuscular-mycorrhizal fungi (AMF) have been lost. In this work, shrubs of Clusia pusilla were used as nurse plants to increase the deposition of seeds and mycorrhizal propagules transported by wind. The effect caused by cuttings or by seedlings of C. pusilla with or without mycorrhizas and P in the recruitment of seedlings of indigenous plant species from La Gran Sabana, was assessed. Eight treatments were performed in a forest sterilized soil: a non mycorrhizal control (C), three AM treatments (M1, M2 and M3) where AM inocula were used, a treatment fertilized with P (TSP, 150 kg/ha) and three treatments in which the different AM inocula and P were applied simultaneously (M+P). AM treatments were: M1, inoculated with Glomus manihotis, M2, inoculated with AMF from a savannah and M3, AMF from a shrub-land. Results showed that cuttings of C. pusilla, of treatment M1+P and M2+P, were the most effective in promoting the recruitment of seedlings, in comparison with the control, but not in comparison with fertilized treatment. Cuttings were most effective as nurse plants than seedlings. In conclusion, mycorrhizal and fertilized C. pusilla shrubs could be used as a viable strategy to re-start the plant succession in degraded lands from La Gran Sabana.

(# 684) Use of RFLP patterns to determine Cortinarius species groups

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The Demonstration of Ecosystem Management Options study is designed to test the ecological effects of green-tree retention as an alternative to clear-cutting. Mushrooms and truffles were sampled over 3 pre-treatment and 3 post-treatment years, at three study sites, in the Oregon and Washington Cascades. Mycorrhizae were also quantified from soil cores. The Cortinariaceae in our study area are poorly understood taxonomically. In order to better assess Cortinarius species diversity, we extracted DNA from 44 randomly selected sporocarp collections from each of the three study sites. We used the primers ITS4 and ITS1F for PCR amplification and RFLPs were run on the resulting products. We found that therestriction enzymes Hae3 and Cfo were best for distinguishing RFLP species, although we also used Hinf1, Dpn2, and Rsa. Preliminary results determined about 50 Cortinarius RFLP species within the study area. The three sites had 22 to 24 species each. Almost half of the RFLP species are represented by a single collection and only a third were represented by more than two collections per species. This reflects the same pattern as ectomycorrhizae from soil cores at these sites: only a few types were common and most types were rarely encountered. Matches between the Cortinarius mushroom and mycorrhizae RFLP patterns were also found. With this randomized sub-sample method, we can estimate relative abundance of taxa and detect differences in diversity among treatments and study sites. This taxonomic approach will improve the accuracy of our assessment of treatment effects on the below-ground ecosystem.

(# 685) The effect of Bradyrhizobium Japonicum and Methyl Jasmonate (MeJA) on Soybean (Glycine Max) Nodulation, Nitrogen Fixation and Grain Yield under Short Season Conditions

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Jasmonates (Jasmonic Acid – JA, and Methyl Jasmonate – MeJA) are naturally occurring in plants and are important signal molecules involved in induced disease resistance and biotic and abiotic stress responses of the plant. Their presence in the rhizosphere has also been reported due to its rhizosecretion from the root cells. Besides its role in-planta, jasmonates can also act as signaling molecules in rhizobium-legume symbiosis. We have recently shown that jasmonates induced the transcription of nodulation genes in Bradyrhizobium japonicum and also produced substantial amount of lipo chitooligosaccharides (LCOs) when these cultures were induced with jasmonates. Since jasmonates induced nodulation genes and also caused LCO production from B. japonicum, we conducted two field experiments in the year 2002 to determine whether incubation of B. japonicum with MeJA prior to inoculation increases soybean nodulation variables and grain yield. At both sites, experiments were designed as two factorial randomized complete block design (RCBD) with four replications. Factor A consisted of inducer molecules while factor B consisted of B. japonicum strains. The results of the experiments showed that both genistein and methyl jasmonate significantly increased nodule number and nodule weight per plant. Due to enhanced nitrogen fixation attributed to increased nodule number and weight, the soybean plants showed increased dry matter accumulation and total grain yield. In conclusion, the results of this study indicate that MeJA can be used to promote soybean nodulation and grain yield under low spring field temperature conditions.

(# 686) Do Common Mycorrhizal Networks Limit Plant Competition and Species Exclusion in Temperate Forests?

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In nature, networks of ectomycorrhizal fungal mycelia encompass and connect the roots of neighbor plants, often including multiple plant species over several square meters. Greenhouse experiments have shown that carbon and nitrogen fixed by seedlings move directionally into neighbors' tissues via common mycorrhizal networks (CMN's) when the neighbors are shaded or have lower N concentrations. It has been hypothesized that CMN's might limit competition, particularly between established plants and seedling recruits, and have indirect effects on community structure. I have designed and implemented a large-scale field experiment to test the role of CMN's in mediating competition between overstorey trees and a suite of seedling species that co-occur in a temperate mixed hardwood-conifer forest. Interim survival data collected at the end of the 2002 growing season are consistent with the hypothesis that seedling performance is negatively affected by competition with overstorey tree roots, even at low light levels. They also support the hypotheses that CMN's between overstorey trees and seedlings in this system partially offset negative competitive effects on seedlings and that the least shade tolerant seedling species in the experiment derives the most benefit from being connected to rootsof surrounding overstorey trees. If CMN's confer relatively greater benefits to seedling species most likely to be excluded at low light in the absence of CMN's, they may play an important role in maintainingthe diversity of compatible tree species in mixed species forests.

(# 687) Potential and use of mycorrhizae in phytoremediation of soil

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In many industrial but also agricultural regions, soil pollution with a wide variety of synthetic organic chemicals, often characterized by a high persistence, but also with heavy metals has taken place. Heavy and profound contaminations need individually adapted ex site treatments but weak and often expanse contaminations need effective and inexpensive clean-ups. Here plant based in site applicable methods offer possibilities for natural decontamination especially based on the degradation capability of selected rhizosphere organisms. On heavy metal uptake and binding by mycorrhizal fungi and root systems and also effective accumulator plants a lot of information is available, but much less on the potential for biodegradation of organic xenobiotics as contaminants. After a short overview on results in literature experiments in part with white rot fungi but especially with different mycorrhizal associations are presented, which explore and demonstrate their potential and effectiveness in the degradation of organicxenobiotics but also elucidates the significance of the host plants.

(# 688) Crops and agricultural practices for biomass/bio-fuel production and greenhouse gas mitigation in Eastern Canada

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Crops can help to reduce the greenhouse effect, because they have the capability to remove CO2 from the atmosphere through photosynthesis to produce biomass that can be use for biofuels. Lipo-chitooligosaccharides (LCOs), compounds produced by rhizobia in their interactions with legume roots, can increase photosynthesis. The use of these compounds in combination with tillage practices such as no-till could be useful for both biomass production and soil carbon sequestration. The objective of the research was to determine the optimum balance between biomass production, carbon sequestration and N2O emission for a range of crops (corn, sorghum, soybean and switchgrass). The treatments were tillage system (no-till in comparison with conventional tillage), nitrogen fertilization rates (0, ½ and full rates) and LCOs. Soil and plant variables were evaluated during the season. In 2001 crops were strongly affected by drought and the effect of treatments was small; the highest N rate was sometimes excessive. In 2002 corn responded more to nitrogen fertilization than the other crops. Sorghum grew well in all three nitrogen fertility levels. No-till plots had dry weight values lower than conventional tillage plots; those differences diminished and were not significant by the season's end. LCO application caused increased soybean biomass at mid season, but dry conditions resulted in no difference by the end of the season. Sorghum produced the most biomass, at around 1.5 kg/m2. The optimum management for greenhouse gas reduction (biomass produced vs. greenhouse gases produced during crop production) is discussed.

(# 689) Framework for Predicting Soil Biodiversity Attributes at Regional Scale

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Soil organisms contribute to the functioning of the soil system, in particular, water and air flow through the formation of soil pores and aggregates, in nutrient cycling through the breakdown of organic residues and uptake by plants, in suppression of soil-borne pests and pathogens and in breakdown of toxic substances. Specific data about soil biota population occurrence at regional scales (i.e. Soil Landscapes of Canada polygons, and Ecodistrict level)are not readily available for Canada. A modelling approach based on determining the significant interrelationships of population abundance with soil attributes is being explored as a means to predict potential occurrence of soil biota groups. An example of the proposed model methodology will be presented for Prescott-Russell counties (Ontario) for predicting potential earthworm occurrence. Benefits and challenges of this approach will be discussed in terms of feasibility for developing a national indicator for soil biodiversity.

(# 690) Modifying the dietary cation-anion difference of timothy using fertilization

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Decreasing the dietary cation-anion difference (DCAD) in forages may help to prevent milk fever of postpartum cows. A split-split-plot greenhouse experiment was conducted to establish fertilization treatments that may decrease the DCAD of timothy. We evaluated soil type (loam and clay), N fertilization (65 and 130 kg N/ha), and Cl and S fertilization (NH4Cl at 50 and 100 kg Cl/ha; (NH4)2SO4 at 35 and 70 kg S/ha). Timothy concentrations of K, Ca, Mg, Na, P, Cl, and S were determined. Concentrations of Ca, P and Mg were respectively 45, 40, and 15% higher in plants grown on loam than on clay soil, while the K concentration was 19% higher in timothy grown on clay soil. Soil type did not affect Cl and S concentrations but DM yield was higher on loam than on clay soil. Nitrogen fertilization did not affect DM yield and any of the elements used in the calculation of DCAD. Concentrations of Cl and Ca were respectively 90 and 13% higher in timothy fertilized with NH4Cl than with (NH4)2SO4. The Cl concentration was 55% higher in plants fertilized with 50 kg Cl/ha of NH4Cl than with 100 kg Cl/ha. Timothy fertilized with (NH4)2SO4 had a 12% greater DM yield than when fertilized with NH4Cl. Our results indicate that soil type and Cl fertilization affect some of the elements used to calculate the DCAD.

(# 691) Adaptation of eastern Canadian crops and cropping systems to climate change

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In the Province of Quebec the last two years were both unusually dry and hot, and probably represent the sort of climate-changed conditions that will be much more common in the future. Our objective was to examine the yields of several full season crops, and key elements of crop production systems for suitability to climate changed conditions. Four crops were grown in the field: soybean, corn, sorghum, and switchgrass. All crops, except soybean, were fertilized with nitrogen at 0, ½ and the full rate, and under till and no-till conditions. Yield and/or biomass data were collected in 2001 and 2002. Additionally, data of yield for the same crops grown in Montreal and data of precipitation, evaporation and temperature were collected from the statistical records over the last 20 years. Yield in the experiments was low, and this was associated with low precipitation during the second half of the season in both years. Yield for corn and soybean were reduced in both years. Sorghum and switchgrass are warm season crops and grew well in dry and hot conditions obtained in those years. It seems that some of the crops used were more affected by low precipitation than others. Analysis of yield data records indicated that the yield of major crops declined in the last two years because of drought. Climate change conditions may make no-till systems more appropriate and lead to reductions in N fertilizer applications.

(# 692) Effect of arbuscular mycorrhizal inoculation and vermicompost on growth of Carica papaya L. plants under greenhouse and field conditions

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The objective of this research was to evaluate the effects of arbuscular mycorrhizal fungi and vermicompost on papaya plants production under greenhouse conditions, as well as their agronomic performance. The fungal colonization and the several rates of vermicompost used as growing media werehandled under greenhouse conditions. Papaya plants were transplanted to field conditions and they were fertilized using chemical fertilizer, vermicompost and plants without fertilization were used as a control. Variables such as growth, plant height, leaves number, internodes number, stem diameter, total dry matter, and leaf area shown higher values in plants with vermicompost associated with arbuscular mycorrhizal fungi under greenhouse, even when mycorrhizal colonization was not detected with the highest rates of vermicompost. N, P, and K content in papaya leaves and stems in greenhouse, and the papaya petioles under field conditions exhibited similar performance. Under field conditions, plant growth was influenced by vermicompost applied in the greenhouse; the mycorrhizal-arbuscular fungi only enlarged the papaya stem diameter. The chemical fertilization exhibitedthe higher values of number fruit and fresh fruit yield per plant.

(# 693) Arbuscular mycorrhizal fungi isolated from saline soils and their efficiency on lettuce plants (Lactuca sativa L.)

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The objective of this study, was the identification of arbuscular mycorrhizal fungi species, isolated from saline soils and evaluate their infectivity and effectiveness in lettuce plants (Lactuca sativa L.) grown in sterile sand and greenhouse conditions. A selection of saline soils samples from different sites ofthe State of San Luis Potosí, were submitted to physical and chemical analysis. Five sites were sampled: 1) La Matanza, 2) González, 3 and 4) Norias del Refugio and 5) El Sabinito. Electrical Conductivity in these soils varied from 8.0 to 10.80 dSm-1, in saturation soil extract, which were classified as highly saline. From sampled crop roots in selected sites (peppers, tomato, corn and sunflower), spores were extracted counted (150 and 500 spores/100 g soil). On the average, colonization was of 40%. Species identified in these soils were: Glomus mosseae, Glomus aff. Etunicatum, Glomus intraradices and Paraglomus sp. Three morph species of Glomus genus and one Paraglomus genus were identified: Glomus mosseae, Glomus aff. Etunicatum, Glomus intraradices and Paraglomus sp. Efficiency of the five multistrains of the mycorrhizal fungi, was studied on lettuce plants. Data shown that all multistrains conserved their infective capacity (mycorrhizal colonization higher than 80%). Effect of infective capacity on studied variables (root volume, foliar area and dry weight), values were not significant for the five multistrains.

