Saskatoon 2010

Joint Conference of the CSSS & CSA

Transfers and Transformations: Our Evolving Biosphere

University of Saskatchewan

Saskatoon, Saskatchewan

20 – 24 June 2010

http://www.usask.ca/saskatoon2010

Internet access while on the U of S campus

Wireless Access Points or "hot spots" are installed in number of public locations on campus, providing wireless network access to members of the campus community. Look for the yellow wireless symbol that identifies locations with wireless network coverage.

The U of S guest wireless network service is available to conference attendees who have been provided with a conference ID specific for their use. The guest wireless service connects to the Internet from outside the U of S firewall. Because the connection is outside the firewall, some U of S network resources are not accessible when connected to the guest wireless service.

Conference attendees will need to create a connection to the guest wireless network, identified by the "guest" SSID. Instructions are available for Windows[1] and Macintosh[2] computers.

1. Log in using your University provided conference ID:

   Username: csss1csa2
   Password: guest1june

2. Establish a VPN or enable other security measures as appropriate (i.e. if you are going to use the wireless network to access secure resources).

If you would like to check your email but do not have a computer with you, you can use one in the College of Agriculture & Bioresources Computer Lab (Rooms 3D67 and 2D15 in the Agriculture Building). Please contact the Computer Lab Manager (Dan Aussant; Room 3D67) should you encounter any difficulties.

[1] http://www.usask.ca/its/services/networks/setup_guides/windows/guest/index.php
[2] http://www.usask.ca/its/services/networks/setup_guides/macintosh/guest/index.php

Table of Contents

Welcome to Saskatoon!

On behalf of the *Department of Soil Science* and *University of Saskatchewan*, let me welcome you to *Saskatoon 2010: Transfers and Transformations*, the 2010 joint conference of the Canadian Society of Soil Science and Canadian Society of Agronomy. This is a particularly exciting year for us in the Department of Soil Science as we celebrate our 91st year as an academic unit at the University of Saskatchewan. Much has changed since that first year, so our conference theme of *Transfers and Transformations* is particularly fitting for our department. Indeed, over the years, our disciplines have transformed from addressing largely agricultural issues to the current reality that encompasses not only production agriculture—including the impacts of a changing climate on agriculture—but also the impacts of agriculture and resource development on the environment. The sessions in this year's program reflect the transformations in the kinds of research in which our societies are engaged, and we are excited to have an opportunity to transfer information about the latest research advances highlighted in this conference.

This year's conference also allows us to share our celebration of the works of Dr. Pan Ming Huang, who passed away this past year. Dr. Huang was a distinguished researcher who made significant contributions to the fields of soil and environmental chemistry. The P.M. Huang symposium will provide an opportunity for researchers to hear talks on topics that reflect Dr. Huang's philosophy that "*soil is the central organizer of the terrestrial ecosystem*".

Thanks to all who submitted abstracts and to those who have made the journey to Saskatoon. A particular thanks to all of the grad students who are sharing their research results—sometimes with still more research to come, but always interesting and current. Along with our invited speakers, we have a great line-up of presentations and posters to look forward to. The conference planning committee has worked hard to organize what we hope will be an exciting, interesting and fruitful event for all participants.

We are extremely excited to host the joint meeting of our two societies here is Saskatoon and hope that your stay in Saskatoon is enjoyable. So, while you are here, please be sure to take a look around our beautiful and vibrant city, and enjoy the many opportunities to transfer information and transform our scientific endeavors.

Fran Walley
Head, Department of Soil Science
Co-Chair, *Saskatoon 2010*

Bienvenue à Saskatoon!

Au nom du Département de Science du Sol et de l'Université de la Saskatchewan, je vous souhaite la bienvenue à la conférence annuelle commune de la Société Canadienne de Science du Sol et de la Société Canadienne D'Agronomie, Saskatoon 2010 : Transferts et Transformation. Cette année 2010 est particulière pour nous puisqu'elle marque la 91ème année d'existence du Département de Science du Sol au sein de l'Université de la Saskatchewan. Le département a beaucoup évolué depuis sa création et le thème de notre conférence, Transferts et Transformations, reflète bien ces évolutions. En effet, au fil des années, nos disciplines se sont transformées : centrées initialement sur des problématiques agricoles, nos disciplines concernent aujourd'hui non seulement la production agricole - dont les impacts du changement climatique sur l'agriculture - mais aussi les impacts de l'agriculture et de l'utilisation des ressources sur l'environnement. Les sessions du programme de cette année attestent des transformations des recherches menées par nos sociétés, et nous sommes heureux d'avoir l'opportunité de transférer les résultats de nos recherches récentes à l'occasion de cette conférence.

Cette année, la conférence nous permet également de partager avec vous notre hommage à Dr. Pan Ming Huang, décédé l'année dernière. Dr Huang était un chercheur reconnu, et ses contributions dans le domaine la chimie du sol et de l'environnement ont été significatives. Le symposium dédié à P.M. Huang permettra aux chercheurs d'entendre des communications reflétant la pensée de M. Huang : « le sol est l'organisateur central de l'écosystème terrestre ».

Merci à tous ceux qui ont proposé des communications et à ceux qui ont faits le déplacement à Saskatoon. Je remercie particulièrement l'ensemble des étudiants gradués qui présentent leurs résultats de recherche : ils ont parfois encore beaucoup de travail devant eux, mais leurs présentations sont toujours intéressantes et d'actualité Nous avons de nombreuses présentations orales et posters, en plus de nos intervenants invités. Le comité d'organisation a beaucoup travaillé pour préparer cette conférence et nous espérons qu'elle sera un moment enrichissant et apprécié par tous les participants.

Nous sommes très heureux d'accueillir ici à Saskatoon la conférence annuelle de nos deux sociétés et nous espérons que vous allez apprécier votre séjour à Saskatoon. Profitez de votre passage pour découvrir notre belle ville, et saisissez toutes les opportunités pour transférer vos connaissances et faire vivre nos collaborations scientifiques.

Fran Walley
Directrice, Département des sciences du sol
Co-Chair, *Saskatoon 2010*

Welcome from the Canadian Society of Soil Science

On behalf of the Canadian Society of Soil Science (CSSS), it is my pleasure to welcome you all to the 2010 Annual General Meeting. We are proud to present this year's AGM jointly with the Canadian Society of Agronomy (CSA). The theme of the AGM is **'Transfers & Transformations: Our Evolving Biosphere'**. Our world is in a constant state of change, and it critical that sound science is in place to address the challenges that emerge to the long-term economic, social and environmental sustainability. As soil scientists and agronomists, we have an important role to play in addressing the need for improving agricultural production and resource management to support the growing world population, while ensuring that the integrity of our land, air and water are maintained for future generations.

It is also a pleasure to be meeting here in Saskatoon on the 91st anniversary of the University of Saskatchewan's Department of Soil Science and to celebrate their many achievements over the years. The impact of the work done here has been felt locally, nationally and internationally.

I hope that this conference provides you with ample opportunities to share your science with both your fellow CSSS members and our colleagues in CSA. Please also take the time to meet with your CSSS Council members and provide us with your input. A society is only as vital as its membership, so your participation and ideas are important to create an energetic and relevant Canadian Society of Soil Science.

Cynthia Grant, President
Canadian Society of Soil Science

Welcome from the Canadian Society of Agronomy

Scientific conferences are the venues for researchers to share their ideas and discoveries with colleagues. You have come to the biggest gathering of agronomists and soil scientists in Canada. The CSA executive and conference organizers welcome you to an exceptional program at *Saskatoon 2010*!

Truly one of the highlights of *Saskatoon 2010* is the Gwynne Dyer Plenary Lecture. The CSA is hosting the Norman Borlaug Symposium, in honour of our late colleague, on the future of plant breeding in Canada. There is also a symposium on organic agriculture with the intriguing title "Beyond Organic". This year the CSA has initiated an "Awards Symposium" where CSA award winners will present invited talks, including one by Dr. Gordon Rowland, our new Distinguished Agronomist, called "Life in the Flax Lane". CSA is again sponsoring a practical Statistics Workshop on use of mixed models and multivariate analysis. The workshop has been a hot ticket. Didn't score a ticket? Don't worry, CSA will broadcast the entire workshop as a free webinar! Tell your colleagues- even those who could not come to Saskatoon.

On Wednesday night, we will celebrate amazing careers and outstanding achievements of several colleagues at the Awards Banquet. Also on Wednesday, we hope you will come to the CSA Annual General Meeting (membership not required to attend) where you can discuss important CSA activities and initiatives. For example, the planned study of the state and future of the Agronomy profession (including jobs) in Canada. Also, how we can make our Journal, the Canadian Journal of Plant Science, stronger. You can also meet the new executive and president Dr. Rigas Karamanos who is well known in the city of Saskatoon for his soccer exploits. You can also meet our new president-elect Dr. Malcolm Morrison who may reveal his secrets on how to become a CSA president.

The importance of agronomy to the security, safety and sustainability of our future food supplies is axiomatic to us, but largely a mystery to the well-fed public. The CSA is committed to spread this message. I invite you to participate in a special discussion intended to fashion a defining statement on "Challenges for Canadian Agronomy in the next 50 years". This statement will be publicized widely to politicians, decision makers and the media, and will be the rallying cry for our organization. The discussion will immediately follow the CSSS Professional Development Session (same room) and will slightly overlap with the Graduate Student Reception (grad students- please drop in briefly). Tuesday at 6 PM; we need to hear your voice!

A big thank-you to the organizers and to everyone attending for helping to make *Saskatoon 2010* a great meeting.

Shabtai Bittman, President
Canadian Society of Agronomy

Saskatoon 2010 is a joint meeting of the:

Canadian Society of Soil Science (www.csss.ca)
&
Canadian Society of Agronomy (wwww.agronomycanada.com)

Conference Planning Committee Co-Chairs

Dan Pennock & Fran Walley

Conference Planning Committee

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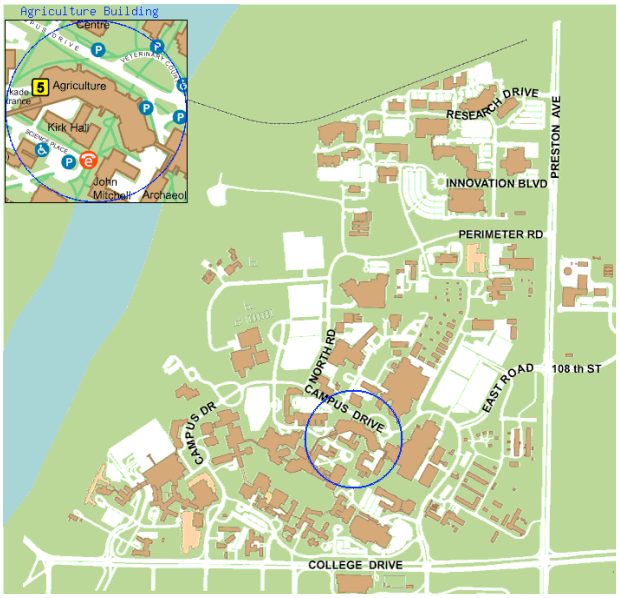
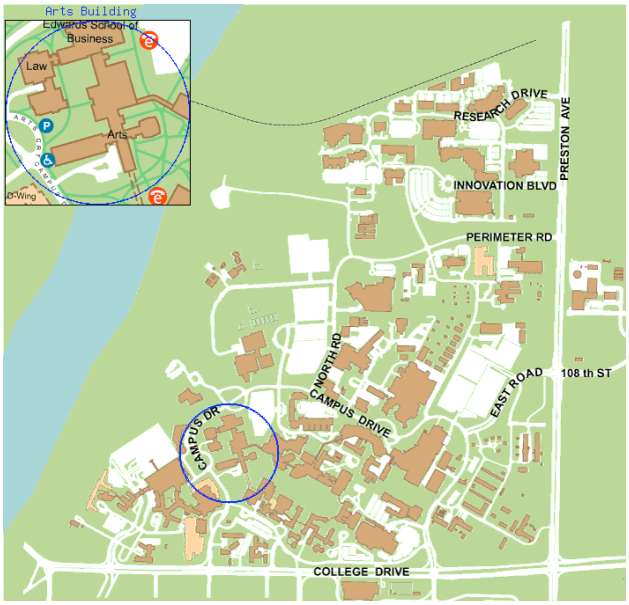
Media Access and Production(eMAP) & Hospitality Services

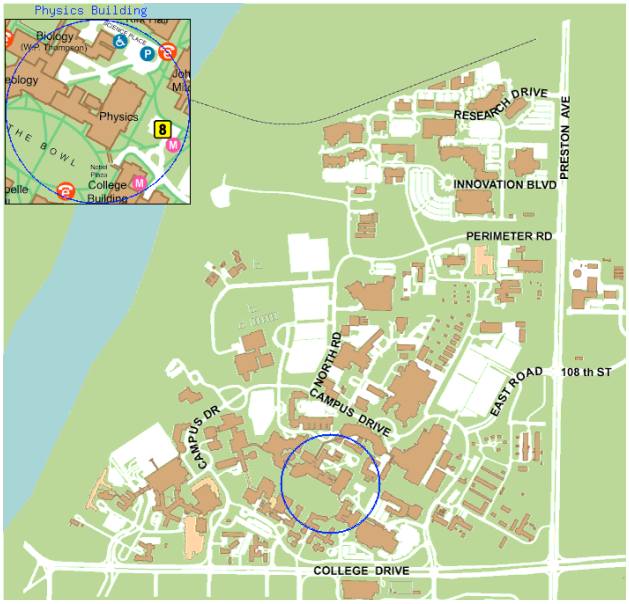
University of Saskatchewan – Campus Maps



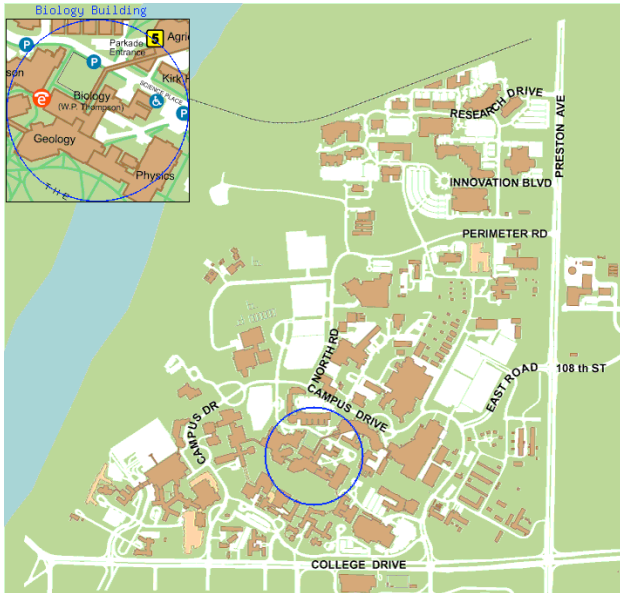
Agriculture Building (51 Campus Drive)
Department of Soil Science (5th Floor)
Opening Reception (Attrium, lower level)



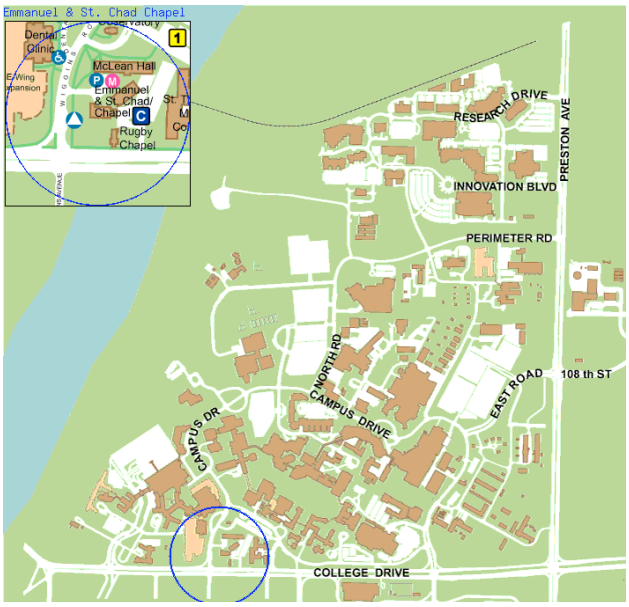
Arts Building (9 Campus Drive)
P.M. Huang Symposium Plenary (143 Arts)
Gwynne Dyer Plenary (143 Arts)



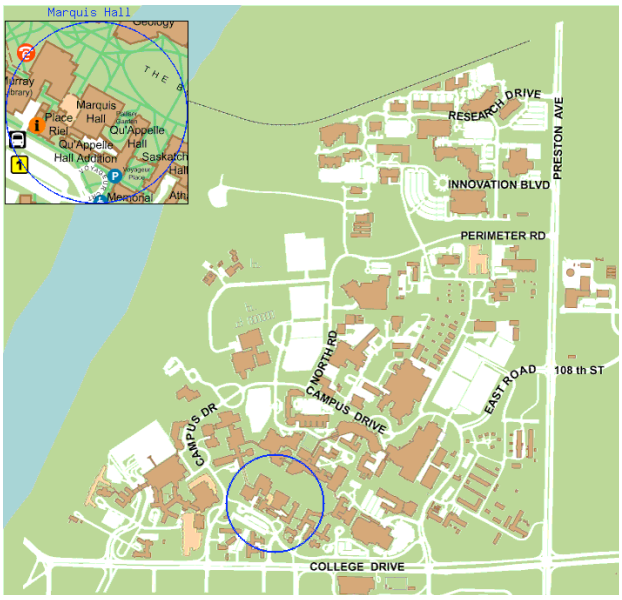
Physics Building (116 Science Place)
CSSS/CSA Sessions (Rooms 103, 130, & 165)
Coffee Breaks (Attrium, main level)



Biology Building (112 Science Place)
CSSS/CSA Sessions (Rooms 106 & 125)
Poster Sessions (Attrium, main & lower levels)
Coffee Breaks (Attrium, main level)



Emmanuel and St. Chad (1337 College Drive)
Grad Student BBQ & Social (Tuesday evening)



Marquis Hall (97 Campus Drive)
Department of Soil Science (5th Floor)
Opening Reception (Attrium, lower level)

Getting to the University from Downtown Saskatoon (Shuttle Bus Schedule)

A special shuttle service will be running between the Park Town Hotel which is located at the bottom of the University Bridge on Spadina Crescent (924 Spadina Crescent East) and the University. Other hotels on Spadina (the Bessborough, Sheraton Cavalier, and Radisson) are within easy walking distance (3-5 minutes) of the Park Town. The bus will pick up conference participants on Spadina, in front of the hotel (the river side of the hotel and NOT at the city bus stop). Check with the front desk people if you are not sure where to wait (be sure you tell them that you are waiting for the conference shuttle bus). The drop-off and pick-up point at the University is at the north doors of the Agriculture Building except for the buses after the banquet. The pick-up after the banquet (Wednesday evening) is at Place Riel. Although the meeting sessions will not be held in the Agriculture Building, all events are only a short walk away.

A special bus also will be available to transport participants to the Sunday welcoming reception and the Monday evening Gwynne Dyer lecture at TCU Place.

Please note that if you miss the shuttle bus, there are a number of other city buses that pass by the Park Town and will drop you off at the University. Check with the Park Town staff at the front desk for schedules and bus stop locations. It is also a fairly easy walk to the Agriculture Building on Campus, and there is a really lovely pathway along the river that will get you to campus. Set your sights on the Agriculture Building—it is the large (6 floors), fully mirrored building. It is approximately a 15 minute walk from the Park Town hotel to the Agriculture Building.

There is no shuttle for Thursday morning. Please make alternate arrangements if you are participating in a field tour.

SUNDAY, JUNE 20

Destination: Park Town to University (Welcoming Reception)

Bus #	**Pick Up** Front Entrance of the Park Town	**Drop Off** Front Entrance of Agriculture Building, north door.	**Notes**
Bus # 1	6:00pm	6:15pm	Bus does 2 loops
Bus # 1 2nd trip	6:30pm	6:45pm	

Destination: University to Park Town Hotel

Bus #	**Pick Up** Front Entrance of Agriculture Building, north door.	**Drop Off** Front Entrance of the Park Town	**Notes**
Bus # 1	8:45pm	9:00pm	Bus does 2 loops
Bus # 1 2nd trip	9:15pm	9:30pm	

MONDAY, JUNE 21:

Destination: - Park Town to University (morning)

Bus #	**Pick Up** Front Entrance of the Park Town	**Drop Off** Front Entrance of Agriculture Building north door	**Notes**
Bus# 1	7:15am	7:30am	
Bus# 1; 2nd trip	7:45am	8:00am	

Destination – University to Park Town (afternoon) Note: If you attending the Gwynne Dyer lecture, please note that the bus leaves from the University.

Bus #	**Pick Up** Front Entrance of Agriculture Building north door.	**Drop Off** Front entrance of Park Town	**Notes**
Bus# 1	5:15pm	5:30pm	

Destination – University to TCU Place (Gwynne Dyer Lecture)

Bus #	**Pick Up** Front Entrance of Agriculture Building north door.	**Drop Off** Front entrance of TCU Place	**Notes**
Bus# 1	5:45pm	6:00pm	
Bus# 1; 2nd trip	6:15pm	6:30pm	

Destination –TCU Place to the Park Town and University

Bus #	**Pick Up** Front entrance of TCU Place.	**Drop Off** Park Town/ Front Entrance of Agriculture Building north door	**Notes:** There are two stops. The first is at the Park Town, and the second is at the Ag. Building on the University campus
Bus# 1	8:30pm	8:45/9:00pm	
Bus# 1; 2nd trip	9:15pm	9:30/9:45pm	

TUESDAY, JUNE 22

Destination: - Park Town to University (morning)

Bus #	**Pick Up** Front Entrance of the Park Town	**Drop Off** Front Entrance of Agriculture Building north door	**Notes**
Bus# 1	7:15am	7:30am	
Bus# 1; 2nd trip	7:45am	8:00am	

Destination – University to Park Town (afternoon)

Bus #	**Pick Up** Front Entrance of Agriculture Building north door.	**Drop Off** Front entrance of Park Town	**Notes**
Bus# 1	5:15pm	5:30pm	

WEDNESDAY, JUNE 23

Destination: - Park Town to University (morning)

Bus #	**Pick Up** Front Entrance of the Park Town	**Drop Off** Front Entrance of Agriculture Building north door	**Notes**
Bus# 1	7:15am	7:30am	
Bus# 1; 2nd trip	7:45am	8:00am	

Destination – University to Park Town (afternoon) Note: There is no shuttle service back to the banquet. City buses are available if you need transportation to campus.

Bus #	**Pick Up** Front Entrance of Agriculture Building north door.	**Drop Off** Front entrance of Park Town	**Notes**
Bus# 1	5:15pm	5:30pm	

Destination: - University – Park Town (evening)

Bus #	**Pick Up** Front entrance to **Place Riel**	**Drop Off** Front Entrance Park Town	**Notes** Transportation after the banquet
Bus# 1	9:15pm	9:30pm	
Bus# 1; 2nd trip	9:45pm	10:00pm	

Getting to TCU Place for the Monday Evening Gwynne Dyer Public Lecture

Gwynne Dyer will present a public lecture at 7:00 PM on Monday, June 21st. The lecture, titled *Climate Wars: The Problem is Food*, will be presented at TCU Place in downtown Saskatoon. This lecture is free of charge to the public and will be preceded by a reception and book signing starting at 5:30 PM.

TCU Place is centrally located in downtown Saskatoon and is within easy walking distance (5-10 minutes) of all the major hotels along Spadina Crescent. If you are driving, you can access TCU Place from Idylwyld Drive turning on either Auditorium Avenue (to access the rear of the building and loading area) or 22nd Street to access the front of the building and parking areas and lots. We also have arranged a shuttle bus from the University; so, if you are still on campus attending conference events or in residence you can get the shuttle at the front entrance (north doors) of the Agriculture Building (see the shuttle bus schedule for details).

U of S Soil Science Events

'Ecosystems and Art'

Sunday, June 20th (Exhibit Room 1E80, Agriculture Bldg.)

Professor Ken Van Rees

This exhibition is presented by the students from the '**Ecosystems and Art**' graduate course in the Department of Soil Science that occurred recently at the Emma Lake Kenderdine Campus. There is a growing movement worldwide to merge the arts and sciences together in experiential learning and this course addresses the transformative processes of this creative experience. The exhibition at the reception for the Annual Meeting of the CSSS and CSA will portray the student's engagement of various boreal ecosystems through an alternative set of skills and experiences.

Join us for our 91st Birthday Celebration

Tuesday, June 21st (2:30 PM) presentation by Professor Darwin Anderson

(coffee and cake to follow)

The Department of Soils began in 1919, ten years after the establishment of the University of Saskatchewan. The first Professor was Roy Hansen, a PhD graduate from the University of Illinois. He published Extension Bulletin No. 1, on the importance of inoculating legumes with rhizobacteria, and initiated the Soil Survey. The Soil Survey, recommended by a Royal Commission on better farming, was the major project of the Department and was directed by successive Heads, A.H. Joel and John Mitchell. Soil Survey Report No. 12, completed in 1944, covered most of the agricultural part of the Province, a huge accomplishment. The first MSc degree was awarded in 1934, and the first PhD in 1960. Soil fertility research began in the late 1920s, becoming more sophisticated in 1944 with the use of radioactive phosphorus in field experiments. The Department developed further in the 1960s with professors in all sub-disciplines of Soil Science, many of whom achieved international reputations, attracting graduate students and research fellows from around the world. The Saskatchewan Soil Testing Lab was set up in 1966, providing an important service to Saskatchewan farmers for just over 25 years. A more environmental focus began in the 1970s and '80s, with more women in professional positions, although the first female professor, Dr. Fran Walley, was not hired until the late 1990s. The Department today has an even greater emphasis on environmental science, in teaching and research, and is strongly positioned to remain an important entity with a broadly defined mandate in Soil Science. Archival photographs, the history written by Jim Ellis, and my personal experience over four decades will be used to discuss the history of the Department of Soil Science.

Special Breakfast Event

Redefining Success: Scientists seeking work-life balance

Tuesday, June 22nd (7:00–8:15 AM Marquis Hall)

Hosted by

U of S Departments of Soil and Plant Sciences,
Canadian Society of Soil Science, Canadian Society of Agronomy &
the Green Crop Network

This breakfast event will include short panel presentations by a number of scientists at different career stages. Each is successful in her/his own right, and each has chosen a different path to that success. This will be an opportunity to discuss shared challenges such as pregnancy, raising small children while building new research programs, making time for family/self, finding work-life balance, and redefining success in science to make this balance possible. All are welcome to attend, regardless of career stage, sector or gender!

Breakfast will be available at 7AM. Panel begins 7:20AM.

There is no charge to attend this event; we ask, however that you sign up for the breakfast at Registration desk by Monday 1PM.

Canadian Light Source (CLS) Synchrotron Tours

Tuesday, June 22nd (10:00–11:45 AM and 1:00–3:15 PM)

Hosted by

U of S Department of Soil Science
&
Canadian Light Source (CLS) Synchrotron

For those of you registered for the Canadian Light Source Tours (CLS), please sign up for a tour time at the registration desk either Sunday or Monday. **All tours will take place on Tuesday, June 22nd**. A shuttle bus will pick you up at the north doors of the Agriculture Building (look for a volunteer in a green tee-shirt) and deliver you to the CLS. Return shuttle service is also available immediately after your tour at the CLS front door round-a-bout. Available tour times are:

Tuesday morning:
10:00 AM (returns to Ag Bldg by 10:45 AM)
10:30 AM (returns to Ag Bldg by 11:15 AM)
11:00 AM (returns to Ag Bldg by 11:45 AM)

Tuesday afternoon:
1:00 PM (returns to Ag Bldg by 1:45 PM)
1:30 PM (returns to Ag Bldg by 2:15 PM)
2:00 PM (returns to Ag Bldg by 2:45 PM)
2:30 PM (returns to Ag Bldg by 3:15 PM)

Graduate Student Events

Professional Development Session for Grad Students: How do soil science and agronomy contribute to society?

Tuesday, June 22nd (Physics 103)

Hosted by

U of S Soil and Plant Sciences Graduate Students
&
the Green Crop Network

Centered on a panel discussion involving a diverse group of invited speakers, this session will allow graduate students in soil science and agronomy to share ideas and gain insights into real-world applications and benefits of these broad fields. The panelists, each representing different sectors of soil science and agronomy, have been invited to share their perspective on the question *How do soil science and agronomy contribute to society*? The different sectors represented on the panel include academia, industry, environmental consulting, government policy, international development, government research and extension, and agricultural production (farmer). By selecting panelists from diverse sectors, students will have the opportunity to gain insights into the variety of career opportunities that may await them after graduate school. The student audience is invited and encouraged to ask questions and share comments to create a lively discussion.

Student BBQ and Social

Tuesday, June 22nd (Grad Commons, St. Emanuel & Chad)

Hosted by

U of S Soil and Plant Sciences Graduate Students,
Canadian Society of Soil Science, Canadian Society of Agronomy &
the Green Crop Network

All graduate students and postdoctoral fellows are invited to attend a free, catered barbeque at the newly renovated graduate student commons on the U of S Campus. Students from across Canada and abroad will have the opportunity to mingle in an informal environment. Alcoholic and non-alcoholic beverages will be available.

Certified Crop Advisor Program
Continuing Education Unit (CEU) Credit

The conference organizers are pleased to announce that the Prairie Provinces CCA Board for Continuing Education Unit (CEU) credit has approved CEU credit for a number of talks being presented as part of the *Saskatoon 2010* conference. Please note that the CCA program is independent of the conference and all questions regarding CEUs should be directed to the CCA Certification Representative for the Prairie provinces (Michelle Lovejoy).

A list of sessions for which CCA/CEU credit can be earned will be available at the registration desk. Please look for the CCA sign near the applicable sessions to sign in and out in order to receive CCA CEU credit. CCA/CEU sign-in sheets will be posted outside the session rooms. Certified Crop Advisers who attend the meetings need to make sure their name and CCA certification number is indicated on the sign-in sheet before the end of the conference.

Participants who would like to keep a record that they have attended the meeting for future reference should copy down the CEU Tracking Number from the top of the sign-in sheet. CCA meeting participants should see the credits appear on their CEU statements scheduled to be mailed out during the months of January and September. The CEU statements are also available on the CCA website at www.certifiedcropadviser.org. **Please direct all questions regarding CEU credits to:**

Michelle Lovejoy
Certification Representative
Certified Crop Advisor Program
5585 Guilford Road
Madison, WI 53711

FAX: (608) 273-2081
Voice-mail: (608) 268-4953
Email: mlovejoy@sciencesocieties.org

Post Conference Field Tours & NMR Workshop

Thursday, June 24th

Note: All of these events have sold out

Buses for all tours leave from the North Doors of the Agriculture building

Lunch and snacks are provided for all tour participants

Agronomy Field Tour (Note the 7:00 am start to this trip)

The agronomy field tour will introduce participants to progressive agronomic practices and services in Saskatchewan. It includes a stop at a progressive Saskatchewan grain farm and a tour of the extraction and processing facilities at the PCS-Allan potash mine.

Date & Time: Thursday, June 24, 7:00 am to 4:00 pm

Contact: Tom Jensen IPNI (tjensen@ipni.net)

Pedology Excursion: Soils and Landscapes of the Aspen Parkland Ecoregion

The excursion is a 300-km round-trip that crosses the South Saskatchewan Valley twice, with stops at the Seager Wheeler Farm (a National Historic Site) and the Minichinas Hills Upland. The excursion includes Black and Dark Gray Chernozem, Gray Luvisol, Eutric Brunisol (with a buried soil) and their associated glacial landscapes. There will be opportunity to discuss how these soils fit into the current Canadian System of Soil Classification and how that fit might be improved in a revised CSSC.

Date & Time: Thursday, June 24, 8:30 am to 5:00 pm

Contact: Darwin Anderson (darwin.anderson@usask.ca) or
Angela Bedard-Haughn (angela.bedard-haughn@usask.ca)

Wetlands Field Tour: (Please bring appropriate footwear for wet conditions)

Wetlands are a critical zone for interactions between earth and biological science disciplines such as soil science, hydrology and water quality, wildlife, waterfowl, and plant/microbial biology. The multitude of studies that have been completed at the St. Denis National Wildlife Area since its establishment in 1968 provide insights on these interactions that is unique in western Canada. On the field trip the lead researchers involved in these studies will lead us through these interactions at the site itself.