(# 694) Mycorrhizae and neighbor effects on response to herbivory in spotted knapweed and native bunchgrasses

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Herbivory is an important ecological force structuring grassland communities, and those plants able to compensate for herbivory by replacing lost foliage have a competitive advantage. Because both nutrient availability and competition with neighboring species will influence a plant's compensatory growth, and because arbuscular mycorrhizae (AM) affect both nutrient status and competitive interactions, AM may influence a host plant's response to herbivory. Our research addresses the role ofAM in the compensatory response of an exotic forb and two grasses native to North American grasslands. In the western U.S., Centaurea maculosa has invaded millions of ha of semiarid rangeland. In an experiment with plants grown singly in pots, Centaurea had significantly more extraradical hyphae than either of the native grasses, Festuca idahoensis and Pseudorogneria spicatum. Plants with AM didnot increase compensatory growth, but had higher tissue N and P concentrations. We are now evaluating the compensatory growth of C. maculosa grown with one of three neighboring species, eitherwith or without AM. Non-AM plants will be grown in a sterilized field soil and sand mixture with a microbial wash added. Pots will be divided by a mesh barrier that excludes roots but not hyphae or water, so that we can specifically assess the role of extraradical hyphae for compensatory growth enhancement. A clipping treatment on C. maculosa or the native grasses will simulate herbivory. We hypothesize that the amount of neighboring plant's root and hyphal production will influence the clipped plant's compensatory growth.

(# 695) 2,4-D degradation in amended soils

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2,4-Dichlorophenoxyacetic acid (2,4-D) is a widely used, broadleaf herbicide. Our study examined 2,4-D degradation in soils of different textures amended with different rates of fresh hog manure and municipal biosolids. Microcosms were used to measure evolution of 14CO2 from amended and non-amended soils treated with 14C-2,4-D. Soils treated with biosolids resulted in higher total 2,4-D degradation than soils treated with fresh hog manure. Total 2,4-D degradation increased in the order of sandy clay loam < silty loam < sandy loam < clay loam soil, and increased with decreasing rates of fresh hog manure and biosolids applications from 50 > 100 > 200 lb N acre-1.

(# 696) 2,4-D degradation as a result of incubation length of amended soils

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Producers generally do not apply an amendment such as hog manure and a pesticide at the same time. Our interest lay in determining whether the amount of time between amendment application and herbicide application affected the rate of herbicide degradation. 2,4-Dichlorophenoxyacetic acid (2,4-D) is a widely used, broadleaf herbicide. This study examined 2,4-D degradation as a result of incubation length of soil amended with fresh hog manure and municipal biosolids. Microcosms were used to measure evolution of 14CO2 from amended and non-amended soils incubated for 0, 7, 14, or 28 days prior to treatment with 14C-2,4-D. Total 2,4-D degradation was greatest in amended soils that were not incubated prior to 14C-2,4-D addition, and lowest in soils that were incubated for 28 days prior to 14C-2,4-D addition. While incubation lengths of 7 and 14 days did not differ from each other in total degradation, differences were observed from the 0 and 28 days of pre-incubation treatments.

(# 697) THE EFFECT OF ARBUSCULAR MYCORRHIZAL (AM) COLONIZATION ON THE ALUMINUM TOLERANCE OF TWO SOYBEAN VARIETIES: ONE TOLERANT OF ALUMINUM AND ONE SENSITIVE

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A greenhouse study was initiated to evaluate the effect of arbuscular mycorrhizal (AM) colonization on the Al tolerance of two soybean varieties, Young and PI 416937. Although results from hydroponic studies and evidence from the literature have suggested that PI 416937 is Al tolerant, and that Young is sensitive to Al, the addition of Glomus etunicatum to the plant growth medium, yielded opposite results. The Al sensitive soybean variety, Young, survived lethal concentrations of Al while in the symbiotic state, but did not survive in the non-symbiotic state. In contrast, the tolerant soybean variety, PI 416937, died under lethal concentrations of Al, whether it was mycorrhizal or not. To try to understand the mechanism behind this, we will use an Al specific stain, Lumogallion, to localize the Al in the root systems. Our research group has successfully developed this methodology for visualizing Al present inectomycorrhizae. From preliminary results, this methodology holds promise for localizing Al in endomycorrhizas as well.

(# 699) Effects of Long-term Applications of Dairy Manure Slurry on Structure of the Soil Food Web and Nitrogen Flux under Tall Fescue

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Plots of tall fescue in the Fraser Valley of British Columbia have been either left untreated or were treated with dairy manure slurry or fertilizer, each at 50 or 100 kg mineral N/ha, two to four times per year since the beginning of 1994. Soil samples taken on nineteen dates from 1997 through 1999 were analyzed for bacterial and fungal biomass, protozoan abundance and nematode community structure. Bacterial biomass was greater in manure-treated soil than in fertilized and untreated soil and represented a significant pool of dynamic and labile soil N. In contrast, fungal biomass was greater in untreated soil than in manure-treated and fertilized soils and was less dynamic. Microbivorous protozoa and nematodes were consistently more abundant in soil treated with manure at both rates than in fertilized and untreated soil. Estimates of microbial biomass consumed by the micro-fauna were more than 3-fold greater for manure-treated soil than for fertilized and untreated soil, indicating that sustained use of manure increases turnover of the microbial biomass and flux of nutrients through the soil food web more than it increases size of the microbial biomass. A greater percentage of nematodes with enrichment opportunist life-history strategies was found in manure-treated soil than in fertilized and untreated soil, indicating enhanced microbial and nutrient turnover. Simpson's diversity and the nematode Maturity Index (MI2-5), indicators of structural complexity of micro-faunal communities, did not differ between manure-treated and fertilized soil, although both had lower diversity and MI2-5 values than untreated soil.

(# 701) Natural abundance stable isotope ratios support myco-heterotrophic nature and host-specificity of certain achlorophyllous plants

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Over 400 species of achlorophyllous vascular plants are thought to obtain all carbon from symbiotic fungi. Consequently, they are termed 'myco-heterotrophic.' However, direct evidence of myco-heterotrophy in these plants is limited. During an investigation of the patterns of nitrogen and carbon stable isotopes of various ecosystem pools in two old-growth conifer forests, we sampled six species of achlorophyllous plants, considered to be myco-heterotrophic, to determine the ability of stable isotope ratios to provide evidence of myco-heterotrophy and host-specificity within these symbioses. Dual-isotope signatures of the achlorophyllous plants differed significantly from those of all other pools. They were most similar to the signatures of ectomycorrhizal fungi, and least like those of green plants. Delta ^{15}N values of the achlorophyllous plants correlated strongly and positively with those of putative mycobionts. Used in conjunction with other methods, nitrogen and carbon stable isotope ratios can be used to demonstrate myco-heterotrophy and host specificity in these plants when other ecosystem pools are well characterized. This method also appears promising for estimating the degree of heterotrophy in photosynthetic, partially myco-heterotrophic plants.

(# 702) Functional Implications of Changes in Communities of Soil Microfauna Resulting from the Use of Organic Soil Amendments and Mulches in Tree-fruit Production Systems

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In order to evaluate the impacts of alternative organic soil amendments and mulches on the quality of soil for high-density apple production, a series of field experiments have been established in the Okanagan Valley of British Columbia on coarse-textured soils typical for the region. Treatments considered to date include municipal composts, municipal biosolids, dairy manure solids, alfalfa hay, shredded office paper, and waste paper fibre slurry, as well as several combination treatments such as shredded paper applied over municipal biosolids or compost. Routine application of glyphosate for weed suppression was the control in all experiments. Impacts of the various treatments on structure and function of the soil food web was assessed through analyses of communities of microfauna. Nematode community indices such as the Enrichment Index (EI) were very responsive to root zone organic matter management, discriminating among treatments in all experiments. The EI was increased, relative to the control, under treatments expected to result in increased nutrient mineralization, such as combinations of shredded paper mulch applied over municipal biosolids and alfalfa hay applied over dairy manure solids. The EI also correlated with soil N status and leaf nutrient uptake. Shredded paper mulch, which resulted in the best cumulative tree growth, also increased the nematode Structure Index, a measure of food web connectance and biodiversity. Populations of root-lesion nematodes, damaging pathogens of apple, were reduced under shredded paper mulch in one of the two experiments on non-fumigated soil.

(# 703) Alternative frameworks for the spatial analysis of soil-plant relationships: a case study from a forested catchment of the Lower Laurentians

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Recent technological advances have allowed for the rapid acquisition of large and extensive spatial datasets, opening the door for the development of an array of methods of spatial analysis. The parallel development of the fields of ecosystem and landscape ecology have brought forward issues pertaining, among other things, to ecosystem complexity, part-whole interactions and scale. The aim of this presentation is to demonstrate that any analytical method used to study soil-plant interactions through space bears with it a different conceptual view of those issues. To demonstrate the implications of this, we used data collected on a forested catchment of the Lower Laurentians. On this study site, a combination of 150 regularly spaced and random sampling points were located to cover an area of approximately 4 ha. Soil samples were taken at each location and all trees with a diameter at breast height bigger than 8 cm were located, measured and identified to species. An experiment was also conducted to characterize the leaf litter fall distribution pattern of each species. Two different methods of spatial analysis were used to examine the spatial distribution of the trees and soil nutrients, and to analyze the multi-scale soil-tree relations. The results are used to illustrate that contrasting outcomes may arise from the use of methods of analysis underlain by different conceptual frameworks.

(# 704) Expression of the ammonium assimilating genes in the Suillus bovinus - Scots pine mycorrhizosphere

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In the nitrogen limited boreal forests mycorrhizal mycelium plays a significant role in nitrogen acquisition of trees. As the soil colonising mycelium is the place where uptake of the nutrients takes place, knowledge of ammonium assimilation in the fungal cells is needed for better understanding of the nitrogen cycling in the forest ecosystem. The central role of ammonium is even more highlighted by the fact that both nitrate and nitrite, the other forms of inorganic nitrogen in soil, have to be converted to ammonium before incorporation into organic compounds.

We have cloned and characterised Suillus bovinus GS/GOGAT -pathway genes and their transcription in the Scots pine - S. bovinus mycorrhizosphere. Transcription of the genes was found to be constant in the microcosm cultures containing natural humus. GS, unlike GOGAT, is highly transcribed but most of the detectable GS transcripts are non-functional due to 5'-end truncation. We have also measured the corresponding enzyme activities in the mycorrhizosphere. It seems that GS and GOGAT are regulated at the protein level by modulating translation activity, protein turnover and/or activity of the enzyme itself according to the cellular conditions. Based on our latest results we are presenting a model for the role of ammonium assimilation pathways in the S. bovinus mycelium for the Scots pine - S. bovinus mycorrhizal symbiosis.

(# 705) Root Exudation Patterns of Plants Grown in Hydrocarbon Contaminated and Non-Contaminated Soils.

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The presence of plant roots has been shown to increase the degradation of organic pollutants. In phytoremediation systems, root exudation patterns are thought to control the microbial populations responsible for hydrocarbon transformation/degradation. Because of their importance toward rhizosphere ecology, root exudates have been the focus of many studies. Few of these studies, however, have examined root exudation profiles in contaminated settings.

This study examined the organic and amino acid, phenolic and volatile organic compound profiles found in the root exudates of northern wheatgrass (Argopyron dasystachyum) and poplar (Populus deltoides) grown under contaminated and non-contaminated settings. Rhizosphere soil was acquired by rinsing excavated roots with de-ionized water. Root exudates were separated and purified using solid phase extraction techniques, and quantified using gas chromatography and mass spectrometry. The presence or absence of compounds of interest will be discussed.

(# 706) Arbuscular Mycorrhizae and Soil/Plant Water Relations

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The water relations of arbuscular mycorrhizal (AM) plants have been compared often. However, virtually nothing is known about the comparative water relations of AM and nonAM soils or about the relative influence of AM colonization of soil vs AM colonization of plants on host water balance. Mycorrhizal symbiosis typically affects soil structure, and soil structure affects water retention properties; therefore, it seems likely that mycorrhizal symbiosis may affect soil water relations. We observed a slight but significant AM effect on the soil moisture characteristic curve of a Sequatchie fine sandy loam following seven months of mycorrhization by Glomus intraradices/Vigna unguiculata. In a separate study, no AM effects on either the wet or dry hysteretic curves were discernible after 15 months of mycorrhization by G. intraradices or Gigaspora margarita on roots of Phaseolus vulgaris. Using myc- bean mutants, we determined that about half of the considerable promotion of stomatal conductance by G. intraradices and Gi. margarita was attributable to soil colonization and about half to plant colonization. A path analysis modeling approach revealed that soil hyphal colonization had larger direct and total effects on dehydration tolerance of bean than did root hyphal colonization, root density, soil aggregation, soil glomalin concentration, leaf phosphorus concentration or leaf osmotic potential. Our findings support the assertion that colonization of soil may play as important a role as colonization of roots regarding how AM symbiosis affects the water relations of host plants.

(# 709) Arbuscular Mycorrhizae From Savannah Sites In Namibia

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In different savannah biomes of Namibia, arbuscular mycorrhizae were monitored with morphological and molecular tools. Diversity of AM spores (monitored by wet-sieving and decanting) is high; 47 species were encountered. The distribution of species is patchy, leading to the assumption that not all species occurring at these sites have been recorded. Surprisingly, the diversity of glomalean sequences derived from colonized grass roots is not as high. Possible explanations include a separate community ofAM fungi inhabiting non-grass hosts in these areas and different communities of AM fungi at different times of the vegetation period.

(# 710) Use of the Root-Organ Culture (ROC) System Technology to Study the Suppressive Effect of Arbuscular Mycorrhizal Fungi on Plant Parasitic Nematodes

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In recent years, the development of the root-organ culture (ROC) technology system has opened new avenues to study various aspects of the symbiosis. Numerous studies have been dedicated to interactions between arbuscular mycorrhizal fungi (AMF) and bacteria and fungi, while interactions with nematodes were seldom considered. This communication reports on the development and the interactionbetween two obligatory parasitic nematodes, Radopholus similis and Pratylenchus coffeae, and the obligatory AMF symbiont, Glomus intraradices, under ROC conditions. Glomus intraradices provided the roots with increased protection against both nematodes, by suppressing nematode reproduction in the roots. For both R. similis and P. coffeae, nematode populations in mycorrhizal roots were reduced by 50 % compared to the populations in the non-mycorrhizal roots. The internal and externalmycorrhizal development was not influenced by the presence of the nematodes. This study supports the potential of the ROC system for isolating factors responsible for the suppressive effect, like biochemicalchanges in the mycorrhized root and qualitative and quantitative changes in root and/or AMF exudates. In addition, an hypothesis such as microbial changes in the rhizosphere can be ruled out under ROC conditions. Therefore, the ROC system may represent a valuable tool for studying the AMF-nematode interaction, complementary to classical experimental approaches.