Date & Time: Thursday, June 24, 8:30 am to 5:00 pm

Contact: Dan Pennock (dan.pennock@usask.ca)

NMR Workshop:

Using ^{31}P NMR Spectroscopy to Characterize Phosphorus in Environmental Samples

Instructor: Dr. Barbara Cade-Menun, Agriculture & Agri-Food Canada

Date: Thursday 24 June 2010, 9 am – 3 pm

Location: Saskatchewan Structural Sciences Centre, Thorvaldson Building, University of Saskatchewan

Contact: Barbara.Cade-Menun@agr.gc.ca.

Plenary & Keynote Speakers

P.M. Huang Symposium (Monday June 21st)

Antonio Violante, Ph.D.

Dr. Violante is Professor of Soil Chemistry at the University of Naples Federico II, Italy, where he received his academic degrees in Chemistry. Additionally, he has completed postdoctoral training at the University of Wisconsin, USA (1976-1977) working with professor M. L. Jackson and the University of Saskatchewan, Canada (1981-1982) working with professor P. M. Huang. He was invited as Visiting Professor in the Department of Soil Science, University of Saskatchewan in 1985, 1992, and 2003. He was Head of the Dipartimento di Scienze Chimico-Agrarie (1994-2000) and Coordinator of the *Doctoral School in Agrobiology and Agrochemistry* (1990-2002). He taught courses in Agricultural Chemistry, Soil Chemistry, Environmental Biogeochemisty and Soil Mineralogy and trained many M.S. and Ph.D. students and postdoctoral fellows and received visiting scientists worldwide.

Dr. Violante has contributed to promote research on the interface between soil chemistry and mineralogy and soil biology. The areas of research include the formation mechanisms of Al-hydroxides and oxyhydroxides, the surface chemistry and reactivities of short-range ordered precipitation products of Al and Fe, the influence of biomolecules on the sorption/desorption of nutrients and xenobiotics on/from variable charge minerals and soils, the factors which influence the sorption and residual activity of enzymes on variable charge minerals and organo-mineral complexes, and the chemistry of arsenic in soil environments. He was the scientific chairman and chief organizer of International and National Congresses. Dr. Violante is the author of 180 refereed research articles and book chapters and invited reviews, and co-edited seven books. He has international research and teaching experience in Canada, USA, Europe, China and Chile.

He is Fellow of *Soil Science Society of America* and *American Society of Agronomy*. He is chair of Commission 2.5 of the IUSS.

Donald L. Sparks, Ph.D.

Dr. Sparks is S. Hallock du Pont Chair of Soil and Environmental Chemistry, Francis Alison Professor, and Director of the Delaware Environmental Institute at the University of Delaware at Newark. He also holds joint faculty appointments in the departments of Civil and Environmental Engineering and Chemistry and Biochemistry, and in the College of Marine Studies. He received his B.S. and M.S. degrees at the University of Kentucky, Lexington, and his Ph.D. degree in 1979 from the Virginia Polytechnic Institute and State University, Blacksburg, VA.

Dr. Sparks is internationally recognized for his research in the areas of: kinetics of soil chemical processes, surface chemistry of soils and soil components using in-situ spectroscopic and microscopic techniques and the physical chemistry of soil potassium. He has pioneered the application of chemical kinetics to soils and soil minerals including development of widely used methods, elucidation of rate-limiting steps and mechanisms, and coupling of kinetic studies with molecular scale investigations, particularly synchrotron based x-ray absorption spectroscopy. His discoveries on the formation and role of surface precipitates in the retention, fate and transport of metals in natural systems have received worldwide attention and had major impacts in the areas of sorption models, metal speciation and soil remediation/contamination. He is the author, coauthor, or editor, of 267 publications.

Dr. Sparks serves on the Scientific Advisory Committees of the Advanced Light Source at Lawrence Berkeley National Laboratory and the Center for Environmental Molecular Science (EMSI) at the State University of New York at Stony Brook, and the Steering Committee of the Institute of Soil and Environmental Quality (ISEQ) at the University of Delaware. He is the recipient of numerous awards and honors, and is a Fellow in the *American Society of Agronomy*, *Soil Science Society of America*, and the *American Association for the Advancement of Science.*

CSA Statistics Workshop (Monday June 21st)

Rong-Cai Yang, Ph.D.

Dr. Yang is a Research Scientist with Alberta Agriculture and Rural Development (ARD) and is ARD Professor, University of Alberta, Edmonton.

Dr. Yang obtained his PhD degree in quantitative genetics and plant breeding from the University of Saskatchewan. He has provided high-level advice and mentorship to ARD scientists and their partners in statistical design and analysis of research experiments. Dr. Yang has maintained a very active research program in statistical genomics related to crop and animal improvement. His current research interests and activities include: (i) the development of mixed-model methodology for studying genotype-environment interactions and evaluation of long-term crop variety trials in western Canada; (ii) breeding theory and methodology for self-pollinated crops; and (iii) statistical and genetic analyses of large-scale genomic data (particularly those from Alberta Bovine Genomics Program).

Eric Lamb, Ph.D.

Dr. Lamb is a plant ecologist and statistician in the Department of Plant Sciences at the University of Saskatchewan. His research program in plant ecology is focused on disentangling the complex networks of ecological mechanisms that structure plant and soil biodiversity. Dr. Lamb has training and research expertise in experimental and field survey design, univariate and multivariate statistical methods, and specialized techniques including Structural Equation Modeling. He teaches a practically-oriented graduate course in biostatistics and experimental design based on the *R* statistical platform.

Gary Crow, Ph.D.

Dr. Crow is an Associate Professor in the Department of Animal Science at the University of Manitoba, with research interests in Animal Genetics and Animal Production Systems. For over 20 years he has taught a graduate course in Research Methodology first to Animal Science students, then to a broader audience of Agriculture and Food Science students, as well as to students from the Faculty of Science. This has included providing advice to students on their particular problems in the area of design and analysis, primarily using SAS software. Dr. Crow also teaches undergraduate and graduate courses in genetics as it is applied to farm animals. His current research activities include study of genetic conservation in cattle, systems modeling of beef cattle production systems, study of cattle use of riparian zones and collaborative study with University of Manitoba plant geneticists on application of mixed models to variety trial data collected over many years and sites. Dr. Crow recently completed ten years as Associate Head of the Department of Animal Science and has been involved in a number of administrative activities over that time including university Animal Care committees. Dr. Crow received his B.Sc.(Agr.) and M.Sc. from the University of Guelph, and his Ph.D. from the University of Saskatchewan.

Plenary Session (Tuesday June 22nd)

Gwynne Dyer, Ph.D.

Gwynne Dyer is a London-based independent journalist whose articles are published in 45 countries. His most recent project is the book and a radio series 'Climate Wars', which deals with the geopolitics of climate change.

Gwynne has worked as a freelance journalist, columnist, broadcaster and lecturer on international affairs for more than 20 years, but he was originally trained as an historian. Born in Newfoundland, he received degrees from Canadian, American and British universities, finishing with a Ph.D. in Military and Middle Eastern History from the University of London. He served in three navies and held academic appointments at the Royal Military Academy, Sandhurst and Oxford University before launching his twice-weekly column on international affairs, which is published by over 175 papers in some 45 countries.

His first television series, the 7-part documentary 'War', was aired in 45 countries in the mid-80s. One episode, 'The Profession of Arms', was nominated for an Academy Award. His more recent television work includes the 1994 series 'The Human Race', and 'Protection Force', a three-part series on peacekeepers in Bosnia, both of which won Gemini awards. His award-winning radio documentaries include 'The Gorbachev Revolution', a seven-part series based on Dyer's experiences in Eastern Europe and the former Soviet Union in 1987-90, and 'Millenium', a six-hour series on the emerging global culture.

Dyer's major study 'War', first published in the 1980s, was completely revised and re-published in 2004. During this decade he has also written a trio of more contemporary books dealing with the politics and strategy of the post-9/11 world: 'Ignorant Armies' (2003), 'Future: Tense' (2004), and 'The Mess They Made' (2006). The latter was also published as 'After Iraq' in the US and the UK and as 'Nach Iraq und Afghanistan' in Germany.

His most recent projects are a book and a radio series called 'Climate Wars', dealing with the geopolitics of climate change. Dr. Dyer will present a talk entitled 'The Geopolitics of Food' at 8:30 AM, Tuesday June 22nd in Arts 143.

Reclamation/Remediation of Disturbed Landscapes (Tuesday June 22nd)

Lee Barbour, Ph.D.

Dr. Barbour is a Professor in the Department of Civil and Geological Engineering at the University of Saskatchewan. A geoenvironmental engineer, he is widely recognized as an expert on water flow and contaminant transport in soil and mine waste materials.

His research on reclamation cover designs on mine waste materials has resulted in modifications to the environmental regulations governing reclamation of saline overburden soils, technology transfer of reclamation design tools, and the establishment of 'instrumented watersheds' to characterize water movement in reclamation landscapes, especially at oil sands reclamation sites.

Dr. Barbour currently leads a team of U of S scientists in helping to transform more than 20,000 hectares of land disturbed by oil sands mining into sustainable ecosystems.

Charles M. Reynolds, Ph.D.

Charles M. "Mike" Reynolds received BS and MS degrees in soil science and soil fertility/chemistry, respectively and a PhD in soil microbiology. After post doctoral research in soil enzyme systems, he joined the Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, NH as a research scientist. He established and leads CRREL's soil microbiology laboratory, focusing on soil biochemical processes including bio- and phyto-remediation at cold, remote sites. Recent projects are investigating bio-inspired sensor phenomena in surface soils, soil-plant-microbial-sensor systems, novel uses of biopolymers in soil, microbial fuel cells in soils, and rapid, stand-off techniques for characterizing soil biology. He also serves on review panels, graduate student committees, mentors junior technical staff, served as an associate editor for Journal of Environmental Quality, and is on the editorial board of the Journal of Soil Sediment Contamination and is senior associate editor for the International Journal of Phytoremediation. For his contributions to a hyperspectral technique for rapidly determining post-decontamination endospore viability, he received a Signature Support Program "Next Generation Signatures Award" for outstanding contributions to signature science in 2008 and a Department of the Army Commendation for outstanding service to National Security in 2009. In 2007 he received the Lifetime Achievement Award at the AEHS Annual International Conference on Soils, Sediments and Water for his soil remediation research.

Arctic Soils (Tuesday June 22nd)

Chris Burn, Ph.D.

Chris holds the NSERC Northern Research Chair in Permafrost in the Yukon and Northwest Territories at the Department of Geography and Environmental Studies, Carleton University. He came to Canada in 1981 as a Commonwealth Scholar, and completed both the M.A. and Ph.D. at Carleton, studying permafrost. He then moved to UBC as a Killam Fellow, to study with J.Ross Mackay, the world authority in his field. In 1989 Chris was awarded an NSERC University Research Fellowship, which he took up at UBC, and brought back to Carleton in 1992.

The emphasis of his research program is on the response of permafrost to climate change, and to surface disturbances. His approach is field-based, and he has concentrated his effort in the Mayo area, central Yukon Territory, and in the western Arctic at Herschel Island and at the Illisarvik experimental site on Richards Island. He strives to describe the magnitude and rate of surface terrestrial processes, and to provide numerical or analytical solutions that reproduce ground behaviour. Recently he has been engaged in determining the response of ground temperatures to climate change over the last 100 years in the western Arctic.

His research program is distinctive in the extent of collaboration with northern agencies. Through the Northern Research Chair there are formal partnerships with the Village of Mayo and the First Nation of Na Cho Nyak Dun in central Yukon, with Yukon and Aurora Colleges, Department of Environment, Government of Yukon, and the Water Resources Division, DIAND. He has a good working relationship with the Western Arctic Field Unit of Parks Canada, the City of Dawson, and the Vuntut Gwitchin First Nation, northern Yukon. These agencies suggest areas for research of direct relevance to northern communities.

Chris has published over 100 articles relating to permafrost conditions in northwest Canada. He was involved in several public hearings of the Joint Review Panel for the Mackenzie Gas Project and is currently working on a portrait of the natural and cultural environment of Herschel Island.

Borlaug Symposium on Plant Breeding (Tuesday June 22nd)

Harvey Voldeng, Ph.D.

Dr. Voldeng has been involved with research and cultivar development in Canada for 42 years. Dr. Voldeng joined Agriculture and Agri-Food Canada (AAFC) in 1968 as a field crop physiologist. From 1974 to 1999 he was the short season soybean breeder for AAFC, and since 2000 has been the spring wheat breeder for Eastern Canada. Dr. Voldeng also served as Section Head for Crops at from 1987 to 2000 for the Eastern Cereals and Oilseeds Research Centre at the Central Experimental Farm, Ottawa. Dr. Voldeng is responsible for producing hard red and hard white spring wheat cultivars for eastern Canadian producers.

Ken Richards, Ph.D.

Dr. has been a researcher/manager with AAFC for 34 years initially at the Lethbridge Research Station and more recently at the Saskatoon Research Station. Dr. Richards research career has included responsibilities for the development of management practices for native bees for pollination of forage legume crops; and most recently managing, directing and coordinating Canada's genetic resources program for plant, animal and microbial genetic resource encompassing all basic functions of gene banks (acquisition, distribution, maintenance, regeneration, characterization and evaluation, and documentation).

Ron Knox, Ph.D.

Dr. Knox has worked in the roles of biotechnologist and plant pathologist for over 23 years at AAFC. He contributes to both the hexaploid and durum spring wheat cultivar development programs through the application of DNA markers for marker assisted selection, production of doubled haploid lines and assessment of breeding material for disease resistance. He is involved with the discovery and validation of markers to disease resistance and quantitative trait loci associated with grain quality traits.

Greg Gingera, Ph.D.

Dr. Gingera is a canola breeder with Dow AgroSciences in Saskatoon. Dr. Gingera responsibilities include the development of glyphosate tolerant *Brassica napus* L. open-pollinated varieties and hybrids containing the omega-9 (high oleic acid, low linolenic acid) fatty acid profile. Dr. Gingera is in charge of supervision of greenhouse and field activities regarding glyphosate tolerant variety and inbred development as well as the characterization of open-pollinated varieties and hybrids. Prior to joining DOW Agrosciences, Dr. Gingera was a plant breeder with Pioneer Hi-Bred International, where he developed *Brassica juncea* L. lines with unique fatty acid profiles.

Wetlands: Transfers and Transformations (Wednesday June 23rd)

Garth van der Kamp, Ph.D.

Dr. van der Kamp is a Research Scientist with Environment Canada's National Hydrology Research Centre (NHRC) located in Saskatoon, SK.

Garths current research has its focus on ensuring that aquatic ecosystems are conserved and protected. This involves studying the impacts of climate changes and land-use changes on prairie wetlands and lakes, evaluating groundwater availability and sustainability; assessing the impacts of groundwater withdrawals on aquatic ecosystems; measuring groundwater flow and solute transport in low -permeability formations; and studies of the hydrology of peatlands.

Dr. van der Kamp is the Environment Canada representative on the Prairie Provinces Water Board, Committee on Groundwater and is an associate editor for the *Journal of Groundwater* and *Canadian Water Resources Journal*. Garth also is a recipient of the *Robert N. Farvolden Award* for outstanding contributions to Canadian hydrogeology (International Association of Hydrogeologistst–Canadian National Chapter, 2005) and the *J. Tuzo Wilson Medal* for outstanding contributions to Canadian geophysics (Canadian Geophysical Union, 2009).

Joe Yavitt, Ph.D.

Dr. Yavitt is a Professor in the Department of Natural Resources at Cornell University in Ithaca, NY. He is an ecosystem ecologist, and his general scientific interest is in the ecological causes and consequences of changing climate, biodiversity, and pollution.

Ecosystem ecologists examine components of the ecosystem (structure) and seek to understand processes that link the components together (function). This research is particularly important in the face of increasing human domination of ecosystems; domination that threatens vital ecosystem services, such as biodiversity, water quantity and quality, clean air and soil, and climate control via biologically derived greenhouse gases.

He is particularly interested in understanding biogeochemical and microbial processes in soil. Soils are a fundamental, but hidden component of ecosystems, and thus we know little about soil critters and how they process and recycle plant material and nutrients within and among different soils.

Dr. Yavitt also has a long-standing interest in community ecology and, especially, interrelationships between abundance, distribution, and diversity of the species that impact ecosystems.

Tim Moore, Ph.D.

Dr. Moore is a Professor in the Department of Geography at McGill University. His interests lie in the relationships between soil and the environment, particularly the regulation of fluxes of gases, nutrients and elements between the soil and the atmosphere, the biosphere and the hydrosphere and the effect of human activities and climate change.

For the past decade, most of his attention has focused on peatlands and wetlands and the controls on the cycling of carbon in these systems. Northern peatlands contain one third of the global soil carbon pool, store carbon dioxide (CO_2) in accumulating peat, emit methane (CH_4) to the atmosphere and are major sources of dissolved organic carbon (DOC). His work, in landscapes ranging from the Northwest Territories to Nova Scotia, has attempted to measure the magnitude of these fluxes, to establish the important controls, to develop models and to examine the effect of changes, such as directly anthropogenic (for example, through the drainage or flooding of peatlands) or indirectly (for example, through climatic change and atmospheric nitrogen deposition) on carbon cycling. Thus, his work integrates aspects of atmospheric chemistry, plant ecology, hydrology, microbiology and soil science in a search to understand biogeochemical patterns in the landscape.

Dr. Moore is a member of the *Global Environmental and Climate Change Centre*; associate editor of the *Journal of Geophysical Research–Biogeosciences* and *EcoScience*, and a member of the Editorial Advisory Board for *Global Change Biology*.

Forest Soils: Natural, Managed and Intensive Systems

(Wednesday June 23rd)

Doug Maynard, Ph.D.

Dr. Maynard team leader of the soil sustainability and productivity group at the Pacific Forestry Centre, Canadian Forest Service in Victoria, BC. He is also an Adjunct Associate Professor in the Department of Geography at the University of Victoria. Dr. Maynard earned his B.Sc. (Agriculture) and M.Sc. (Soil Science) from the University of British Columbia and his PhD (Soil Chemistry) from the University of Saskatchewan. He joined the Canadian Forest Service (Natural Resources Canada) in 1981 at the Northern Forestry Centre, Edmonton, and transferred to the Pacific Forestry Centre in 1997. The primary focus of Dr. Maynard's research has been natural and human caused disturbance and their effects on soil productivity. Dr. Maynard has authored or co-authored more than 50 peer-reviewed publications. He is Co-Editor of the Canadian Journal of Forest Research (since January 2003) and was an Associate Editor of the Canadian Journal of Soil Science from 1997 - 2005. Dr. Maynard was editor of the book "Sulfur in the Environment", published in 1998. Most recently, he co-edited a special issue of the Canadian Journal of Soil Science on "Forest Soil Disturbance." In 1991, Dr. Maynard was awarded a Citation of Appreciation from Environment Canada for his contribution to the National Acid Rain Program.

Green Crop Network Mini-Workshop (Wednesday June 23rd)

Goretty Dias, Ph.D.

Dr. Dias holds a B.Sc. in Physical Geography and a Ph.D. in Atmospheric Science from the University of Guelph. Her areas of expertise include GHG measurement and analysis and air quality measurement technique development. In her academic and consulting work over the last 20 years, Dr. Dias has worked extensively with the Canadian agriculture sector to quantify and analyze air emissions, giving her a strong understanding of agricultural systems.

During the past 6 years, Dr. Dias has conducted LCA studies of the Canadian agriculture sector and bioenergy projects. Her recent projects include: assessing LCA methods for Ontario's Low Carbon Fuel Standard; developing an LCA module for biomass production in Ontario; LCA of short rotation willow in Ontario; and a review of an LCA of electricity generation for California by the National Renewable Energy Laboratory (NREL).

Dr. Dias is currently Network Manager for the NSERC Bioconversion Network, based at the University of Guelph, and is Sessional Faculty in the Department of Geography.

Shirong Tang, Ph.D.

Dr. Tang is a Professor and Deputy Director of the Agro-Environmental Protection Institute, Ministry of Agriculture, China. He is the Director of the Key Laboratory of Production Environment and Agro-product Safety of the Ministry of Agriculture and Tianjin Key Laboratory of Agro-environment and Food Safety. He is also the Director of the Specialty of Production Environment and Agro-product Safety, Chinese Agro-environmental Protection and Ecological Association. His research interests are global climate change and crop adaptation, ecology and environmental restoration as well as plant-microbe interactions related to metal and radionuclide hyperaccumulation. To date, he has completed more than 20 national and international research projects. He has published more than 70 refereed publications in national and international scientific literature as primary author, or co-author.

Susan MacWilliams, B.Sc.

Susan MacWilliam is a lifecycle assessment (LCA) analyst with SRC. Susan has a BSc in chemistry and several years of experience working in the fields of molecular plant protection and environmental analysis via lifecycle assessment. She is currently working on several LCAs relating to agriculture and biofuel systems.

Henry Janzen, Ph.D.

Dr. Janzen is a research scientist in soil biochemistry with Agriculture and Agri-Food Canada at Lethbridge, Alberta. He has studied the flows of carbon and nitrogen in agricultural ecosystems, especially their links to global cycles and long-term changes in the biosphere. An important focus has been finding ways of storing more carbon and reducing greenhouse gas emissions in these ecosystems as a way of mitigating climate change.

Matt McCandless, M.Sc.

Matt McCandless's work is primarily focused on water resources, sustainable agriculture, ecosystem goods and services, and climate change adaptation – often combining both policy and technical research. His current topics of interest include ecosystem goods and services valuation and optimization, life-cycle assessment of bioproducts, and climate change and water resources. He also observes regional climate change negotiations and has conducted research in the area of agricultural offsets.

Since joining the *International Institute for Sustainable Development* (IISD) in 2006, Matt has been the lead researcher on projects involving water policy, hydrological analysis, greenhouse gas mitigation in agriculture, valuing environmental externalities generated by agricultural beneficial management practices, evaluating policies for enhancing ecosystem goods and services provision through agriculture, and providing support to the province of Manitoba during regional climate change negotiations. He has made several presentations of his work, as an expert witness and speaker.

Warren Mabbe, Ph.D.

Dr. Mabbe is an Assistant Professor at Queen's University, with a joint appointment in the School of Policy Studies and the Department of Geography. His international research programme focuses on the interface between policy and technology, addressing issues that bridge the gap between researchers and decision-makers. Prior to taking this post, he worked at the University of British Columbia and the University of Toronto, as well as the Food and Agriculture Organization of the United Nations. Dr. Mabee is currently Associate Task Leader (Policy) for the International Energy Agency's Bioenergy Task 39, Director of the Queen's Institute for Energy and Environmental Policy, and Associate Director of Queen's Sustainable Bioeconomy Centre.

Donald L. Smith, Ph.D.

Dr. Smith is a well-known researcher and one of the leading experts in the field of plant-microbial interaction. He currently leads the NSERC funded Green Crop Network on crops and climate change, including work on biofuels, the director of the McGill Network for Innovation in Biofuels and Bioproducts (McNIBB). Throughout his research career, work on nitrogen fixation has been a consistent theme, beginning with an undergraduate research project on cyanobacteria in 1974. Current work in this area includes signaling between symbiotic partners during establishment of the legume-rhizobia symbiosis. He is also involved in the physiological responses of crop plants to increasing atmospheric CO_2 levels and to climate change. During his 22 years at McGill, 51 graduate students have worked under his direct supervision. Altogether this research activity has resulted over 240 publications, five patents issued and three others applied for, and a spin-off company.

Program Overview

Sunday June 20th

9:00 - 5:30	Soil Judging Contest
5:00 - 9:00	On-Site Registration (Atrium, Agriculture Building)
6:30 - 9:30	Welcome Reception (with bar service)

Monday June 21st

7:30	Coffee & Snacks (Physics Lobby & Arts 143)			
7:30 - 12:30	On-Site Registration (Physics Foyer)			
8:15 - 8:30	WELCOME			
8:30 - 9:30	P.M. Huang Memorial Symposium --- Plenary (Arts 143)			
9:30 - 10:00	COFFEE BREAK (Physics Foyer)			
10:00 - 11:45	P.M. Huang Symposium (Physics 103)	Pedology (Physics 130)	Beyond Organic (Physics 165)	Soil Greenhouse Gases (Biology 106)
12:00 - 1:00	LUNCH (Marquis Hall)			
1:00 - 2:15	P.M. Huang Symposium (Physics 103)	CSA Award Winners (Physics 130)	Beyond Organic (Physics 165)	Soil Greenhouse Gases (Biology 106)
2:15 - 2:45	COFFEE BREAK (Physics Foyer)			
2:45 - 3:45	P.M. Huang Symposium (Physics 103)	Soil Science Education & Raising Awareness (Physics 130)	Beyond Organic (Physics 165)	Soil Greenhouse Gases Nutrient Cycling (Biology 106)
3:45 - 5:00	Poster Session (Geology/Biology Atrium)			
4:00 - 7:30	Statistics Workshop (Physics 103)		4:45 - 6:10	CSSS - Annual General Meeting (2E25 Agric)
5:30 - 9:00	Gwynne Dyer Public Talk --- TCU Place --- "Climate Change: The Problem is Food" Book signing & Public reception @ 5:30 Public lecture @ 7:00			

Tuesday June 22nd

8:00	Coffee & Snacks (Physics Lobby & Arts 143)				
8:00 - 11:00	On-Site Registration (Physics Foyer)				
8:30 - 9:30	Gwynne Dyer --- Plenary (Arts 143)				
9:30 - 10:00	COFFEE BREAK (Physics Foyer)				
10:00 - 12:00	Reclamation & Remediation (Physics 103)	Borlaug Symposium (Physics 130)	Arctic Soils (Physics 165)	Unscheduled	Soil Fertility (Biology 106)
12:00 - 1:00	LUNCH (Marquis Hall)				
1:00 - 2:15	Reclamation & Remediation (Physics 103)	Borlaug II & Forage Crops Breeding (Physics 130)	Arctic Soils (Physics 165)	International Soils & Agronomy (Biology 125)	Soil Fertility (Biology 106)
2:15 - 2:30	COFFEE BREAK (Physics Foyer)				
2:30 - 3:45	Reclamation & Remediation (Physics 103)	Abiotic Stress & Cropping Systems (Physics 130)	Soils: Nutrient Cycling (Physics 165)	Plant Ecology (Biology 125)	*90 Years of Soil Science: The U of S Experience* (Biology 106)
3:15 - 3:45	Birthday Cupcakes (Physics Foyer)				
3:45 - 5:00	Poster Session (Geology/Biology Atrium)				
4:30 - 6:00	Professional Development Session Panel Discussion (Physics 103)		5:00 - 6:00	CSSS - Pedology Round Table (1E80 Agric)	
6:30 - 11:00	Grad Student Reception & BBQ (Grad Commons)		6:00 - 7:00	CSA - President's Discussion (Physics 103)	

Wednesday June 23rd

8:00	Coffee & Snacks (Physics Foyer)				
8:00 - 11:00	On-Site Registration (Physics Foyer)				
8:30 - 9:30	Wetland Symposium (Physics 103)	Pulse Crops (Physics 130)	Forest Soils (Physics 165)	Soil Hydrology & Physics (Biology 125)	GCN Life Cycle Assessment (Biology 106)
9:30 - 10:00	COFFEE BREAK (Physics Foyer)				
10:00 - 12:00	Wetland Symposium (Physics 103)	Crops - General (Physics 130)	Forest Soils (Physics 165)	Soil Hydrology & Physics (Biology 125)	GCN Sustainable Bioeconomies (Biology 106)
12:00 - 1:00	LUNCH (Marquis Hall)				
1:00 - 2:15	Wetland Symposium (Physics 103)	Agronomy & Fertility I (Physics 130)	Forest Soils (Physics 165)	Soil Hydrology & Physics (Biology 125)	GCN International Soils & Agronomy (Biology 106)
2:15 - 2:45	COFFEE BREAK (Physics Foyer)				
2:45 - 3:45	Wetland Symposium (Physics 103)	Agronomy & Fertility II (Physics 130)	Unscheduled (Physics 165)	Unscheduled (Biology 125)	GCN Agriculture & Climate Change (Biology 106)
3:45 - 5:00	Poster Session (Geology/Biology Atrium)				
3:15 - 4:15	CSA Business Meeting (1E80 Agric)		5:00 - 6:30	Student Award Deliberations (2D26 Agric)	
6:30 - 9:00	Banquet & Awards Presentation (Marquis Hall)				

Thursday June 24th

7:00 - 4:00	AGRONOMY Field Tour
8:30 - 5:00	*PEDOLOGY EXCURSION: Soils and Landscapes of the Aspen Parkland Ecoregion*
8:30 - 5:00	WETLANDS Field Tour
9:00 - 3:00	*NMR WORKSHOP: Using ^{31}P NMR Spectroscopy to Characterize Phosphorus in Environmental Samples*

Oral Presentations

(Listed by day and session)

Instructions for:

Speakers:

The schedule is tight, so presentations **MUST BE LOADED IN ADVANCE**.

Make sure you arrive in your presentation room at least ½ hour before your session starts (i.e., either in the morning, at lunch, or during a coffee break) to load your presentation. An assistant will be in each of the presentation rooms starting at 7:45 AM to assist in loading your presentation.

Session Chairs:

Please arrive in your presentation room at least ½ hour before your session begins. An assistant will be available in your session room starting at 7:45 AM and throughout the day to provide help with the AV equipment and to load presentations.

Monday Morning 7:30 to 12:00

7:30	Coffee and Snacks Arts 143 and Physics Foyer	
8:15 to 8:30	**ARTS 143** **Welcome**	
	Huang Memorial Symposium	
8:30 to 8:45	**Tee Boon Goh** Introduction and P.M. Huang Memorial	
8:45 to 9:30	**Antonio Violante** Impact of Biomolecules on the Formation and Reactivity Toward Nutrients and Pollutants of Variable Charge Minerals and Organomineral Complexes in Soil Environments	
9:30 to 10:00	**Coffee** Location: Physics Foyer	
	Huang Memorial Symposium Chair: Tee Boon Goh	**Beyond Organic Symposium** Chair: Steve Shirtliffe
	PHYSICS 103	**PHYSICS 165**
10:00 to 10:15	**Maria Martin** Characterization of arsenic-bearing co-precipitation products formed in Bangladesh groundwater	**Steve Shirtliffe** Introduction to Symposium
10:15 to 10:30	**James Dynes** X-ray absorption spectroscopy studies of Cu(II) sorption on aluminum precipitation products formed under the influence of tannate and by anthropogenic mine soils	**J. Diane Knight** Phosphorus Fertility Management on Prairie Organic Farms
10:30 to 10:45	**Annemieke Farenhorst** Soil chemistry can be used in predicting 2,4-D sorption variations in soil-landscapes.	**Hida Manns** The gain or loss of soil: a matter of moisture and carbon
10:45 to 11:00	**Baljeet Singh (CSSS Student)** Rapid Quantitative Analysis of Herbicides Sorption by Near Infrared Reflectance Spectroscopy (NIRS): A Ray of Evolution in Pesticide Science	**Gourango Kar (CSSS Student)** Phosphorus source and band application effects on spatial distribution and chemical speciation of soil P
11:00 to 11:15	**Mihiri Manimel Wadu (CSSS Student)** 31P Solid State NMR Speciation of Precipitated P from Varying Exchangeable Ca:Mg Ratios	**Kim Schneider (CSSS Student)** Biological contributions to plant phosphorus uptake in organic and conventional dairy farm soils
11:15 to 11:30	**Guangrong Yang (CSSS Student (NM))** Effects of Land Use on Soil Phosphorus Sorption-Desorption	**Frank Larney** Soil Properties of an Irrigated Rotation Study with Sustainable and Conventional Management Practices
11:30 to 11:45	**Question Period**	**Derek Lynch** Productivity, soil quality changes and nitrogen losses under extended organic vegetable rotations
11:45 to 12:00	**Open**	**Laura Wiebe (CSA Student)** Examining the nitrogen economy of organically selected wheat genotypes
11:45	**Lunch Marquis Hall**	

Monday Morning 7:30 to 12:00

	Coffee and Snacks Arts 143 and Physics Foyer	
8:15 to 8:30	**ARTS 143** **Welcome**	
	Huang Memorial Symposium	
8:30 to 8:45	**Tee Boon Goh** Introduction and P.M. Huang Memorial	
8:45 to 9:30	**Antonio Violante** Impact of Biomolecules on the Formation and Reactivity Toward Nutrients and Pollutants of Variable Charge Minerals and Organomineral Complexes in Soil Environments	
9:30 to 10:00	**Coffee** Location: Physics Atrium	
	Pedology Chair: Maja Krzic	**Greenhouse Gases** Chair: Marie Boehm
	PHYSICS 130	**BIOLOGY 106**
10:00 to 10:15	**Paul Sanborn** Pedological diversity in Cordilleran basaltic soils and paleosols	**Chris Van Kessel** Linking N_2O emissions in agriculture to crop productivity
10:15 to 10:30	**Fougère Augustin (CSSS Student)** Mineral weathering rates and hydroclimatic conditions in Podzols	**Craig Drury** Long-term Effects of Crop Rotation and Fertilization on Nitrous Oxide Emissions
10:30 to 10:45	**Ambreen Shah** Effect of different soil regimes on Nitrogen and Carbon cycles in arable and grassland soils	**Siobhan Stewart (CSSS Student)** Perennial Forage Impact on Carbon Dioxide and Nitrous Oxide Emissions in the Red River Valley, Manitoba
10:45 to 11:00	**Elena Ponomarenko** Charcoal-Cored Concretions in Prairie Soils	**Reynald Lemke** Measuring Time-dependent Changes in N_2O Flux
11:00 to 11:15	**Valérie Viaud** Spatial modelling of pedogenesis in a hummocky landscape of Central Saskatchewan under native prairie	**Chunli Li** Nitrous oxide emissions from an acid soil in response to polymer-coated urea application and herbicide management in a canola-barley cropping system
11:15 to 11:30	**James Leslie Henry** Hydropedolog: An Emerging Science and Paradigm Shift for Soil Science alias : The Piezometric Surface as a Soil Forming Factor	**X.H. Shi (CSSS Student)** Daily variation of CO_2 efflux and prediction models under two tillage systems of a Black soil in Northeast China
11:30 to 11:45	**Priyantha B. Kulasekera** Effect of the soil-tongueís shape on water and solute transport in layered soils	**Xiaobin Gao** Influence of Constant versus Fluctuating Water Contents and Crop Rotation on Nitrous Oxide Emissions from Soils
11:45	Open	Open
11:45	**Lunch Marquis Hall**	

Monday Afternoon

1:00 to 2:45

	PHYSICS 103	PHYSICS 165
	Huang Memorial Symposium Chair Fran Walley	**Beyond Organic** Chair: Steve Shirtliffe
1:00 to 1:15	**Donald Sparks** Shining Light on Biogeochemical processes at Soil Interfaces	**A.M. Hammermeister** Mainstreaming Organic Research: Canada's New Organic Science Cluster
1:15 to 1:30		**Benaragama D.I.D.S. (CSA Student)** Enhancing the competitive ability of organic oat (*Avena sativa*.L) cropping systems
1:30 to 1:45		**Eric Johnson** Adapting Mechanical Weed Control to Conventional Cropping Systems: What Are the Possibilities?
1:45 to 2:00	**Peter Leinweber** Advances in soil organic nitrogen research by mass spectrometry and synchrotron techniques	**Iris Vaisman (CSA Student)** Nitrogen dynamics and wheat yield in a no-till organic green manure system using the roller crimper
2:00 to 2:15		**Harun Cicek (CSA Student)** Growth and N supply from legume cover crops in organic rye and wheat production
2:15 to 2:45	**Coffee** Physics Foyer	

Monday Afternoon
1:00 to 2:45

	PHYSICS 130	BIOLOGY 106
	CSA Awards Chair: Shabtai Bittman	**Greenhouse Gases** Chair Chris Van Kessel
1:00 to 1:15	**Michael Peel** Increasing rumen bypass protein of alfalfa **Best CJPS Paper**	**Angela Straathof (CSSS Student)** Soil Type Affects N2O Emissions and Populations of Nitrifying and Denitrifying Bacteria in Mycorrhizal-Inoculated Willows
1:15 to 1:30		**H. Asgedom** Effect of Manure and urea formulatoins on Nitrous Oxide Soil Emissions from a Rapeseed Field in the Red River Valley
1:30 to 1:45	**Umut Toprak (CSA Student)** A New Target in Insect Control: Peritrophic Matrix	**Gwendolyn Donohoe (CSA Student)** Soil greenhouse gas emissions and soil nutrient relationships from overwintering beef cattle excreta on grassland
1:45 to 2:00	**CSA Pest Management Award**	**Q. Huang (CSA Student)** The effect of diet on methane emissions from liquid manure storage
2:00 to 2:15	**Gordon Rowland** Life in the flax lane **CSA Distinguished Agronomist Award**	**Gwendolyn Donohoe (CSA Student)** Nutrient balance and greenhouse gas emissions from overwintering beef cattle
2:15 to 2:45	**Coffee** Physics Foyer	

Monday Afternoon 2:45 to 5:00

	PHYSICS 103	PHYSICS 165
	Huang Memorial Symposium Chair Fran Walley	**Beyond Organic** Chair: Steve Shirtliffe
2:45 to 3:00	**Derek Peak** Surface Chemistry of Soils: Insights from oxyanion adsorption spectroscopic studies	**C.M. Williams (CSA Student)** Quantifying the benefits of cool season pulse crops to subsequent barley crops in rotation
3:00 to 3:15		**Perry Miller** Organic lessons for conventional Ag in wheat-fallow Montana: Do green manures make agronomic sense?
3:15 to 3:30	**Adam Gillespie (CSSS Student)** Do varying landscape positions and management regime affect the stabilization of organic N & C – an X-ray absorption and pyrolysis mass spectrometry study of whole soils.	**Martin Entz** Exploring organic agriculture's place within the agricultural revolution
3:30 to 3:45	**Xueming Yang** X-ray absorption spectroscopy studies of Cu(II) sorption on aluminum precipitation products formed under the influence of tannate and by anthropogenic mine spoils	**Workshop Discussion**
3:45 to 5:00	**Posters with Bar Service** **Geology/Biology Atrium 1st and 2nd Floor**	
Late Afternoon/ Evening	**Statistics Workshop** 4:00 to 7:30 Physics 103	
	CSSS AGM 2E25 AGRC 4:45 to 6:10	
	Gwynne Dyer Public Talk Reception 6:00 to 7:00 Talk at 7:00 TCU Place (Downtown) Buses leave at 5:30 and 6:15	

Monday Afternoon 2:45 to 5:00

	PHYSICS 130	BIOLOGY 106
	Soil Science Education and Raising Awareness Chair Maja Krzic	**Greenhouse Gases** Chair Chris Van Kessel
2:45 to 3:00	**Angela Bedard-Haughn** Teaching Pedology in January: Adventures in online education	**Ravindra Ramnarine** Conventional and no-tillage effects on the quantity and $\delta^{13}C$ signature of SOM fractions
3:00 to 3:15	**Maja Krzic** Emerging approaches to soil science education	**Martin Chantigny** The duration of extraction influences the nature of water-extractable soil organic matter
3:15 to 3:30	**Rachel Strivelli (CSSS Student)** Development of an innovative community of practice platform for soils professionals in British Columbia	**Ahmed Landi** Evaluating the amount of carbonic greenhouse gasses (GHGes) emission from rice paddies and carbon balance in soil
3:30 to 3:45	**Kent Watson** Web-Based Learning Tool on Soil Parent Material and Landscape Development	**Ahmed Landi** Affect of cultivation period on some soil quality indices
3:45 to 5:00	**Posters with Bar Service** **Geology/Biology Atrium 1st and 2nd Floor**	
Late Afternoon/ Evening		
	CSSS AGM 2E25 AGRC 4:45 to 6:10	
	Gwynne Dyer Public Talk Reception 6:00 to 7:00 Talk at 7:00 TCU Place (Downtown) Buses leave at 5:30 and 6:15	

Tuesday Morning 8:30 to 12:00

8:00	**Coffee and Snacks Arts 143**	
8:30 to 9:30	**Gwynne Dyer** The Geopolitics of Food **ARTS 143**	
9:30 to 10:00	**Coffee** Physics Foyer	
	PHYSICS 103	**PHYSICS 165**
	Remediation and Reclamation Chair Bing Si	**Arctic Soils** Chair Angela Bedard-Haughn
10:00 to 10:15	**Lee Barbour** Observations of the Maturation of Juvenile, Reconstructed Soil Profiles	**C.R. Burn** Permafrost and climate change, western Arctic coast, Canada
10:15 to 10:30		
10:30 to 10:45	**Sylvie A. Quideau** Building organic matter in reconstructed Oil Sands soils	**Carissa D. Brown (CSSS Student)** Short-interval fires result in additive carbon loss in northern boreal forests
10:45 to 11:00	**Francis J. Larney** Topsoil replacement depths and organic amendments on reclaimed wellsites: Residual effects after ten years	**Maxime C. Paré (CSSS Student)** Does the Quality of Organic Matter Influence Mineralization in Cryosols? A field-based study of Sub- to High Arctic soils.
11:00 to 11:15	**L.A. Leskiw** Innovation in Soil Compaction Mitigation: Subsoiling and Injection of Organic Pellets	**Marcus R. Phillips (CSSS Student)** The Role of Cryoturbation in the Depth Distribution of Soil Organic Carbon at Two Canadian Arctic Sites
11:15 to 11:30	**L.K. Tallon (CSSS Student)** Field and Numerical Modeling Investigation of a Sloping Unsaturated Layer Soil Cover System	**Daryl Dagesse** The effects of freezing-induced desiccation on bulk soil volume and aggregate stability
11:30 to 11:45	**Henry Wai Chau (CSSS Student)** The Degree of Soil Water Repellence and its Temporal Persistence on Natural and Reclaimed Soils	**Darwin Anderson** Mapping Arctic Landscapes
11:45 to 12:00	**Kathryn Bessie** Reclamation of Vertisolic Soils	Unscheduled
11:45 to 1:00	**Lunch** Marquis Hall	

Tuesday Morning 8:30 to 12:00

8:00	**Coffee and Snacks Arts 143**	
8:30 to 9:30	**Gwynne Dyer** The Geopolitics of Food **ARTS 143**	
9:30 to 10:00	**Coffee** Physics Foyer	
	PHYSICS 130	**BIOLOGY 106**
	Borlaug Symposium Chair: Gavin Humphreys	**Soil Fertility** Chair Fran Walley
10:00 to 10:15	**Harvey Voldeng** Plant Breeding in Canada - Past, present and future	**Mônica B. Benke** Retention of injected anhydrous NH3 fertilizer as affected by soil physical and chemical properties
10:15 to 10:30		**Richard Engel** A micrometeorological study to quantify cold weather volatilization of ammonia from surface-applied urea
10:30 to 10:45	**K.W. Richards** Plant Genetic Resources: building blocks for plant breeders	**J.Y. Yang (CSSS Student)** Estimating Biological N2 Fixation in Canadian Agricultural Land from 1981 to 2006
10:45 to 11:00		**Tom King (CSSS Student)** Leaching of nitrogen and phosphorus from intact soil cores of a Black Chernozem as influenced by manure management.
11:00 to 11:15	**Ron Knox** A prospectus of molecular breeding in Canada	**Aimé J. Messiga (CSSS Student)** Changes in soil phosphorus availability and other nutrient elements as affected by tillage and P fertilization
11:15 to 11:30		**Y.K. Soon (CSSS Student)** Influence of nitrogen pools and microbial activity on crop N Influence of nitrogen pools and microbial activity on crop uptake following legume crops
11:30 to 11:45	**Greg Gingera** Challenges of Private Industry Plant Breeding in Canada	**Darshani Kumaragamage** Nutrient release from solid cattle manure in a perennial forage system
11:45 to 12:00		Unscheduled
11:45 to 1:00	**Lunch** Marquis Hall	

Tuesday Afternoon 1:00 to 2:30

	PHYSICS 103	PHYSICS 165
	Remediation and Reclamation Chair Lori Phillips	**Arctic Soils** Chair Maxime Pare
1:00 to 1:15	**Charles M Reynolds** Green approaches for soil remediation and a look towards the future	**Steven Siciliano** The nitrifier/denitrifier communities in Arctic and Antarctic soils: who is there and what are they doing?
1:15 to 1:30		**Martin Brummell (CSSS Student)** Soil Gas Profiles in Arctic Ecosystems
1:30 to 1:45	**Lori Phillips** Field-scale assessment of phytoremediation at a former oil tank battery in Bruderheim, Alberta	**Krista Hanis (CSSS Student)** Eddy Covariance Measurements of Spring Melt Methane Emissions for a Subarctic Fen at Churchill, MB
1:45 to 2:00	**Trevor Carlson** Application of enhanced in-situ bio-denitrification technologies	**Samiran Banerjee (CSSS Student)** Spatial relationships between microbial abundance and soil attributes in Arctic ecosystems
2:00 to 2:15	**Noorallah Juma** Comparison of performance of four, pressurized, onsite, soil-based dispersal systems at an at-grade installation in Leduc County, Alberta	**Patrick Borden** Clay Mineralogy in Arctic Tundra Gelisols, Northern Alaska
2:15 to 2:30	**Coffee** Physics Foyer	

Tuesday Afternoon 1:00 to 2:30

	PHYSICS 130	BIOLOGY 106	BIOLOGY 125
	Borlaug Symposium II & Forage Crop Breeding Chair: Bruce Coulman	**Soil Fertility** Chair Jeff Schoenau	**International Agriculture** Chair Mike Grevers
1:00 to 1:15	**Han-Qi Tan** Efforts Toward Saturating Barley Malting Quality QTLs with Ac/Ds Transposons	**Jeffrey Nimmo (CSA Student)** Nutrient Flows on Maritime Dairy Farms	**Olusola Adesanwo** Legume incorporation on solubiization of Ogun phosphate rock on slightly acidic Southwestern Nigerian Soils
1:15 to 1:30	**Rohit Dhanda (CSA Student)** Oat fat - possible new direction for better human health and livestock?	**T.Q. Zhang** Crop growth and phosphorus loss in a clay loam soil amended with Enviropig low-P manure	**Ali Al Jaloud** Availability and Fractionation of Trace Elements in Arid Calcareous Soils
1:30 to 1:45	**Edmond Sottie (CSA Student)** Evaluation of new sainfoin germplasm for use in bloat-free grazing systems	**Waraidzo Chiyoka (CSSS Student)** Characterization of Nutrient Release in Chernozemic Soils Amended with Anaerobically Digested Beef Cattle-Feedlot Manure	**Abd El-Alim Metwally** Yield and soybean characters under some intercropping patterns with corn
1:45 to 2:00	**Robert Kazuk (CSA Student)** Condensed tannins in tame forage agronomy	**D.V. Ige** Determination of phosphorus requirement of growing pigs for environmental management of manure phosphorus	**Akbar Forghani** Comparison of different Zn extractants and distribution of its different forms in calcareous soils of Iran
2:00 to 2:15	**Surya Acharya** New sainfoin populations for mixed alfalfa pasture	**Darshani Kumaragamage** Leaching losses of phosphorus from manured and fertilized soils	**Saeedee Esmizadeh** Evaluating the amount of carbonic greenhouse gasses (GHGes) emission from rice paddies and carbon balance in soil
2:15 to 2:30	**Coffee** Physics Foyer		

Tuesday Afternoon 2:30 to Evening

	PHYSICS 103	PHYSICS 165
	Remediation and Reclamation Chair: Lori Phillips	**Nutrient Cycling in Soils** Chair: Maren Oelbermann
2:30 to 2:45	**Dave Goorahoo** Reclamation and Management Strategies for Salt Affected Agricultural Lands In the San Joaquin Valley, California.	**Adekunbi Adeleke (CSSS Student)** Effect of arbuscular mycorrhizal fungi and plant growth-promoting rhizobacteria on glomalin production
2:45 to 3:00	**Amanda Mycock (CSSS Student)** Characterizing Soil Carbon and Nitrogen Status in a Smelter-Affected Area of the Canadian Boreal Shield.	**Melissa Arcand (CSSS Student)** Stable isotope methods for the determination of pea nitrogen rhizodeposition
3:00 to 3:15	**Steve Sheppard** Quantifying trace element transfer for risk assessments ñ interpretation based on 40 elements in 25 plant species	**Martin Chatigny** New insights into the overwinter loss of soil residual N using 15N tracing techniques.
3:15 to 3:30	**Fikre Debela (CSSS Student)** Organic Acids Inhibit Pb- and Zn-Phosphate Formation in Phosphate Amended Metal Contaminated Soils	**Louis-Pierre Comeau (CSSS Student)** Quantity and Fate of Carbon Rhizodeposition in Lentil, Pea, Canola and Wheat Rotations
3:30 to 3:45	**Richard Heck** Development of Morphometric Indicators of Soil Quality based on 3D X-ray CT Imagery	Unscheduled
3:45 to 5:00	**Posters with Bar Service** **Geology/Biology Atrium 1st and 2nd Floor**	
Late Afternoon/ Evening	**Grad Student Discussion Panel** 4:00 to 6:00	
	Grad Student Reception & BBQ 6:30 to 11:00 Grad Commons	**CSA President's Discussion** 6:00 to 7:00 Physics 103
	Pedology Roundtable 4:30 to 6:00 Room: 1E80	

Tuesday Afternoon 2:30 to Evening

	PHYSICS 130	BIOLOGY 106	BIOLOGY 125
	Abiotic Stresses & Cropping Systems Chair: Helen Booker	**90 Years of Soil Science at the University of Saskatchewan**	**Plant Ecology** Chair: Xiying Hao
2:30 to 2:45	**Surya Acharya** New salinity tolerant alfalfa for western Canada	**Darwin Anderson** 90 Years of Soil Science at the University of Saskatchewan(26)	**Rim Klabi** Seasonal variation and temporal dynamics of arbuscular mycorrhizal (AM) and non-AM endophytes in different plant communities of native forage stands
2:45 to 3:00	**Rosalind Bueckert** Drought and genotypic effects on mineral and phytate concentrations in chickpea seed		**Eric Lamb** Effects of plant species richness and evenness on soil community diversity and function
3:00 to 3:15	**Ymène Fouli** Double Cropping Effects On Forage Yields and the Water Balance in Southeastern Pennsylvania		**Jin Li (CSA Student)** Germination thresholds of native and invasive species in the Mixed-grass Prairie as affected by global change: a FACE study
3:15 to 3:30	**Walelign Worku** Comparative Performances of Two vs Three Component Intercropping Systems Involving Maize, Common Bean and Mung Bean.	**90th Birthday Cake** **Physics Foyer**	**Rakhi Palit** Ecotypic variation in reproductive phenology and seed production of Festuca hallii
3:30 to 3:45	Unscheduled		Unscheduled
3:45 to 5:00	**Posters with Bar Service** **Geology/Biology Atrium 1st and 2nd Floor**		
Late Afternoon/ Evening	See Physics 103		
	Pedology Roundtable 4:30 to 6:00 Room: 1E80		

Wednesday Morning 8:30 to 10:00

8:00	**Coffee and Snacks Physics Atrium**		
	PHYSICS 103	**PHYSICS 165**	**PHYSICS 130**
	Wetland Symposium Chair Dan Pennock	**Forest Soils** Chair: Ken Van Rees	**Pulse Crops** Chair: Yantai Gan
8:30 to 8:45	**Tim Moore** Canadian Peatlands and Global Change	**Doug Maynard** A 2020 Vision for Forest Soil Research: Building on the Work of Our Predecessors -Keynote address	**Rosalind Bueckert** Pattern of yield filling in lentil: pod and seed dynamics
8:45 to 9:00			**Adil Choudhry** Controlling lentil indeterminacy with desiccant application
9:00 to 9:15	**Nathan Basiliko** Similar patterns of substrate mineralization exist across peatland types	**Elena Ponomarenko** Signature of Hurricanes in Forest Soils of the Maritimes	**Hossein Zakeri** Lentil leaf nitrogen and SPAD: a non-linear estimation using Artificial Neural Networks
9:15 to 9:30	**Varun Gupta (CSSS Student)** DNA stable-isotope probing to identify active methanotrophs in northern peatlands	**François Courchesne** Upland forest soils contribute trace elements to the stream during a rainfall event	**Tamira Delgerjav** The performance of two low phytate field pea lines
9:30 to 10:00	**Coffee** Physics Foyer		

Wednesday Morning 8:30 to 10:00

8:00	**Coffee and Snacks Physics Atrium**	
	BIOLOGY 125	**BIOLOGY 106**
	Soil Physics and Hydrology Chair: Jane Elliott	**Green Crop Network** Chair: Don Smith
8:30 to 8:45	**Cory Kartz (CSSS Student)** On the Transport of Viable but Non-Culturable (VBNC) E.coli O157:H7 in Soil and Groundwater	**Goretty Dias** Anatomy of a LCA: Implications for bioenergy crop systems
8:45 to 9:00	**Thair Patros (CSSS Student)** The Effect of Hysteresis on Specific Yield (Drainable Porosity) and Fillable Porosity	
9:00 to 9:15	**Emmanel Rotimi Ojo (CSSS Student)** Field versus Factory Calibration of Frequency Domain Reflectometry Soil Moisture Probes	**Susan MacWilliam** Lifecycle and socio-economic analysis of pulse crop production in Western Canada
9:15 to 9:30	**Dan Reynolds** Measuring Soil Hydraulic Properties Using a Cased Borehole Permeameter: Falling Head Analyses	
9:30 to 10:00	**Coffee** Physics Foyer	

Wednesday Morning 10:00 to 12:00

	PHYSICS 103	PHYSICS 165	PHYSICS 130
	Wetland Symposium Chair: Nathan Basiliko	**Forest Soils** Chair: Nicolas Belanger	**CSA Crops - General** Chair: Jane King
10:00 to 10:15	**Garth van der Kamp** An overview of the processes that control the water balance and salinity of prairie wetlands	**Bradley Pinno** Rapid changes in soil carbon and root biomass with forest encroachment in the aspen parkland ecoregion of Saskatchewan	**Malcolm Morrison** A Method for Selecting Low Cadmium (Cd) Accumulating Soybean Varieties
10:15 to 10:30		**Sue Grayston** Enhanced carbon sequestration and greenhouse-gas fluxes following fertilization of B.C. coniferous forests	**Taryn Dickson (CSSS Student)** Meteorological Impacts of the 2008 Growing Season on Canola Quality (Brassica napus) in Western Canada
10:30 to 10:45	**Nathalie N. Brunet (CSSS Student)** Water quality characteristics of prairie wetland drainage	**Carolyn Winsborough (CSSS Student)** Greenhouse gas and soil nutrient dynamics at Haliburton Forest: nitrogen and phosphorous additions to soils to study the effects of high nitrogen deposition	**Tarlok Sahota** Straw production potential of spring and winter cereal varieties at Thunder Bay
10:45 to 11:00	**Jane Elliott** Dissipation of the herbicide thifensulfuron-methyl in a prairie wetland	**M. Derek MacKenzie** Does Charcoal Affect the Spatial Pattern of Soil Processes in Forest Ecosystems?	**Lindsey Cartier** Effect of cover crop type and planting date on nitrogen uptake and subsequent cucumber yield income
11:00 to 11:15	**Dani Degenhardt (CSSS Student)** Dissipation of Herbicides in Water and Sediment of Two Canadian Prairie Wetlands	**Susan J. Robertson** Positive Influences on Root Symbioses by Biochar Enhances Seedling Growth in Sub-Boreal Forest Soils	**Hema Duddu (CSA Student)** Morphological Characterization and Seed Persistence Estimation of Cow Cockle (Saponaria Vaccaria. L)
11:15 to 11:30	**Paul Messing (CSSS Student)** Atmospheric concentrations of currently used pesticides in relation to wetland water quality in Manitoba, Canada	**Dan Harrison (CSSS Student)** Fertilizer-induced changes in soil nutrient cycling in immature pine and spruce forests in British Columbia	**Ahmad Esmaeili Taheri (CSA Student)** Functional Diversity of Fungi Associated with Durum Wheat Root in sw Saskatchewan
11:30 to 11:45	**Lisette Ross** Modeling of Spring Hydrology Dynamics in Northern Prairie Wetlands in Relation to Vegetation, Soil Properties and Land-use	**Holly Hynes (CSSS Student)** Does forest harvesting affect soil microbial diversity and nitrogen fluxes in field sites on the Boreal Plain of Alberta?	**Fetus Odeleye** Evaluation of the maturity of seeds from different sections of infloresences of Amaranthus cruenthus and Celosia argentea
11:45 to 12:00	Unscheduled	**Scott Smith** Digital soil mapping in the Okanagan Basin, British Columbia to support forest biomass harvesting suitability	Unscheduled
11:45	Lunch Marquis Hall		

Wednesday Morning 10:00 to 12:00

	BIOLOGY 125	BIOLOGY 106
	Soil Physics and Hydrology Chair: Dan Reynolds	**Green Crop Network** Chair: Don Smith
10:00 to 10:15	**Wenxiu Zou (CSSS Student)** The effect of long-term fertilization on soil water storage and water deficit in the black soil zone	**Cesar Miranda** Sustainable bioeconomics: International aspects of crop production
10:15 to 10:30	**Hailong Liu (CSSS Student)** Using DSSAT model to simulate crop yield, soil water content and nitrate loss under an integrated wetland-reservoir and subsurface irrigation system	
10:30 to 10:45	**Olatuyi S.O.** Two-Dimensional Redistribution of Bromide as Influenced by Nitrogen Fertilization and Landscape Position	**Henry Janzen** Using biomass wisely: reflecting on the long-term prospects
10:45 to 11:00	**Asim Biswas (CSSS Student)** Scale specific spatial pattern of soil water storage and its relation to topographic indices	
11:00 to 11:15	**Barbara Cade-Menun** Characterizing Dissolved and Particulate Phosphorus in Snowmelt Runoff from Cattle Winter Bale-Grazing Sites	**Shirong Tang** Combined effects of metal stress and elevated CO_2 on crops: advantages and disadvantages
11:15 to 11:30	**Gro Lilbaek** Impact of Irrigation on Surface and Groundwater Quality in Southern Alberta	
11:30 to 11:45	**Jane Elliott** Reducing Dissolved Phosphorus Losses in Runoff from Conservation Tillage Fields.	**Matthew McCandless** Ecosystem services in the bioeconomy: Balancing sustainable development priorities
11:45	Lunch Marquis Hall	

Wednesday Afternoon 1:00 to 2:45

	PHYSICS 103	PHYSICS 165	PHYSICS 130
	Wetland Symposium Chair: Lisette Ross	**Forest Soils** Chair: Nicolas Belanger	**CSA-Fertility I** Chair: Rigas Karamanos
1:00 to 1:15	**Joe Yavitt** Methanogens in Boreal to Temperate Peatlands	**Suzanne Brais** Soil Quality and Tree Growth in Jack Pine and White Spruce Plantations of Forest and Old Field Origin	**Marijke Van Andel (CSSS Student)** Development of a simple and affordable method of measuring total ammonia loss from land applied manures
1:15 to 1:30		**Nicolas Bélanger** Impacts of hybrid poplar growth on soil nutrient availability: evidence for efficient scavenging and recycling of base nutrients	**Khaled Alotaibi (CSSS Student)**Comparison of manure from wet distillers grain versus conventional rations on crop yield and nutrient recovery in east-central Saskatchewan
1:30 to 1:45	**Pascal Badiou** Carbon Sequestration And Greenhouse Gas Emissions In Canadian Prairie Pothole Wetlands	**Joel Ens (CSSS Student)** Effect of Establishing Willow (Salix spp.) Plantations on Soil Carbon and Greenhouse Gas Dynamics	**Jeff Schoenau** Placement of solid cattle manure: Effects on crop yield and nutrients in a Black Chernozem in east-central Saskatchewan
1:45 to 2:00	**Stephan Glatzel** Greenhouse gas turnover in a restoring bog in North Germany	**Ryan Hangs (CSSS Student)** Response of willow growth to irrigation and fertilization in Saskatchewan	**Mehdi Sharifi** Nitrogen mineralization potential in a soil with long-term history of fresh and composted manure containing straw or wood-chip bedding
2:00 to 2:15		**M.A.K Wijesinghe** Impact of Arbuscular and Ecto Mycorrhizal Inoculation on Soil Aggregation and Arbuscular Mycorrhizal Diversity in Willow (Salix spp.) Rhizosphere	**Ymène Fouli** Conservation Tillage to Reduce Nutrient Losses from Surface Applied Poultry Litter on the Delmarva Peninsula
2:15 to 2:45	**Coffee** Physics Foyer		

Wednesday Afternoon 1:00 to 2:45

	BIOLOGY 125	BIOLOGY 106
	Soil Physics and Hydrology Chair Gro Lilbaek	**Green Crop Network** **International Agriculture** Chair Mike Grevers
1:00 to 1:15	**Jim Miller** Influence of Off-Stream Watering With and Without Fencing on Environmental Quality of the Lower Little Bow River and Associated Landscape in Southern Alberta	**Darwin Anderson** A Japan-Saskatchewan Pedology Exchange
1:15 to 1:30	**Amber Smith (CSSS Student)** Nutrient Export In Run-Off From An In-Field Cattle Overwintering Site In East-Central Saskatchewan	**T.B. Goh** CSSS - Twinning Projects in Sri Lanka , Vietnam, and Ethiopia
1:30 to 1:45	**Tom King (CSSS Student)** Relationship of solid cattle manure placement method in a black Chernozem to phosphorus and nitrogen movement in simulated snowmelt water.	**Wondwosen Tena** Identification of Growth Limiting Nutrient(s) in Alfisols: Soil Physico-Chemical Properties, Nutrient Concentrations and Biomass Yield of Maize
1:45 to 2:00	Unscheduled	**Anthony Kimaro** Diagnosis of nutrient imbalances with vector analysis in agroforestry systems
2:00 to 2:15	Unscheduled	**Maren Oelbermann** Soil Carbon Dynamics in Complex Agroecosystems of Latin America
2:15 to 2:30	Coffee	**Annemieke Farenhorst** Universities Communities and Other Stakeholders Working Together to Improve Pest Management Strategies and Practices in Central America
2:30 to 2:45	**Coffee** Physics Foyer	

Wednesday Afternoon 2:45 to Evening

	PHYSICS 103	PHYSICS 165	PHYSICS 130
	Wetland Symposium Chair Lisette Ross	Unscheduled	**CSA-Fertility II** Chair: Malcolm Morrison
2:45 to 3:00	**Maria Kernecker (CSSS Student)** Earthworm mediated soil carbon and nitrogen transformations in riparian buffers		**S. Indraratne** Transgenic crops and their impact on nutrient availability, metal status and isotope signature in soils
3:00 to 3:15	**Toktam Sajedi** Drainage effects on site productivity and soil carbon stores in a cedar-swamp ecosystem in coastal British Columbia		**Tariok Sahota** Comparative performance of urea and ESN in rainfed spring wheat in northern Ontario
3:15 to 5:00	**Posters with Bar Service Geology/Biology Atrium 1st and 2nd Floor**		
Late Afternoon/ Evening	**CSA Business Meeting** 4:00 to 5:00 Room: 1E80		
	Awards Banquet Marquis Hall Cash Bar 5:30 to 6:30 Dinner6:30		

Wednesday Afternoon 2:45 to Evening

	BIOLOGY 125	BIOLOGY 106
	Unscheduled	**Green Crop Network** Chair Don Smith
2:45 to 3:00		**Donald Smith** Agriculture and Climate Change: The Road Ahead
3:00 to 3:15		
3:15 to 3:30		**Warren Mabee** Agriculture and Climate Change: the role of biorefining
3:30 to 3:45		
3:30 to 5:00	**Posters with Bar Service** **Geology/Biology Atrium 1st and 2nd Floor**	
Late Afternoon/ Evening	**CSA Business Meeting** 4:00 to 5:00 Room: 1E80	
	Awards Banquet Marquis Hall Cash Bar 5:30 to 6:30 Dinner6:30	

Poster Presentations

(Listed by day and session)

Instructions for:

Poster Presenters:

Posters are on display for the entire day of your session. Please hang your poster between 7:45 AM and 8:30 AM on the morning of your session and on your assigned poster board. All posters should be removed after the poster session ends on the day of your session. Please make sure your poster is removed by 6:00 PM. An assistant will be available in the Geology/Biology Atrium to answer any questions, and help you locate your poster board.