(# 711) New Conceptual Model for Ectomycorrhizal Succession at an Ecosystem Scale

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Community assembly following disturbance - succession - is a key concept in ecology. However, the successional theories that are relevant on an ecosystem scale remain poorly developed for mycorrhizal fungi. Such conceptual model is proposed here. In primary successional ecosystems, allochthonous (out of site) sources provide the propagules, which remain dormant in the soil propagule bank in absence of susceptible hosts. The fungi that initiate root colonization are selected among the propagules that are compatible with available hosts and thrive under the environmental pressures of the successional ecosystem. The fungi capable of root colonization under these environmental pressures (the fundamental niche) will be further selected based on biotic interactions - mainly competition among the resident fungi (the realized niche). The outcome of the environmental and competitive selection will further allow the most fit species to allocate energy to propagule production, thus contributing to the autochthonous (on site) propagule dispersal and building dominant components in the propagule bank. The proposed model integrates fungal life history strategies, host specificity and susceptibility, niche concepts, competitive interactions and role of fitness in propagule production. Each selective force (availability of susceptible host plants, environmental tolerance and competition) is presented as a filter through which only a proportion of the available fungi can pass.

(# 712) From Australia to New Zealand: How Did Fungi Find a Niche in Hell?

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Pisolithus is widely distributed globally and is often found in adverse environments. In New Zealand (NZ), it is restricted to low fertility, highly acidic soils in geothermal areas. There it associates withheath-like prostrate kanuka Kunzea ericoides var. microflora (Myrtaceae) dominant in NZ geothermal areas, and less commonly with Leptospermum scoparium (Myrtaceae). Phylogenetic analysis of ITS sequences revealed NZ strains belong to 3 distinct clades matching Australian species P. marmoratus, P. albus and Pisolithus species 10, all of which are associated with eucalypts and acacias. All 3 species were distributed across the Taupo Volcanic Zone, the main active volcanic area in NZ. They co-occurred in restricted areas, with 2 species sometimes colonizing root tips in the same soil volume, signifying co-occurrence of species at a smaller scale. More than 80% of ectomycorrhizal morphotypes on kanuka root tips in hotter soils were identified as Pisolithus species. Arbuscular mycorrhizal colonisation was also observed in kanuka fine roots. High genetic similarity between NZ and Australian strains suggests Pisolithus fungi were introduced to NZ from Australia by trans-Tasman airflow during recent geological times. Both host genera also probably colonized NZ in recent geological times. The success of this newly described long-distance migration of ectomycorrhizal fungus and plant hosts may be related to the capacity of Kunzea and Leptopermum species to establish without ectomycorrhizal colonisation and act as “nurse plants” for wind blown ectomycorrhizal inoculum.

(# 713) Enzyme Activity as a Measure of Soil Fertility: Why the Correlation is So Low

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Soil enzyme activity has often been correlated with soil fertility and/or plant response (yield, plant nutrition) as an indicator of soil quality. Historically, however, the correlation is often low, meaning there is no significant relationship between soil enzyme activity and fertility. I hypothesize that one of the reasons for this poor relationship is the inappropriate methods commonly used for performing soil enzyme activity. For example, soil phosphatase (acid or alkaline and soil arylsulfatase activity are usually determined using an artificial substrate, not found in soils. This presentation will illustrate the methods normally used to perform soil enzyme activities; time will be allowed for discussion of this issue and my hypothesis.

(# 714) Influence of Tillage and Crop Residue Management on Crop Yield, Greenhouse Gas Emissions and Soil Quality

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The objective of this study was to determine the influence of tillage and crop residue management on crop yield, soil aggregation and nitrous oxide (N2O) emissions on a Gray Luvisol soil near Star City, Saskatchewan. The field experiment was established in 1998 on a 4-year rotation (barley-pea-wheat-canola) under two tillage systems (no tillage, NT and conventional tillage, CT), two levels of straw (straw retained and straw removed) and four rates of N fertilizer (0, 40, 80 and 120 kg N ha-1, except no N to pea phase of the rotation). Tillage and straw treatments usually had no effect on crop seed yield in 1998, 1999 and 2000. In 2001 (after 4 years) NT had 389 kg ha-1 more seed yield of canola than CT, and straw retention increased seed yield by 258 kg ha-1 compared to straw removal, respectively. The combination of NT and straw retention gave the highest yield. The N2O emissions were substantially higher under CT than NT where N was applied. The proportion of aggregates in the fraction with the smallest sieve opening (<0.42 mm) was significantly greater in CT compared to NT, while there was a higher proportion of large aggregates (>12.7 mm) under NT than under CT. Straw retention tended to increase the proportion of large aggregates and decrease the proportion of fine aggregates. In summary, the findings suggest that returning crop residue under NT would improve soil quality and productivity and may also be better for the environment.

(# 715) The Regulation of Mycorrhization: a New Aspect ?

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The establishment of the arbuscular mycorrhizal symbiosis is a complex exchange of signals between the arbuscular mycorrhizal fungus and the host plant. In presence of the mycorrhizal fungus various metabolic changes are initiated in the host plant, which can result e.g. in an enhanced resistance of mycorrhizal plants towards soil-borne fungal pathogens. The effect of these changes on further mycorrhization still remains mostly unclear. Metabolic changes in mycorrhizal plants are discussed in thecontext of regulation of mycorrhization.

(# 717) Establishment of Hybrid Poplar Plantations in Saskatchewan, Canada: An Agroforestry Initiative

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The production of Short-Rotation Woody Crops is growing steadily throughout North America. In Saskatchewan interest in developing hybrid poplar plantations for local pulp and fiber-producing companies has augmented an expanding forest industry. In many areas marginal farmland, often adjacent to or formerly forested land, is considered appropriate for tree production. Preliminary results from a 6 year-old plantation indicate good potential for operational-scale hybrid poplar production over a 15 to 20 year rotation period. Research conducted on two sites, encompasses a total of 44 ha (~ 105 acres). The field trials were established in the spring of 2002 and are designed to assess various silvicultural practices that are regarded to enhance the growth of hybrid poplars. These practices include: 1) type of tree stock used, 2) rate and frequency of fertilizer application, 3) pruning secondary trunks and lower branches from the trees, and 4) weed control. A primary research goal is to achieve maximal rates of plant production, in both above ground and below ground (root) systems. Research activity also focuses on biophysical processes and interactions, such as nutrient uptake and recycling, root production and turnover, and competition between trees and weeds. Greater understanding of how and why hybrid poplars respond to their physical environment and imposed silvicultural practices will ensure the ability to manage plantations in a sustainable manner.

(# 718) Fields Under Organic Management: A Survey of Soil Fertility

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Organic production has been expanding rapidly in Saskatchewan. A 1996 survey identified 404 organic farmers in the Province (certified and in transition) with a total of 213,320 acres certified. A survey completed by the Saskatchewan Organic Directorate in 2000 estimated 1000 farmers were either certified or in transition, with over one million acres under organic management. One concern with organic production, is that because acceptable organic amendments for returning nutrients to the soil are very limited in number, soil fertility may decline over the long term. Seventy-six organically managed fields were soil sampled and analysed for suite of physical and chemical characteristics. In addition, producers completed a management questionnaire specific to the same fields, that identified years under organic management, rotations, amendments applied, green manure crops grown, as well as a variety of tillage practices. The overall objectives were to document fertility status on organic farms, as well as to identify agronomic practices affecting soil fertility. The results of these surveys will be discussed.

(# 721) Soil And Plant Response To Organic Amendments On Three Strawberry Cultivars.

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Every year, over 100,000 tones of organic material are diverted from disposal in Nova Scotia landfills through green cart programs, backyard composting, and other composting programs. Testing the potential use of organic amendments on various food crops has become inevitable. There is a growing interest among the consumers in organically produced crops. However, there is a lack of scientific research evaluating small fruit production using organic methods. A comparative study between organic amendments and chemical fertilizers is vital in order to understand the feasibility of using organic amendments in place of chemical fertilizers.

Thus, a three-year study was initiated with the objectives of evaluating four different organic amendments in comparison with chemical fertilizers on three different strawberry (Fragaria x ananassa Duch.) cultivars. Studies on plant nutrition, soil fertility and yield of strawberry cultivars will be conducted to meet the objectives. The four organic amendments are, Municipal solid waste (MSW) compost, Alfalfa meal +Rock Phosphate, Ruminant manure compost and YMFC (Yard waste, manure and food waste compost). The results will help determining the soil and plant response of different maturing strawberry cultivars and the associated fertility to different organic amendments applied.

(# 722) Intraspecies Receptivities of Potato Cultivars to Arbuscular Mycorrhizal Colonization

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Interest in the agronomic potential of arbuscular mycorrhizal (AM) symbioses for sustaining soil quality and productivity has been directed mainly at high-value and intensively-managed horticultural crops, forest nurseries and drastically disturbed habitats in need of rehabilitation. The impacts of physical and chemical factors in the environment on mycorrhizal colonization are well-known. Biological factors such as crop selection and differences in mycorrhizal dependency between species and even cultivars of the same crop are also important but considered less frequently. Cultivars genetically engineered for pest resistance are rapidly gaining popularity with farmers in North America. For example, Bt corn varieties account for about 35 % of total corn hectarage in Canada. However, the non-target impact of transgenessuch as Bt toxin genes from Bacillus thuringiensis, on mycorrhizal colonization is not known. Arbuscular mycorrhizal colonization of stained, randomly collected roots from two commercial, isogenically-related Bt and non-Bt potato varieties was monitored over a three-year period of continuous cropping to the same field soil containing natural inoculum. The AM colonization of the variety Shepody, tended to be greater than that of Superior. The introduction of the Bt transgene tended to enhance or have no effect on AM colonization but not consistently for the same variety from year to year. Colonization levels ranging from 4-18 % were comparable to literature reports for potato and appeared to be caused primarily by Glomus species.

(# 723) Detection and Partial Purification of a Branching Factor from Root Exudates of Lotus japonicus

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Very little is known about the molecular mechanisms governing signalling and recognition between arbuscular mycorrhizal (AM) fungi and host plants. The hyphae of AM fungi extensively branch in the vicinity of host roots prior to appressorium formation. This differential hyphal morphogenesis is suggested to be a host recognition response of AM fungi. Low-molecular-weight lipophilic compounds exuded from roots have been shown to elicit hyphal branching. However, the hyphal branching-stimulating compounds, called “branching factors”, have not been isolated.In order to fully understand the molecular mechanisms underlying the signalling and recognition events in AM symbiosis, we have recently started to isolate and identify the branching factors from rootexudates of the model legume Lotus japonicus. Plants were grown hydroponically in a M medium. The hydroponic solution was passed through a Diaion HP-20 column, and lipophilic compounds adsorbed on the resin were eluted with methanol. This eluate was concentrated in vacuo, and the resulting aqueous concentrate was extracted with ethyl acetate. Hyphal branching-stimulating activity of the ethylacetate extract was tested using a microinjection bioassay with some modifications. In the modified bioassay, a test sample solution was applied to a 6 mm paper disc, and the disc was placed in front of a growing hyphal tip of Gigaspora margarita. The ethyl acetate extract elicited strong hyphal branching at 1.9 microgram/disc. Bioassay-guided purification of the extract by repeated column chromatography over silica gel and ODS resulted in the isolation of a semi-purified fraction that showed activity at 0.13 microgram/disc.

(# 724) Small scale spatial distribution structure of ectomycorrhizal types in a red oak stand

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Spatial distribution of ectomycorrhizae is influenced by a variety of biotic and abiotic factors. In additionto interspecific interactions, abiotic parameters like soil water content, pH value or nutrient concentrations, which may vary in the range of millimetres in the soil, have an important influence on the spatial distribution structure of ectomycorrhizal coenosis.To understand the dispersion of ectomycorrhizal types it is necessary to know their distribution patterns. Data about the spatial distribution of ectomycorrhizae are mostly available on a macro-scale from fruitbody collections and in a meso-scale from soil samples. However, on the micro-scale distribution, hardly any data exist.Therefore, the aim of this study was to determine the characteristic micro-scale structures of ectomycorrhizal types in the forest floor.Our investigations were conducted in a red oak stand growing on a sandy site in northeastern Germany. A monolith with 600 cm length, 6 cm width and 3 cm depth of the top organic soil layer (forest floor) was excavated and divided in small cuboids each with a volume of 4 cm^3. These cuboids were dispersed in waterand the ectomycorrhizal types were qualitatively recorded.First results show that most of the ectomycorrhizal types could be found in the first centimetre of the organic top soil layer. Different ectomycorrhizal types show different spatial distribution patterns. Some types like Cenoccocum geophilum are dominant in the complete investigated depth of 3 cm, some types prefer only a specific depth and other types show different large cluster-formations with or without preferring one of the three investigated centimetres.

(# 727) Two Cryptosporiopsis species Form Functional Ericoid Mycorrhiza in Dutch Ericoid Plants and Are Able To Degrade Soluble Phenolics

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Two Cryptosporiopsis species were recently isolated from the roots of Calluna vulgaris, Erica tetralix, Vaccinium vitis-idaea and V. myrtillus from two different locations in the Netherlands. One will be described as a new species based on morphological and molecular characters, using sequence data of the 5.8 S nuclear ribosomal DNA and flanking internal transcribed spacers (Verkley, Zijlstra, Summerbell & Berendse, in press). We tested the abilities of these species to induce formation of functional ericoid mycorrhiza by means of synthesis trials. Additionally, tests for polyphenolic degradation were performed, because ericoid mycorrhizal and ectomycorrhizal species are known to produce enzymes that degrade phenolics. Dutch isolates of Hymenoscyphus ericae and Oidiodendron maius were included in the tests. The isolated Cryptosporiopsis species were able to produce ericoid mycorrhizal fungal structures in Calluna seedlings and to enhance the nitrogen uptake compared to that seen in non-inoculated seedlings. Additionally, they produced phenol-oxidizing enzymes at the same levels or higher as known ericoid mycorrhizal fungi. We conclude that these Cryptosporiopsis species are functional ericoid mycorrhizal fungi and are able to degrade soluble phenolics.

(# 728) Impact of Spacing and Emergence Variability on Corn Yield

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Non-uniform spacing and emergence of corn (Zea mays L.) plants within a row may reduce grain yield. To examine the impact non-uniformity, a series of experiments were conducted at two locations in South Central Ontario in 2000 and 2001. In the first experiment, within-row spacing treatments of 6.7 to 16.2 cm in standard deviations (SD) were established using Roundup Ready® corn planted with different proportions of conventional corn seeds which were removed using glyphosate prior to 3-leaf stage. In the second experiment, corn was hand planted to produce various combinations of corn plant spacing and emergence. In the final experiment, spacing and emergence were varied using three planters with differing configurations under conventional and zero tillage at planting speeds of 7.7 and 11.9kph. Spacing uniformity was not a significant factor in determining corn yield. Corn plants in an unevenly spaced canopy exhibited compensatory growth. Per plant yield reductions exhibited by crowded plants were offset by per plant yield increases of plants next to gaps. Where emergence was non-uniform, however compensatory growth was not exhibited and yields were decreased. Compared to the uniformly early emerged plants, one out of six plants with a 2-leaf stage delay in emergence reduced yield by 4%, and one out of six plants with a 4-leaf stage delay reduced yield by 8%. Results indicate that the ability of a corn planter to singulate seeds is not as critical as its ability to place seeds at a uniform depth and with proper seed to soil contact

(# 730) Improvement of axenic culture of arbuscular mycorrhizal fungi

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We have already reported that arbuscular mycorrhizal (AM) fungi, such as Gigaspora margarita, Glomus caledonium, Glomus fasciculatum and Glomus spp. (R-10), were axenically proliferated by using the 25% methyl alcohol (MeOH) eluates of bahiagrass roots fractionated by flash chromatography (Ishii et al., 1995; 1998). It takes several months, however, to obtain new spores in this axenic culture without roots. In order to improve the axenic culture, we investigated effects of both blue and red light emitting diodes (LED) on growth of arbuscular mycorrhizal fungi under axenic cultural conditions. We also reported thatred lighting ranging from 612nm to 730nm remarkably stimulated the hyphal growth of G. margarita, but blue lighting showed inhibitory effects (Yachi et al., 2001). When the spores of G. margarita and Glomusspp. (R-10) in the media with only agar or the media with AM growth stimulants and minerals were incubated under the lighting (10μE·m-2·s-1) by red and blue LEDs at 28ºC, the hyphal growth was stimulated by the lighting caused by red LED or red LED + blue LED. Red lighting negated inhibitory effects by blue. Interestingly, new spores formed from the hyphae with and without the mother spores were observed within one month in G. margarita (2 weeks in Glomus spp.) under the lighting of red LED +blue LED. These results show that it is possible to put this technique for the proliferation of AM fungi without roots to practical use.

(# 731) Peptides as new growth stimulants for arbuscular mycorrhizal fungi

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Currently, flavonoids (Carr et al., 1985; Gianinazzi-Pearson et al., 1989; Nair et al., 1991), polyamines (El Ghachtouli et al., 1996; Ishii et al., 2000), alginate oligosaccharide (Ishii et al., 2000) and ethylene (Ishii et al., 1996; Geil and Guinel, 2002) have been known to influence markedly hyphal growth of mycorrhizal fungi. These growth stimulants, however, have less effect on spore formation and spore germination. Since we first succeeded the axenic culture of arbuscular mycorrhizal (AM) fungi by using the 25% methyl alcohol (MeOH) eluates of bahiagrass roots fractionated by flash chromatography (Ishii et al., 1995; 1998), four kinds of growth stimulants were isolated from the 25% MeOH eluates, and two of them were identified as eupalitin and 2,3-dihyro eupalitin (Ishii et al., 1997; 2002). In this study, we made an attempt on the identification of other growth stimulants in the eluates. As the results, two growth stimulants were identified as peptides. These peptides remarkably promoted spore formation as well as hyphal growth under the axenic cultural conditions of AM fungi. The concentrations of the peptides in bahiagrass roots were markedly increased by water stress treatment. Furthermore, an aspartic acid oligomer synthesized artificially has great effects on the spore germination and hyphal growth of Gigaspora margarita. These results suggest that the peptides will be very important compounds on mycorrhizal symbiosis.

(# 732) Arbuscular mycorrhizal fungi penetrate into Arabidopsis thaliana roots

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Although members of the Brassicaceae such as A. thaliana have been known to be non-mycorrhizal plants, Glenn et al. (1985) reported that arbuscular mycorrhizal (AM) formation occurred even in these plants. In order to clarify symbiotic mechanisms by AM fungi, we have conducted the screening of mycorrhiza formed by A. thaliana as its complete base sequence has been already demonstrated. Almost all of the A. thaliana used (30 mutants and 141 ecotypes) did not present AM formation except for 5 ecotypes and 2 mutants. In particular, the percentage of AM infection in 3 ecotypes (1484, 1502 and 1524) and ctr1-1 mutant was 61.3, 12.7, 10.7 and 5.8, respectively. Evidence of AM development in ctr1-1 strongly supports some reports (Ishii et al., 1996; Geil and Guinel, 2002) that ethylene plays an important role in AM symbiosis. Ishii et al. (1996) also indicated that spore germination and hyphal growth of AM fungi were stimulated at concentrations ranging from 0.01 to 0.1 ppm ethylene, but 0.2 ppm and above were inhibitory. The finding that several kinds of ecotypes have the ability to display higher percentages of AM infection will aid in the genetic analysis of mycorrhizal symbioses.

(# 733) Little N is cycled from senescing annual grasses to neighboring plants in a California oak woodland

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In California blue oak woodlands, dominant species have differing competitive strategies for nutrient acquisition, both spatially and temporally. Spatially, grasses and forbs have high growth rates and morefine-root surface area; oaks have the opposite. Temporally, grass/forb fine root production is greatest in winter, and in oaks is greatest in summer after grasses have senesced. Thus nutrient movement among plants may be influenced by phenology, and may also be affected by common mycorrhizal networks. This field study examined effects of phenology on ^{15}N movement from a donor grass to neighbouring plants, and how ^{15}N was partitioned within plants. In spring and summer 2002, donor grassshoots were labelled with 0.5% ^{15}N-urea (99%) solution for 48 hours at vegetative, flowering, or seed-filling stages. Two weeks later, roots and shoots within 7.5 cm of the donor were harvested. Acquisition of ^{15}N by receiver plants was affected by donor phenology. All receiver plants acquired ^{15}N when the donor grass was flowering; oaks continued to receive more during donor senescence. Partitioning between roots and shoots was similar among plant groups, but varied with harvest time. Forbs, the plants with the greatest biomass, received the greatest amount of ^{15}N. However the % derived from source was less than 0.1%, thus the amounts transferred were small and may not be physiologically significant. Since there was no preferential transfer of ^{15}N from grass donor to grass receivers, the data do not support the theory of ^{15}N transfer via a common mycorrhizal network.

(# 734) Tracking Changes in AM Fungi Grown in Pot Cultures Over Long Periods

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Cultures of arbuscular mycorrhizal fungi (AMF) have been exchanged between researchers around the world for many years. Until recently, taxonomy and hence identification of fungi for quality control in maintenance of cultures has relied totally on morphological characteristics. With the advent and wider application of molecular techniques taxonomy is advancing and is becoming far more precise. It is now possible to look closely at species which we have cultured over many years in media different to their origins to see if any genetic drift has occurred.

Glomus versiforme cultures used in many labs today reportedly all have the same origin. G. versiforme has been grown in pot cultures in Adelaide for over a decade in low phosphate (<10ppm) soil/sand mix at a pH of 7.88. Cultures with different times of initiation were compared using standard molecular techniques. These cultures were also compared with one from Denmark (assumed to be from the same original source) and a possible new source of G. versiforme from Australia, both with respect to spore characteristics and genetic sequences. Colonization patterns of G. versiforme have also been studied in Lycopersicum esculentum Mill. (tomato) 76R (wild type) and rmc (reduced mycorrhizal colonization mutant). This comparison serves as a morphological indicator of any possible genetic shift.

(# 736) Pedological Studies in the Izeh Area of southern Iran

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The study area is located in northeast of Khozestan province in southwestern of Iran. The climate is semi-arid with mean annual rainfall of 650 mm. There was not any published document regarding the soils of this area. The objective of this study was to examine physical, chemical, and mineralogical properties, and also, obtain information on the fertility of these soils. Two transects from north to south and east to west on the different physiographic units was sampled. The soils are classified in three orders. Topography is the most important factor in the formation of these orders. X-ray analysis indicate that smectite, illite and chlorite are dominant, and palygorskite, kaolinite, vermiculite and interastratification clays are present in smaller quantities. The soils have sufficient phosphorous and potassium for crop production and medium soil organic matter.

(# 737) Lipo-chitooligosaccharide: handling and storage

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Lipo-chitooligosaccharides (LCOs or Nod factors) produced by rhizobia are not only important for the establishment of legume-rhyzobia symbiosis, but also have a potential to improve somatic embryogenesis, seed germination and plant growth and development of some important crops. We evaluate different methods of handling and storage of Nod Bj-V(C18:1 MeFuc), the major Nod factor produced by Bradyrhizobium japonicum, on its recovery and biological activity. During freeze drying to purify LCO solution obtained through HPLC isolation, approximately 10% of the LCO was lost, regardless whether polypropylene or glass material were used as the container. For sterilization, filter materials affected the amount of LCO loss, being in order: polyestersulfone (32.3%), cellulose acetate (55.1%), nylon (51.9%), polytetrafluoroethylene (62.0%) and mixed cellulose ester (68.2%). Autoclaving LCO can be used an alternative to filtering to sterilize LCO solution; around 70% of the LCO was recovered after autoclaving for durations of 15 to 30 minutes. Storage temperature affected LCO degradation. LCO degraded faster when stored at 23 ± 2 oC (room temperature) than at 4 ± 1 oC (refrigerator); after a duration of 16 months 74% of the LCO was recovered following room temperature storage and 84% following fridge storage. When tested at the same concentration (10-7 M), the biological activity (root hair deformation and seed germination in soybean) of LCO obtained from autoclaved and stored samples were similar to that of freshly prepared LCO.

(# 738) Enhancement of Calcium Uptake into Soybean by Nod Factor

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Nod factors or lipo-chitooligosaccharides (LCOs) produced by rhizobia during legume-rhizobia symbiosis are known to cause transient increases in cytosolic calcium concentration in the root hairs of legumes. Soybean seedlings at the V1 stage were placed in treatment solutions containing LCO, rhizobial innoculum, or various other compounds. Seedlings were then transferred into test solution containing Murashige and Skoog basal salt medium and the radiotracer 45CaCl2 to examine Ca uptake. Twenty-four hours following the addition of the radiotracer, trifoliolate leaf samples were harvested and 45Ca2+ measured by liquid scintillation counting. Incubation with NodBj-V(C18:1 MeFuc) prior to testing increased the 45Ca2+ uptake into seedling leaves in a concentration-dependent manner. Similarly, incubation with Bradyrhizobium japonicum strains 532C and USDA3 also increased 45Ca2+ uptake into trifoliolate leaves. No increased 45Ca2+ uptake occurred into seedling leaves following incubation with strain Bj-168, a nodC- mutant incompetent to produce LCO or either Rhizobium leguminosarum and Sinorhizobium meliloti, two Rhizobia that do not normally nodulate soybean. The tetramer or pentamer of chitosan and lumichrome also did not affect 45Ca2+ uptake. This work suggests that rhizobial symbiosis, in addition to its known role in provision of nitrogen, also improves calcium uptake into soybean plants.

(# 739) The use of new Köppen climate map for mycorrhizal sampling

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A new Köppen climate map was generated using the methodology as published on the web site: http://clem.mscd.edu/~wagnerri/Climatology/classification.htm and the climate surfaces (rainfall, temperature) developed by ARC-ISCW. The current Köppen climate map (created from station point data) showed potential for improvement and having the recently developed climate surfaces it was possible to do so.

Uses of this map include the very broad determination of animal/plant/disease climate suitability. It could also be used to ensure that the country's main weather station networks do cover the spatial variability in climate. An example presented on the poster is where climate, pH, P and top soil texture grids were reclassified in classes of importance for mycorrhizal fungal growth and a permutation (all possible combinations) map was generated to present the possible sites where different mycorrhizal fungal types (indigenous ecotypes) could be found. Examples of maps and results for isolates already baited are presented.

(# 740) Farmer-directed on-farm experimentation examining the impact of companion planting barley and oats on timothy-alfalfa forage establishment in central Newfoundland

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Growing barley or oats in the year of forage establishment is a common agronomic practice in marginal growing regions, but is not often recommended to growers. We worked with a dairy farmer in central Newfoundland in a 4-yr study to address his question of what the best cereal species and seeding rate were for use in companion cropping during forage establishment. Our treatments consisted of barley planted at three seeding rates together with a forage companion crop of timothy (Phleum pratense L.) and alfalfa (Medicago sativa L.), and oats planted similarly. The alfalfa-timothy mixture companion planted with barley yielded 11% more forage dry matter than with oats in the year of planting, but the two species did not differ for any other forage quality trait, or yield. Increasing seeding rate from 22.5 to 67.5 kg ha-1 resulted in a linear increase in forage dry-matter yield in the year of planting of 32%, and linear decreases in percentage crude protein of 20%, P of 12% and Ca of 35% in the harvested forage. Companion planting oats or barley at rates increasing from 45 to 67.5 kg ha-1 in the planting year resulted in a 9% increase in timothy-alfalfa in the second-year forage harvest, but did not alter any other forage quality trait. The decision process for the choice of cereal species, and the seeding rate of the companion planted cereal, will involve a producer-inferred balance between higher yields at higher seeding rates, with an inevitable forage quality decline as yields increase in the year of seeding.