Monday Poster Sessions Geology/Biology Atrium 1st and 2nd Floors					
Name of First Author		Title	Session Affiliation	Position	Student Presenter
Campbell	Leslie	Learning from the present and past: a review of agricultural impacts on soil fertility	Beyond Organic	1	CSA
Fraser	Tandra	Can plants access P pools not accounted for in traditional soil tests? A study of organically managed soils across Saskatchewan	Beyond Organic	2	
Sullivan	Clare	Managing annual green manures to improve yield and soil health in organic production systems	Beyond Organic*	3	CSSS
Halde	Caroline	Continuous no-till in organic grain production: possible?	Beyond Organic	4	CSA
Malhi	Sukhdev	Influence of Tillage, Crop Residue, N Fertilizer and Liquid Swine Manure Management on Greenhouse Gas Emissions	GHG - Manure	5	
Cheng	Yi	Denitrification and heterotrophic nitrification dominate N2O emissions in humid subtropical soils of China	GHG - Soils & Crops	6	CSSS
Gillis	Daniel	A novel model describing carbon mineralization from soils amended with organic residues	GHG - Soils & Crops	7	CSSS
Lemke	Reynald	Does crop type influence nitrous oxide emissions from crop rotations on the Canadian prairies?	GHG - Soils & Crops	8	
Moulin	Alan	Probability Distribution Functions for Nitrous Oxide Fluxes	GHG - Soils & Crops	9	
Ramnarine	Ravindra	Contribution of carbonates to δ13C-CO2 emissions in laboratory-incubated soil.	GHG - Soils & Crops	10	CSSS (NM)
Zou	Wenxiu	Nonlinearity detection in the spatial variation of nitrous oxide emission by delay vector variance	GHG - Soils & Crops	11	
Xie	Hongtu	Application of mid-infrared spectroscopy for soil property prediction and identification	P.M Huang Symposium	12	
Kiersch	Kristian	Application of pyrolysis-field ionization mass spectrometry (Py-FIMS) and synchrotron-based X-ray absorption spectroscopy (C- und N-XANES) to determine heat effects on soil organic matter	P.M Huang Symposium	13	CSSS (NM)
Martin	Maria	Competitive adsorption of arsenite and arsenate with organic phosphorus on goethite	P.M. Huang Symposium	14	
Martin	Maria	Characterization of arsenic-bearing co-precipitation products formed in Bangladesh groundwater	P.M. Huang Symposium	15	
Pannu	Ravinder	Quantifying mercury and greenhouse gas fluxes from soils in response to increasing water filled pore space.	P.M. Huang Symposium	16	CSSS(NM)
Basiliko	Nathan	Environmental datasets from on-campus ecosystems facilitate experiential learning in large lecture-based courses	Soil Science Education	17	
Basiliko	Nathan	Bringing leading international scientists to the University of Toronto Mississauga classroom via the web	Soil Science Education	18	
Quenum	Mathieu	Segmentation strategies of agricultural plots in management zones according to their phosphorus sorption capacity	Soil Science Education	19	
Wildfong	Danielle	Delivery of soil science to farmers using advanced simulation tools: a 10 year Case Study	Soil Science Education	20	
Shabaga	Jason	Soils: Charting New Territory in High-School Education	Soil Science Education	21	CSSS
Singh	Baljeet	Pesticide Root Zone Modeling (PRZM) in soil profiles of two research sites in Manitoba and Saskatchewan, Canada	Soil Science Education	22	CSSS
Guérin	Julie	Should Moorsh-Forming Process be Considered in the Canadian System of Soil Classification for Organic soils?	Soils - Pedology	23	

Tallon	Lindsay	Heat Capacity Estimation Errors in Bentonite Samples Due to Void Space Using Single Probe Heat Pulse Measurements	Soils - Pedology	24	CSSS
Al Otaibi	Fahad	Potential use of Endophytic Bacteria as Plant Growth Promoting Inoculants	Soils - Microbiol	25	CSSS
Dai	Mulan	Arbuscular mycorrhizal (AM) and non-AM endophytic fungal proliferation in prairie wheat fields is related to soil properties, management, and plant nutrients uptake	Soils - Microbiol	26	
Helgason	Bobbi	Influence of extraction method on DNA and RNA recovery from soils of varying textures and organic matter contents	Soils - Microbiol	27	
Németh	Deanna Deaville	Effect of corn (*Zea mays* L.) biomass removal on soil nitrifying microbes, denitrifying microbes and N_2O emissions during a spring thaw event.	Soils - Microbiol	28	CSSS
Yang	Chao	Fungicide application effects on diversity components of chickpea rhizospheric N2-fixing bacterial community	Soils - Microbiol	29	CSSS (NM)

Tuesday Poster Sessions Geology/Biology Atrium 1st and 2nd Floors					
Name of First Author		Title	Session Affiliation	Position	Student Presenter
Biswas	Asim	Scale Dependent Spatial Variability of Soil Properties in the High Arctic	Arctic Soils	1	CSSS
Brummell	Martin	Latitude-Driven Variation in Soil Biodiversity in the High Arctic	Arctic Soils	2	CSSS
Harvey-Schafer	Alexis	Influence of liquid water on gas diffusion coefficient and nutrient flux in PHC contaminated soil under frozen conditions	Arctic Soils	3	CSSS
Chen	Jing	Physiological characterization of barley progeny lines with contrasting levels of carbon isotope discrimination	Crops and Fertility	4	CSSS
Slater	Susan	Relative mRNA transcript levels of main seed development transcription factors in high oil versus low oil phenotypes of Brassica napus.	Crops and Fertility	5	
Clair	Thomas	Air Pollution from Agricultural Ammonia in Canada: Sources, Ecological Impacts and Policy Implications	Reclamation/Remediation	6	
Chau	Henry	Determination of Hydrophobic Conducting Porosity using Tension Infiltrometer	Reclamation/Remediation	7	CSSS
Richman	Darin	Assessing the Bio-Environmental Degradability of Light-Weight Packaging Materials in Controlled Composting Environments	Reclamation/Remediation	8	
James	Kyle	Application of a C18 membrane as a lipid sink for evaluating bioaccessibility of PAHs in soil	Reclamation/Remediation	9	CSSS
Mathews	Shiny	Arsenic oxidation and reduction in the growth media and biomass of hyperaccumulator Pteris vittata L.	Reclamation/Remediation	10	
Peters	Rachel	Bioavailability of PAH contaminated soil in swine	Reclamation/Remediation	11	CSSS
Steinke	Lance	Biophysical Parameters for Evaluating Land Reclamation in the Rocky Mountains	Reclamation/Remediation	12	CSSS
Szmigielski	Anna	Persistance of sulfentrazone in Saskatchewan soils.	Reclamation/Remediation	13	
Bentz	Jennifer	Landscape-Scale Distribution of Heavy Metals In Flin Flon, MB	Reclamation/Remediation	14	CSSS
Dallaire	Catlan	Characterization of thin soils on exposed bedrock outcrops in a stressed Boreal ecosystem	Reclamation/Remediation	15	CSSS
Owojori	John	Effects of metal contamination on survival and reproduction of the oribatid mite Oppia nitens and Collembola Folsomia candida	Reclamation/Remediation	16	
Rittl	Tatiana	Criteria definition for determining the extension and use of the Ribeira Touristic State Park (PETAR) buffer zone (S„o Paulo-Brazil)	Reclamation/Remediation	17	CSSS
Sorenson	Preston	Spatial Patterns in Forest Floor Development on Reclaimed Sites in Northern Alberta	Reclamation/Remediation	18	CSSS
Larney	Frank	Topsoil Replacement Depths and Organic Amendments on Reclaimed Wellsites: Residual Effects After Ten Years	Reclamation/Remediation	19	
Wallace	Brian	Seasonal dynamics of soil aggregates 8 years following the application of biosolids to a degraded semi-arid native grassland	Reclamation/Remediation	20	CSSS
Hunter	Amanda	Soil Water Repellency and Critical Water Content of Soil and Organic Materials in Oil Sands Reclamation	Reclamation/Remediation	21	CSSS

Ngombe	Dean	On-Farm Remediation of Pesticides Waste using Biobeds	Reclamation/Remediation	22	CSSS
Betts	Aaron	Remediation Potential of Phosphorus Amendments for Lead in Urban Soil	Reclamation/Remediation	23	CSSS
Alotaibi	Khaled	Biochars and ashes produced from pyrolysis and gasification as amendments to increase the fertility of a Brown Chernozem soil	Soils - Fertility	24	CSSS
Cade-Menun	Barbara	Phosphorus under Long-Term and Short-Term No-Till in a Wheat-Pea Rotation with Five P Fertilization Rates	Soils - Fertility	25	
Porterfield	Jim	Results from Stabl-U/ESN Blend Studies Combined with Mineral Dust, Gypsum PAM and Soil Imprinting	Soils - Fertility	26	
Royer	Isabelle	Soil phosphorus dynamics after ploughing an old grassland.	Soils - Fertility	27	
Giles	Courtney	A simultaneous time and depth assessment of soil and leachate phosphorus in poultry manure-amended soil columns	Soils - Fertility - Manure	28	
Hao	Xiying	Rate of available phosphorus release from previously manured loamy sand soil	Soils - Fertility - Manure	29	
Stefankiw	Jocelyn	Composted versus fresh distillers grain derived manure as nutrient source for canola	Soils - Fertility - Manure	30	CSSS
Kosty	Courtney	The Impact of Cropping History on Glomalin-Related Soil Protein and Water Aggregate Stability	Soils - Nutrient Cycling	31	CSSS
Angers	Denis	Estimation of soil carbon saturation deficit at the national level: an example using French agricultural soils	Soils - Nutrient Cycling	32	
Comeau	Louis-Pierre	Pulse Crop Effect on Soil Organic Nitrogen Mineralization in two Saskatchewan Ecoregions	Soils - Nutrient Cycling	33	CSSS
Sather	Morgan	Modification of the Bradford and ELISA methods for quantification of glomalin soil-related protein	Soils - Nutrient Cycling	34	CSSS
Shi	Xiuhuan	Effect of zone tillage on the distribution of soil organic carbon in a Brookston clay loam soil	Soils - Nutrient Cycling	35	CSSS
Yang	Xueming	Residual effect of organic amendments on the accumulations of soil organic carbon and total nitrogen 10 years after application	Soils - Nutrient Cycling	36	
Navarro Borrell	Adriana	Influence of drought and arbuscular mycorrhizal fungi inoculation on growth and development of Black Bean (Phaseolus vulgaris L.)	Agron - Microbiol	37	CSSS(NM)
Fraser	Tandra	Nitrous oxide emissions from long-term cattle and swine manure amended soils in the Black soil zone of Saskatchewan, Canada	GHG - Manure	38	
Guérin	Julie	The influence of intensifying field pea production on nitrous oxide emissions and soil organic carbon status	GHG - Soils & Crops	39	

Wednesday Poster Sessions Geology/Biology Atrium 1st and 2nd Floors					
Name of First Author		Title	Session Affiliation	Position	Student Presenter
Prasad	Rajib	Utilization of Mutation Breeding for Improvement of Fenugreek (*Trigonella foenum-graecum* L.)	Agron - Crops	1	CSA
Biligetu	Bili	The impact of temperature and water potential regimes on seed germination of side-oats grama (Bouteloua curtipendula) population	Agron - Crops	2	
Knox	Ron	DNA markers associated with common bunt resistance in McKenzie wheat	Agron - Crops	3	
Ross	Shirley	The forage value of seven annual crops harvested at 10 weeks growth	Agron - Crops	4	
Bruns	H. Arnold	Production Practices That Impact Pre-Harvest Aflatoxin Contamination of Corn	Agron - Crops	5	
Chytyk	Cody	Cool Saskatchewan spring temperatures affect phosphorus nutrition in winter cereals.	Agron - Fertility	6	CSA
Gao	Yimin	Nitrogen, Phosphorus and Zinc Fertilizer Applications on Soil Micronutrient Absorbability and Accumulation of Oats and Canola	Agron - Fertility	7	
Hubbard	Michelle	Plant-associated fungi enhance wheat abiotic stress tolerance under controlled conditions	Agron - Microbiol	8	CSSS
Lupwayi	Newton	Microbial colonization of legume crop residues during decomposition	Agron - Microbiol	9	
Oliveira	Vitória	Adsorption and Desorpion of Fomesafen in Latosols	Agron - Microbiol	10	CSSS
Prescott	Cindy	Response of soil organisms to retention of living trees after forest harvest	Forest Soils	11	
Hangs	Ryan	Screening willow clones for salt tolerance	Forest Soils	12	CSSS
Phillips	Lori	Influence of long-term fertilization on carbon cycling in forest soils	Forest Soils	13	
Piper	Candace	Soil enzyme activities in boreal forest soils up to 18 years after harvest	Forest Soils	14	CSSS
Schmidt	Margaret	Chemical characteristics of nutrients in throughfall and stemflow of bigleaf maple and Douglas-fir in a temperate coniferous forest	Forest Soils	15	
Swallow	Matthew	Moisture Mediated Alterations of Microbial Communities in Boreal Forest Floors.	Forest Soils	16	CSSS
Humphreys	Gavin	Blackpoint incidence in Canadian and New Zealand hard white wheat	International	17	
Jacomine	Paulo	Diagnostic Surface Horizons Used in the Brazilian System of Soil Classification	International	18	
Araujo	Maria do Socorro	Characterization of porosity in Brazilian soils using X-ray computer tomography	International	19	
Antonino	A.C.D.	Comparison between porosity determination by volumetric ring and X-ray computer tomography in Brazilian soils	International	20	
Messiga	Aimé Jean	Dynamics of diffusive phosphate ions in the top-soil of no-till vs. mouldboard ploughing	International	21	CSSS
Navarro Borrell	Adriana	The role of arbuscular mycorrhizal fungi in reactive oxygen species metabolism under drought conditions in black bean (*Phaseolus vulgaris* L.)	International	22	CSSS(NM)
Yang	Jingmin	Sensitivity Analysis of the DSSAT-CERES-Maize Model to Input Parameters on Black Soil in Northeast China	International	23	

Aljaloud	Ali	Reuse of Wastewater for Irrigation in Saudi Arabia and its Effect on Soil and Plant	Soils - Hydrology	24	
Cade-Menun	Barbara	Watershed Evaluation of Beneficial Management Practices within the Pipestone Creek Watershed, Saskatchewan	Soils - Hydrology	25	
Tiessen	Kevin	Small dams and reservoirs: effect on stream water quality and quantity in the Canadian Prairies	Soils - Hydrology	26	
Elliott	Jane	Crop Residues and Soil as Nutrient Sources in Snowmelt Runoff	Soils - Hydrology	27	
Japp	Mitchell	Monitoring soil nutrient and water quality on soils irrigated with liquid swine effluent	Soils - Hydrology	28	
Miller	Jim	Leaching of Nitrate, Chloride, and Phosphorus from Undisturbed Soil Cores Amended with Fresh or Composted Beef Cattle Manure	Soils - Hydrology	29	
Patros	Thair	Evolution of Specific Yield (Drainable Porosity) With Respect To Its Use In Estimating Groundwater Recharge	Soils - Hydrology	30	CSSS
Qin	Xiaobo	Effect of long-term fertilization on Nitrogen leach of groundwater in rice paddyóóa case study of Hunan, China	Soils - Hydrology	31	
Zhang	Beibei	Water Deficit and High Temperature Affected Water Use Efficiency and Arabinoxylans Concentrations in Spring Wheat	Soils - Hydrology	32	CSSS
Zhou	Wei	Effects of irrigation and organic fertilization on the mobility and drainage of P from a lysimeter soil	Soils - Hydrology	33	CSSS
Ross	Lisette	The Vegetation of Prairie Wetlands in Native and Agricultural Landscapes: Implications for Wetland Health and Restoration	Wetlands Symposium*	34	
Martin	Maria	Iron-rich snow and water in an alpine site (NW-Italy): effects of soil-snow interaction on microbial redox processes.	Wetlands Symposium	35	
Messing	Paul	The impact of eight herbicides at environmentally relevant concentrations in Prairie Pothole wetlands on aquatic invertebrates	Wetlands Symposium	36	CSSS
Murata	Alison	Electrical conductivity as an indicator of wetland hydrology	Wetlands Symposium	37	CSSS
Preston	Michael	Microbial activity and diversity in James Bay peatlands	Wetlands Symposium	38	CSSS
Irvine	Silver	Cation, Electrical Conductivity, pH, and Total and Organic Carbon Analysis of Seven Horizons in a Dry Pond Soil, Kamloops, British Columbia	Wetlands Symposium	39	CSSS
Forghani	Akbar	Comparison of different Zn extractants and distribution of its different forms in calcareous soils of Iran		40	

Abstracts

(Listed in alphabetical order)

Instructions for:

Speakers:

The schedule is tight, so presentations **MUST BE LOADED IN ADVANCE**.

Make sure you arrive in your presentation room at least ½ hour before your session starts (i.e., either in the morning, at lunch, or during a coffee break) to load your presentation. An assistant will be in each of the presentation rooms starting at 7:45 AM to assist in loading your presentation.

Session Chairs:

Please arrive in your presentation room at least ½ hour before your session begins. An assistant will be available in your session room starting at 7:45 AM and throughout the day to provide help with the AV equipment and to load presentations.

Poster Presenters:

Posters are on display for the entire day of your session. Please hang your poster between 7:45 and 8:00 AM on the morning of your session and on your assigned poster board. All posters should be removed after the poster session ends on the day of your session. Please make sure your poster is removed by 6:00 PM. An assistant will be available in the Geology/Biology Atrium to answer any questions, and help you locate your poster board.

NEW SAINFOIN POPULATIONS FOR MIXED ALFALFA PASTURE

S. Acharya, Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, T1J 4B1, A. Iwaasa, Agriculture and Agri-Food Canada, Swift Current, SK, S9H 3X2, B. Coulman, University of Saskatchewan, Saskatoon, SK, S7N 5A8, P. Jefferson, Western Beef Development Center, Humboldt, SK, S0K 2A0, T. McAllister, and Y. Wang, Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, T1J 4B1

Forage legumes in grazing systems improve animal performance, profitability for livestock producers and sustainability of the livestock industry. In western Canada, where most Canadian beef cattle reside, alfalfa is grown extensively due to its wide adaptability, high productivity and nutritional quality. However, alfalfa can cause bloat in grazing cattle while sainfoin, which contains condensed tannins (CT), is known to be bloat free. Protein binds to CT in the rumen, slowing the digestibility and this complex passes into the lower digestive tract, where the protein is broken down and utilized by the animal.. Previous studies have shown that a small proportion of sainfoin in an alfalfa stand provides enough CT to eliminate the risk of bloat in grazing cattle. Sainfoin is adapted to most soil zones in western Canada and is of high nutritive value.

The problem with the available sainfoin cultivars in Canada is that they do not persist in mixed stands with alfalfa. They also do not regrow at the same rate as alfalfa, so after the first cut or grazing, these cultivars have limited effectiveness for controlling bloat in mixed stands. This slow regrowth is also related to the poor persistence of sainfoin, reducing its bloat control benefit in older stands. Therefore, the focus of the Lethbridge Research Centre (LRC) breeding program is to develop cultivars that better match the growth pattern of alfalfa, providing adequate sainfoin in mixed stands for season long bloat control, and having better persistence. New sainfoin populations with improved forage yield and adaptation to grow in mixed stands with alfalfa have been developed at LRC. Performance data on these populations, both in pure and mixed stands, will be presented and discussed in detail

KEYWORDS: cattle grazing, bloat, sainfoin, alfalfa

NEW SALINITY TOLERANT ALFALFA FOR WESTERN CANADA

S. N. Acharya, Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, T1J 4B1 and H. Steppuhn, Agriculture and Agri-Food Canada, Swift Current, SK, S9H 3X2

A salinity tolerant alfalfa (*Medicago sativa* L.) population was developed by the Agriculture and Agri-Food Canada Research Centre, Lethbridge, Alberta in cooperation with Canada's Salinity Testing Facility (Semiarid Prairie Agricultural Research Centre) at Swift Current, Saskatchewan. This synthetic population, tested as SC –A101 in Western Forage Trials, was developed for improved seedling vigor and high forage yield under saline conditions. This population yielded about 1% better than Beaver check in our Western Forage Trials in 36 location years and would be called 'Bridgeview' alfalfa when registered. The pedigree of this cultivar consists of saline tolerant selections from Apica, AC Blue J, Barrier, Beaver, Heinrichs, Rangelander and Roamer alfalfa. Bridgeview performed better than Beaver alfalfa in the third year of a test conducted in a naturally saline field plot area in Vauxhall, AB and was found to perform significantly better than Rangelander alfalfa in an indoor test at 16 dS/m salt levels. This salinity tolerant population is well suited for hay production in western Canada and the indications are that it would perform well in both pure and mixed stands with grasses and other legumes.

KEYWORDS: salinity tolerance, alfalfa improvement

EFFECT OF ARBUSCULAR MYCORRHIZAL FUNGI AND PLANT GROWTH-PROMOTING RHIZOBACTERIA ON GLOMALIN PRODUCTION

Adekunbi Adeleke, Fran Walley, and Rich Farrell, Department of Soil Science, College of Agriculture and Bioresourecs, University of Saskatchewan

Glomalin, operationally defined (and measured) in soil as 'glomalin-related soil protein' (GRSP) is an N linked glycoprotein produced by arbuscular mycorrhizal fungi (AMF). By the virtue of its role in aggregate formation and stabilization, glomalin contributes to C and N storage. Furthermore, Nichols and Wright (2006) reported glomalin has the largest pool of soil N and organic C compared to other soil pools. Because of the association between AMF and plant growth-promoting rhizobacteria (PGPR), another beneficial soil microorganism, we hypothesized that the interactions between AMF and PGPR could enhance glomalin production, thereby increasing soil C and N storage. A series of growth chamber and laboratory experiments were conducted to examine the hypothesis. We found significant interaction between Glomus intraradices and Pseudomonas aeruginosa R75 or P. cepacia R85 in their effects on GRSP concentrations in the mycorrhizosphere (soil directly influenced by AM hyphae) of pea under gnotobiotic system. These beneficial interactions were also observed under non-sterile conditions. The interaction effect was not, however, evident on C and N storage, and GRSP levels did not correlate with soil C and N content.

KEYWORDS: arbuscular mycorrhizal fungi, glomalin-related soil protein, plant growth-promoting rhizobacteria

LEGUME INCORPORATION ON SOLUBIIZATION OF OGUN PHOSPHATE ROCK ON SLIGHTLY ACIDIC SOUTHWESTERN NIGERIAN SOILS

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Michael Tunde Adetunji; Department of Soil Science, University of Agriculture, Abeokuta, Nigeria
Sitapha Diatta Africa Rice Center, International Institute of Tropical Research, Ibadan, Nigeria

Effectiveness of legume incorporation on solubilization of Ogun phosphate rock (OPR) on slightly acidic soils was tested on two experimental sites in Southwestern Nigeria. The fertilizer treatments consisted of four rates of Ogun phosphate rock (0, 30, 60 and 90 kg ha^{-1}) and triple superphosphate (TSP) at 40 kg ha^{-1} . The legume treatments consisted of cowpea (Vigna unguiculata L) and mucuna (Mucuna puriens L). Legumes were grown to maturity as pre-rice crop and the biomass incorporated into the soil with OPR treatments ten weeks before planting rice. The experiments were laid out as randomized complete block design with three replicates. The interrelationship among different P rates on grain yield of rice (NERICA 1) was investigated by subjecting the data collected to GGE Biplot analysis.

Plots treated with TSP and cowpea biomass gave the highest value (11.33 mg kg^{-1}) in soil available P and it differs significantly from other treatments, however effect of OPR addition increases soil available P significantly over control plots but the effect was pronounced on legume treated plots. Plots with mucuna biomass and 30 kg P ha $^{-1}$ OPR gave 9.33 mg kg-1 compared with 2.80 mg kg^{-1} on plots treated with mucuna biomass alone, similar result was obtained with cowpea treated plots. No significant effect on soil available was obtained after harvest in IITA similar to observations in IAR&T. At IITA, the first principal component (PC1) accounted for 99.1% of the interaction through GGE biplot analysis. Legume plots treated with TSP; and OPR with 90 kg P ha^{-1} were better correlated with rice grain yield than other treatments in 2004 while Plots with mucuna biomass and 30 kg P ha^{-1} gave the best correlation in 2005 similar to observations in IAR&T.

KEYWORDS: Ogun phosphate rock; Legume, Phosphorus

REUSE OF WASTEWATER FOR IRRIGATION IN SAUDI ARABIA AND ITS EFFECT ON SOIL AND PLANT

Professor Ali Aljaloud

This paper addresses the reuse of treated municipal wastewater and its effect on soil and plants. The research study showed that reuse of treated municipal wastewater in irrigation provided plants with supplementary levels of nutrients, such as Nitrogen (N), Phosphorus (P) and Potassium (K)and other micro-nutrients. Research results indicated that using treated municipal wastewater in crop irrigation saved 45% and 94% in the cost of the fertilization programs for wheat and alfala respectively. Additionally, wheat yield increased by 11% and alfalfa production improved by 23%. Overall profit for wheat and alfalfa were recorded 14% and 28% higher than the untreated. The concentration of heavy metals such as Copper (Cu), Lead (Pb) and Cobalt (Co) in plant tissue and soil was low compared to established standards, these heavy metal concentrations are well below hazardous levels. This study showed that treated municipal waste water can be used safely for irrigation of a wheat and alfalfa crops. It enriched the soil in minerals, increased plant nutrients uptake, promoted crop yield and improved the overall profit.

KEYWORDS: Wastewater reuse, heavy metals accumulation in soil and plants, wastewater, use of municipal wastewater for irrigation.

COMPARISON OF MANURE FROM WET DISTILLERS GRAIN VERSUS CONVENTIONAL RATIONS ON CROP YIELD AND NUTRIENT RECOVERY IN EAST-CENTRAL SASKATCHEWAN

Khaled Alotaibi, Jeff Schoenau,Department of Soil Science,University of Saskatchewan
Xiying Hao,Agriculture and Agri-Food Canada,Lethbridge Research Centre

Distillers grain, a co-product of ethanol production, has recently been included in animal diets. Due to the higher concentration of nutrients contained in distillers grain compared to original feed-stock grain, distillers grain derived manure is reported to be higher in nutrient content, especially nitrogen and phosphorus. It is hypothesized that, similar to conventional manure, land application of distillers grain manure can be agronomically beneficial and environmentally sound if properly managed. Consequently, the objective of this study was to evaluate the effectiveness of manure from cattle fed wet distillers grain (WDGCM) in comparison with manure from cattle fed barley (BFCM) on wheat yield and nutrient recovery in east-central Saskatchewan. A 2-year field experiment was established in the fall of 2008 to address the study objective. This paper reports on the first field season in 2009. The WDGCM and BFCM were applied at two rates of 15 or 30 tonnes ha^{-1} using two methods of application, broadcast and incorporated or injected. Disturbed and undisturbed controls were included. Manure addition significantly increased wheat grain yield, with the highest grain yield at the higher rate (30 tonnes ha^{-1}). A slightly better yield response was observed when manure was injected, likely due to reduced volatile ammonia losses and better crop root access to manure- derived nutrients when placed in a band. The two manures had relatively similar composition, resulting from dilution by bedding materials used in the cattle feedlot pens. Per unit of nutrient added, there was little difference in yield responses to the two different manure sources. The nutrient content of the manure appears to be the main driver influencing crop production. Solid manure injection may have some benefit in increasing crop recovery of applied manure nutrients compared to the broadcast and incorporation application method.

KEYWORDS: distillers, grain, manure, yield, wheat

BIOCHARS AND ASHES PRODUCED FROM PYROLYSIS AND GASIFICATION AS AMENDMENTS TO INCREASE THE FERTILITY OF A BROWN CHERNOZEM SOIL

Khaled Alotaibi, Jeff Schoenau,Department of Soil Science,University of Saskatchewan
Terry Fonstad,Department of Agricultural and Bioresource Engineering, University of Saskatchewan

Pyrolysis and gasification of organic waste materials produces biochars and ashes as co-products of these processes. Pyrolysis is a low oxygen combustion process that produces carbon-rich chars from organic materials, whereas ash produced from gasification is typically high in phosphorus. Due to their nutrient content, chars and ashes offer potential as alternative sources of fertilizer nutrient, and were examined in field and controlled environment experiments in 2009. The objective of the field experiment was to examine biochar applied alone at 2000 kg C ha^{-1} or combined with 50 kg N ha^{-1} as urea on canola yield, nutrient uptake and nutrient recovery on a nitrogen and phosphorus deficient Brown Chernozem. The objective of the growth chamber experiment was to examine the effect of two types of ash: dried distillers grain ash (DDGA) and meat & bone meal ash (MBMA) applied at 100 kg P ha^{-1} on canola yield and nutrient recovery on the same soil used in the field experiments. The field experiment treatments included: biochar (BC) applied alone, biochar with 50 kg N ha^{-1} (BC+N), 100 kg urea-N ha^{-1} and a control. In the growth chamber experiment the treatments were: 1 rate (100 kg P ha^{-1}) of DDGA and MBMA, 3 rates of mineral P (50, 100, 200 kg P ha^{-1}) as $Ca(H_2PO_4)_2$ and a control. All growth chamber treatments received a basal application of 200 kg N ha^{-1} as urea including the control. Biochar applied alone had limited effect on yield. However, BC+N showed equivalent yield to the urea treatment, despite having only half as much urea N added. This suggests that biochar may be improving nutrient retention and utilization. Both types of ash significantly increased yield similar to the mineral fertilizer treatment, and were deemed an effective source of phosphorus for canola nutrition.

KEYWORDS: biochar, ash, pyrolysis, gasification, yield, phosphorus

A JAPAN-SASKATCHEWAN PEDOLOGY EXCHANGE

Darwin Anderson
Department of Soil Science
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Participating in projects in Thailand, Vietnam and Ethiopia has been an important aspect of my career. An unexpected exchange with Kyoto University in 2008-09 proved to be an especially positive experience, and is the topic of this paper. The exchange resulted from a friendship made years earlier when Dr. T Kosaki and I traveled together to observe the Chernozemic soils of Saskatchewan. Interest by scientists at Kyoto and other Japanese universities in the soils of the steppes of Eurasia resulted, in a roundabout way, in their coming to Saskatchewan to observe our soils, similarly occurring in a continental interior under a cool and dry climate. The exchange included three scientists visiting Saskatchewan in 2008 to plan a field excursion and to sample several soil profiles. I spent February to May 2009 at Kyoto University as a guest professor in the Laboratory of Soil Science in the Division of Environmental Science and Technology. I gave lectures in English on Canadian soils to graduate students, took part in a Science English class, and advised students writing papers in English. Trips were made to observe soils to the National Institute of Agri-Environmental Sciences, and to the Fukushima Research Centre where a former U of S student is a research scientist. Twelve Japanese scientists took part in the field excursion in Saskatchewan in August 2009. Dormitories at the University and at the Kenderdine Campus in the Boreal Forest Ecoregion were used. The excursion included Chernozemic, Vertisolic and Solonetzic soils in the prairie, and Gray Luvisol, Brunisolic and Organic soils as far north as the Canadian Shield. The exchange has been a satisfying experience for all, for scientific, cultural and aesthetic reasons, and well worth the effort to organize.