(# 741) Two-way nitrogen transfer between Eucalyptus and Casuarina linked by a common ectomycorrhizal network: 15N natural abundance studies.

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Plant roots are often linked by common mycorrhizal networks (CMNs) that are pathways for nutrient transfer between plants. One-way N-transfers between mycorrhizal plants have been reported by ^{15}N enrichment labelling, but not two-way transfers. Nor was such transfer evidenced by ^{15}N natural abundance (^{d15}N) studies. In mixed Australian native Casuarina and Eucalyptus communities, both mycorrhization and nitrogen cycling are extensive. We asked: Does two-way N-transfer occur between the non-leguminous actinorrhizal N-fixing Casuarina and the non-N-fixing Eucalyptus? Is N-transfer affected by mycorrhization and/or N-fixation? Eucalyptus maculate and Casuarina cunninghamiana were grown in 3-compartment-box (300 ´ 12 ´ 150cm, separated by a 37µm mesh). The middle 10mm narrow compartment acted as the air gap bridge for hyphal linkage, and excluded root contact and water movement. Three 'N-donor' seedlings [either Casuarina or Eucalyptus, without (half-year-old) or with (1-year-old) external ^{14}N supplement] were planted on one outside compartment and three 'N-receivers' on the other. We observed bi-directional N-transfers between Eucalyptus/Casuarina pairs by detecting the variations of their ^{d15}N values, linked by a CMN with the fungus Pisolithus tinctorius. The results suggest that N_2-fixing capacity is not a prerequisite for N-transfer, but may affect the intensity of this two-way mycorrhiza-mediated N-transfer. If Casuarina was not nodulated, N-transfer to Casuarina or to Eucalyptus was similar. If Casuarina was nodulated, more N (2-4 times) was transferred than in non-nodulated mycorrhizal pairs, whether Casuarina or Eucalyptus was the N-donor. Surprisingly, Eucalyptus (non-N_2-fixer) donated 1.5 times more N to Casuarina (N_2-fixer) than the reverse, especially when adequate external N was accessible. Growth of Casuarina was significantly increased by interspecific N-transfer relative to Eucalyptus. We postulate a 'myco-centric' N-transfer mechanism to account for these differences. The magnitude of mycorrhiza-mediated N-transfer and N movement may be determined by dynamic four-way interactions among plant roots, mycorrhizal fungi, N_2-fixing bacteria, and soil N resource availability.

(# 742) Monitoring the impacts of introduced biocontrol agents on mycorrhizal fungi populations in soybean and potato crops using PCR-SSCP analysis

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Single strand conformational polymorphisms (SSCP) electrophoresis analysis has been used to monitor the impacts of inoculating biocontrol agents (BCAs) in soybean and potato fields on arbuscular mycorrhizal fungi (AMF) populations. In soybean fields under conventional tillage(CT) and no-tillage (NT), two types of BCAs (SoilGard® Gliocladium viren; Glomus intraradices + Glomus mossae) have been applied alone or in combination in random blocks repeated six times. Also, in a potato field, cedar's bark chips, chitosane powder or talc have been applied on seed potatoes alone or in combination with a BCA (Streptomyces spp. strain EF-76) in random blocks repeated four times. Soil samples from each plot have been collected at three dates during two successive growing seasons. Total soil DNA has been extracted, purified and quantified. DNA extracts were used in nested PCR assays done with a first set of primers (NS1/NS41) then with a second set of primers (NS31/AM1) to amplify a partial sequence of the 18S rRNA of AMF. SSCP analysis of NT soybean fields showed the higher number of SSCP profiles and sampling dates induced quantitatives modifications among those profiles. During growing seasons, qualitatives and quantitatives modifications were observed among the fewer number of band profiles from CT soybean fields. The BCA applied to potato seeds showed higher impacts on AMF populations early on during the growing season.

(# 743) Relation between sorption and biodegradation of 2,4-D in soil, as influenced by soil texture and soil organic matter characteristics.

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This study examined the relation between herbicide biodegradation and sorption as influenced by soil texture and soil organic matter characteristics. Five soils were collected from different regions in Manitoba with the soil organic carbon contents ranging from 0.9 to 3.8%. Organic amendments that were added to these soils included wheat and canola crop residues, wood shavings, and humic acid.

Soil alone, amendments alone, and soil/amendment combinations were incubated at two different temperatures and herbicide mineralization was studied by adding a 14C-ring labeled herbicide (2,4-D) to soil and trapping evolved 14CO2 in 1 N NaOH. Herbicide sorption was quantified using the batch-equilibrium technique, and reported as the sorption distribution coefficient (Kd).

Results indicated that herbicide sorption and biodegradation are well correlated, however, the strength of correlation was strongly influenced by previous exposure of soil to 2,4-D, the decomposition stage of soil organic matter, and soil temperature.

(# 745) Chitin Content Influenced by Heavy Metals in Arbuscular Mycorrhial Fungal Spores

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Biostabilization is a promising alternative for remediation of soils contaminated by potentially toxic elements (PTEs). This alternative involves the use of microorganisms and bioproducts to stabilize and ameliorate toxic effects of these elements to the plant-soil-environment system. Few studies have regarded the nature of PTE-accumulation and mechanisms involved in arbuscular mycorrhizal fungi (AMF), which may be important to obtain a better understanding of their participation in plant tolerance and ecological significance in polluted soils. Previous results showed that the spore cell wall thickness was increased under polluted conditions. This study regards the potential participation of chitin, the main structural cell wall compound in spores of AMF, as a PTE-sequestering agent. Spores of two AMF (Glomus mosseae BEG-132 and G. caledonium BEG-133), isolated from a soil polluted containing high PTEs concentrations, were used. Four different treatments, regarding two continuous or discontinuous propagation cycles under polluted conditions, were established. They were: WP-WP, P-WP, WP-P, and P-P; where WP=without polluted soil and P=polluted soil. Chitin quantification of spores was obtained by the ratio of hexosamines to neutral sugars in three independent measurements. It was observed that spores propagated with polluted soil increased the amount of chitin in comparison to absence by two cycles of polluted condition in the propagation substrate (control). In spores of BEG-132 in the control treatment (WP-WP), the chitin amount was 0.19; while in the other treatments the range was between 0.20-0.25. In BEG-133, it was 0.16 in WP-WP, 0.21 in both P-P and P-WP, and 0.23 in WP-P. It is suggested the use of AMF on bioremediation technologies by participating on sequestration-accumulation of PTEs and decrease of plant PTE-toxicity.

(# 746) Models of Plant & Fungal Population Interactions During Mycorrhizal Symbiosis

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This paper contests that the mycorrhizal ecological term 'mutualism' is sometimes over-emphasised or over-stated in order to convey overall mutual / bi-directional 'benefits' to plant and fungal symbiont partners.

This paper also describes how ecological costs and benefits of plant-fungal symbiosis can be modelled, pictured & linguistically accounted for, to reflect the symbiogenesis or ontogeny of various mycorrhizal symbioses.

Mycorrhizal population interactions of plants, humans & soil fungi are diagrammed and tabled to describe positive (+), negative (-) and neutral (0) or negligible symbiont interactions, environmental and social impacts.

(# 747) A low-cost & low-heat method for transmitted-light dissection microscope examinations of intact root segments

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A transmitted-light dissection microscope method is described that enabled good subject illumination produced from a low-heat 'energy-efficient' light source. The practical advantages of this method included an absence of incident light reflections from wet surfaces of intact, cleared & stained Zea.mays root segments. Furthermore, there were also savings made in root segment sample preparation times, & reduced materials costs for microscope examinations.

This method was attained by the low-cost modifications and re-use of a common research & teaching microscope, a 1960's vintage Olympus SZIII dissection microscope. Modifications to the 'trans-illuminator' base included a 21W fluorescent light tube with an 'Edison-screw' connection replacing both the mirror and the original light source, a 20W Olympus incandescent light bulb.

(# 748) The Contribution of Soil Fractions to the Dynamics of Soil Organic Matter.

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A transmitted-light dissection microscope method is described that enabled good subject illumination produced from a low-heat 'energy-efficient' light source. The practical advantages of this method included an absence of incident light reflections from wet surfaces of intact, cleared & stained Zea.mays root segments. Furthermore, there were also savings made in root segment sample preparation times, & reduced materials costs for microscope examinations.

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(# 749) Phosphorus, Arbuscular mycorrhizal fungi and performance of the wetland plant Lythrum salicaria L.

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The importance and functioning of arbuscular mycorrhizal (AM) associations in terrestrial systems have received considerable attention, but this is not the case for aquatic or semi-aquatic systems. While manystudies have documented the occurrence of AM fungi in aquatic systems, few have attempted to clarifytheir importance. In this study we attempted to identify the role of AM in inundated soils. Two questions were asked. Under inundated conditions:

1) Do AM fungi improve plant performance?
2) Can high levels of phosphorus lead to an uncoupling of the AM association?

To address these questions, L. salicaria plants were grown under inundated conditions and exposed to one of five phosphorus levels (0, 1.25, 5, 10, 40 mg/L). L. salicaria is a semi-aquatic, facultatively mycorrhizal species which is known to form AM associations under flooded conditions. The presence ofAM fungi had no detectable benefit for any measures of plant performance (total shoot height, shoot dry weight, shoot fresh weight, root fresh weight, total root length or total root surface area). AM+ plants displayed reduced shoot height at 10 mg/l P. Overall, shoot fresh to dry weight ratios were higher in AM+ plants although the biological significance of this was not determined. AM colonization levels were significantly reduced at P concentrations of 5 mg/l and higher. The results suggest that AM fungi have little effect on plant response to P supply in inundated conditions and that the AM association canbecome uncoupled at relatively high levels of P supply

(# 750) Effect of Long-Term Contrasting Anthropogenic Emission on Ectomycorrhizal Community Structure of Scots Pine Stands in Poland

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Scots pine stands grown on acidic, sandy and nutrient poor soils with low buffering capacity which cover the bulk area of the of the Polish Lowland are often subjected to different anthropogenic impacts. As a result, a loss of mycorrhizal diversity can occur with consequences on root growth and tree performance. As ectomycorrhizas reveal varying degrees of sensitivity to environmental pollution we investigated the mycorrhizal coenosis (i.e. composition and abundance of morphotypes) of P. sylvestris trees growing close to a phosphate fertilizer plant (SO_2, NO_x, F, Al_3+ pollution) and Copper Smelter (SO_2, heavy metals pollution). The third stand was situated in the experimental forest, free of acute pollution and was considered as a control. Three different approaches were performed: sporocarp inventories, morphological analysis of ectomycorrhizal roots and molecular techniques based on PCR-RFLP method. To explore the role of genetic factor on mycorrhiza formation in the condition of industrial pollution Scots pine populations were examined spanning the north-south range of the species. The vertical distribution of mycorrhizas was additionally studied. By comparison with similar studies from control P. sylvestris plots situated in the region free of industrial emission, our data indicate that severe soil contamination by heavy metals resulted in marked changes in community composition of mycorrhizal fungi. Significant effect of the genetic factor on mycorrhizal community structure was revealed.

(# 751) Elemental and Isotopic Partitioning in Ectomycorrhizal Systems under Exponential Growth

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Steady-state conditions (exponential growth) are valuable for culturing mycorrhizal symbioses because constant internal nutrient conditions are created. Exponential growth should prove useful in studying the partitioning of isotopes, nutrients and elemental tracers (e.g., strontium) between mycorrhizal fungi and their plant hosts, and thereby provide important models for linking mycorrhizal fungi to biogeochemistry. In this study, patterns of ^{13}C and carbon partitioning in cultures of non-mycorrhizal and ectomycorrhizal Pinus sylvestris (colonized by Suillus luteus or Thelephora terrestris) were assessed at two N availabilities during exponential growth. At high N availability (5% day-1), system ^{13}C was 1.0‰ higher than at low N availability (3% day-1). Colonization by Suillus increased system ^{13}C by 0.9‰ at low N availability, indicating improved water use efficiency and enhanced photosynthesis rates, presumably because of enhanced sink strength. Allocation to mycorrhizal fungi was greatest at low N with Suillus colonization. Relative to foliage, roots and mycorrhizal fungi were enriched in ^{13}C about 1.5‰ and 3‰, respectively. This progressive enrichment with increasing distance from foliage probably arose because mobile carbon compounds (sugars and amino acids) were enriched in ^{13}C relative to many immobile compounds (phenolics and lignin), with mobile, ^{13}C-enriched carbon then becoming the source carbon for further isotopic fractionation along biosynthetic pathways. Nutrient concentrations in mycorrhizae versus foliage and comparisons with literature values suggested that mycorrhizal colonization affected nutrient partitioning, and that therefore elemental ratios in foliage (e.g., Ca/Sr) should not be used as unequivocal indicators of source material. These results also imply that reduced mycorrhizal colonization in response to anthropogenic N deposition could strongly affect the uptake and cycling of many nutrients.