KEYWORDS: Kyoto University, Japanese Society of Pedology, Andosols, Chernozemic soils, Gray Luvisol, Vertiols, boreal forest, Prairie Ecozone

MAPPING ARCTIC LANDSCAPES

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Two weeks with Stan Rowe in the Arctic in 1970 remains a memorable experience of my graduate study. Rowe was a Professor of Plant Ecology at the University of Saskatchewan and a member of my graduate committee. Our work was near the University of Saskatchewan's Arctic Research and Training Centre at Rankin Inlet in present-day Nunavut. Our intent was to study vegetative communities and associated soils in the tundra landscape. Somewhat puzzling to a practical soil surveyor was Rowe's focus on making a map of our study area. In retrospect, mapping is an essential component of the study of vegetation and soil, consistent with theoretical and practical considerations. One of Rowe's most significant papers, published in Ecology in 1961, is entitled The Level-of-Integration Concept and Ecology. The concept provided a hierarchical structure for observing nature in that: "The object at whatever level must contain, volumetrically and structurally, the objects of the lower level, and must therefore be itself parts of the level above." Attention must be given to the three-dimensional landscape units that contain the plant communities and soil profiles, not simply the latter two. Mapping forces one to develop the models (conceptual and/or statistical) that connect soil and vegetation within the structure provided by geological material, landform and climate, and is a hypothesis generating and testing exercise. The paper will present the theory in which mapping is grounded, and connect theory to the maps and landscape units that were recognized, described and mapped. Today, the capabilities of mapping vegetative cover with remotely sensed data, coupled with digital elevation models, and ground-truthing to establish connections between soil, vegetation and landscape constitutes an effective way to better understand landscapes and possible responses to change.

KEYWORDS: Cryosolic soils, arctic vegetation, Stan Rowe, level-of-integration concept, hierarchical theory, soil-landscape models, plant community, soil profile

ESTIMATION OF SOIL CARBON SATURATION DEFICIT AT THE NATIONAL LEVEL: AN EXAMPLE USING FRENCH AGRICULTURAL SOILS

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The concept of soil organic C (SOC) saturation proposed by Hassink (1997) suggests that the quantity of stable SOC is limited and determined by the soil's content in fine particles (fine silt and clay). This concept has been tested and validated in a number of situations worldwide. The difference between the theoretical SOC saturation value estimated by Hassink's model and the measured SOC content of the fine fraction corresponds to the soil's saturation deficit, and may represent a potential for SOC sequestration in stable form. Based on the national soil test data base (BDAT) and Hassink's equation, we have calculated the saturation deficit of French arable soils. Considering the whole data base (n = 90 000), the median saturation deficit was estimated at 35%. It varied from 20% for coarse-textured to 45% for fine-textured soil, indicating a greater potential for SOC sequestration in the latter. Mapping of the SOC saturation deficit at the national level allowed to analyze its spatial structure and the factors controlling it. Saturated soils corresponded to specific land use (grassland, meadows) or farming systems (livestock production with high manure production. The effect of altitude in reducing the deficit was also noticed which is probably combined with the presence of meadows. Of note, some very sandy soils appeared to be almost saturated, largely due to their very small fine fraction. Finally, soils from the southern part of the country showed the greatest saturation deficit which is likely attributable to the combined effects of climatic factors (low production, high temperature) and land use (vineyards, orchards). Based on this approach, a similar study could be performed for Canadian soils provided that detailed and spatially explicit soil data be available.

KEYWORDS: carbon, saturation,

COMPARISON BETWEEN POROSITY DETERMINATION BY VOLUMETRIC RING AND X-RAY COMPUTED TOMOGRAPHY IN BRAZILIAN SOILS

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Characterization of soil voids is fundamental to understand water movement and solute transport. Traditionally, they have been indirectly quantified by measuring specific soil physical properties, such as soil bulk density and particle density, which allow the porosity calculation. X-ray compute tomography (X-ray CT) permits direct non-destructive investigations of the soil pore system from tridimensional (3D) imagery. The aim of this work was to compare the porosity, of soils from Pernambuco State, in Northeastern Brazil, quantified by traditional method and by X-ray CT. In the first method, soil porosity was indirectly calculated by using soil bulk density and particle density data, determined by volumetric ring and pycnometer methods, respectively. In the second method, soil porosity was directly calculated using 3D imagery obtained by X-ray CT. Samples were collected at 0–5, 5–15 and 15–40 cm depths, with three replications. In the traditional method, samples were collected with 98 cm^3 - sharpened rings and dried at 105° C for 24 h. In the X-ray CT method, undisturbed samples were collected into 50 mm height and diameter PVC cylinder and air dried for two weeks. A significant correlation between soil porosities obtained by both methods was found, although the X-ray CT presented more reliable results than the traditional method.

KEYWORDS: texture, bulk density, pore, X-ray CT

CHARACTERIZATION OF POROSITY IN BRAZILIAN SOILS USING X-RAY COMPUTE TOMOGRAPHY

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Porosity is a soil characteristic which exerts a strong influence on erosion since it is related to soil hydraulic conductivity. Non-destructive techniques such as X-ray compute tomography (X-ray CT), combined with spatial analysis, enable direct quantification of soil architecture in three dimensions and determine the pore morphology. The aim of this study is to measure soil porosity using obtained by X-ray CT. Undisturbed samples, of various textures, were collected from 0-5, 5-15 and 15-40 cm depths, with three replicates, in two humid and two semiarid areas, from Pernambuco State, Brasil. Cylindrical samples prepared for CT analysis were collected in PVC cylinders, with diameter and height of 50 mm. A final volume of 18.75 cm^3 was used for quantitative analysis with a voxel size of 40 mm. Morphological features including pore quantity, size distribution, shape, tortuosity and connectivity were evaluated with reference to soil particle size distribution, texture, bulk density and hydraulic conductivity

KEYWORDS: pore morphology, erosion, hydraulic conductivity

STABLE ISOTOPE METHODS FOR THE DETERMINATION OF PEA NITROGEN RHIZODEPOSITION

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Pulse crops can play an integral role in reducing the environmental impacts of traditional cereal-based crop rotations in the prairies by reducing reliance on N fertilizers and potentially improving soil C storage. Determining the impacts of pulse crops on N supply to subsequent crops and/or N and C dynamics from remaining crop residues requires better quantification of belowground residue contributions of N to soil, including those from rhizodeposits. This greenhouse study used the cotton-wick method to label pea plants (*Pisum sativum*) continuously with 0.4% (w/v) ^{15}N-enriched urea (99 atom %) to determine N rhizodeposition at 9 leaves fully expanded (vegetative stage), early flowering, and maturity of pea. Roots plus nodules comprised 21% and 18% of total biomass at the vegetative and early flowering stages, respectively, and 12% and 11% of total pea N during the same growth stages. The aboveground plant parts were preferentially enriched with ^{15}N, which is expected since ^{15}N urea solution is fed directly to the stem. Incomplete recovery of the added ^{15}N label in above and belowground plant parts suggests that some of the ^{15}N label was unrecovered due to errors in sample recovery and/or that some of the ^{15}N was released to soil (N rhizodeposition). Complete results will be discussed and contrasted with preliminary results from the second part of this study that will determine N rhizodeposition using an atmospheric method of labelling pea plants via symbiotic fixation of $^{15}N_2$.

KEYWORDS: rhizodeposition, nitrogen, pulse crops, stable isotopes

EFFECT OF MANURE AND UREA FORMULATIONS ON NITROUS OXIDE SOIL EMISSIONS FROM A RAPESEED FIELD IN THE RED RIVER VALLEY

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A field trial was conducted in 2009 at the National Centre for Livestock and the Environment (NCLE) at Glenlea, Manitoba. The experiment compared nitrous oxide (N_2O) emissions from rapeseed plots fertilized with dairy manure (Manure), urea, and two formulations of urea, environmentally smart nitrogen (ESN), and SuperU. The treatments were broadcast-incorporated at a rate of 140 kg available N ha^{-1} . A Control treatment with no N application was also examined. Plant growth was determined at vegetative, flowering and maturity. Nitrous oxide emissions were determined using static vented chambers with decreasing frequency from fertilizer application to freeze-up (total of 25 occasions). Application of fertilizers increased the N_2O-N emission rates as well as biomass productivity. The highest average emission rate was from urea (7.79 g ha^{-1} day^{-1}) and the lowest from Control (2.55 g ha^{-1} day^{-1}). The ESN, Manure and SuperU treatments had average N_2O-N emission rates of 4.63, 4.92 and 7.23 g ha^{-1} day^{-1}, respectively. The ESN had the lowest amount of cumulative N_2O emissions among the inorganic fertilizers and was close to that of Manure. However, the SuperU's cumulative emissions was comparable to that of urea. The grain yield from urea treated plots was 2.76 t ha^{-1} and from Manure plots 2.16 t ha^{-1}, which were higher than SuperU (1.83 t ha^{-1}) and ESN (1.52 t ha^{-1}). The Control had the least grain yield (1.03 t ha^{-1}). The cumulative N_2O-N emission from Manure was 32% less than that of SuperU; however the grain yield was higher by 18%. Except for Manure, higher cumulative N_2O-N emission rates were related to higher grain yield. Fertilizer induced N_2O-N emissions depend on the type of nitrogen sources and evaluation of fertilizers should consider emissions per dry matter yield.

KEYWORDS: ESN, nitrous oxide, manure, oilseed, Red River Valley, SuperUrea, urea

MINERAL WEATHERING RATES AND HYDROCLIMATIC CONDITIONS IN PODZOLS

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Mineral weathering has profound effects on the evolution of soils properties, on elemental cycling in terrestrial ecosystems and on the composition of surface and ground waters. Evidence from field research shows that weathering rates are related to the properties of the soil parent material, to biotic activity and to variations in climatic conditions (Wilson, 2004). Soil pH, specific surface area, available moisture, temperature and the concentration of dissolved organic substances are all crucial site variables controlling weathering rates (Holmqvist et al., 2003). One of the key challenges now faced by weathering research in the field is the assessment of the effect of individual environmental factors under conditions where many factors vary simultaneously. In most cases, the presence of such confounding factors largely impedes our capacity to isolate and quantify the specific controls exerted by a given factor, for example hydroclimatic conditions, on weathering rates.

The first objective of this field study is to quantitatively estimate mineral weathering rates for a series of 21 catchments (62 podzolic soil profiles) located on the Canadian Shield and part of the Québec lakes network. The sites vary with respect to hydroclimatic conditions, soil properties (pH, texture, mineralogy) and forest cover. Weathering rates will be computed on a profile basis using the mass balance method of Brimhall et al. (1991). The second objective is to isolate and quantify the climatic component of the complex environmental signal affecting weathering rates for the 21 catchments. To this end, we will use a multivariate statistical approach to take into consideration the confounding effect of environmental factors others than climate on weathering. It is anticipated that the results will constitute a first step towards estimating the effects of changing climatic conditions on weathering rates in forest soils.

KEYWORDS: weathering, climate, podzol, catchment

CARBON SEQUESTRATION AND GREENHOUSE GAS EMISSIONS IN CANADIAN PRAIRIE POTHOLE WETLANDS

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Canadian prairie pothole wetlands are one of the most threatened ecosystems in North America, where in some settled regions greater than 70 % of these wetlands have been lost. Wetlands are known to play an important role in carbon sequestration and greenhouse gas emissions, however, little is known on the role that prairie potholes play in these processes. Due to the interest in using these systems to offset greenhouse gas emissions Ducks Unlimited Canada in collaboration with researchers from across the Canadian prairies conducted a study where carbon sequestration and greenhouse gas emissions were measured across a series of 65 prairie potholes in Alberta, Saskatchewan, and Manitoba. Results demonstrating the range of carbon storage and greenhouse gas emission as well as some of the ecological drivers regulating these processes in prairie potholes will be presented.

KEYWORDS: nitrous oxide, methane, carbon

SPATIAL RELATIONSHIPS BETWEEN MICROBIAL ABUNDANCE AND SOIL ATTRIBUTES IN ARCTIC ECOSYSTEMS

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Soil attributes characteristically vary from location to location. In most cases, spatial heterogeneity has patterns and tends to decline with the decrease in distance between spatial positions Owing to this intrinsic variability of soil attributes microbial abundance may also vary across multiple spatial scales. Permafrost soil ecosystems dominate about one-fifth of the world's and the majority (40%) of the Canadian landscape. Despite the growing interests in microbial spatial variability, studies investigating this issue in Arctic soils are extremely limited. In this study we examined the abundance of archaea, bacteria, and fungi in three Arctic soil ecosystems and assessed the soil attributes that determine microbial spatial heterogeneity. At each site, 93 soil samples were collected along three transects and soil pH, moisture, dissolved organic carbon, dissolved organic nitrogen, total organic carbon, and total nitrogen contents were measured. Microbial abundance was examined by real time PCR. Spatial variability and spatial correlation was estimated by semivariogram and cross-semivariogram analyses respectively. The overall abundance of archaea (10^8-10^{11}), bacteria (10^8-10^{10}), and fungi (10^8-10^{10}) in Arctic soils is similar to agricultural or grassland soils. In spite of the extreme conditions, microbial spatial distribution is well-structured in Arctic soils and demonstrates high spatial dependency (0.54-0.99). The range, zone of spatial dependency, of microbial spatial variability varies between 0.2 m and 7.24 m. The studied soil attributes were significantly ($P<0.01$) correlated to microbial spatial distribution. Although the strength and range of spatial variability differ among sites, the overall spatial structure is similar.

KEYWORDS: archaea, bacteria, fungi, spatial variability

OBSERVATIONS ON THE MATURATION OF JUVENILE, RECONSTRUCTED, SOIL PROFILES

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Reclamation efforts associated with the mining of oil sands in Northern Alberta are attempting to reconstruct sustainable profiles at unprecedented scales over extremely challenging parent materials. Syncrude alone has reclaimed nearly 5000 ha of disturbed land since 1978, approximately 20% of a total disturbance area of 21,000 ha, and this at just one mine site. This is a footprint equivalent to twice the surface area of the city of Saskatoon. These reconstructed profiles have been placed over a range of parent materials comprised of saline/sodic overburden, sand and fine tailings, as well as refining by-products such as coke and sulphur. The goal of these reconstructed profiles is to accelerate the development of soil profiles through the placement of an organic rich 'A' horizon of peat/mineral mix overlying a 'B' horizon of salvaged glacial lacustrine clay or till. It is anticipated that this reconstructed soil profile and its associated ecosite characteristics (particularly available water, soil chemistry and nutrients) will then evolve along a trajectory towards that of comparable natural profiles.

A collaborative research program into the design and performance of reconstructed soil profiles on lands disturbed by oil sands mining has been ongoing at the University of Saskatchewan since the late 1990s. This research has involved investigators from the Departments of Civil and Geological Engineering, Soil Science, and Geology.

This presentation will highlight the performance of several reconstructed soil profiles over different parent materials including saline-sodic shale, sand tailings and coke. Of particular interest will be the evolution of the hydraulic properties, the available water holding capacity and the water balance of these soil profiles over time. The evolution of the interactions between the chemistry of the parent materials and the reconstructed soils will also be highlighted. The research highlights the relatively long time frames that are required to demonstrate the trajectory and maturation of these profiles; possibly decades (5-15 years) for physical changes and water dynamics and longer (15-30 years) for chemical weathering.

KEYWORDS: reclamation, saline-sodic, soil, oil sands

SIMILAR PATTERNS OF SUBSTRATE MINERALIZATION EXIST ACROSS PEATLAND TYPES

Nathan Basiliko, and Kristine Haynes, University of Toronto Mississauga, Department of Geography, Jim McLaughlin, Ontario Forest Research Institute, Ontario Ministry of Natural Resources, and Kara Webster, Great Lakes Forestry Centre, Canadian Forest Service

Known controls on relatively slow rates of organic matter mineralization in peatlands include soil conditions such as anoxia, poor carbon substrate quality, low nutrient availability, cold temperatures, and the presence of inhibitory compounds. We compared in vitro substrate mineralization rates under aerobic and anaerobic conditions in peat soils from poor (pH 4.3), intermediate (pH 5.4) and rich (pH 6.7) fens in central Ontario. Ten substrates, including extracts from two sedge and two moss species, lignin, p-coumaric acid, Na-benzoate, cellulose, glucose, and a mixture of amino acids were added at 20mg C/g dry peat to sub-samples of each soil collected from five within-site sampling locations (each 20m apart) at each of the three sites in May and August 2009. The relative ability to mineralize substrates in the short term was nearly as similar across sites as within sites (average R values of 0.88 and 0.90, respectively). Natural extracts from different plant litters were always mineralized in the same rank order across sites and at rates faster than any of the synthetic substrates. Preferential mineralization of plant litter extracts by peat from the native site of each litter was not observed. The very similar ability of microbial communities in disparate peatlands to mineralize a suite of both natural and synthetic organic molecules and compounds indicates that, at least under controlled temperature and aerobic or anaerobic conditions, substrate quality is perhaps the "master variable" influencing microbial carbon dioxide production across peatland types.

KEYWORDS: peat, decomposition, microbial, carbon dioxide

ENVIRONMENTAL DATASETS FROM ON-CAMPUS ECOSYSTEMS FACILITATE EXPERIENTAL LEARNING IN LARGE LECTURE-BASED COURSES

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The University of Toronto Mississauga (UTM) is a suburban campus in the Greater Toronto Area and includes considerable protected natural area (covering approximately 100 ha) made up of mature forest, grassland (maintained with periodic controlled burning), and marshes. A tower-based weather station has been continuously operational since 1975 and semi-permanent soil pits exist across ecosystems on campus and represent soils from the Luvisolic, Brunisolic, and Gleysolic orders. This setting provides excellent opportunities for leading accessible, hands-on environmental science field experiences for fall or summer-term courses with laboratory or practical sessions. To facilitate use of these campus "natural resources" for courses in the winter-term or those based on lecture-only formats, soil (moisture and temperature) and atmosphere (temperature) monitoring stations were installed in a forest, grassland, and wetland ecosystem to generate datasets of real, local environmental dynamics, which are the basis for laboratory-report style exercises. These data, tower-based weather data, and other data collected directly by students in upper-level courses with laboratory sessions including soil chemical, physical, and biological properties, are archived on a web-accessible database. The web-based resource is presently being developed to be more easily accessible to students and instructors outside of the UTM community. In this poster we summarize the specific technical aspects of the initiative, provide examples of practical exercises based on the datasets, and summarize feedback from students in a large 2nd year lecture-based Geography course where initial exercises were implemented in winter 2010.

KEYWORDS: education, environmental data, web portal

BRINGING LEADING INTERNATIONAL SCIENTISTS TO THE UNIVERSITY OF TORONTO MISSISSAUGA CLASSROOM VIA THE WEB

Nathan Basiliko Department of Geography, University of Toronto Mississauga

I present a case example of using interactive video conferencing (via Skype T.M.) to facilitate interactions between leading environmental scientists and students in a 4th year undergraduate/graduate course, Advanced Biogeochemistry, at the University of Toronto Mississauga. The format of a typical weekly course meeting includes a lecture drawn mainly from a graduate level soil science, and terrestrial ecosystem ecology, textbook. Following the lecture, students lead discussion of two or three recent primary research articles focussing on the biogeochemical cycle(s) at hand. Research papers that typically either contradict or improve upon the state of understanding presented in the graduate-level texts are selected. The class then videoconferences with the lead author of one of the research papers. This interaction includes a general overview the researcher's academic history and research area, the history and "behind the scenes" aspects of the study at hand, and ends with questions directly from the class. Beyond giving a direct opportunity for clarification of any unclear aspects of the particular scientific studies, this approach allows upper level undergraduate and first year graduate students unique extended insight into how a broad range of researchers ask and answer questions of environmental science. Student feedback on this web-teleconferencing initiative is presented from the 2010 pilot year. I conclude by making specific recommendations on how this approach can best be implemented successfully by other instructors.

KEYWORDS: education, guest scientists, web-based videoconferencing

TEACHING PEDOLOGY IN JANUARY: ADVENTURES IN ONLINE EDUCATION

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One of the challenges we face in teaching soil genesis and classification to undergraduates is finding ways to show students what soils look like in their natural environment. Field courses are ideal, but it is increasingly difficult to find the time (without cutting into students' summer employment or classroom-based courses) and faculty (as many soils departments grow smaller) to teach them. Of course this is further limited in Saskatchewan by a very short period of time within the academic year when we can get shovels into the ground! In 2009, University of Saskatchewan piloted a fully on-line course in Soil Genesis and Classification through the Centre for Continuing and Distance Education; it was offered a second time in 2010. This presentation will provide an overview of the course, with examples, and cover some of the challenges and advantages of this delivery method.

KEYWORDS: soil genesis, classification, education, web-based, blackboard

IMPACTS OF HYBRID POPLAR GROWTH ON SOIL NUTRIENT AVAILABILITY: EVIDENCE FOR EFFICIENT SCAVENGING AND RECYCLING OF BASE NUTRIENTS

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In the context of plantations, scientists have long been in agreement that increased nutrient demand due to the fast growth of trees leads to a decrease in soil nutrient availability. However, recent research suggests that some tree species have abilities which allow them to obtain more nutrients via sources (e.g. soil mineral weathering, atmospheric dry deposition) that are normally not readily available for other plants. Hybrid poplar plantations are increasing in popularity in Canada. They are nutrient demanding which means they will likely require soil amendments in the mid-term. In this respect, understanding whether these trees have the ability to promote soil mineral weathering via the production of acid root exudates is important. We investigated the calcium, magnesium and potassium levels of soils of twenty hybrid poplar plantations, aged from 3 to 20 years, in Quebec, and compared the results with those of adjacent fallows. To evaluate whether available (exchangeable) and structural (in minerals) base nutrient pools were being depleted, we used a sequential extraction with diluted salt and weak acid solutions. Structural calcium and magnesium in the upper soil (0-20 cm) of the plantation was lower than in the fallow soils of the same depth, whereas available potassium was higher in the plantation soils compared to the fallow soils. There was no difference in available calcium and magnesium or structural potassium between plantation and fallow soils, nor was there an effect of plantation age when used as a co-variable. The calcium and magnesium results suggest increased soil mineral weathering by the hybrid poplar trees. This process may have helped preserve available forms. The potassium results indicate efficient recycling/retention. The different response between base nutrients may be due to their: (1) intrinsic abundance in the mineral structures and soils, and (2) relative mobility in the plant-soil system. As a whole, the hybrid poplars appear to be efficient in scavenging and preserving base nutrients.

KEYWORDS: hybrid poplar plantations; adjacent fallows; upper soil base nutrients; available and structural base nutrient forms; induced soil mineral weathering of Ca and Mg; increased K recycling/retention.

ENHANCING THE COMPETITIVE ABILITY OF ORGANIC OAT (*AVENA SATIVA*. L) CROPPING SYSTEMS

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Effective weed management strategies are limited in organic oat cultivations as herbicide use is prohibited. Enhancing the crop competitive ability by integrating both cultural and mechanical weed control methods is a key strategy in managing weeds in such instances. Yet the relative efficacy of different strategies and their interactions when combined is not well known. The objectives of this research were, to develop a competitive organic oat cropping system integrating both cultural and mechanical weed control techniques. Four cultural practices, two oat genotypes, CDC Baler (competitive) and Ronald (less competitive), two planting densities (250, 500 plants m^{-2}), two row spacings (11.5,23 cm), and post -emergence weed harrowing were factorialy applied to two organically managed oat fields in 2008 and 2009 in Saskatoon, Saskatchewan. The results indicated that doubling the seeding rates significantly ($P < 0.05$) increased the grain yield by 10.7 % and reduced the weed biomass ($P < 0.001$) by 41 %.The competitive oat genotype CDC Baler was more weed suppressive ($P < 0.05$) than Ronald. Post emergence harrowing increased ($P < 0.01$) the grain yield by 13 % compared to the non harrowed control. On the other hand, harrowing reduced ($P < 0.001$) the weed density on 3 of the 4 site years tested. Importantly there were no interactions identified except for weed biomass where harrowing on high crop density planting were the most effective ($P = 0.07$). The results clearly indicated that increasing crop density and post-emergence weed harrowing was the most effective strategy in weed control. Thus highlights the importance of integrating both cultural and mechanical weed management practices over the use of individual practices to manage weeds in organic cropping systems.

KEYWORDS: organic crop production, crop competitive ability, integrated weed management

RETENTION OF INJECTED ANHYDROUS NH_3 FERTILIZER AS AFFECTED BY SOIL PHYSICAL AND CHEMICAL PROPERTIES

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Anhydrous ammonia (NH_3) is generally the cheapest and the most extensively used N fertilizer in North America. A controlled lab experiment was conducted to evaluate the effect of soil physical and chemical properties and moisture content on injected NH_3 retention. Ten different surface soils with clay content ranging from 2 to 75%, pH from 4.0 to 8.1, and TC from 11 to 50 g kg^{-1} were used. Ammonia was injected to soils at 0 (air dried) and 100% field capacity (FC) and NH_3 -N retention was measured 3 h, 1 d, 2 d, 4 d, 7 d and 9 d following injection. Moisture content did not seem to influence (P>0.05) the amount of NH_3 retained by soil. Of the NH_3 -N injected, 95% and 83% was retained (mean across soils) with air dried soil (0% FC) and moist soil (80% FC), respectively, 1 d after injection. However, the amount of NH_3 -N retained varied significantly (P<0.05) among soils. The maximum NH_3 -N retained at 1d was 135 mg kg^{-1} (93% of injected) by an Orthic Gray Luvisol with 5.0 pH, 75% clay and 50 g kg^{-1} TC, and the minimum was 69 mg kg^{-1} (66% of injected) by a Dark Brown Chernozemic with 7.2 pH, 12.7% clay and 21 g kg^{-1} TC. Soil NH_3 retention was negatively correlated with pH (r = 0.729**, n=10). There is no significant (P>0.05) correlation between NH_3 retention and the soil clay or TC contents. Our results suggest that most injected anhydrous ammonia is retained by soil independent of soil moisture conditions and that the lower the pH, the greater the amount of NH_3 retained by soil.

KEYWORDS: anhydrous ammonia (NH_3), ammonia retention, soil properties

LANDSCAPE-SCALE DISTRIBUTION OF HEAVY METALS IN FLIN FLON, MB

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The surface enrichment of heavy metals, as a result of smelter activities, has contributed to environmental degradation surrounding the Hudson Bay Mining and Smelting Co. Ltd. complex in Flin Flon, MB. As a first step in developing an effective revegetation strategy and to help focus future sampling efforts, a study was undertaken to characterize the distribution of heavy metals over the landscape. Surface soils (0-5 cm) along two transects were sampled at 100 m intervals extending from 1-km to 4-km from the smelter. The soils were analyzed for Cu, Zn, As, Cd, Hg, Pb, and Ni using inductively coupled plasma mass spectroscopy (ICP-MS). With the exception of Ni (a non-smelter metal), metal concentrations were inversely related to distance from the smelter (rs = -0.355 to -0.617; $P \leq 0.01$). However, the fact that these correlations were generally low suggests that distance from the smelter was not the primary factor regulating their spatial distribution. Indeed, metal concentration was more closely linked to landscape position than distance. Three distinct landform classes were identified: LFC-1 (developed mineral soils with a distinct B horizon on upper and mid slope positions) had the lowest metal concentrations; LFC-2 (poorly developed soils on upper and mid slope positions) had intermediate and wide ranging metal concentrations; and LFC-3 (mineral soils in depressions and organic soils) had the highest metal concentrations. These data suggest that landscape-directed sampling could provide a quick diagnostic measure of the relative concentrations of smelter-related metals within the zone of interest for revegetation; i.e., within a 5-km radius of the smelter complex.

KEYWORDS: revegetation, smelter, heavy metals, Flin Flon

REMEDIATION POTENTIAL OF PHOSPHORUS AMENDMENTS FOR LEAD IN URBAN SOIL

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Lead contamination of soil can be found in many urban areas around the world due to historical use of lead in paint and gasoline as well as industrial processes. Current methods of remediation are too costly and disruptive to address this issue, especially at the scale needed. On-site chemical immobilization is a promising remediation method being developed that involves applying amendments to the contaminated soil. The resulting reaction permanently reduces the mobility of the contaminant in the environment and in the human body, which greatly reduces the health risk. Phosphorus sources have high potential as amendments because phosphate is a necessary reactant to convert lead to a highly insoluble form. This research shows the reduction in human bioaccessibility from soil incubation with phosphorus sources each applied at two rates. Relevant soil effects were also measured to consider the potential to disturb the environment from each treatment. This considers the feasibility of field treatment.

KEYWORDS: lead, bioavailability, soil remediation, human health, public health

RECLAMATION OF VERTISOLIC SOILS

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The Vertisolic soil order is relatively new to Canada, being incorporated in the 3rd edition to the Canadian System of Soil Classification in 1998. These soils are characterized by high clay content (greater than 60%) and are self-churning. The properties of vertisolic soils create some unique challenges for managing these soils for farming, as well as for disturbance and reclamation. EBA Engineering Consultants Ltd. (EBA) has conducted pre-disturbance assessments, monitoring, post-reclamation assessments and initiated remedial methods for sites with vertisolic soils disturbed by upstream oil and gas well sites and borrow pits used to supply clay for transportation. These soils are highly susceptible to compaction if worked when wet. This paper presents data from a couple of sites disturbed by anthropogenic activities and provides comments from interviews with the landowners. One site will be used to demonstrate the effects of disturbance on plant growth and changes in soil chemistry. On another site, the dramatic change of structure over one freeze-thaw cycle is documented. Remedial actions undertaken on one site and their effectiveness will be reviewed.

KEYWORDS: reclamation, vertisolic soils

THE IMPACT OF TEMPERATURE AND WATER POTENTIAL REGIMES ON SEED GERMINATION OF SIDE-OATS GRAMA (BOUTELOUA CURTIPENDULA) POPULATION

J.Biligetu and M.P.Schellenberg

Drought is the most frequent cause of stand establishment failure of forages in semi-arid regions. An experiment was conducted to determine effects of simulated dry condition and temperature on germination of side oats grama (Bouteloua curtipendula (Michx.) Torr.), a common warm season grass of the central plains of North America considered to be valuable forage. Experimental design was a randomized complete block design with four replicates, each replicated unit consisting of 50 seeds. Seed used in the study was a combination of equal quantities of seed from 10 collections across Manitoba and Saskatchewan, Canada. Over a 21-d period, germination was studied in three growth chambers with constant temperatures of 15, 20, and 30°C and water potentials of –1.2, –0.9, –0.6, –0.3, and 0MPa. Total germination increased with the increase of temperature, but germination was severely restricted by water stress lower than –0.3MPa. When water potential was 0MPa, germination was 51, 72, and 91%, at temperature of 15, 20, and 30°C respectively. In contrast, at water potential of –0.3MPa, germination was 21, 52 and 77% for the same respective temperatures. The germination was less than 10% at water potentials of –0.6 and –0.9MPa. No germination occurred at a water potential of –1.2MPa. With the wide range of response, germinating seeds at water potential of –0.3MPa at temperature of 20°C or higher could be used as a screening tool for improved germination under drier condition.

KEYWORDS: side-oats grama, germination, water potential, temperature

SCALE SPECIFIC SPATIAL PATTERN OF SOIL WATER STORAGE AND ITS RELATION TO TOPOGRAPHIC INDICES

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Soil water is the limiting factor in semi arid agriculture and a key element in environmental health. Various factors including topography, water routing processes, soil texture, vegetation and depth to water table control soil water storage in field. These factors are not random and exhibit specific patterns at different scales making the soil water storage highly scale dependent. This paper examines the spatial patterns of soil water storage and its relationship with different topographic indices at different scales. Soil water was measured along a transect of 576 m established over hummocky landscape at St. Denis National Wildlife Area, Saskatchewan. Time Domain Reflectometry and Neutron Moisture Meter were used to measure the soil water at vertical sampling interval of 20 cm up to 1.4 m depth over three years period. Topographic indices were calculated using open source Software for Automated Geoscientific Analyses. The variations in the spatial series of soil water storage and the topographic indices were separated into different mode functions (Intrinsic Mode Functions [IMF]) according to their characteristic scales following the empirical mode decomposition. The small scale variations were separated in IMFs with low numerical numbers and large scale variations were separated at IMFs with high numerical numbers. The IMFs contributing substantial variations to the total variance were selected for cyclic correlation analyses. The contemporeous correlation, the correlation between scale components, and the correlation between its lags/leads indicated the procyclical (positive), countercyclical (negative) or acyclical (zero) correlation between soil water storage and topographic indices. The magnitude of the correlation indicated the strength of the correlation which explained the controls of different topographic indices on soil water storage. The scale specific correlation between soil water storage and the topographic indices can improve the predictive power of hydrologic, weather prediction and general circulation models, and the simulation of different land surface processes

KEYWORDS: soil water, spatial variability, scaling, empirical mode decomposition, cyclic correlation, topographic indices

SCALE DEPENDENT SPATIAL VARIABILITY OF SOIL PROPERTIES IN THE HIGH ARCTIC

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Information on soil spatial variability is important in developing logical, empirical, and physical models of landscape processes. Little is known about the scales of spatial variability of soil properties in the high arctic. The objective of this study was to examine the dominant scale of spatial variability of soil properties in the high arctic. Surface soil samples were collected from a 512 m transect established in Truelove lowland at Devon Island, Nunavut, Canada. The landscape of the area comprised of series of raised marine beaches and the lowlands developed from sea during glacial retreat at Holocene. The study area was mainly covered by organic, static and turbic cryosols based on the landscape position. Soil samples were analysed for particles sizes, pH, EC, organic carbon, total carbon and total nitrogen. Bulk density of the samples was also measured. The variability in the soil properties was separated into different mode functions (Intrinsic Mode Functions [IMF]) according to their characteristic scales following Empirical Mode Decomposition. Out of 6 IMFs separated for each soil properties, the IMF-1 represented very small scale variations which explained a large proportion of the total variations. The prevalent freeze thaw cycles in the high arctic operates cryoturbation processes at very small scales. Sometimes the cryoturbation processes occurred in field modifies the landform in some medium to large scales creating some micro-topographical variations, which was separated in IMF-2 and IMF-3. The variation separated in IMF-4 represented quite well the effect from the position of ridges on the landscape. Very large scale variations were represented through IMF 5 and IMF 6. However, the variance contribution at these scales was very low compared to other scales indicating less intense processes that modified the spatial distribution of soil properties.

KEYWORDS: soil spatial variability, scaling, high arctic, soil properties, cryoturbation, empirical mode decomposition, intrinsic mode functions

CLAY MINERALOGY IN ARCTIC TUNDRA GELISOLS

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Little is understood about chemical weathering processes in Alaskan arctic soils where moisture is generally not limited but acidity varies and average soil temperature is close to or below freezing. Weathering reactions in soil convert primary minerals into secondary clay minerals. Silty loam textured soils from three sites in moist acidic tundra (MAT) and three sites in moist non-acidic tundra (MNT) in the northern Arctic Foothills, Alaska, were characterized with emphasis on the origin of clay minerals. MNT soils had a discontinuous and thinner organic layer which leads to a deeper summer thaw and greater cryoturbation than the MAT soils. MNT had higher cation exchange capacity and base saturation than MAT. These buffer against acidification and account for the pH differences of MAT and MNT. Other chemical characteristics including percent carbon and nitrogen as well as iron and aluminum were similar (by horizon) across the MAT/MNT boundary. X-ray diffraction of coarse (.0002 -.002 mm) and fine clay (<.0002 mm) fractions indicate that illite, vermiculite and kaolinite are the predominant clay minerals. Presumably, kaolinite is detrital and vermiculite is weathered from illite. The proportion of vermiculite to illite is higher in MAT and the illite to vermiculite proportion is higher in MNT. This shows that soil acidity does affect weathering processes despite the low soil temperature.

KEYWORDS: clay mieralogy, gelisols, alaska, tundra, pedology, weathering, cryoturbation, arctic foothills

INFLUENCE OF DROUGHT AND ARBUSCULAR MYCORRHIZAL FUNGI INOCULATION ON GROWTH AND DEVELOPMENT OF BLACK BEAN (*PHASEOLUS VULGARIS* L.).

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We studied the physiological aspects of drought tolerance in black bean plants (Phaseolus vulgaris L., variety Tomeguín 93) inoculated with the arbuscular mycorrhizal fungi (AMF): IES-9 Glomus intraradices, IES-10 Acaulospora sp. and a mixture of both (Mixed). Plants were well watered or under a drought treatment consisting in 5 days without water before harvest. We measured colonization, abundance of spores and external mycelia of the AMF, as well as bean height, number of leaves, knots, flowers, sheaths and grains; the fresh and dry weight of each organ, foliar area and total biomass of the plants, at four harvest time, i.e. at 20, 40, 60 and 80 days after germination (DAG). Non-inoculated controls were in the same conditions. Mixed inoculum and Glomus intraradices established good colonization when well watered as well as under drought. Root colonization level was lower with Acaulospora sp. Mixed inoculum and Glomus intraradices increased best bean biomass and produced the largest foliar areas on well watered plants. Acaulospora sp. did not promote plants growth. The Mixed inoculum increased the yield of black bean plants, not only in amount of grains, but also reduced time to maturity (life cycle completed at 60 DAG) under good water conditions and under drought. This good performance under drought was attributed to the superior protective effect of the species of AMF when used in combination, in the Mixed inoculum. Good yields were also obtained in the plants inoculated with G. intraradices at 80 DAG. Drought did not reduced the growth and development of the mycorrhized bean plants as compared to well watered plants; they had similar total and root biomasses, and number of leaves, flowers, sheaths and grains. Inoculation with AMF, in particular when used in combination, can mitigate the effect of drought in black bean.

KEYWORDS: Mycorrhiza, drought, black bean.

THE ROLE OF ARBUSCULAR MYCORRHIZAL FUNGI IN REACTIVE OXYGEN SPECIES METABOLISM UNDER DROUGHT CONDITIONS IN BLACK BEAN (PHASEOLUS VULGARIS L.).

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We tested the antioxidant response under drought in black bean (Phaseolus vulgaris L., variety Tomeguin 93) inoculated with the arbuscular mycorrhizal fungi (AMF): IES-9 Glomus intraradices, IES-10 Acaulospora sp. and a mixture of both (Mixed). Antioxidant enzymatic activities and the equivalent of Malondialdehyde (MDA) were measured in foliar tissues, as well as fungal colonization in the roots 45 days after germination (DAG). Plants were subjected to two periods of drought: 4 days without watering (equivalent to 60-70% of field capacity) and 8 days without watering (equivalent to 50-60% of field capacity). Controls were normally watered. The higest superoxide dismutase (SOD) activity was shown in plants inoculated with Acaulospora sp. when drought was applied during 4 days. Lower activity was found in plants inoculated with the Mixed inoculum and with G. intraradices. Catalase activity (CAT) increased in the plants inoculated with G. intraradices after 8 days of drought, in comparison with the control. Guaicaol peroxidase activity (G-POD) was highest in the plants inoculated with the individual inoculums. In plants inoculated with Acaulospora sp. and in non-mycorrizal plants bigger concentration of equivalent of MDA was obtained in comparison with mycorrhizal plants after 4 days without watering. More MDA was related to higher cellular damages. The higher level of root colonization was obtained with G. intraradices inoculation. Together, antioxidant enzyme activity and low membrane damage in the mycorrhizal plants indicate the protective role of G. intraradices and of the Mixed inoculum, to a lower extent. Some evidence sugests that Acaulospora sp. could functions as a parasite if the plants are under drought during the early establishment of the symbiosis.

KEYWORDS: Mycorrhiza, drought, antioxidant activity

SOIL QUALITY AND TREE GROWTH IN JACK PINE AND WHITE SPRUCE PLANTATIONS OF FOREST AND OLD FIELD ORIGIN

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Losses of soil organic matter and increased soil compaction have been identified as the factors most likely to directly impact tree growth in managed forests. We compared the soil quality of plantations established on former agricultural lands (n = 20) with plantations established following clear cutting of native forests (n = 20). Half of the plantations had been planted with jack pine (Pinus banksiana Lam) and half with white spruce (Picea glauca (Moench) Voss), 9 to 27 years prior to the study. Old field plantations had lower (0 - 10 and 10 - 20 cm) mineral soil macroporosity and higher field capacity than forest plantations indicating more severe soil compaction. However, old field plantation had also higher soil C content, raising the permanent wilting point and canceling compaction effects on available water holding capacity. An indicator of organic matter quality, namely the potential net mineralization per unit of soil Kjeldahl N was lower in old fields. Species also affected soil quality indicators —with lower values of macroporosity and higher values of field capacity observed under white spruce. Despite significant differences in soil conditions, no significant effect ($p < 0.05$) of plantation origin on tree growth could be found. Old fields can support productive plantations of both species.

KEYWORDS: reforestation, soil quality indicators, tree growth, compaction, N net mineralization

SHORT-INTERVAL FIRES RESULT IN ADDITIVE CARBON LOSS IN NORHTERN BOREAL FORESTS

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Fires are expected to become more frequent due to climate warming in many areas of the boreal forest. A reduction in the time between fires, or the fire return interval (FRI), may have important effects on the global carbon cycle by increasing or decreasing the size of boreal carbon stores. The main objective of this research was to quantify and compare the amount of carbon consumed and remaining after fire in forests burned after long- vs. short-intervals in black spruce (*Picea mariana* [Mill.] BSP) forests of northern Yukon. We hypothesized that black spruce stands with a shortened FRI would have greater consumption of carbon than those experiencing a historically typical FRI. Using field measurements of forest canopy, soil organic horizons, and adventitious roots in burned and unburned stands, we reconstructed the pre-fire stand conditions to estimate the biomass lost in each fire and the impacts on post-fire residual carbon stores. Carbon stores were also compared with unburned stands. The additive loss of carbon following fires that recurred after a short interval resulted in a much greater total reduction in carbon relative to pre-fire or unburned conditions in mature stands. Consequently net ecosystem production, or carbon storage across disturbance intervals, was dramatically reduced following short-interval burns. Recovery of these stores would require a subsequent lengthening of the fire cycle, which appears unlikely under future climate scenarios.

KEYWORDS: carbon, biomass, soil organic horizon, fire frequency, adventitious root method, disturbance, Yukon

SOIL GAS PROFILES IN ARCTIC ECOSYSTEMS

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Arctic soils are a source of the greenhouse gases (GHG) carbon dioxide, methane, and nitrous oxide, but the contributions of different Arctic vegetation and soil communities to GHG processes are not well understood. Alexandra Fjord lowland, on Ellesmere Island, Canada, is a High Arctic oasis with climatic conditions less severe than the surrounding landscape of polar desert and glacial ice, and harbours a range of vegetation communities also found throughout the Arctic. Gases and microbial communities were investigated in the soils underlying six vegetation communities at Alexandra Fjord in the summer of 2009. These communities are representative of 1.5 million square kilometres of Arctic terrain. The polar desert soils, representing nearly 300 000 km^2, were a source of both N_2O and CH_4, despite generally low soil respiration rates. Carbon dioxide fixation below the soil surface indicated the presence of chemoautolithotrophs in mildly-acidic, granitic soils, but not in adjacent mildly-basic, dolomitic soils. Lowland communities, including a sedge wetland and a range of prostrate-shrub tundras, showed a range of consumption and production patterns of GHG, indicative of populations of autotrophs and heterotrophs at different positions in the active layer in different communities. Surface fluxes measured by closed chambers agreed with net soil production measured by subsurface probes, supporting the utility of our probe design and below-ground measurements. Alexandra Fjord communities are representative of nearly a quarter of Arctic vegetation, allowing our estimates of net ecosystem fluxes and subsurface processes to be applied to a large area.

KEYWORDS: Greenhouse gas, soil, vegetation communities, Alexandra Fjord, Ellesmere Island

LATITUDE-DRIVEN VARIATION IN SOIL BIODIVERSITY IN THE HIGH ARCTIC

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While animals and plants generally show clear patterns of declining diversity with increasing latitude, global surveys of soil microorganisms have found no such association for bacteria and Achaea. Latitude determines solar irradiance, at temporal scales ranging from instantaneous measures to total annual flux. Soil communities, while insulated from direct solar input, do respond to changes in temperature and organic matter inputs driven by irradiation. This research project will examine soil communities along a gradient of latitude covering 10º in the polar deserts of Arctic North America.
Six study sites on Baffin, Devon, and Ellesmere Islands have been chosen for investigation. At each site, geospatial transects with characteristics based on preliminary work in similar ecosystems will be created and measurements of greenhouse gas flux, soil chemical and physical parameters, and soil biological communities from the surface to the permafrost layer will be taken. Soil samples will provide DNA, allowing for qPCR-based examination of community composition and diversity. Soil greenhouse gas release is dependent upon the activities of a range of microorganisms, capable of consuming or producing CO_2, CH_4, and N_2O depending on factors including temperature, soil moisture, redox conditions, and community composition and biotic interactions. Measurement of fluxes, subsurface conditions, soil parameters, and community structure will contribute to knowledge both of Arctic contributions to climate change processes and biogeographic patterns of soil organisms.

KEYWORDS: Latitude, biodiversity, soil, Arctic, polar desert

WATER QUALILTY CHARACTERISTICS OF PRAIRIE WETLAND DRAINAGE

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The prairies contain millions of pothole wetlands that are typically small, shallow, and lack permanent surface water connections. They are thought to improve water quality in the prairies by acting as sinks for non point source loads. Recent agricultural intensification has lead to substantial wetland drainage throughout the prairies, which is perceived to negatively impact water quality. However, wetlands can naturally form connections (i.e. spills) via the fill and spill mechanism. To investigate whether artificial ditches impact downstream waters differently than spills, water samples were collected along the length of seven ditches and five spills from Smith Creek watershed, Saskatchewan during the snowmelt period of 2009 and analyzed for major ions, DOC, and nutrients. Ditches were longer, more channelized, had higher velocities and were more likely to connect to streams. TDN, NO_3, and K concentrations and loads were also greater in ditches. Normalized mass data showed that solute loads did not change along the connections, suggesting solute mass in the wetland is equivalent to that exported upon natural or artificial wetland drainage. A wetland drainage experiment was conducted in November 2008 after monitoring wetland water chemistry for 20 weeks. As the wetland drained, N, P, and major ion concentrations along the newly constructed ditch increased and exceeded measurements obtained in the wetland at the start of the experiment. At varying times after the start of drainage, orthoP, NH_4 DOC, and HCO3 decreased relative to chloride, indicating biotic or abiotic solute uptake along the length of the new ditch. Overall, elevated N and P concentrations in the wetland in spring and greater TP, orthoP, TN and DOC loads in ditches than in the newly constructed ditch suggests that the yearly drainage of ditched wetlands in spring potentially impacts downstream water quality more than the initial drainage of permanent wetlands.

KEYWORDS: prairie pothole, ditch, salinity, major ions, nitrogen, phosphorus, dissolved organic carbon, wetland drainage

PATTERN OF YIELD FILLING LENTIL: POD AND SEED DYNAMICS

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Lentil, an indeterminate crop, has continued vegetative growth during reproductive growth. In wet years and when it has a high nitrogen (N) supply, lentil fails to mature in the short growing season in Western Canada, resulting in low unstable yields. Field trials at several location-years in dryland conditions in Saskatchewan were used to test if pod growth and the pattern of pod setting were related to nitrogen availability. For each trial, two cohorts of flowers in each trial, one soon after flowering and the other about 2 weeks later, were followed from pollination to maturity. In a fertility study, N fertilizer and rhizobia treatments had more plant N compared to the control treatments. Treatments deriving N from fixation had patterns of greater N availability in mid to late reproductive growth, and often matured later. From tagged flowers, the final pod size, pod growth rate, and time to fill pods were measured. Large-seeded cultivars had larger seed and pod growth rates. In a tillage trial, treatments under short (ST) or long-term (LT) minimum tillage set a similar proportion of pods in the first cohort. Later flowers set less pods, and these pods were bigger in the ST than the LT treatment in the second cohort. Yields were higher under the ST and were associated with greater plant N availability. When late season N was available, the later cohort of pods was better supported. Patterns of yield filling will be discussed.

KEYWORDS: yield, pod, seed growth, lentil, reproductive

DROUGHT AND GENOTYPIC EFFECTS ON MINERAL AND PHYTATE CONCENTRATIONS IN CHICKPEA SEED

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The minerals Zn, Fe, Mg and Ca in chickpea seed are important dietary constituents in vegetarian diets. The aim of this study was to measure and explore any associations of these minerals with phytic acid, another naturally occurring constituent of grain that may reduce bioavailability of elements. Grain was harvested from replicated field plots grown at Saskatoon and Swift Current, SK, in 2002 and 2003. Samples represent typical dryland production practices from high yielding sites in SK, and weather experienced included the record hot dry year of 2003. Seed was dried, ground to a meal after 1 year of room temperature storage, stored for 5 years at -18C followed by 2 years at room temperature. Subsamples were acid digested, and minerals measured on an Atomic Absorption Spectrophotometer; phytic acid was measured using HPLC methodology. Chickpea showed significant year, location, genotypic and year x location interactions for all minerals except Mg (no year effect). Minerals in 10 genotypes ranged from 29-52 ppm for Zn, 77-112 ppm for Fe, 1448-2457 for Mg, 1211-2457 for Ca, and 0.38-0.90% for phytate. Phytate and Fe, Mg and Ca decreased in 2003 from 2002 concentrations. Except for Ca and phytate, minerals were greater at Saskatoon than Swift Current. Kabulis had greater Zn, the same Fe, but lower Mg and Ca than desi cultivars. Large seeded cultivars had greater Zn and Mg, the same Fe, but lower Ca than small seeded cultivars. Fe and Ca concentrations positively correlated with phytate concentration. The effects of environment and genotype on minerals mean that chickpea can be exploited by breeding, in addition to sourcing favourable nutritional profiles by environment, seed size and market class.

KEYWORDS: chickpea, seed, size, desi, kabuli, Zn, Fe, Mg, Ca, phytate, mineral

PERMAFROST AND CLIMATE CHANGE, WESTERN ARCTIC COAST, CANADA

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The climate in Canada's western Arctic is changing more rapidly than in most other regions of North America. At Inuvik, the mean annual air temperature has been increasing about 0.8°C/decade since 1970. Climate observations were made at Herschel Island between 1890 and 1910, and differ significantly from today's autumn and winter temperatures. Sea ice formation occurs about 6 weeks later now than during the whaling era. Herschel Island is an ideal location for studying permafrost response to climate change, because the snow cover is thin and the ground surface and materials are relatively uniform. Ground temperatures to 42-m depth on the island have been reconciled by locally calibrated geothermal simulation with climate change over the last century. Permafrost has warmed by 2°C at 20-m depth over this period. In the Mackenzie delta area, permafrost at tundra sites has also responded to recent warming, but the warming has been concentrated since 1970. We have validated a simulation of permafrost for conditions at Illisarvik, on Richards Island, where we have two 50-m temperature cables. In this case, ground temperatures have been reconciled with the air temperature record for Tuktoyaktuk since 1925. This simulation has been run into the future using Environment Canada's best GCM ensemble for the region, and suggest that permafrost will be sustained throughout this century. Although changes to the future climate are greatest in winter and least in summer, considerable thickening of the active layer is anticipated, because winter cooling is greatly reduced.

KEYWORDS: Permafrost, active layer, climate change, Herschel Island, Illisarvik,geothermal simulation

CHARACTERIZING DISSOLVED AND PARTICULATE PHOSPHORUS IN SNOWMELT RUNOFF FROM CATTLE

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Winter cattle bale grazing in fields has become common in the Canadian Prairies, replacing winter corral feeding. The aim is to spread feed and manure across fields, increasing soil fertility while reducing manure hauling and spreading. However, little is known about the environmental impact of this practice, particularly with nutrients in spring runoff while soils are frozen. To test this, we established six 350 m^2 microwatersheds. Four microwatersheds were bale grazed (300 cow days ha^{-1}) in winter 2009; two were controls. One-litre runoff samples were collected and filtered (0.7-µm GF filters). Particulates were analyzed for total P, C and N. Filtrate was analyzed for dissolved C, ammonium, nitrate, total N, total P and molybdate-reactive P (MRP). Samples were also analyzed by 31P NMR to characterize dissolved and particulate P forms, along with samples of manure mixed with hay and plant litter from the feeding site. Concentrations of dissolved C, particulate C, total N, dissolved ammonium, total P, dissolved total P and MRP were significantly higher in of runoff from bale-grazed sites than controls. Dissolved P from grazed sites was mostly orthophosphate, while a range of organic and inorganic P forms were seen in runoff from control sites. Particulates from both grazed and control sites contained both inorganic and organic P forms, as did the manure/hay and litter samples. The P forms in particulates from grazed and control sites were significantly different from P forms in the manure/hay and litter samples. These contained more orthophosphate and less organic P than the particulates. This work shows that it is possible to quantitatively characterize both dissolved and particulate P forms in runoff, which gives a clearer picture of how P is transported than measuring only total P and MRP.

KEYWORDS: cattle, manure, runoff, nutrients, P forms

PHOSPHORUS UNDER LONG-TERM AND SHORT-TERM NO-TILL IN A WHEAT-PEA ROTATION WITH FIVE P FERTILIZATION RATES

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Conservation tillage is a common practice in the Canadian prairies, to minimize wind and water erosion, conserve moisture and sequester organic carbon. However, little is known about the fate of applied fertilizers with long-term no-till, particularly phosphorus (P), which can stratify without mixing from tillage. This study examined the forms and concentrations of soil P under long-term (> 28 years) and short-term (8 years) no-till, using duplicate plots of a wheat-pea rotation. Seed-placed monoammonium phosphate was added at rates of 0 11.2, 20.4, 33.6 and 44.8 kg P_2O_5 ha^{-1} every year to the same plots. Soils were sampled each fall at 0-7.5, 7.7-15 and 15-30 cm depths, beginning in 2008. Preliminary results on soils sampled in 2009 indicate that total P was significantly higher under short-term no-till, while total inorganic P and bicarbonate-extractable (Olsen) P were significantly higher under long-term no-till in the top two depths. There were no significant differences with crop or fertilizer rate, but there was a significant interaction with length in no-till and fertilizer rate for total P and Olsen P, which were highest in long-term no-till receiving higher rates of fertilizer than short-term or long-term no-till receiving lower rates of fertilizer. Total organic P was generally high in these soils, averaging 60% at the surface and 40% at 15-30 cm depth, with no significant differences with length of no-till. Phosphorus-31 NMR showed a range of P forms at all depths, including phytate, DNA, phospholipids, orthophosphate and pyrophosphate. Orthophosphate was highest in the surface of soils receiving higher P fertilization, and was comparable at lower depths regardless of fertilization rate. These results suggest that P fertilizer can accumulate in the surface of soils under no-till, especially sites under long-term no-till receiving high rates of P fertilizers.

KEYWORDS: tillage, phosphorus, ferilization, stratification

WATERSHED EVALUATION OF BENEFICIAL MANAGEMENT PRACTICES WITHIN THE PIPESTONE CREEK WATERSHED, SASKATCHEWAN

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The Watershed Evaluation of Beneficial Management Practices (WEBs) project is a national project to scientifically evaluate the combined effects of beneficial management practices (BMP) implementation, soils, topography, land cover, land use and climate on economic and water quality outcomes. For the purpose of this study, BMPs are defined as science-based farming activities designed to help minimize potential environmental impacts, such as sediment and nutrient runoff into water bodies. This poster will introduce the new Saskatchewan WEBs project, which was established in fall 2009. The objectives of this project are 1) to measure the effectiveness of selected agricultural BMPs common to Saskatchewan in reducing nutrient and sediment transfer from fields to receiving waters; 2) to measure interactions of BMPs and hydrology in a landscape dominated by "fill and spill" wetlands; 3) to model and predict the relative contribution of nutrients and sediments to a common outlet, Moosomin Reservoir, with and without BMP implementation; and 4) to develop an economic evaluation for the implementation of BMPs within the Pipestone Creek Watershed. Partners in this project include: Agriculture and Agri-food Canada (Research Branch and AESB), Saskatchewan Watershed Authority; Lower Souris River Watershed Committee, Indian Head Agricultural Research Foundation, Ducks Unlimited Canada, The University of Saskatchewan, The University of Regina, The University of Alberta, and Environment Canada.

KEYWORDS: beneficial management practices, Saskatchewan, water quality

LEARNING FROM THE PRESENT AND PAST: A REVIEW OF AGRICULTURAL IMPACTS ON SOIL FERTILITY

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Conventional agriculture involves the use of synthetic pesticides and chemicals, which boost short term soil productivity at the expense of long term fertility. The recent rise of the alternative agriculture movement is thought to have been a response to an increasing awareness of these long term detrimental effects in an attempt to promote better managed soils and healthier agro-ecological environments. Despite this, alternative techniques have yet to be adequately integrated as a popular agricultural technique and remain, as their name implies, an alternative to other methods that degrade the soil. We undertook a review of the literature on conventional and alternative agriculture techniques in terms of their effects on soil nutrient levels. In doing so, this review demonstrates the long term beneficial effects of alternative farming practices on soil health and fertility and highlights the need for more research on the topic. In an effort to properly contextualize contemporary views and the burgeoning popularity of alternatives to conventional agricultural systems, our study also includes a historical exploration of ideas concerning the detrimental impacts of agriculture extending back to the 1920s. This involves a thorough examination of historical findings related to long term soil fertility in the Canadian Journal of Soil Science (then known as The Canadian Journal of Agronomy). Sections of the literature are analyzed in order to capture the general environmental narrative regarding alternative agriculture at the time. These findings have the ability to help explain various aspects of today's organic movement and to place contemporary agricultural ideologies within a historical framework. We suggest that future research should explore the modifications to conventional agriculture that incorporate the environmentally beneficial aspects of alternative systems. This would be a promising first step toward a hybrid agricultural system focused on maximizing yield while maintaining soil fertility and minimizing environmental damage.

KEYWORDS: agroecosystems, alternative agriculture, sustainability, soils, fertility management

APPLICATION OF ENHANCED IN SITU BIODENITRIFICATION TECHNOLOGIES

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Elevated levels of nitrate, nitrite, and ammonia have been identified within shallow soil and groundwater regimes at bulk fertilizer storage and handling facilities in Western Canada. Traditional means of addressing impacts have proven to be both costly and often ineffective. This has lead to the development, testing and implementation of techniques for the remediation of fertilizer based groundwater impacts based on the enhanced in situ biodenitrification (EISBD) principles. EISBD techniques have been evaluated using bench studies, field based pilot tests and full scale remediation. It can be concluded that remediation of the fertilizer-based groundwater impacts using EISBD is generally both technically feasible and economical. Important lessons learned, the process of evaluating and applying EISBD techniques, and the positive and negative aspects of this remediation option are described in this paper.

KEYWORDS: Remediation, Nitrate, Bioremediation, Nitrite, Electron Donor, Electron Acceptor

EFFECT OF COVER CROP TYPE AND PLANTING DATE ON NITROGEN UPTAKE AND SUBSEQUENT CUCUMBER YIELD INCOME

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Cover crops are used for improving agro-ecosystem processes including; soil quality, erosion control, foraging and nutrient management. Our objectives were to determine the effects of planting date and cover crop type on N cycling and yield in a cucumber-cover crop-cucumber rotation from 2008-2010. Cover crop treatments were no cover, no cover + N (84 kg N ha^{-1} applied before cucumber planting in 2009), rye (Secale cereale L.), oats (Avena sativa L.), oilseed radish (OSR) (Raphanus raphanistrum [L.] var. oleiferus Metzg [Stokes]), peas (Pisum sativum L.) and hairy vetch (Vicia villosa L.). In a split-plot design, cover crops were planted in early August and early September. By November 2008/2009, early-planted vetch, peas and oats produced significantly higher biomass (2212-5314 kg ha^{-1}) and had higher N content (65-153 kg N ha^{-1}) compared to the late-planted (562-1293 kg ha^{-1} and 18-46 kg N ha^{-1}). Early-planted OSR produced significantly higher biomass (4597 and 5307 kg N ha^{-1}) compared to the late-planted (1469 and 2330 kg N ha^{-1}), which did not translate into higher N content between early (67 and 98 kg N ha^{-1}) and late-planted (44 and 74 kg N ha^{-1}). Cover crop planting time had no effect on cucumber yield income. Cover crop treatments provided cucumber yield income that was higher or not different (1871-2988$ ha^{-1}) than the no cover (2235$ ha^{-1}). The no cover+N had the highest cucumber yield income (3405$ ha^{-1}) which was not different from OSR and oats (2933 and 2988$ ha^{-1}). The low yield income of rye (1871$ ha^{-1}) may be due to late biomass incorporation in the spring which lowered cucumber stand count compared to all other treatments. These results suggest that optimum planting date for cover crop biomass accumulation, N uptake and subsequent cucumber yield income is dependent on cover crop type and grower management practices.

KEYWORDS: crop nutrition, nitrogen cycling, cover crops, cucumbers

NEW INSIGHTS INTO THE OVERWINTER LOSS OF SOIL RESIDUAL N USING ^{15}N TRACING TECHNIQUES

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The risk of loss of soil residual N is often estimated based on the level of soil NO_3^- remaining after harvest. However, soil N transformations have been shown to occur in cold and frozen agricultural soils, which is likely to influence the fate of soil residual N. Tracing the overwinter fate of spring-applied ^{15}N -enriched mineral fertilizer revealed that 20 to 50% of the residual fertilizer may be lost from harvest to seeding in corn cropping systems. A similar study with spring-applied ^{15}N -enriched pig manure indicated that up to 50% of residual manure N was lost during winter, even though this residual N was essentially present in the organic N and recently-fixed ammonia-N pools. Implications of these results on our understanding of the soil internal N cycle during winter will be discussed.

KEYWORDS: soil residual N, N losses, ^{15}N, cold soils, frozen soils

THE DEGREE OF SOIL WATER REPELLENCE AND ITS TEMPORAL PERSISTENCE ON NATURAL AND RECLAIMED SOILS

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Soil water repellency has an adverse effect on environmental quality due to reduced infiltration, increased overland flow, increased preferential flow, decreased water storage and increased erosion. Presence of soil water repellence is reported in all types of soils at variable degrees and is considered as the norm rather than the exception. Detailed investigation about the degree of soil water repellence and its temporal persistence is essential for environmental management, especially in reclamation. The purpose of this study is to compare the degree of soil water repellence and its temporal persistence in soils with varying degrees of soil water repellency. Soil samples were collected from natural and reclaimed sites located in the Athabasca Oil Sands region. The degree of soil water repellence was assessed by measuring the change of water drop contact angles with time on prepared soil surfaces. Soils from natural sites showed a lower degree of soil water repellence; however highly persistent when compared to reclaimed soils. Differences in soil water repellence directly impact soil hydrological properties. High degree and persistent soil water repellence results in decreased infiltration, increased runoff and increased preferential flow. However, a low degree but high persistent water repellence may have better water storage capability due to decreased water flow and deep drainage.

KEYWORDS: soil water repellency, contact angles, reclamation, water

DETERMINATION OF HYDROPHOBIC CONDUCTING POROSITY USING TENSION INFILTROMETER

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The significance of conducting porosity of soil is of critical importance to infiltration and movement of water, and transport of solute & pollutant in soil. Understanding the movement of water and solute requires accurate measurement of conducting porosity through soils. Different pore behavior including pore tortuosity, surface roughness, pore discontinuity and dead end pores influences the conducting porosity. As soil water repellency is present in all types of soils to a certain degree, the issue of hydrophobic pores has yet to be addressed. This study was conducted to determine if hydrophobic pores affect the conducting porosity in soil. Tension infiltrometer measurements were taken at 5 pressure heads using water (-0.3, -3, -7, -10 and -13 cm) and 95% ethanol (-0.11, -1.31, -2.64, -3.77 and -4.9 cm) at a water repellent site. Pressure heads were adjusted for infiltration of ethanol to account for differences in surface tension and density as compared to water. As the ethanol flow is not affected by hydrophobicity, the effect of hydrophobic pores on conducting porosity was assessed after comparing infiltrating water and ethanol. The conducting porosity in soil was higher under ethanol infiltration compared to water. As the hydrophobicity cannot alter ethanol infiltration, the lower conducting porosity in water indicated the effect of hydrophobic pores on conducting porosity. The effect of hydrophobic pores must be taken into to account when characterizing the conducting porosity.