(# 752) Effect of Management Practices on Mycorrhizal Colonization, Early P nutrition and Yield in Corn

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Phosphorus deficiency in juvenile corn plants reduces yield and delays maturity even if ample soil P is available later. Poor colonization of corn roots by arbuscular mycorrhiza (AM) may contribute to low P uptake by juvenile plants. Management practices that reduce root colonization lead to reduced early P uptake and yield. We examined the effects of management practices that reduce AM colonization on early P status and yield of corn. Intensive tillage reduced AM colonization and P uptake at the 3-6 leaf stage, reduced yield and delayed maturity at harvest. Sidebanded P (30 kg P ha-1) did not reduce AM colonization and increased P status of juvenile plants. However, corn with low AM colonization, such asafter fallow or canola, did not take up as much sidebanded P as well-colonized plants. Similarly, juvenileplants growing on manured soil did not have reduced P colonization even if P was supplemented by sidebanding. Young corn plants with reduced colonization due to previous fallow had less P uptake on manured soil than well-colonized corn. Because the amount of P taken up by corn at the 6-leaf stage is less than 1 kg ha-1, we are investigating the possibility of using small amounts of seed-placed P in combination with optimizing AM colonization to ensure adequate levels in young plants.

(# 753) Surface-Banding with Assisted Infiltration- New Low Disturbance Technique for Applying Slurry on Land

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Manure nutrients are required for crops but applying manure onto land can lead to environmental concerns. Some of these risks can be reduced by injecting manure into soil or quickly incorporating the manure after application. However, injection and incorporation may cause excessive soil disturbance, so less disruptive systems are required. This study compared effects of applying dairy slurry on a perennial grass sward by broadcasting or banding on the soil surface, with a new technique designed for rapid infiltration with low soil disturbance. The new applicator, called AERWAY SSD (Holland Equipment, Norwich, ON), creates vertical aeration slots then bands manure over the slots. Results from two years of testing in south coastal BC show that the new applicator delivers manure uniformly and does not damage existing crops. The method slightly improves crop response (yield and N offtake) to manure and reduces ammonia volatilization by over 40% and odour emission by 35% compared to surface broadcasting. There is also indication that the system will reduce surface runoff, although it does not reduce emission of nitrous oxide compared to surface broadcasting. The applicators, which are available in 2.5- to 10-m widths, have proven through extensive farm use all over North America to be robust, rapid and relatively low cost.

(# 754) Arbuscular Mycorrhizal Fungi and Temperature

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I have found differences in the fungal genotypes colonising plants from sites varying in temperature along an altitudinal gradient. Well colonised plants from cold sites became markedly less colonised when brought into culture in a warmed greenhouse. This poster assesses whether this difference is a direct response to temperature.

(# 755) The ectomycorrhizal community of true fir (Abies spp.) in the Southern Sierra appears to have a higher component of hypogeous fungi than previously studied communities

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Marc Meyer (University of California, Davis)
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Hypogeous fungi play important roles in the ecology of western U.S. coniferous forests. Studies of hypogeous sporocarps show impressive annual production rates and high levels of species richness. Despite this fact, in most underground ectomycorrhizal (ECM) community studies they seem to be less important on the roots, making up 0-5% of the species and no more than 15% of the root biomass. We took a directed effort to address this discrepancy and to develop an estimate of hypogeous contribution based on the belowground ECM community. In order to increase our ability and accuracy of identifying hypogeous ECM taxa, we compared DNA sequence data from the internally transcribed spacer (ITS) region of the rDNA amplified from three sources: 1) ECM root communities of true fir (Abies concolor and Abies magnifica) in a Sierra Nevada old growth mixed conifer forest; 2) scat samples collected from small mammals throughout the same study site; and 3) hypogeous sporocarps found throughout the Sierra Nevada. Our results show that hypogeous taxa make up a minimum of 15-20% of the species and 25-40% of the dry root biomass on Abies spp. in this old growth forest. This value is much higher than has been reported in other ECM studies. We speculate that the difference is due in part to the large number of unidentified sequences and morphotypes in all ECM studies but also may be related to the importance of hypogeous fungi in dry forests such as the one in this study.

(# 756) The interactive effects of AMF and leaf endophytes on leaf physiology: defense against a common pathogen

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The vast majority of plants are actually a mosaic of plant and fungal tissues. Mycorrhizal fungi colonize the roots and the leaves are associated with fungal endophytes — fungi that colonize and grow asymptomatically within healthy plant tissues. Both arbuscular mycorrhizal fungi (AMF) and foliar endophytes are ubiquitous among woody plants in diverse lowland tropical forests. Potential benefits ofthe belowground fungi are well known, but there is relatively little known about the effects of leaf endophytes and almost nothing is known regarding the interactive effects between the two symbioses. Using a community of three locally common AMF species and a single species of leaf endophyte, we created factorial combinations of the host species, Theobroma cacao, with and without the two symbioses. From the highly diverse assemblage of leaf endophytes, we chose a species that showed an antagonistic effect on in vitro growth of a common foliar pathogen, Phytophthora sp. We measured the interactive effects of below- and aboveground fungi on the water relations of healthy hosts both at the level of the root and the leaf, plant productivity, and photosynthesis. Following introduction of the foliarpathogen, we re-examined plant physiology. The protection by endophytes against leaf damage and lossare discussed in terms of the potential mechanisms demonstrated by the changes in plant physiology.

(# 757) Reduced Tillage Does Not Enhance Organic Carbon Sequestration in Southern Ontario Soils.

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Soil organic carbon (SOC) is a critical pool for maintaining soil quality and for mitigating global climate change. Here we report on long-term field studies that examined tillage effects on SOC sequestration in loamy sand and silt loam soils. Crops (corn, soybeans, wheat, rye, and tobacco) were pulse labeled with 14CO2 to measure decay of plant residues. Sequestration of corn residue C and decay of relic SOC was determined using delta 13C techniques. In the sandy soil only, residue decay was marginally slower with reduced tillage during the first two growing seasons but not thereafter. Furthermore, tillage practices had no affect on corn-derived C accumulation in soil or decay of relic SOC. We conclude that reduced tillage does not promote SOC sequestration in a subhumid climate.

(# 758) Role of Mycorrhizal Associations in Water Flow Regulation of Woody Plants

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There is growing evidence that in addition to stomatal regulation of plant water flow, Aquaporin mediated root water transport plays a significant role in controlling water balance in plants. Ectomycorrhizae alter roots water flow properties, including roots hydraulic conductivity in woody plants. In the studied ectomycorrhizal plants, root hydaulic conductivity increased several-fold and this increase may be highly significant for the growth and survival of plants in challenging environments, including cold and nutrient-deficient soils. Similarly to plants, the studied species of fungi have been demonstrated to contain aquaporins which regulate water flow across the membranes. However, there ispresently little evidence suggesting that the fungal water channel proteins are responsible for the increase in root hydraulic conductance of the ectomycorrhizal plants. This presentation reviews current knowledge of water flow control in plants exposed to difference environmental conditions and the role of mycorrhizal associations in these processes.

(# 759) Evolutionary Studies of Mycorrhizal Fungi: Milestones and Future Directions

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The widespread production and use of molecular phylogenies has had a dramatic impact on our knowledge of evolutionary patterns within mycorrhizal fungi and has fundamentally changed the way that we identify these fungi in nature. Evolutionary patterns that used to be discerned by intuitive and deductive approaches are new routinely tested with phylogenetic and statistical methods. In many cases,the latter have confirmed long held beliefs, but in other cases novel relationships and patterns have beenrevealed. Evaluating the validity of conclusions drawn from molecular phylogenetic studies requires increasingly sophisticated knowledge of the models employed. The rRNA genes and spacers have beenthe primary targets for phylogenic studies in fungi and the sequences produced have been instrumental in the growth of molecular ecology. However, problems with rRNA loci, including their conservative rate of change and alignability of divergent sequences, mean that evolutionary patterns for many groups of interests remain unresolved. Large scale international projects are new focusing on several protein coding genes; this multi-gene approach will likely resolve the evolutionary pattern in many additional groups and will enable an independent evaluation of earlier rRNA-based conclusions.

(# 760) Molecular physiology of nitrogen assimilation in ectomycorrhizas

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The widespread production and use of molecular phylogenies has had a dramatic impact on our knowledge of evolutionary patterns within mycorrhizal fungi and has fundamentally changed the way that we identify these fungi in nature. Evolutionary patterns that used to be discerned by intuitive and deductive approaches are new routinely tested with phylogenetic and statistical methods. In many cases,the latter have confirmed long held beliefs, but in other cases novel relationships and patterns have beenrevealed. Evaluating the validity of conclusions drawn from molecular phylogenetic studies requires increasingly sophisticated knowledge of the models employed. The rRNA genes and spacers have beenthe primary targets for phylogenic studies in fungi and the sequences produced have been instrumental in the growth of molecular ecology. However, problems with rRNA loci, including their conservative rate of change and alignability of divergent sequences, mean that evolutionary patterns for many groups of interests remain unresolved. Large scale international projects are new focusing on several protein coding genes; this multi-gene approach will likely resolve the evolutionary pattern in many additional groups and will enable an independent evaluation of earlier rRNA-based conclusions.

(# 761) Function of the extraradical versus root-associated mycelium in Paxillus involutus/Betula pendula association: identification of differentially expressed genes using High-density cDNA macroarray.

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The bulky tissue of the ectomycorrhizal mantle provides a structure suitable for nutrient storage and plays a key role in control of nutrient transfer between fungus and plant through its intimate contact with the root surface. However it does little to increase the surface area of the colonized root in contact with the soil. This function is provided by the extraradical mycelium which, as single hyphae or linear aggregates of such hyphae, extends from the mantle. Structural attributes of these mycelial systems are ofadditional importance, because singly and collectively, their constituent hyphae form the connection between mantle and soil, and so provide the pathways for nutrient exchange. A molecular approach has been developed to demonstrate a differential gene expression between mycorrhiza and extraradical hyphae using High-Density cDNA macro-array experiments in order to go further by comparing gene expression profiles in different nitrogen conditions. Hyphae of Paxillus involutus were allowed to extend from mycorrhizal roots of Betula pendula in non-sterile peat microcosms. Total RNA was extracted and retro-transcribed to synthesize double strand probes, which were further used to hybridize 1200 fungal cDNAs spotted onto Hybond N+ nitrocellulose filters. The most differentially expressed genes between the two tissues have been sequenced and these data confirm that the extraradical mycelium possesses specific functions, not shared with the mycelium in close contact with root cells. These genes are mainly involved in nitrogen acquisition, urea cycle and morphogenesis. Their further molecular and biochemicalcharacterization will allow us to determine how the mycelium is able to adapt itself when the nitrogen composition of soil changes.

(# 762) System responses to environmental change: the mycorrhizal component

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As ecosystems experience rapidly changing environments, mycorrhizal fungi inthem will need to respond to these changes, but they will also modulatesystem responses to them. This rather obvious statement implies that weunderstand both the structure and dynamics of communities of mycorrhizalfungi and the basic biology of species of mycorrhizal fungi in response toenvironmental factors. Regrettably neither of these assumptions is true.In a warmer, CO_2-rich world, will some mycorrhizal fungi be at an advantage,others disappear? What consequences will that have for the system? Mostecosystems have diverse communities of either arbuscular or ectomycorrhizalfungi; what controls that diversity is largely unknown, although the role ofplant partners in the symbiosis is becoming apparent. Under environmentalchange, plant communities will experience both extinction and invasionevents: will mycorrhizal fungi exert some control over those events ormerely reflect them?

(# 764) Communication between the partners in the arbuscular mycorrhizal symbiosis

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Fossil data have shown that, early during terrestrial colonisation, plants were already living in close association with arbuscular mycorrhizal (AM) fungi. During these 400 million years of genome/genome interaction, plants and AM fungi became highly interdependent. Until recently, the study of the intimate molecular and cellular mechanisms underlying the obligate biotrophic nature of AM fungi was an almost inaccessible challenge. An experimental system was developed to grow AM fungi in vitro using hairy roots as plant host. This system opened new possibilities to study the growth requirement of the fungal partner as it provides, for cellular and biochemical analyses, clean fungal material at various symbiotic stages. AM fungi possess all primary metabolic functions (glycolysis, pentose phosphate pathway, TCA cycle, glyoxylate cycle, CO2 dark fixation, gluconeogenesis, nucleic acid, lipid and amino-acid biosynthesis, etc), including the capability of utilising exogenous simple sugars. However these functions are expressed during separate fungal developmental stages (and in different cellular domains), under the control of plant host regulation. These data on fungal metabolic capacities and the large genome size of AM fungi would not be expected if the fungus had been subjected to important genetic loss during its long endosymbiotic life. Rather, these data encourage our current investigations on AM symbiotic signalling and on the mechanisms by which plants can tune vital functions of their fungal partner.

(# 765) Indicators of Phosphorus Non-Point Source Pollution in a Large Watershed

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The Pike River is amongst the main watercourses discharging into Missisquoi Bay, a spur of Lake Champlain extending into Quebec. Its watershed drains some 630 km2, of which 99 km2 are located in Vermont. The development of agroenvironmental indices of non-point P pollution was supported by remote sensing, spatial integration of data and the Soil and water assesment tool (SWAT). These indices were evaluated on subwatersheds of about 5 km2. The validation of the indicators at the sub-watershed scale was supported by water quality records from the monitoring of 18 tributaries and sections of the Pike River. The agricultural land use, topographic attributes, the runoff SCS curve number, the mass balance of P and the P soil saturation were significantly scorrelated with P concentrations measured under peak streamflow conditions, in response to spring and fall long-duration precipitations, snowmelt and saturated or frozen soils conditions. associated with peak stream flow. It was found that 82 % of the variation for bioavailable P sampled within the hydrological network is explained by the P mass balance (at soil surface) and subwatershed agricultural land use. The P sources and transport agri-environmental indicators provided valuable and complementary explanations of spatial distribution of stream P data.