KEYWORDS: hydrophobicity, conducting porosity,tension infiltrometer

PHYSIOLOGICAL CHARACTERIZATION OF BARLEY PROGENY LINES WITH CONTRASTING LEVELS OF CARBON ISOTOPE DISCRIMINATION

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^{13}C discrimination ($\Delta^{13}C$) in C3 plants as an indirect measure of water use efficiency (WUE, ratio of dry matter to transpired water) has opened up the prospect for selecting crops under rainfed environments, and more physiological information need to be explored to characterize the different performance between genotypes. A set of F6 progeny lines of six-row barley (Hordeum vulgare L.) with contrasting levels of leaf carbon isotope discrimination derived from two parents, 'W89001002003' (low $\Delta^{13}C$) and '160049' (high $\Delta^{13}C$), were grown in the greenhouse under well-watered and water-deficit conditions in Vegreville, Canada. Nine days of water deficit was imposed at the stem elongation stage followed by stepwise re-watering to pre-deficit level. Leaf area, specific leaf area (SLA), leaf relative water content (RWC), leaf $\Delta^{13}C$, and nitrogen concentration were analyzed in the same penultimate leaves from the main stem. High- $\Delta^{13}C$ group lines showed significantly higher leaf $\Delta^{13}C$, lower WUE, greater plant height, larger leaf area, higher nitrogen concentration than those of low- $\Delta^{13}C$ group lines. A significantly negative relationship between WUE and leaf $\Delta^{13}C$ was observed. Genotypic variations in leaf gas exchange parameters (assimilation rate, transpiration rate, stomata conductance and internal CO_2 concentration) in response to water deficit were also investigated. The consistent contrasting level of leaf $\Delta^{13}C$ between parental lines across years could be intrinsic. The potential reasons why some progeny lines performed better than their parents were discussed.

KEYWORDS: barley, carbon isotope discrimination, water-use efficiency, leaf gas exchange, drought

DENITRIFICATION AND HETEROTROPHIC NITRIFICATION DOMINATE N_2O EMISSIONS IN HUMID SUBTROPICAL SOILS OF CHINA

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The relative importance of N_2O emissions from denitrification, autotrophic nitrification and heterotrophic nitrification in humid subtropical soils is not well understood. A ^{15}N tracer experiment was carried out to determine the relative contribution of denitrification and autotrophic and heterotrophic nitrification to N_2O emissions in several subtropical soils in this investigation. Soil samples derived from the same granite parent material were collected from rice paddy land (R), tea land (T), natural secondary coniferous forest (C), brush land (B), and upland (U) in a typical subtropical region of China. The N_2O fluxes, and the contribution of denitrification and heterotrophic nitrification to N_2O emissions was significantly different among studied subtropical soils during 9 days of incubation. The N_2O production rates decreased in the order of U > R > T > B > C soils. The contribution of autotrophic nitrification to N_2O emission was negligible in all studied soils, except for R soil with less than 13% of N_2O produced from autotrophic nitrification. Heterotrophic nitrification contributed to around 85.4-96.0% of the N_2O emission in the T, B and C soils, while denitrification was responsible for 69.7 and 79.9% of the N_2O emission in the U and R soils, respectively. The average contribution of heterotrophic nitrification to N_2O was positively correlated with C/N ratio and clay content, while the average contribution of denitrification to N_2O was negatively correlated with C/N ratio and clay content, suggesting soil properties such as C/N ratio and clay content controlled the contribution of denitrification and heterotrophic nitrification to N_2O emission.

KEYWORDS: autotrophic nitrification, clay content, C/N ratio, heterotrophic nitrification, denitrification, N_2O

CHARACTERIZATIN OF NUTRIENT RELEASE IN CHERNOZEMIC SOILS AMENDED WITH ANAEROBICALLY DIGESTED BEEF CATTLE-FEEDLOT MANURE

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Anaerobic digestion of beef cattle feedlot manure to generate biogas results in a nutrient-rich substrate: anaerobically digested manure (ADM). The solid fraction from ADM, or separated solids (SS), is often applied to cropland. However, nutrient availability (mineralization) from land-applied SS is currently poorly understood. Such knowledge is needed in order to determine the fertilizer value and environmental impacts of SS applications. The anaerobic digestion process could conceivably alter the physical and biochemical properties of manure, thereby altering nutrient availability from SS-amended vs. manure-amended soils. We tested this hypothesis using a 10-wk laboratory incubation study in which nitrogen (N) and phosphorus (P) mineralization was monitored in a Dark Brown Chernozemic clay loam and a Black Chernozemic silty clay amended with fresh manure, SS, pelletized SS (PSS), and urea + monoammonium phosphate (UMP). Amendments were applied at rates corresponding to 100 and 200 kg N ha^{-1}, with a 0 N control included for comparison. Amended soils were maintained near 70% of field moisture capacity and incubated for 10 wk at 22°C. Results from this study will indicate whether SS is at least as good as manure with regard to nutrient (N and P) supply to crops. Additionally, the results will provide some valuable information on the environmentally-significant potential for P-enrichment from SS application in these soils.

KEYWORDS: Anaerobically digested manure, mineralization, nutrient availability

CONTROLLING LENTIL INDETERMINACY WITH DESICCANT APPLICATION

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Lentil has an indeterminate growth habit. Flowering and pod filling continue simultaneously or alternately as long as temperature and moisture permit growth to occur. A moisture or nitrogen stress is required to encourage seed set and maturity, which can be attained by using a chemical desiccant. The present study was conducted to optimize the rate and time of diquat application with the goal of reducing biomass without affecting yield. The experiments were conducted in Indian Head and Saskatoon, SK during the year 2007 and 2008 in split plot design. Two cultivars of lentil CDC Plato and CDC Viceroy were planted at three fertility levels, control, rhizobial inoculation and 50 kg N/ha. Desiccant treatments included control, quarter rate of diquat one week after flowering (WAF), half rate one WAF, quarter rate three WAF and half rate three WAF. The biomass accumulation in lentil decreased at maturity irrespective of the treatments due to N remobilization from vegetative parts to the seeds. Maximum reduction in biomass at all growth stages was attained with half rate of diquat applied one week after flowering, but it also reduced yield due to excessive burning of crop which reduced the photosynthetic efficiency of plants at grain filling stage. The effect of desiccant on yield was found independent of the soil fertility levels and the maturity group of cultivars. Late planting of lentil coupled with high dose and earlier application of diquat was found lethal for lentil yield. Quarter rate three weeks after flowering is recommended for effectively controlling vegetative growth in lentil.

KEYWORDS: lentil, indeterminacy, diquat, desiccant application

COOL SASKATCHEWAN SPRING TEMPERATURES AFFEXT PHOSPHORUS NUTRITION IN WINTER CEREALS

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Low temperatures can affect plant growth by slowing the diffusion of certain soil nutrients. Phosphorus is one of these nutrients that has a clearer “pop up” effect in a cool year as compared to an average temperature year. Deficiency, even if early in the crop year, can adversely affect its yield potential. Research sites were selected from the brown, dark brown and black soil zones in southern Saskatchewan. Plant root simulator (PRS™) technology was used to assess bioavailable phosphorus in soil samples from these sites. Three cultivars of winter wheat and five cultivars of winter rye were planted in a randomized complete block design in September of 2008. Two phosphorus fertilizer rates were applied with the seed. Overall, plots that received high phosphorus had significantly more yield than those with a more conservative rate. This trend was also evident in all sites with winter rye. However, in the hardier winter wheat plots, high phosphorus did not result in significant yield differences. The cool spring of 2009 resulted in growing degree days that were 18-30% lower than the 10 year average. These low spring temperatures limit phosphorus diffusion and thereby resulted in a larger yield to the high phosphorus treatment. Phosphorus demand does not increase in a cooler year but it is shown extra phosphorus will supplement its uptake when diffusion rates are low.

KEYWORDS: winter wheat survival, crop nutrition, nutrient bioavailability, nutrient adsorption

GROWTH and N SUPPLY FROM LEGUME COVER CROPS IN ORGANIC RYE AND WHEAT PRODUCTION

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Organic farming systems rely heavily on legumes for N supply. The predominant legume system for prairie organic farmers is a full season legume. One disadvantage with this system is loss of economic crop production for that year. Late-season legume cover crops have the advantage of being compatible with continuous cropping, but little is known about legume cover crops in prairie organic grain production. The objective of this study was to test several legume cover crops grown with fall rye. Red clover and sweet clover were relayed cropped with rye by broadcast seeding the legumes into rye in early spring. Pea, lentil, cowpea, hairy vetch and soybean were double cropped by direct-seeding these legumes immediately after rye seed harvest. Field experiments were established at three Southern Manitoba locations in a randomized complete block design with 4 replicates. At Glenlea in 2008, red and sweet clover and forage pea produced 4118, 1438 and 692 kg ha^{-1} dry biomass by late autumn. Under drier conditions at Carman that year, forage pea resulted in higher late season biomass production than red and sweet clover. Legume N benefit was determined by measuring N uptake into the following spring wheat crop. At Glenlea, wheat after red clover and sweet clover yielded significantly more than the control. At Carman, in spite of dry conditions and relatively little legume biomass in the fall of 2008, spring wheat in 2009 following double cropped forage pea, hairy vetch and cow pea yielded 2523, 2153 and 2118 kg ha^{-1} respectively (compared with 1991kg/ha for the control). Results of year 1 indicate that late-season legumes have the ability to supply modest amounts of N resulting in wheat yield increases the following year. Work is continuing to learn more about adaptation of these legumes under different weather conditions

KEYWORDS: Legume cover crops, organic agriculture, relay and double cropping

AIR POLLUTION FROM AGRICULTURAL AMMONIA IN CANADA: SOURCES, ECOLOGICAL IMPACTS AND POLICY IMPLICATIONS

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Ammonia (NH_3) emitted from agricultural sources has become an important global atmospheric pollutant over past decades due the expansion of meat, egg and dairy farming and increased use of NH_3-based fertilizers. Ammonia is an important precursor to formation of secondary particulates (PM) which affect human health. Moreover, in some parts of Canada, the combination of agricultural NH_3 with NOx originating from transportation and power generation, result in atmospheric reactive nitrogen (Nr) pollution. There has been extensive research in Europe and US but relatively little work in Canada on the ecosystem impacts of Nr. A workshop with Canadian experts on the emission, atmospheric transportation and transformation, and ecosystem effects of Nr, held in April 2009, concluded: a) Agricultural NH_3 plus NOx production are concentrated in southern Alberta and Windsor-Québec corridor; NOx hotspots are located in the Tar Sands region of Alberta and Saskatchewan; high NH_3 emissions occur in southern Manitoba and the lower Fraser Valley. b) Deposition rates of Nr in much of southern Canada is similar to parts of Europe where significant ecological effects have been detected. Preliminary Canadian assessments of Nr critical load exceedances for effects on plant growth show that areas of high NH_3 emissions have plant communities which are affected by ambient concentrations and deposition. Also, ground-level ozone resulting from NOx emissions may be responsible for an annual $500m reduction in the harvest value of Canadian forests. There is also evidence that phytoplankton populations in the eastern Arctic are being influenced by increasing Nr deposition. c) 30% reductions in NH_3 emissions will have little impact on reducing regional PM levels in most o Canada except southern ON, suggesting that significant changes to ambient PM concentrations will generally require large NH_3 reductions. The impact of emissions is felt downwind of sources.

KEYWORDS: NH_3, NOx, deposition, reactive nitrogen

PULSE CROP EFFECT ON SOIL ORGANIC NITROGEN MINERALIZATION IN TWO SASKATCHEWAN ECOREGIONS

. Louis-Pierre Comeau, Amy Sangster, and Angela Bedard-Haughn, Department of Soil Science, College of Agriculture, University of Saskatchewan

The lack of spatio-temporal understanding of factors that control soil organic nitrogen mineralization makes it difficult to accurately predict how much ammonium (NH_4) and nitrite (NO_3) will be released from the soil for crop uptake. The objective of this study was to compare gross N mineralization rates in crop rotations that do or do not include pulse crops. This study was carried out in long-term rotation plots at Agriculture and Agri-Food Canada Research Stations at Scott SK (pea-wheat, canola-wheat and wheat-wheat) and Swift Current SK (lentil-wheat and wheat-wheat). Each of the selected crop rotations was sampled twice during the 2009 growing season: pre-seeding (May) and at anthesis (July). In each replicate plot of the rotation, three intact soil cores (15cm by 5cm i.d.) were extracted with a slide hammer sampler. Two of these cores were labeled with (^{15}N H4)2SO4 solution (30 µg N ml-1 at 98% ^{15}N) and the third one was used as a blank (no injection). The differences in the concentration and enrichment of the NH4 pool immediately after injection compared to 24-hours after injection were used to calculate the gross N mineralization rate. Results will be presented and compared to gross mineralization measurements completed at AAFC Scott in 2008.

KEYWORDS: nitrogen mineralization, moist mixed grassland Ecoregion, mixed grassland Ecoregion, pea, lentil, canola, wheat

QUANTITY AND FATE OF CARBON RHIZODEPOSITION IN LENTIL, PEA, CANOLA AND WHEAT ROTATIONS

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The transformation of CO_2 into soil organic matter mitigates global warming and improves crop yields. Carbon (C) rhizodeposition is the initial step toward C sequestration. The objective of this study was to compare the quantity and fate of newly formed soil organic carbon (SOC) from pulse versus non-pulse crops after one growing season of canola, lentil, pea and wheat. This greenhouse study was carried out with intact soil cores (39 cm by 20.3 cm i.d.) from long-term rotation plots at Agriculture and Agri-Food Canada Research Stations at Scott and Swift Current, SK: pea-wheat, canola-wheat, wheat-wheat, and lentil-wheat. Pea, lentil, canola and wheat were seeded into cores from their respective rotations and were pulse labelled with ^{13}C under controlled conditions. Labelling was done weekly for 2 h starting 20 days after germination and continuing to the end of embryogenesis (8 label sessions). The atmospheric enrichment during the labelling session was 33 atom% $^{13}CO_2$ and the total CO_2 concentration was maintained within range of current atmospheric concentrations (380-430 ppm). The CO_2 was devolved into the chamber by injecting a saturated solution of $NaHCO_3$ (33% ^{13}C) into a beaker with 12M HCl. Total CO_2 concentration was monitored with an infrared gas analyzer (IRGA). At harvest, soil samples (0-10 cm) were collected from each soil core. Soil organic matter (SOM) was fractionated into dissolved organic matter (DOM), light fraction (LF) (0-1.7 g cm^{-3}), and heavy fraction (HF) (>1.7 g cm^{-3}). For every SOM fraction, ^{13}C was analysed by isotope ratio mass spectrometer. The results of this work will provide an estimate of the amount and fate of C rhizodeposition of pulse versus non-pulse crops in two different Ecoregions.

KEYWORDS: carbon rhizodeposition, dissolved organic matter, light fraction, heavy fraction, ^{13}C pulse labelling, plexiglas chambers

UPLAND FORE ST SOILS CONTRIBUTE TRACE ELEMENTS TO THE STREAM DURING A RAINFALL EVENT

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Even in pristine ecosystems, forest soils were chemically impacted by human activities that accelerated trace element cycling. Their subsequent transfer to streams and water bodies is a key environmental concern. The concept of hydrological connectivity is used to assess the distribution of soil moisture in a watershed and the potential of these source areas to convey water to the stream. Knowledge on connectivity is critical to understand, predict or manage the transfer of potentially toxic substances from soils to surface waters. The aim of this study is to establish the timing of the contribution of soil solutions from source areas of the watershed to the trace element content of the stream during rainfall. Soil solution and stream water chemistry together with water table levels were measured at a high temporal intensity and spatial density during a 32-mm rainfall. Field work was conducted in the Hermine, a 5 ha headwater catchment of the Canadian Shield with deciduous forest, shallow Podzols and 1150 mm/yr precipitation. Soil solutions were collected under the LFH and in the B horizons using triplicate zero-tension lysimeters arrays located downslope and uphill. A network of 94 wells was installed to monitor water table levels during rainfall. Discharge was measured and sampled at the outlet whereas precipitation was collected at a nearby weather station. After filtration at 0.45-µm, the total dissolved concentration of 16 trace elements was determined by ICP-MS. At peakflow, a clear pattern of near surface saturation developed close to the channel but also along two zones extending upslope and connecting the stream to unexpected source areas. This well organized connectivity pattern is reflected in the stream chemistry: it shifted from a dominance of solutes originating from downslope organic horizons at the beginning of the storm to a major contribution from the upslope mineral horizons at peakflow.

KEYWORDS: forest soils, trace elements, watershed, hydrological connectivity

ARBUSCULAR MYCORRHIZAL (AM) AND NON-AM ENDOPHYTIC FUNGAL PROLIFERATION IN PRAIRIE WHEAT FIELDS IS RELATED TO SOIL PROPERTIES, MANAGEMENT, AND PLANT NUTRIENTS UPTAKE

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In a quest for indicators of arbuscular mycorrhizal (AM) fungi activity in cultivated soils, we sampled 121 wheat fields across the Canadian prairies in 2009. Soils, crops and crop management were described, as well as development of the intra and extraradical mycelia of AM fungi and the intraradical colonization of wheat by non-AM fungi, which were very abundant. Soils of different types had different properties and productivity. Root colonization by AM and non-AM endophytic fungi decreased with increasing soil P level. Root colonization by non-AM fungi decreased with plant tissue P content. AM fungi colonization was positively related with plant tissue Zn concentration. Tillage intensity had no influence on root colonization by AM, or non-AM fungi, or on extraradical AM hyphal length. Pesticide application was associated with reduced AM fungal root colonization. A first year of results suggest that (1) high P fertility and pesticide application negatively influence the abundance of fungal root endophytes in wheat crops, (2) tillage has little impact on the fungi living in wheat roots and (3) AM fungi contribute little to wheat P uptake, but may improve wheat uptake of Zn.

KEYWORDS: AM fungi, endophytic fungi, colonization, tillage, phosphorus, soil type, wheat

THE EFFECTS OF FREEZING-INDUCED DESICCATION ON BULK SOIL VOLUME AND AGGREGATE STABILITY

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Certain forms and structures within a soil experiencing freezing temperatures are often attributed to the freeze/thaw process. This process is primarily associated with the volumetric expansion resulting from the phase change of pore water to ice. The actual processes, however, are more complicated than those due to simple expansion. Pore water migration, driven by the temperature gradient within a freezing soil, results in the growth of pore ice and possibly discrete ice lenses. The effects of the concomitant freezing induced desiccation between areas of ice growth and concentration of pore water in zones of freezing are also seen following freeze/thaw. The effects of freezing were determined via volume measurements of cylindrical soil cores, while wet aggregate stability (WAS) and dispersible clay (DC) measurements gauged the effects of the freeze/thaw and freeze drying processes on 1-2 mm soil aggregates from soils of three different textural classes (sandy loam, clay loam and clay). Water content at the time of freezing was an important factor in both the freeze/thaw process and the individual freezing and thawing phases. Freezing soil experienced bulk volume shrinkage at initial water contents up to approximately 85% saturation and expansion only at initial water contents higher than this. Higher initial water contents also resulted in significantly lower soil aggregate stabilities (decreased WAS and increased DC) following freeze/thaw. The action of liquid water during the thaw phase had a major affect on post freeze/thaw soil properties as freeze drying, where sublimation of pore ice removed the effects of liquid water during thawing, resulted in improved aggregate stabilities (increased WAS and decreased DC) at all water contents and for all soils. Higher clay contents resulted in greater volumetric change effects and significantly higher aggregate stabilities following all freezing treatments.

KEYWORDS: freeze/thaw, desiccation, volume change, aggregate stability

CHARACTERIZATION OF THIN SOILS ON EXPOSED BEDROCK OUTCROPS IN A STRESSED BOREAL ECOSYSTEM

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Anthropogenic activities, primarily smelter emissions and logging, have led to a failure in forest recovery and subsequent soil loss near Flin Flon, MB and Creighton, SK. Consequently, exposed upland bedrock soil basins (UBSB) have increased in size and extent over the last century resulting in thin, coarse-textured pockets of soil with little to no vegetation occurring sporadically in this area. Particle size distribution, pH and carbon content were examined in order to define a subpopulation of disturbed bedrock soils. Samples were collected from juvenile Dystric Brunisols, Cumulic Regosols and Orthic Regosols on UBSB. Fire and weathering processes appear to have altered textural distributions resulting in coarse, silt dominated soils. Soil and microbial biomass carbon was highly variable and most likely influenced by erosion and severe fires. Two types of UBSB were identified: 1) shallow, localized pockets of soil in bedrock depressions; and 2) more extensive shallow soils occurring adjacent to exposed bedrock ridges, where the latter would result in superior seed beds for use in restoration. Further observation is needed to distinguish UBSB from similar but less disturbed soils in this area. Future research should consider the role of fire intervals on forest recovery and observed soil properties, and examine the mineralogy of the silt-fraction to determine its origin and formation.

KEYWORDS: exposed, bedrock, dystric brunisol, Flin Flon, silt, smelting, Canadian Shield, disturbed, fire, shallow

ORGANIC ACIDS INHIBIT Pb-AND Zn-PHOSPHATE FORMATION IN PHOSPHATE AMENDED METAL CONTAMINATED SOILS

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The in situ immobilization of bioavailable Pb and Zn in soils into their sparingly soluble forms by phosphate amendment have been used as an effective and economically viable means to remediate Pb- and Zn-contaminated soils. Lead phosphate (pyromorphite – PY) and zinc phosphate (hopeite – HP) minerals have reported Ksp values as low as 10-84.4 and 10-35.3, respectively, hence can effectively immobilize Pb and Zn in soils once their formation is achieved. However, some uncertainties are still unresolved in using this approach to immobilize Pb and Zn including the poor efficiency of PY and HP formation in soils after P treatment. A recent study reported as high as 70% of Pb in soil was not converted to PY after P amendment. In this study, we conducted an incubation experiment to test the role of low molecular weight organic acids (LMWOA) and DTPA in enhancing PY and HP formation in soils. Two levels of P (5,000 and 10,000 mg/kg soil) in forms of phosphoric acid were added to a highly Pb and Zn contaminated soil with and without organic additives (3mmol/kg soil oxalic acid, citric acid and DTPA). The efficiency of PY and HP formation was studied using several qualitative and quantitative techniques including advanced XAFS analysis. Our results indicate that organic additives completely inhibit PY and HP formation at low P level and reduced the formation more than by half at high P level when compared to treatments with no organic additives. We hypothesize that the abundance of LMWOA in soil (as in the case of rhizosphere soil) inhibits the formation of PY and HP through ligand formation process. This implies that P treatment to immobilize Pb and Zn in soils rich with organic carbon can be a challenge.

DISSIPATION OF HERBICIDES IN WATER AND SEDIMENT OF TWO CANADIAN PRAIRIE WETLANDS

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In this study, an ephemeral (E) and a semi-permanent (SP) wetland were divided into halves using a polyvinyl curtain and glyphosate, dicamba, bromoxynil, MCPA, 2,4-D, mecoprop-P and dichlorprop were added to the treated half of both wetlands such that concentrations in the water simulated an over-spraying event, thus representing a worst-case scenario for wetland contamination. Water and sediment samples were taken over the 77-d study period to monitor herbicide concentrations. In water, the DT50 values ranged from 2.3 d (bromoxynil) to 31 d (dichlorprop). AMPA was detected in the water column of both wetlands 5 d post-treatment. The mass of AMPA in each wetland increased with a concomitant decrease in glyphosate mass, suggesting that glyphosate degradation was occurring in the water column. Use of bromide ion as a conservative tracer indicated that majority of the water loss from both wetlands was via infiltration. A strong correlation was found between herbicide mass and bromide ion mass in wetland SP (r2 = 0.59 to 0.76) and wetland E (r2 = 0.80 to 0.95), therefore herbicides were likely lost from the water column along with the infiltrating water. In addition, herbicides were also lost from the water column via sorption to bottom sediment, as evidenced by the detection of all seven herbicides in sediment. In contrast, AMPA was never detected in sediment throughout the 77-d study period. The order of persistence in sediment was similar to that in water. Overall, bromoxynil and glyphosate were the two least persistent herbicides. The mecoprop-P and dichlorprop were more persistent than the 2,4-D and MCPA in both sediment and water, and they remained well above the levels set by the Canadian Water Quality Guideline for the Protection of Aquatic Life when the study was terminated.

KEYWORDS: herbicide fate wetland

THE PERFORMANCE OF TWO LOW PHYTATE FIELD PEA LINES

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Low phytate concentration in pea (Pisum sativum L.) seed would improve the bioavailability of phosphorus and micronutrients in humans and non-ruminant animals. The Crop Development Centre, University of Saskatchewan developed the two low phytate pea lines (1-2347-144 and 1-150-81) using chemical mutagenesis. These lines were grown in field trials at three diverse locations in Saskatchewan in 2009. CDC Bronco, the parent cultivar from which they were derived and 20 other widely grown cultivars were also grown. Agronomic characteristics and phytate content of all lines were determined. The low phytate lines had similar seedling emergence counts, days to flowering, days to maturity, vine length, lodging score, powdery mildew score, mycosphaerella blight score and grain yield compared to CDC Bronco. Harvested seeds of the low phytate lines had substantially higher inorganic phosphorus concentration than CDC Bronco and the other normal phytate cultivars, as well as correspondingly lower phytate concentration than CDC Bronco and the normal phytate cultivars. This experiment is being repeated in 2010.

KEYWORDS: low phytate

OAT FAT- POSSIBLE NEW DIRECTION FOR BETTER HUMAN HEALTH AND LIVESTOCK?

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Oat is a very important crop for livestock feed and human nutrition. Increased interest in the health promoting properties of oat has lead to a need to explore current oat germplasm for improved nutritional quality. A study was conducted to explore the fatty acid profile of diverse accessions from the world oat collection preserved in the Canadian national seed genebank, Plant Gene Resources of Canada (PGRC), at the Agriculture and Agri-Food Canada Research Centre, Saskatoon, Saskatchewan, Canada. The accessions included a wide range of Avena sativa L. and other selected species from the genus Avena (A. byzantina K. Koch, A. sterilis L., A. fatua L. and A. strigosa Schreb.). The fatty acid profile of 650 oat accessions from all species was analyzed using gas chromatography, revealing significant variability for the three major fatty acids in oat oil. A few accessions of A. sativa had higher oleic and lower palmitic acid levels. Some hexaploid wild oat accessions (Avena sterilis) showed very high oleic and below average levels of palmitic and linoleic acid compared with A. sativa average. Based on initial results, selected accessions were grown in 2009 in replicated field trials and re-evaluated to gain insight to the influence of the growing environment on fatty acid composition. The understanding gained from this research suggests the possibility of improving the fatty acid profile of future oat cultivars for both food and feed.

KEYWORDS: oat, fatty acid

ANATOMY OF A LCA: IMPLICATIONS FOR BIOENERGY CROP SYSTEMS

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Today, Life Cycle Assessment (LCA) is a widely recognized concept, in particular with respect to its application to the analysis of transport fuels. However, there are a lot of misconceptions about what an LCA study is and what it can tell us. This presentation will provide an overview of how and why an LCA should be carried out according to internationally accepted standards. These standardized LCA methodologies were originally designed to analyze well-defined and closed industrial systems. The application of LCA methodologies to agricultural systems presents challenges for providing credible LCA results. The agricultural stage is very difficult to assess because of the interaction between farm management practices and environmental factors; additionally, greenhouse gas emissions are just one of many environmental impacts on the farm that should be considered. These challenges will be discussed with respect to data requirements for bioenergy crop systems and the implications for crop research.

METEOROLOGICAL IMPACTS OF THE 2008 GROWING SEASON ON CANOLA QUALITY (*BRASSICA NAPUS*) IN WESTERN CANADA

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The Canadian canola industry includes 52 000 producers, creates 216 000 jobs and is estimated to contribute $14 billion dollars annually to the Canadian economy. According to Statistics Canada, in 2008, western Canada produced a record 12.6 million tonnes of canola, over 75% of which was exported. Predictions of pre-harvest canola quality would improve canola sourcing for oil crushers', improve canola breeders' ability to create varieties adapted to certain weather conditions, and allow worldwide customers to purchase high quality Canadian canola with confidence.

Previous research has identified growing season weather as a factor impacting canola quality. The objective of this study is to create a predictive model for canola quality requiring only meteorological data, seed variety and seeding date as inputs. A selection of Canola Number 1 Canada, low erucic acid and low glucosinolate Brassica napus samples from the 2008 Canadian Grain Commission (CGC) harvest survey were analyzed for quality. All samples were from one of these top-ten varieties, 1841, 5020, 5030, 34-65, 71-45RR and SP Banner. The quality parameters investigated were oil, protein, chlorophyll, glucosinolates contents, and the fatty acid profile. This data was paired up with weather data from the Environment Canada or Canadian Wheat Board weather station in closest proximity to each sample site. Collected values of daily high, daily low, average temperatures, cumulative daily precipitation, and calculated values for evapotranspiration rates, heat stress and crop water deficit were determined for each sample over the span of various physiological development stages, using the P-day index as a method of calculating canola development. Correlations between the weather parameters and canola quality factors were determined and will be used to develop a canola quality predictive model that will be tested with 2009 harvest survey canola samples.

KEYWORDS: canola, Brassica napus, predictive model, weather, oil, protein, chlorophyll, glucosinolates, fatty acid profile

SOIL GREENHOUSE GAS EMISSIONS AND SOIL NUTRIENT RELATIONSHIPS FROM OVERWINTERING BEEF CATTLE EXCRETA ON GRASSLAND

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Overwintering of beef cattle on pasture rather than in a dry lot is one practice with potential to lower production costs. However, it has yet to be determined if overwintering on pasture can be considered a beneficial management practice. The objective of this study was to monitor greenhouse emissions through the growing season of fecal and urine patches deposited on frozen grassland from overwintering mature beef cows. These fecal and urine patches were also compared to mixtures of feces, urine, and bedding material to provide a treatment of dry lot manure. Fecal, urine and dry lot manure were deposited in April, 2009, on grassland while the ground was still frozen. The excreta was collected from three diet treatment groups of cattle. Diets consisted of a low-protein (6% crude protein) forage ration containing increasing concentration of dried-distillers grains with solubles (DDGS) as a protein supplement [0% (control), 10% and 20% w/w supplementation]. Gas emissions from patches were determined using static vented chambers throughout the growing season and emissions of nitrous oxide (N_2O), methane (CH_4), and carbon dioxide (CO_2) estimated. Soil samples were collected weekly to determine soil nitrogen transformations and their relationships to GHG emissions. Cumulative N_2O emissions over the 147 days were 1,413 and 315 mg N_2O-N m^{-2} for urine patches from 20% and control diets, respectively. Cumulative N_2O emissions from fecal patches were lowest with 30 mg N_2O-N m^{-2} from 20% diet. Peak emissions from urine patches occurred in early July and did not occur following application of excreta to soil, when soil available N concentrations were highest. Peak emissions were related to increasing levels of microbial activity, shown by increased emissions of CO_2, resulting from warming temperatures and following large rain events.

KEYWORDS: greenhouse gas emissions, beef cattle, nitrous oxide, overwintering, fecal patches, urine patches, DDGS

NUTRIENT BALANCE AND GREENHOUSE GAS EMISSIONS FROM OVERWINTERING BEEF CATTLE

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A metabolism trial was the first stage of a multidisciplinary study at the University of Manitoba examining the environmental implications of overwintering beef cattle. Thirty mature beef cows were divided into three treatment groups and fed diets of forage having 6% crude protein (CP; Control), the forage supplemented with dried distillers grains with solubles (DDGS) to 10% w w^{-1} (borderline sufficient N, 8.7% CP), and to 20% DDGS (excess N, 11.5% CP). The trial was conducted in October and November, 2008, (fall trial) and again in January and February, 2009, (winter trial) to determine the effects of cold acclimatization on enteric methane emissions, nutrient composition and amount of excreta, and soil greenhouse gas emissions and soil nutrient concentrations following deposition of excreta. Enteric methane emissions were lower in the winter trial and with increasing DDGS supplementation. However, supplementation to 20% also resulted in higher emissions of nitrous oxide (N_2O) from urine applied to soil. The emission-factor as percent of added N evolved as N_2O for urine patches was 0.55 and 0.12 from 20% and Control diets, respectively. Fecal patches had lower emission-factors being 0.04 and 0.07 for 20% DDGS and Control diets, respectively. No difference was found between nutrient concentrations in excreta from supplemented diets due to cold weather acclimatization. Increasing DDGS supplementation increased concentrations of N and P in feces and urine. Total N and organic N content of feces was greater in 20% diets compared to Control and 10% diets. Fecal total P and urine total P, total N, and urea-N were greater in 20% compared to Control diets. Hedley fractionation of feces revealed labile P also increased with supplementation, being 66 to 79% in winter for Control and 20% diets, respectively. Total N to total P ratios of excreta ranged between 4 and 7.