(# 766) Diversity and frequency of occurrence of arbuscular mycorrhizal fungi (AMF) in an agroforestry and monocrop farming system in Malawi

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Robert Sinclair (Amphigro CC)
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Some basic ecological data regarding the AMF in Gliricidia sepium intercropped with maize agro-forestry and maize monocrop farming systems in southern Malawi has been evaluated. Twelve AMF species were identified from the sites. Species diversity and frequency of occurrence was determined in the dry vs. wet seasons and under four different inorganic fertilizer application regimes, namely, the application of nitrogen alone, phosphorus alone, nitrogen and phosphorus in combination and no application. Species diversity indices were subjected to ANOVA and the frequency of occurrence data to logistic regression. Species diversity was higher in the wet season than the dry season ($p<0.001$). Although less significant ($p<0.05$), without inorganic fertilizer, species diversity was higher in agroforestry plots than in monocropped plots. Species diversity was reduced by the application of inorganic fertilizer in agroforestry plots, most notably in plots with N in the dry season and N and P in the wet season. In monocrop plots, the application of N and P singly increased species diversity, but in combination decreased species diversity, most significantly in the dry season between P and the combination of N and P, the latter being lower. Species diversity was consistently low in plots with a combination of inorganic nitrogen and phosphorus fertilizer in both farming systems. There was no relationship between species occurrence and the family or genus of AMF. Four species occurred most in the monocropped system and the remaining eight were not affected by farming system. Five species occurred most in the wet season, three in the dry season and four were not affected by season. The frequency of occurrence of eight out of the twelve species decreased in plots with inorganic fertilizer, one species was enhanced and two species were not affected.

(# 767) Synergism of Arbuscular Mycorrhizal Fungi and Organic Compost in Ameliorating of Soil Nickel ex-Mining

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Pomalaa nickel mining with soil chemical properties: pH = 6.3; C-organic = 0.64 %; N-total = 0.06 %; Bray-P = 0.05 ppm; and Ni = 272 ppm formed an obstacle in reclamation as indicated by nutrient deficiency or toxicity. This paper purposed to discuss synergism effect of two sources of arbuscular mycorrhizal fungi (AMF): Indigenous mycorrhizal from Pomalaa nickel mining (Atm) and introduced one from non mining (Kdi). Both inocula were then multiplied in sterilized soil for three months. 750 g/plant of these inocula which consisted of soil, infected roots and propagules were used as mycorrhizal treatments ina thin layer of 10 cm depth combined with four levels of organic matter (0, 2.5, 5.0, and 10.0 % wt/wt wet soil basis). Non-mycorrhizal treatment was conducted as for mycorrhizal treatment, except, that mycorrhizal propagules were eliminated by heat sterilization at 100º C for 50 minutes. Plant test was Gmelina arborea Roxb. with plant spacing 3 m x 3 m for 20 weeks. The results indicated that inoculation of indigenous AMF (Atm) produced higher biomass and mycorrhizal infection on Gmelina arborea Roxb as compared with non mycorrhizal or introduced AMF from non mining area (Kdi). Available P content was increased two to five fold due to an increase in soil organic matter and AMF inoculation. This finding concluded that dual applications of organic matter and AMF was significantly produced synergism effect on P availability and plant biomass production on soil nickel ex-mining.

(# 768) Water relations and biochemical changes in mycorrhizal and non-mycorrhizal tomato plants in response to drought

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This work aimed in a comparative study of the effects of three arbuscular mycorrhizal fungus (AMF) species on tomato plants (Lycopersicon esculentum Mill) subjected to drought stress. The AMF species studied were Glomus fasciculatum, Glomus clarum and Glomus claroideum. Biomass, leaf water potential (Yw), turgor potential (Yp), osmotic potential at full turgor (Yp 100), relative leaf-water content (RWC), proline and amino-acid content, foliar damage and some oxidative system enzymatic activities wereanalyzed. Percentages of mycorrhizal colonization and visual density were determined. A positive influence of AMF on tomato plants was shown, moreover different responses were observed depending on the species used. The obtained results suggest the ability of AMF to diminish negative effects of drought stress.

(# 769) A protocol for spring milling wheat production in the Maritimes

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Maritime cereal producers have had difficulty in producing spring milling wheat crops of 13.5% grain protein with consistency. A 3-year study was conducted from 1999 to 2001 on three Maritime locations to develop a nitrogen management protocol to produce spring milling wheat with 13.5% grain protein. Ten split nitrogen treatments were applied to four spring milling wheat cultivars. Generally, any split nitrogen application of 75 to 100 kg ha-1 or greater produced grain protein of 13.5%. Ten out of thirty-six small plot trials failed to reach the desired 13.5% grain protein at any N treatment. Moisture stress after flowering, excessive precipitation during early plant development and protein dilution due to high grain yield were some of the possible reasons why 13.5% grain protein was not obtained. As grain protein increased, milling quality traits, such as water absorption, dough stability, twenty-minute drop, dough stability and loaf volume improved. There was little or not improvement in milling quality with nitrogen applications greater than 75 to 100 kg ha-1. Maritime grain producers can produce high quality, high yielding spring wheat with relatively low levels of nitrogen input; however, environmental factors may override management in determining the ultimate product quality.

(# 770) Phosphorus Fertilization Affects Dryland Alfalfa Forage Yield and Mycorrhizae in Southwestern Saskatchewan

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A field study was initiated in 1998 at Swift Current to determine the effect of P fertilization on the over-winter survival and hay production of alfalfa (Medicago sativa L.) when grown dryland either in pure stands, or in association with Russian Wildrye (Psathyrostachys junceus L.).Alfalfa was seeded either in pure stands (MONO) or in association with Russian Wildrye (RWR). When alfalfa and RWR were seeded together, they were either seeded in alternate rows (ALT) or mixed in the same row (MIX). Phosphorus was applied as triple superphosphate (0-46-0) either preplanting (PREP), at rates of 20, 40, or 80 kg P2O5 ha-1 or annually (ANN) at 0 (check), 10, 20, or 40 kg P2O5 ha-1. Alfalfa proportion of ALT and MIX treatments biomass declined from 89% in 1998 to 48% in 2002 but P did not affect alfalfa persistence. ANN 40 produced 20% more forage than the check ($P<0.05$). Soil from selected treatments was screened in a greenhouse pot experiment in 2002/03 for the infectivity of arbuscular mycorrhizal (AM) fungi in alfalfa or RWR as measured as the total number of infection points per individual root mass. AM infectivity was lowest in the check MONO soil and highest in the ALT soil with either the 0 or ANN 40 treatment. Infectivity of the RWR appeared to be more strongly affected by the P treatment, and was consistently lowest in the PREP 80 treatment regardless of the soil or alfalfa. Similar to the alfalfa, infectivity in the RWR was highest in the ALT mixture at zero P (check) soil. In contrast, the infectivity of the RWR was unaffected by growing in the pot with alfalfa. The presence of the RWR in the ALT mixture stimulated the infectivity of AM fungi in both plants but not in the MIX treatment.

(# 771) Mycorrhizal fungi as drivers of ecosystem processes in the heathland and boreo-temperate forest biomes of the world

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Together, heathlands and boreo-temperate forests cover c70% of the terrestrial surface of the northern hemisphere. The fungal symbionts of the roots of members of their dominant families, respectively Ericaceae and Pinaceae-Fagaceae occupy the interface between the soils and plant tissues throughout these systems so they are inevitably involved in the processes whereby the autotrophs acquire their essential nutrients. Our perceptions of the extent and nature of this involvement are changing as we increasingly acknowledge the abilities of ericoid and at least some ectomycorrhizal fungi to mobilise those elements, nitrogen and phosphorus, the scarcity of which most affects plant fitness in these systems. This paper will assess an emerging scenario which places mycorrhizal fungi, with their distinctive physiological capabilities driven by access to current photosynthate, at the centre of nutrientcycling and food-web dynamics in heathlands and boreo-temperate forests. It will discuss the likely consequences of these activities for our understanding of the processes of decomposition and carbon turnover in a warming world.

(# 772) Commercial Challenges of Ectomycorrhizal Fungi

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Inoculation with ectomycorrhizal fungi at the nursery and during outplantings continues to be in its infancy in North America on a commercialbasis. A lack of consistent positive results, due to weak quality controlin supply, misinformation, and an insufficient capital base of commercialsuppliers, have plagued the process. But this is all changing now as themarket forces prevail and the cream begins to rise.

(# 774) Mycorrhizal colonisation and the delivery of phosphate in cereal crops.

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Phosphate (P) is an essential nutrient for plants. A depletion zone of P is rapidly created around the plant roots because P is taken up by P transporters expressed in the epidermal cells of the root and root hairs. Because P has a slow diffusion rate through soil it becomes depleted close to the roots and the plants have to use alternative methods to acquire P. One of these involves a symbiotic relationship witharbuscular mycorrhizal fungi (AMF). AMF are able to access P from a larger soil volume than that accessed directly by the plant roots. Phosphate acquired by mycorrhizal hyphae is transported to the plant at the peri-arbuscular membrane. The interaction of plant/AMF is complex with different effects observed depending on plant species/cultivar and mycorrhizal strain involved.Barley cultivars show various rates of colonisation with Glomus versiforme and the phosphate transporters expressed at the root surface are down-regulated when the plants are colonised by AMF. This lends support to the idea that some or all of the P is supplied to the plant via the mycorrhizal colonisation, depending on the particular plant/AMF association. Plant P transporters expressed only when the plant is colonised by AMF have been identified in barley, rice and wheat. These plant P transporters enable these species to take advantage of the mycorrhizal symbiosis making them particularly important to the cereal industry

(# 775) Responses of field-grown mycorrhizal tomato plants under varying intensities of drought.

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Field experiments were conducted in red sandy loam soil (Alfisol) to examine the nutritional, yield and quality responses of mycorrhizal and non-mycorrhizal tomato plants exposed varying intensities of drought stress conditions. Arbuscular mycorrhizal fungal (AMF) inoculum carrying Glomus intraradicesSchenck & Smith was applied @ 50g/m2 in the tomato nursery just prior to sowing. After the establishment of mycorrhizal colonization, tomato seedlings were transplanted in the main field and subjected to varying levels of drought by irrigating the plants at an interval of once in 11 days (l1), 9 days (l2), 7 days (l3), and 5 days (l4), respectively. The data have shown that drought stress decreased the fruit yields of tomato by 28.2%, 19.4% and 10.0%, in l1, l2, l3, respectively, in comparison to well watered plants. However, mycorrhizal colonization increased the fruit yields by 31.8%, 32.0%, 21.6%, and 12.7% respectively. AMF plants had significantly higher leaf RWC (85-89%) then non-AMF plants (78-85%). Further, fruits harvested from AMF tomato plants had higher total soluble solids, titratable acidity and vitamin C contents. Soil samples drawn from mycorrhizal treatments had higher organic status and available nutrients. The data suggest that mycorrhizal colonization significantly enhance the tomato fruit yield regardless of the intensity of drought stress; however, the response was more pronounced under severe water deficit conditions. Drought tolerance of tomato plants may be associated with improved nutritional status and retention of higher leaf RWC. Enhanced soil fertility may have nutritionally supported tomato plants under drought conditions. Overall, the results have shown that mycorrhizas are the major biological constituent in the soil rhizosphere and need to be considered in the context of organically grown tomato.

(# 776) Emerging trends in mycorrhiza-aided host plant drought tolerance

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Arbuscular mycorrhizal fungal (AMF) symbiosis is known to promote host plant drought tolerance as a result of water uptake by the external mycelium (direct effect) and by the improved host plant P nutritional status (indirect effect) under water deficit conditions. Earlier, it was widely believed that the AMFassociation is less important for N nutrition as NO_3 mobility is severely impeded due to its low concentration and diffusion rate. Under such circumstances, the role of AMF in NO_3 transport to the root surface may be significant. We hypothesized that the external mycelium of the AM fungi can transport NO_3 ions to the host plants and that this contribution varies with the moisture content of the growth medium. Further, the hyphal transport of NO_3 can modify the N assimilation, nutritional status and physiological responses in the host plant. To test the hypotheses, AMF inoculated and non-inoculated maize were grown in drought-stressed conditions. After the establishment of AMF colonization, ^{15}N was assessed using mass spectrometer. The data indicated that ^{15}N atom excess % from AM shoots and roots were 32% and 33% higher than non-AM plants under drought conditions. Further, drought-stressed AM roots had 28% higher glutamine synthetase (GS) activity possibly as a consequence of AMF hyphal acquisition of NO_3 ions from the substrate. This study provides clear evidence that the external mycelium transports considerable amounts of N that modifies the acquisition and assimilation of N by the host plant. The data suggest that the improved N nutritional status assists AM plants to exploit the available soil moisture more effectively to maintain higher leaf water status and normal photosynthetic functions. This study proposes a new hypotheses that the mycorrhizal colonization improves N nutritional status that provides greater ability for the plants to sustain water deficit conditions.

(# 777) Evolutionary Theory: Symbiosis, Mutualism and Mycorrhizae

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Evolution is a complementary process of divergence and integration. Symbiosis, the physiological and/or genetic integration of taxa, is recognized today to be at the basis of macroevolutionary changes. It is held to have played a central role in the evolution of eukaryotes, the origin of land plants, and myriad adaptive evolutionary innovations. It is at the basis of important ecosystems from deep-sea vents to the most biodiverse communities on earth: rainforests and coral reefs.We can see from a symbiotic perspective that every eukaryotic individual is a super-organism, a symbiome, comprised of chromosomal genes, organellar genes, and often with other bacterial symbiontsas well as viruses. The symbiome, the limits of the multicellular organism, extends beyond the activities of its "own" cells.

Nucleotide sequencing analysis has revitalized microbial phylogeny, further strengthening a microbe centered view of life on earth, and the role of symbiosis in evolution. Over the past eight years, genomic analysis has also indicated intense gene swapping between bacteria. When taken together with symbiosis, these data contradict several fundamental tenets of the neo-Darwinian synthesis.Yet throughout the twentieth century, biologists had generally considered symbiosis to be a curiosity, a rare exceptional phenomenon. Its study fell largely outside the conceptual and technical framework of biology. To understand why helps us to understand the place of symbiosis in biology today.

(# 778) Exploring the Bidirectional Transfer of Carbon and Nitrogen Between Fungus and Host in the Arbuscular Mycorrhizal Symbiosis

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It is unclear whether the transfers of carbon (from plant to fungus) and nitrogen (from fungus to plant) inarbuscular mycorrhizas are unidirectional. We are using NMR, GC/MS and autoradiography to address this question by following the transfer of isotopically labelled metabolites in dual cultures of Ri T-DNA transformed carrot roots and Glomus intraradices. ^{13}C1,3 glycerol and ^{13}C2 acetate that can be taken upby the extraradical mycelium (ERM), were used to establish that carbon in the form of triglycerides moves back and forth between the ERM and the intraradical mycelium (IRM) but does not label host metabolites. Consequently, that carbon is not transferred to the host in nutritionally significant quantities. We also observed that carbon is moved from one root system to another via a common mycorrhizal network but that even when the recipient root system is carbon limited there is no significanttransfer into host metabolic pools. We will also report on the progress of autoradiographic experiments designed to localize transferred carbon within the recipient host root. ^{15}N and ^{13}C labelled substrates introduced to the ERM result in ^{15}N labelled proteins in the mycorrhizal root indicating that amino acids are not transferred to the host. Little is known about the form of nitrogen transferred from the root to theERM and whether it is obtained from the cortical cells or taken directly from the apoplast. Initial labellingexperiments suggest that nitrogen is taken up by the fungus from the apoplast and not from intracellularhost metabolic pools.

(# 779) Mycorrhizal Diversity and Functioning Under Elevated Atmospheric CO2

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It has been speculated that the forces driving global change, such as atmospheric CO_2, will also alter thediversity and distribution of organisms within ecosystems. Direct effects of CO_2 on vegetation may work to enhance or reduce biodiversity in natural ecosystems. Such changes in diversity are, in turn, expected to alter ecosystem functioning, such as primary productivity and the cycling of nutrients. This study focused on the effects of elevated atmospheric CO_2 on the species diversity of arbuscular mycorrhizal fungi (AMF). Plants and soil collected from 14 different sites across North America were subjected to ambient and elevated atmospheric CO_2. Fewer fungal taxa were detected under elevated CO_2, especially from those belonging to the genera , Gigaspora and Scutellospora. Further studies determined that such a reduction in AMF richness negatively affected the ability of these fungi to promote plant growth, capture nutrients, and to withstand stresses in soil, such as drought and freezing.Overall, the data suggests that changes to the concentration of atmospheric CO_2 can significantly impact below-ground diversity of AMF, which can in turn affect ecosystem functioning.

(# 781) Quantitative Study of Arbuscular Mycorrhizae and Ectomycorrhizae on Aged Eucalyptus

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Ecalyptus present the capability to form associations with both ectomycorrhizal and arbuscular mycorrhizal fungi, but, the studies dealing with this dual symbiosis have been carried out on young seedlings, grown in experimental condtions or on Eucalyptus from young plantations. They all reported a successional pattern of colonization, the ectomycorrhiza taking over as plant ages. Contrastingly, typical arbuscular mycorrhiza and ectomycorrhiza have been observed within roots of aged eucalypts planted in different ecosystems in Algeria. Arbuscular mycorrhiza and ectomycorrhiza have always been observed on the same root systems. Arbuscular mycorrhiza and ectomycorrhiza have been quantified on roots of 15 years old trees, over the year. Results revealed that ectomycorrhiza and arbuscular mycorrhiza are both present on the same root systems and that it exists a mycorrhizal dynamic depending on environmental factors, in natural conditions.

(# 782) Co-occurrence of Arbuscular Mycorrhiza, Ectomycorrhiza and Ectendomycorrhiza on Aged Eucalyptus: Structural and Ultrastructural Aspect

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Arbuscular mycorrhiza and ectomycorrhiza have never been described together within roots of aged Eucalyptus, despite the fact that Eucalyptus seedlings form associations with both arbuscular mycorrhizal fungi and ectomycorrhizal fungi, early during their development. In this study, three ecologically different Eucalyptus plantations were surveyed. Roots of four Eucalyptus species of 15, 40 and 60 years old, were examined. Samples were collected over two consecutive years, at about two months intervals. A structural and ultrastructural study were performed. These studies revealed that a lot of ectomycorhiza, arbuscular mycorhiza and ectendomycorrhiza were present on the same root systems. Ectomycorrhiza and arbuscular mycorrhiza were also observed on the same root sections. This study showed that the different mycorrhizal associations are in perfect functioning state.

(# 783) Root interactions with nematodes: signals and responses

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Roots are exposed to a wide variety of pathogens and nematodes belong to a group of major economic importance. Nematode pathogens have evolved highly specific interactions with the plant: they employ various sophisticated strategies to explorate the host on the base of a mutual signal exchange that often leads to specific physiological, cytological and anatomical in the plant. Endoparasitic sedentary nematodes are most intriguing: root exudate components attract them to the host root and trigger a specific behavioural programme needed for root invasion. Infective stages enter the root with the aid of a piercing stylet and released pathogenicity factors. Within the root, specific cells are selected for the induction of a feeding structures. Root-knot nematodes induce hypertrophied multi-nucleate giant cells whereas cyst nematodes trigger the formation of hypertrophied syncytia consisting of several hundred former vascular parenchymatic cells. The feeding structures are organ-like functional entities performing profound pathological changes. The triggering signal released by the nematodes is still unknown but any efforts are made to clarify its nature. The feeding structures are the only source of nutrients for the nematodes and once initiated their induction, the juveniles are unable to leave the site. Large amounts of nutrients are taken up during nematode development and all necessary functions for transport and synthesis of nutrients are adopted. As it is the basis of nematode development, induction and maintenance of feeding structures is studied intensively at the molecular biological level. Recent developments and findings will be presented and compared to research in mycorrhiza.

(# 786) Occurrence of Ectomycorrhizal Fungi in Dipterocarps Forests of Bangladesh

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Mycorrhiza promotes the growth of host plants by improving the absorption of nutrients, water from soil and by protecting roots from pathogenic fungi and other stresses. Ectomycorrhizal symbioses are important on a global scale because the dominant trees in most of the world's temperate and boreal forests and in large areas of tropical and subtropical forests are ectomycorrhizal. Dipterocarps have been known to be ectomycorrhizal and the plants of this family are important timber species in Bangladesh. The occurrence of the ectomycorrhizal association of the important Dipterocarp plants namely, Dipterocarpus turbinatus, Hopea odorata and Shorea robusta were surveyed and identification of the fungi were carried out in Mycorrhiza Laboratory of Chittagong University. Laccaria laccata, Lactarius spp., Russula spp., Scleroderma sp. and Suillus sp. were identified from the close association of D. turbinatus. The EM sporocarp of Amanita sp., Laccaria sp., Lactarius sp., Russula sp. and Scleroderma verrucosum were recorded from H. odorata. Shorea robusta was found heavily infected with a number of different fungi. These were Amanita sp., Laccaria sp., Lactarius sp., Russula sp. and Suillus sp.

(# 787) Symbiotic strategies for orchid conservation in Mexico

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Mexico is a big center of Biodiversity. The conservation of endemic and endangered biota is a matter of recent concern. Orchids are one of the must endangered groups because of the accelerated looting and habitats degradation. Biotechnological strategies are needed to be implemented in order to diminish the deterioration of natural populations. The recovery of germplasm and reintroduccion practices, are the basis for the ecological sustainable programs in Botanic Gardens and Reserves. However, today, there is not a well- developed strategy to accomplish these objectives. Symbiotic propagation techniques are highly successfully for the in vitro orchid germination and development. The performance of mycorrhizal plants is much better when reintroduced, shorting the culture time, acclimatization period and field survival. By doing this, the conservation of the mycobiont is also considered. Propagation and reintroduction strategies, however, must be performed to achieve the recovery of populations. Using a model plant, the present is a complete study that shows the conservation of fungi and seed germplasm, the molecular characterization of the isolate, the symbiotic and asymbiotic plant culture and acclimatization, and the reintroduction of an endangered endemic orchid of Mexico.

(# 788) Diversity and occurrence of ectomycorrhizal mushrooms in rain forests of south Cameroon

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Information is strikingly lacking on species richness of ectomycorrhizal mushrooms from rain forests of central Africa. For three years, mushroom excursions were carried out in permanent primary forest plots at four sites within the research area of the Tropenbos Cameroon Programme, with contrasted soil and altitude characteristics viz. Ebimimbang (sandy soil; pH5; 0-300 m asl), Ebom (highly clayey soil; pH4; 300-500 m asl), Nyangong and Bityili (very highly clayey; pH3-4; 500-800 m asl). Excursions took place during the two wet seasons of south Cameroon (April–June and September–November). Collected mushrooms were described in fresh state, dried and exsiccates were examined for microscopic characterization.
About 200 species of putative ectomycorrhizal fungi were found mainly in clumps of ectomycorrhizal caesalps or at the stem base of Uapaca; a few collections of one gasteromycete species were made near Gnetum lianas fallow lands. A provisional key of ectomycorrhizal fungal species by genera indicates that species-rich fungal genera are Amanita, Russula and Lactarius, and members of the Boletales and Cantharellaceae, whereas the genera Scleroderma, Cortinarius and Inocybe contain only limited species. The only ectomycorrhizal fungi that are locally edible are one species of Lactarius (Nyumelane) and few species of Cantharella (Bingobindong, Nyavem, Otsetsa). Species richness was highest in Bityili and lowest in Ebom. Species richness matched the contribution of ectomycorrhizal trees to basal area in forest plots. However, all four sites shared a substantial number of species, suggesting that forests in south Cameroon are homogeneous in terms of ectomycorrhizal fungal species composition.

(# 789) Mycorrhizal associations as indicators of forest quality after land use practices

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Counting mycorrhizal infective propagules (spores, fruitbodies, colonised roots) in forest soils was used to assess impacts of shifting cultivation and selective logging on habitat partitioning and abundance of inoculum of arbuscular mycorrhizal and ectomycorrhizal fungi in south Cameroon. Intact soil cores, disturbed soil samples and fruitbodies were collected from late successional forest stands inside and outside the crown projection of ectomycorrhizal clumps, early forest stands, fallows of Chromolaena with and without Gnetum lianas, fields of food crops, forestry practices including skid trails, bare soil landings and landings recolonized by the early pioneer tree Musanga cecropioides. Percent root colonisation was assessed by the gridline intersect method. Spores of AM fungi were extracted by the wet-sieving and decanting method followed by sucrose centrifugation, and counted under microscope. Fruitbodies of ectomycorrhizal fungi were identified.

Due to creation of skid trails, landings and forest roads, selective logging had a very large negative impact on both ectomycorrhizas and arbuscular mycorrhizas, whereas shifting cultivation, under the present population pressure (10 inhabitants per km), had only a slight positive effect on arbuscular mycorrhizas and a negative effect on ectomycorrhizas. Both types of mycorrhizal inocula were differently partitioned: AM inoculum was continuous throughout the landscape while EM inoculum was patchy, suggesting the need for different management approaches for both AM and EM forest patches. EM clumps indicated least disturbed forest stands conversely to AM forests. Thus, inoculum density of the latter forests can be boosted through AM inoculum addition while EM forest stands, which depended on intact ectomycorrhizal mycelium need special conservation attention.

(# 791) The Compatibility of Some Formulations of VAM Fungus on P Uptake and Crop Yields Grown in Various Marginal Soils in the Tropics

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The beneficial effect of the Vesicular-Arbuscular Mycorrhizae (VAM) fungus to plant growth and yield has been known worldwide. However, there are some problems related to the application of VAM fungus in the field. One of the obvious problems is the voluminousness or the in effectiveness of the inoculum. Therefore, there is a real need to develop one VAM formulation that can work more effectively and efficiently in the field. This study was aimed at determining the compatibility of four formulations of this "biological fertilizer" on cashcrops (corn, soybean, and mungbean) grown in the various marginal soils in the tropics in the central part of Lombok Island, Indonesia. The four formulations studied were the inoculum mixed with: carrier of phosphate rocks (F1), dolomite rocks (F2), charcoal dust (F3), and the mixture of those three (F4) and control (without mycorrhizae). The variables observed were the infection rate, P uptake, growth and yield of the crops, and other related variables. The results of this study indicated that the mixture formulation of F4 VAM inoculum, gave the highest results of P uptake, corn growth and yield, as well as the development of the VAM fungus in the soils. Among the three crops tested, corn gave the highest infection rates and spore number per 100 g soil, as well as showed the best plant growth and yield. Among the formulations tested, the mixture formulation F4 was the most compatible for use in the field, especially with corn.

(# 792) NP Application and VAM Effect on NPK Uptakes and Corn Growth in the Tropical Entisol of Lombok Island, Indonesia

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Most of agricultural soils in dryland area of Lombok Island have been known deficient in nitrogen (N) and phosphorus (P). The common practice to solve this problem is usually by applying commercial fertilizers using Urea and Triple Super Phosphate (TSP). However, high price of commercial fertilizers have forced farmers to reduce the use of the commercial fertilizers and consequently reduced crop yields. One way to overcome this is replacing those commercial fertilizers with alternative sources of fertilizers. One of the potential cheap source of the fertilizers is the bio-fertilizer Vesicular Arbuscular Micorrhizae (VAM) that have been known and used in crop production. This research was aimed at investigating NP application and VAM effect on NPK uptakes and corn growth in the Entisol of Lombok. Nitrogen and P fertilizer were applied and the rates of NP application were: 0, 100, and 175 kg/Ha for urea and 0, 25, and 50 kg/Ha for TSP. Soil was then split into two groups, one incubated with VAM and the other without VAM. Result of this study showed that the application of VAM significantly improved the corn growth and the uptake of NPK. The optimum plant growth was obtained at the combination treatment of 100 Kg urea/ha and 25 Kg TSP/ha with application of VAM. This treatment produced the highest dry-matter yield (124 g/plant), the NPK uptake (3.22 mg N/plant, 0.54 mg P/plant, and 2.88 mg K/plant, respectively), and the fertilizer efficiency (60 % N and 65 % P).