KEYWORDS: greenhouse gas emissions, nutrient balance, DDGS, beef cattle, excreta, nitrogen, phosphorus, overwintering

LONG-TERM EFFECTS OF CROP TOTATION AND FERTILIZATION ON TIROUS OXIDE EMISSIONS

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There has been a tremendous amount of interest in the impact of N source, N rate and crop rotation on reducing nitrous oxide emissions from agricultural soils. The objective of this study was to quantify the effects of crop rotation and N fertilization on nitrous oxide emissions from soils. A long-term study was established in 1959 to investigate the effects of fertilization and crop rotation on crop productivity, soil and environmental quality. Treatments include both fertilized and non-fertilized continuous corn, rotation corn (corn-oats-alfalfa-alfalfa), and continuous bluegrass sod treatments with all phases of the rotation present each year. Denitrification rate (biweekly), nitrous oxide emissions using field chambers (weekly) and soil mineral N concentrations were measured in the corn phase of the rotation from April to October in each of 3 years. The impact of these management treatments on nitrate losses will be discussed.

KEYWORDS: nitrous oxide emissions, denitrification, nitrate loss

MORPHOLOGICAL CHARACTERIZATION AND SEED PERSISTENCE ESTIMATION OF COW COCKLE (SAPONARIA VACCARIA. L) GENOTYPES UNDER DOMESTICATION STUDY

Hema S. N. Duddua, Shirtliffe S. Ja, and Christian J. Willenborgb 2009
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Cow cockle (Saponaria Vaccaria. L), is an introduced summer annual weed of Northern Great Plains. It is being considered for domestication because of its high quality starch, cyclo-peptides and saponins. The present investigation aimed at identifying the characters which aid in domestication of the crop and also to identify the seed persistence changes during this process. The morphological and adaptation study include thirteen genotypes. Among them, 06-Turk-1 was superior with high emergence, duration of flowering, biomass and yield. Manitoba lines were characterized by shorter heights, lower biomass, determinate growth and early maturing with an exception of MAB-89. In persistence study, seeds of semi-domesticated prairie carnation showed high emergence than wild cow cockle under different tillage treatments after the first year. Furthermore, tillage resulted in higher emergence compared to zero tillage. It is hoped that results of this study, would help in domestication and production of better cultivars for Canadian prairies.

KEYWORDS: domestication, morphological characterization, seed persistence

X-RAY ABSORPTION SPECTROSCOPY STUDIES OF Cu(II) SORPTION ON ALUMINUM PRECIPTITAITON PRODUCTS FORMED UNDER THE INFLUENCE OF TANNATE AND BY ANTRHROPOGENIC MINE SOILS

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The sorption of metal cations such as Cu on the surfaces of soil colloidal materials is a major factor controlling their mobility and bioavailability affecting their toxicity and fate. Cu is of interest because it is an essential element required by humans, plants and animals but is toxic at higher concentrations. In natural environments, organic-induced perturbation of the structural network of Al(oxy)hydroxides results in the formation of short range-ordered Al (oxy)hydroxides with altered surface and charge properties compared to "pure" Al (oxy)hydroxides such as gibbsite; often becoming more reactive towards metal cations than the "pure" Al(oxy)hydroxides. However, to date no study has examined the impact of the organic-induced structural perturbation and resultant surface alteration of Al precipitation products on Cu(II) sorption. In this study Al precipitation products formed under the influence of varying tannate/Al molar ratios (0, 0.001, 0.01, 0.1) and "pure' Al(oxy)hydroxides were treated with Cu(II) nitrate until the sorption of Cu from solution was complete (< 24 hr). Also, anthropogenic soils obtained from a Cu mining site were included for comparison. X-ray absorption near edge structure (XANES) spectra at the Cu L- and K-edges were collected from the Cu sorbed Al-tannate materials, "pure" Al (oxy)hydroxides, and from selected soils surrounding the mine. The Cu XANES spectra from these materials were compared to the Cu XANES spectra of standard Cu organic and inorganic reference compounds. The analysis of the XANES spectra provided direct evidence on the coordination nature of Cu in the tannate-induced structurally perturbed Al precipitates, "pure" Al (oxy)hydroxides and the mine soils. The information is contributing to a better understanding of the role of natural organic-induced perturbation of Al precipitation products on the coordination nature of Cu, furthering our understanding on the mechanisms of Cu transformation and transport in natural and anthropogenic soils.

KEYWORDS: aluminum, organic, tannate, sorption, x-ray absorption spectroscopy, copper, precipitate

CROP RESIDUES AND SOIL AS NUTRIENT SOURCES IN SNOWMELT RUNOFF

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On the Canadian prairies, most surface water recharge occurs during snowmelt runoff and most nutrients transported in runoff are in the dissolved form. Although soils and fertilizers are generally regarded as the primary sources of nutrients in runoff from agricultural lands, the contribution of crop residues cannot be ignored, especially during snowmelt when freeze-thaw processes may increase cell rupture and soluble nutrient release. A snowmelt simulation study was designed to assess nutrient release from different plant residues during snowmelt in controlled conditions. Frozen residues were covered with a layer of snow that was typical of over-winter snow-cover and subjected to a thaw-freeze regime that mimicked field conditions. The resulting melt-water was analyzed for dissolved nutrients to assess the release potential of each residue. A range of plant residues, including cereals, pulse crops, oilseeds, forages and riparian vegetation, were collected for testing. Interactions between soils and residues were studied using paired samples of residue and surface soil which were tested alone and in combination. The potential to contribute nutrients to snowmelt was highly variable between residue types with the freshness of the residue material at freeze-up being the major controlling factor. The potential for forage crops, riparian vegetation, actively growing weeds and fall-seeded cereals to contribute nutrients in simulated snowmelt was much greater than for cereal, pulse or oilseed stubble. Simulated snowmelt from wheat stubble contained about half of the P from the corresponding soil while snowmelt from winter wheat crops contained more than 20 times the dissolved P from soil. Interactions between soil and residues reduced the potential P contribution in combined samples. Irrespective of residue type, simulated snowmelt from the combined samples only contained 40% of the P measured when the soil and residue were tested separately.

KEYWORDS: snowmelt simulations, interactions, water quality

DISSIPATION OF THE HERBICIDE THIFENSULFURON-METHYL IN A PRAIRIE WETLAND

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Surface runoff, atmospheric transport, spray drift and other transport processes result in frequent herbicide detections in prairie dugouts and wetlands. In this study, we monitored the dissipation of thifensulfuron-methyl (a sulfonylurea herbicide) that had been applied to a prairie wetland at a rate corresponding to an accidental overspray. Samples were collected for herbicide analysis from two locations in the wetland and at two depths at each location. The water was sampled at 0.5 m below the surface and at 0.1 m above the wetland floor. Baseline samples were collected 5 and 2 days prior to application and post-treatment sampling was done on days 1, 2, 3, 7, 14, 21, 28, 42, and 128 after application. Water temperature was constantly monitored in 0.1-m depth increments throughout the study period and pH, electrical conductivity, total suspended sediments and dissolved oxygen corresponding to each sample were measured in situ. Thifensulfuron-methyl was not evenly distributed throughout the water column in wetland. Higher concentrations were consistently observed at 0.5-m depth than at 0.1 m from the bottom. Most of the herbicide was lost from the water column by Day 7 of the experiment but quantifiable concentrations were still measured at both depths after 128 days. Thermal stratification was present in the wetland. The narrowest temperature range was found at the deepest of the sampling sites. At 0.5-m depth, temperatures responded more quickly to air temperature and higher maximums and lower minimums were observed. The pH of the wetland was close to neutral with higher pH values at 0.5 m than at depth. Total dissolved solids and electrical conductivity were greater at depth than at 0.5 m. Dissolved oxygen varied widely at 0.5-m depth but was consistently low at depth.

KEYWORDS: sulfonylurea herbicide, spatial variability, water column, physical properties

A MICROMETEROLOGICAL STUDY TO QUANTIFY COLD WEATHER VOLATILIZATION OF AMMONIA FROM SURFACE-APPLIED AREA

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In Montana, wheat growers frequently surface-applied urea in the late-fall, winter, or early spring. Although, urea is known to be susceptible to volatilization losses, growers believe this problem is minimized if applications are deferred to cold weather months. The objectives of this study were to quantify ammonia losses from urea surface-applied during the fall to early spring period; and to evaluate the use of NBPT (N-(nbutyl) thiophosphoric triamide) to mitigate losses. Field studies were conducted between 2008 and 2010 at four farms with varying soil textures. Ammonia losses were quantified according to the micrometeorolgical integrated horizontal flux method. Leuning shuttles were placed on masts 0.25, 0.50, 1.00, 1.50, and 2.75 m above ground level in the center of urea and urea+NBPT treated (100 kg N/ha) circular-plots (20 m radius). Background ammonia was accounted for with a third mast, 200 m distant from the treated plots. Shuttles were exchanged weekly over 8-wk gas sampling campaigns. Ammonia-N losses from urea have ranged from 3 to 40% of the application rate over 10 gas sampling campaigns conducted to date. Ammonia-N fluxes as great as 22 kg N/ha/wk occurred during one campaign. In this semiarid region, ammonia losses were sometimes delayed (>2 wk) until sufficient precipitation falls to dissolve urea prills. Significant ammonia losses may then occur over a 3 to 6-wk period. Applying urea to frozen soils or onto snow did not provide protection against volatilization losses. Surprisingly, some of the greatest ammonia losses occurred when urea was applied to surface soils near 0°C combined with high moisture. Coating urea with NBPT (4.2 ml/kg urea) provided at least two weeks of protection against volatilization losses following fertilizer dissolution, and reduced ammonia losses by ~62% over untreated urea.

KEYWORDS: integrated horizontal flux, Leuning shuttles, NBPT

EFFECT OF ESTABLISHING WILLOW (*SALIX* SPP.) PLANTATIONS ON SOIL CARBON AND GREENHOUSE GAS

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Willow (Salix</i> spp.) is currently being developed as a source of bio-energy in Canada. Rapid growth in high-density plantations, short rotation length, and high energy output to input ratios make willow promising as an energy feedstock. However, there is still much research to be done with willow in Canada to ensure net positive impacts on soil carbon and greenhouse gas balances throughout the full willow bio-energy life-cycle. Soils can be both sources and sinks for carbon, CO_2 and other greenhouse gases with balances being altered by changing soil conditions. Planting trees is known to change soil composition, structure and microclimate from the previous land-use. Therefore, we hypothesize that planting willow in short rotation intensive culture will alter soil carbon and greenhouse gas balances from that of the previous land-use. To test this hypothesis, a study on total soil carbon was conducted to elucidate the benefits of planting trees on agricultural land at nine sites across Canada. A local but concomitant study was conducted to directly measure fluxes of CO_2, N_2O and CH_4 into and out of the soil using vented chambers at two sites in or near Saskatoon, Saskatchewan. Measurements were taken from willow plantations, agricultural land and under mature trees. Preliminary results indicate that the change in soil carbon with plantation establishment was variable with increases, decreases and no change being observed at the different sites. The intrinsic properties of the soils, previous land-use and cultural practice (e.g. soil organic matter amendments and fertilization), and willow plantations productivity are factors explaining the different responses. The local greenhouse gas study shows soil respiration and associated CO_2 efflux rates to be highest and N_2O and CH_4 fluxes to be lowest under mature trees. Opposite trends are found for agricultural land. The willow plantations tended to fall between these two land-uses.

KEYWORDS: willow, soil carbon, greenhouse gases, bio-energy

EXPLORING ORGANIC AGRICULTURE'S PLACE WITHIN THE AGRICULTURAL REVOLUTION

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Winnipeg, Manitoba, Canada R3T 2N2 Is organic agriculture advancing the 10,000 year old agricultural revolution, or is it just a counter-revolutionary distraction? Not only is organic farming and gardening advancing agriculture, it is exposing problems in our food system and offering an alternative model. Even now, organic systems have advantages - scoring higher than conventional agriculture for food quality, ecosystem biodiversity and nutrient cycling. Most modern farming systems have turned their backs on sound husbandry and it seems that near-monoculture production is deemed OK. Industrial agriculture is susceptible to "disturbances", such as low fossil-fuel energy supplies, throwing into question its resilience. Organic farming can produce comparable amounts of human-usable calories than conventional production using half the oil. These and other examples suggest that, yes, we need to learn from organic farming and embrace its principles. We would do well to transfer organic techniques into mainstream agriculture. But to stop there would be a mistake – it would take the emphasis off innovating within the organic system. Important challenges exist and we must respond to them without the "training wheels" of technology based on extraction and exploitation. For example, to feed the 10 billion, organic farming needs to recycle nutrients in new and innovative ways. The good news is that rethinking nutrient use and embracing the philosophy of regional or even global nutrient cycles will force helpful changes in the larger society. Future organic food systems will require new ecological knowledge – so our education processes also must be improved. In conclusion, the serious and systemic problems facing the world's food system will be well served by embracing the principles of the organic movement and supporting its development. Organics can help agriculture and society face the future with greater confidence.

KEYWORDS: Resilience, future research, organic farming

EVALUATING THE AMOUNT OF CARBONIC GREENHOUSE GASSES (GHGs) EMISSION FROM RICE PADDIES AND CARBON BALANCE IN SOIL

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Global temperature change is one of the most important issues of GHGes emission. Soil organic matter is the major source of GHGes emissions from the soil. The amount of organic carbon stored in paddy soils is greater than in upland soils because of different biochemical processes and mechanisms specifically caused by the presence of flooded water in paddy soils. During the submerged period of paddy rice cultivation, CO_2 production in the soil is severely restricted under anaerobic condition. Instead, CH_4 is actively produced in the soil and emitted to the atmosphere mainly through the rice plants.This study was conducted to evaluate the amount of three important carbonic GHGes emission from rice paddies. Carbonic GHGes emission for 3 kinds of rice cultivation including: wet-bed-seeding (a), dry-bed-seeding (b) and transplanting (c) in a field were measured at Khuzestan province in Iran. The experiment was performed with 4 time sampling at 4 different growth stages of rice cultivation and three replicates in completely randomized design. We used chamber method and gas chromatograph technique to measure the emission of CH_4, CO_2 and CO from rice paddies. Soil sampling was carried out from the first 10 cm of the soil 4 times during the growth season and organic carbon was determined by walkey black method. Results showed that the highest emissed gas was CO_2 and its highest amount of emission has happened in wet-bed-seeding plot and at the rice cultivation stage. In general CH_4 emission was greatest for (a) and for all kinds of cultivation was high at the tillering and ripening stages and low at the rice cultivation and shooting stages. Organic carbon change is very small but results show that carbon balance is positive and soil organic carbon has increased during the time. Results indicate that dry-bed-seeding is the best cultivation method for rice cultivation.

KEYWORDS: organic carbon- greenhouse gasses- rice fields- carbon emission

UNIVERSITIES, COMMUNITIES AND OTHER STAKEHOLDERS WORKING TOGETHER TO IMPROVE PEST MANAGEMENT STRATEGIES AND PRACTICES IN CENTRAL AMERICA

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Central America is the region with more pesticide use per capita than any other region in the world. In this Project, which began in 2006, Universities are collaborating with rural communities and other relevant stakeholders to increase food security through better pest management practices. The four participating Universities are the Universidad de Costa Rica, Universidad Nacional Agraria (Nicaragua), the Universidad Nacional Autónoma de Honduras. and University of Manitoba (Canada). The project integrates three main components: community-development, technical-development, and policy-development. The community development component works directly with farm families across rural communities to understand how and why they farm the way they do with particular focus on their pest management practices. This is done primarily using a participatory research methodology approach with University students doing field research in farming communities. The technical component implements demonstration plots and facilitates outreach educational activities are meant to raise awareness of safer pesticide storage, handling and use practices, as well as provide alternatives to pesticide use. The project also builds on technical capacities at the three Central America Universities. The policy component includes the development of indicators to help understand current practices, and monitor change in practices over time. Data for the indicators have been collected through the use of locally-developed surveys (over 300 farm families surveyed) to provide information for regionally-relevant indicators. This approach is not only meant to raise awareness and change behaviours at a farming-community level, it is also meant to influence local and national policies related to pesticide use. Research results from this project have been shared through a variety of venues including our bilingual project web-site (http://www.umanitoba.ca/afs/centralamerica_cbpm/).

KEYWORDS: pesticides, food security, small-scale farm families, Central America, agricultural practices

SOIL CHEMISTRY CAN BE USED IN PREDICTING 2,4-D SORPTION VARIATINS IN SOIL-LANDSCAPES

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Pesticide fate models can be used during the process of developing beneficial agricultural management strategies designed to reduce the risk of pesticide off-site movement from agricultural land. The outcome of a risk assessment using pesticide fate models is more influenced by the choice of the pesticide sorption input parameters than the choice of the pesticide fate model itself. Consequently, one of the largest sources of uncertainty when applying pesticide fate models at larger scales is the lack of spatial data on pesticide sorption input parameters. Pesticide sorption parameters vary in and between fields due to both intrinsic (natural conditions in soil) and extrinsic (management practices) factors. We will discuss long-term research on spatial variations of soil characteristics and 2,4-D sorption parameters at the soil-landscape scale. Two hundred and thirty-four PRZM (pesticide root zone model) version 3.12.2 simulations were performed to quantify the influence of the measured in-field variations on the predictions of herbicide leaching to depth. Techniques ranging from conventional chemical fractionation methods to solid state Cross Polarization and Magic-Angle Spinning ^{13}C-Nuclear Magnetic Resonance, were used to provide evidence that specific soil organic matter (SOM) chemical, physical and structural characteristics can explain the variations of a 2,4-D sorption parameter in a soil-landscape. From these studies, we suggest a methodology that can be used to improve on the choice of pesticide sorption input parameters for stochastic approaches in regulatory and environmental risk assessments at the large-scale.

KEYWORDS: herbicide; sorption coefficients; leaching; climate scenarios; soil-landscapes; humic substances; carbon content, UV/Visible light absorbance; ^{13}C-Nuclear magnetic resonance spectroscopy

COMPARISON OF DIFFERENT ZN EXTRACTANTS AND DISTRIBUTION OF ITS DIFFERENT FORMS IN CALCAREOUS SOILS OF IRAN

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Zinc (Zn) is an essential plant nutrient. Knowledge about distribution of Zn between its different chemical forms is useful in understanding the chemistry of this element in soil and also in development of soil testing procedures. The present study was conducted to obtain such information about distribution of zinc forms in calcareous soils of Lorestan province and the comparison between two extraction method which is include Singh et al. (1988) and revised BCR (Rauret, 1999) methods in extracting different zinc forms in these soils and determination of relations between those and some soil properties and effect of corn crop on zinc forms in calcareous soils of Lorestan. Twenty surface (0-30 cm) soil samples of Lorestan province were collected and fractionation of zinc in different chemical forms was performed by two procedure by names Singh et al. and revised BCR. A pot culture expriment with corn plant also in randomized complete design with 3 replication was carried out. The plant top dry weight, Zn concentration and Zn uptake were used as plant response.

Based on the results of this experiment, zinc in soils of the study area by Singh et al. method has been distributed in the forms of Exchangeable, Carbonated, Organically bound, Amorphous and Crystaline sesquioxides bound and Residual that Residual form is the most dominant form. Results obtained by revised BCR method showed that Exchangeable, water and acid soluble, reducible, oxidisable and residual are fractions which is distributed in these soils and residual fraction is the most dominant fraction again. There was a good agreement between total amount and sum of forms of zinc extracted by these two methods. By the use of stepwised regressions, correlation between some of soil properties include values of pH, organic matter content, equivalent carbonate calcium, available P, clay percent and extractable Zn with DTPA have been evaluated. Results obtained for revised BCR method has shown better significant correlation with existing conditions in calcareous soils. By comparison between two methods, this results obtained that revised BCR method have extracted more oxidisable fraction while Singh et al. method could extract more reducible fraction. After a corn growth the amount of all soil zinc forms except manganese oxides bound form changed and this changes showed more logical trend and this method recommend for fractionation of zinc in calcareous soils.

KEYWORDS: Zinc fractionation, calcareous soils, sequential extraction methods

DOUBLE CROPPING EFFECTS ON FORAGE YIELDS AND THE WATER BALANCE IN SOUTHEASTERN PENNSYLVANNIA

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Double cropping is increasingly common on Pennsylvania dairy farms as farmers struggle to produce enough feed and fiber for their cattle. This research studies the effect of using a winter small grain (rye: *Secale cereale* L. and barley: *Hordeum vulgare* L.) on main crop silage yields and soil water balance in no till. A continuous alfalfa treatment was added for comparative purposes. The components of the water balance measured were precipitation, runoff, drainage, and soil water content. Crop evapotranspiration was estimated using the Penman-Monteith method. Small grains harvested for silage were planted in the fall following the harvest of the main crops. Corn (*Zea mays* L.) silage and soybean (*Glycine max* L.) whole-plant yields were not affected by double cropping. Total annual silage yields increased with double cropping compared to single cropping. Double cropping did not reduce runoff any more than single cropping rotations. Runoff was more affected by climatic conditions than by management practices such as crop intensification. Low antecedent soil moisture and low rainfall intensity were the influencing factors in this study. Drainage was no different in double cropping, single cropping and alfalfa (*Medicago sativa* L.) rotations except on a few dates when drainage in alfalfa was lower than in single cropping. Double cropping did not affect soil water content compared to single cropping. However, alfalfa lowered soil water content during a dry season compared to double and single cropping. Crop evapotranspiration was increased by double cropping during the fall and spring seasons. The water balance showed a likely over-estimation of drainage and possibly crop evapotranspiration. Double cropping offers the potential to increase annual silage yields without affecting the water balance in Southeastern Pennsylvania.

KEYWORDS: field water balance, runoff, drainage, soil water content, evapotranspiration, double cropping

CONSERVATION TILLAGE TO REDUCE NUTRIENT LOSSES FROM SURFACE APPLIED POULTRY LITTER ON THE DELMARVA PENINSULA

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The production benefits of no-till are well known. However, when poultry litter is surface broadcast in no-till systems, nutrient losses can be significant due to incidental transfer of nitrogen and phosphorus in runoff. This study was conducted to determine whether conservation tillage could be used to partially incorporate poultry litter in order to reduce nutrient losses in runoff while maintaining some of the production benefits associated with no-till. No-till, vertical till, strip till, and chisel-disc were evaluated in a continuous corn system for three years on Maryland's Eastern Shore. Poultry litter was applied each year at a nitrogen-based rate. Corn grain yield, residue cover, soil nitrogen and phosphorus concentrations, and total nitrogen, phosphorus, and sediments in runoff were monitored over three growing seasons (2006-2008). In the first year, yields in no-till and vertical till were lower than in strip till and chisel disc. Residue cover was preserved with no-till, vertical till, and strip till compared to chisel disc. There were no differences in P and sediment runoff between tillage practices. Strip till and chisel disc reduced nitrogen losses in runoff relative to no-till and vertical till. Partial incorporation of poultry litter by strip till or chisel disc after surface application can reduce nutrient losses on the Delmarva Peninsula.

KEYWORDS: conservation tillage, runoff, nitrogen, phosphorus, residue cover, corn grain yield

CAN PLANTS ACCESS P POOLS NOT ACCOUNTED FOR IN TRADITIONAL SOIL TESTS? A STUDY OF ORGANICALLY MANAGED SOILS ACROSS SASKATCHEWAN

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Saskatchewan is the Canadian leader in organic farming. A previous study of organically farmed fields across Saskatchewan revealed a widespread deficiency of available P using standard soil test protocols. Despite the low available P test results, producers reported crop yields exceeding what was expected. In 2009, a study of organic farms across Saskatchewan was initiated to determine if plants grown under organic management are able to access pools of P that are not measured using traditional soil tests. Three organic farms were recruited from each of the Brown, Dark Brown and Black soil zones of Saskatchewan and one from the Gray soil zone. One conventional farm from each zone was sampled for comparison. Soil and plant N also were investigated to expand the scope of the study and obtain a more comprehensive understanding of nutrient cycling in organic systems. The objectives of the study were to examine P and N mineralization at each site, determine plant P and N uptake over the growing season, quantify arbuscular mycorrhizal fungi (AMF) associations, and assess the relationship between the analysed variables. A comparison of one organically managed site and one conventionally managed site in each soil zone was included to assess if the traditional soil tests performed better on conventionally managed soils. One field seeded to a pulse and one field seeded to a cereal was sampled at each location. Spring soil samples were collected for initial soil characterization and for use in N and P mineralization studies. Plant Simulator Probes (PRS™) were used to measure field mineralization of P and N over the growing season. Plant samples were collected in June, July, August and just before harvest for nutrient analysis. Roots samples were collected mid-season for quantifying AMF colonization. Results from this province-wide study will provide an understanding of the severity of the perceived P deficiency for organically managed soils.

KEYWORDS: organic, phosphorus, uptake, mineralizations, AMF

NITROUS OXIDE EMISSIONS FROM LONG-TERM CATTLE AND SWINE MANURE AMENDED SOILS IN THE BLACK SOIL ZONE OF SASKATCHEWAN, CANADA

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Nitrous oxide emissions from manure-amended soils may differ greatly depending on the type of manure, method of application, and rate of application. In 2009, a research project investigated N_2O emissions from long-term liquid swine manure (LSM) and long-term solid cattle manure (SCM) plots on a Black Chernozem soil in northeast Saskatchewan. Treatments were applied at varying rates to both LSM and SCM plots each year consecutively unless specified and consisted of (i) check (no manure or urea fertilizer); (ii) liquid swine manure (1x, 2x, 4x); (iii) liquid swine manure (1x, 2x, 4x) every 3rd year; (iv) broadcast liquid swine manure (1x); (v) banded urea (1x, 2x, 4x); (vi) solid cattle (1x, 2x, 4x) broadcast and incorporated; (vii) solid cattle manure (1x, 2x, 4x) broadcast and incorporated every 3rd year; and (viii) solid cattle manure (1x) broadcast but not incorporated. Nitrous oxide fluxes were measure 21 times over a 160-day period beginning at snow melt through early fall. Chambers were installed in each of the plots and samples taken at 0, 15, 30, and 45 minutes and the vertical flux density for N_2O was calculated. Soil samples were taken from each plot at seeding and the abundance of denitrifying bacteria determined using the denitrification enzyme assay (DEA). The DEA revealed difference between the soils under the various manure treatments. All sampling will be repeated in 2010 with an additional focus on the soil microbial communities.

KEYWORDS: N_2O emissions, liquid swine manure, solid cattle manure, denitrification enzyme assay

NITROGEN, PHOSPHORUS AND ZINC FERTILIZER APPLICATIONS ON SOIL MICRONUTRIENT ABSORBABILITY AND ACCUMULATION OF OATS AND CANOLA

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Deficiency in soil micronutrients such as Zinc (Zn), Iron (Fe), Boron (B), etc. is a global crop production problem occurring in many countries. The interactions of Zn with nitrogen (N) and Zn with phosphor (P) have caused concerns in the recent decade. A greenhouse experiment was conducted to explore the effect of combined application of N, P and Zn fertilizer on the development, dry matter accumulation and nutrient use efficiency of oat and canola crops, to monitor the absorbability and distribution of micronutrients Zn, Fe, Mn and B in the soil and the plant. Some preliminary data showed that seed yield and stem dry weight were significantly affected by the N and P application rates in both oats and canola with linear relationship between seed yield and P application rates and curvilinear relationship between seed yield and N application rates. The effect of Zn on seed yield and stem dry weight were not significant for both canola and oats. Implications of the results on micronutrient absorbability and accumulation in the plants will be discussed.

KEYWORDS: micronutrients,Absorbability and Accumulation, greenhouse experiment, Oats, Canola

A SIMULTANEOUS TIME AND DEPTH ASSESSMENT OF SOIL AND LEACHATE PHOSPHORUS IN POULTRY MANURE-AMENDED SOIL COLUMNS

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Time and depth studies of phosphorus (P) transport and transformation in soils have previously focused on soil measurements taken initially or following a leaching experiment. In order to better-predict P loss potential from soils we must understand the time and depth scale over which changes in P solubility influence leaching characteristics. Three poultry-manured soil columns were fitted with soil sampling ports at 0-5, 5-10, and 10-15cm depths as well as a spigot for leachate collection. Soil total P (TP), water- and bicarbonate-extractable-P (WEP/BEP), degree of phosphate saturation (DPS), pH, and total C and N were measured biweekly. Phosphorus species in NaOH-EDTA extracts of soils were assessed using solution 31P nuclear magnetic resonance spectroscopy. Leachate pH, total P (TPL), total dissolved-P (TDP), and dissolved-molybdate-reactive-P (DMRP) were measured weekly. Leachate dissolved unreactive P (DUP=TDP–DMRP) and total particulate P (TPP = TPL –TDP) were calculated. Degree of phosphate saturation in manured and control soils was high (>60%) and did not change appreciably with time. Increasing soil WEP and BEP concentrations were correlated with TDP leaching during the ten weeks, particularly in the 10-15cm depth of manured columns (R2=0.427, 0.532). Particulate-P leaching was enhanced following manure application and was likely mediated by organic matter. Microbial activity in the 0-5cm depth, as indicated by the presence of pyrophosphate and orthophosphate diesters, likely contributed to the solubilization of organic P (OP) and resultant orthophosphate release to soil and leachate. Myo-inositol hexakisphosphate remained the dominant form of soil OP and showed little variation with time or depth. The results of this study suggest that: (1) soil extractable-P concentrations have short-term (<10 leaching events) influence on leachate-P characteristics; (2) changes in microbe-derived OP contribute to leachate-P characteristics; (3) the concurrent sampling strategy described here is useful for assessing the behavior of P in leached soils.

KEYWORDS: poultry manure organic phosphorus leaching degree of phosphate saturation

DO VARYING LANDSCAPE POSITIONS AND MANAGEMENT REGIME AFFECT THE STABILIZATION OF ORGANIC N & C –AN X-RAY ABSORPTION AND PYROLYSIS MASS SPECTROMETRY STUDY OF WHOLE SOILS

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Quantity and quality of soil organic N and C are strongly influenced by small-scale variations in landscape position through water redistribution, and management practices such as cultivation. In this study, we use synchrotron-based N and C K-edge XANES spectroscopy and Py-FIMS to explore N and C chemistry between soils obtained from different landscape positions along a hummocky transect and from locations under different management practices. A distinct landscape pattern in N functionality was observed, but only a small management effect was detected. Normally thought as labile, carbohydrates, and low molecular weight aromatics instead were stabilized in shoulder slope positions, while lipids were enriched in depressional areas. Multivariate ordination was applied to XANES data to show increases of heterocyclic-N with cultivation. Most notably were results showing the formation of unique, oxidized N-bonded aromatics, which predominated at calcareous shoulder slope positions. These types of organic N compounds are rarely reported in the literature except for samples obtained in acidic or anaerobic environments. This multiple-method approach reveals that landscape-induced redistribution of water and of soil affects the stabilization mechanisms and composition of soil organic N and C.

KEYWORDS: organic carbon, organic nitrogen, landscape-scale, x-ray absorption, pyrolysis mass-spectrometry

A NOVEL MODEL DESCRIBING CARBON MINERALIZATION FROM SOILS AMENDED WITH ORGANIC RESIDUES

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The decomposition of organic soil amendments is a dynamic process that is not fully understood at present. Carbon mineralization by soil microorganisms has been modeled to derive useful theoretical parameters regarding the decomposition process. This paper compares a new model describing carbon mineralization from amended soil to three others commonly used in the literature. Carbon dioxide evolution from soil amended with five rates of an alkaline stabilized biosolid (0, 2.08, 4.16, 8.32, 12.48 mg/g d.w.) was monitored using alkali traps sampled on days 0, 3, 6, 9, 12, 15, 22, 29, 45, 55, 71, 88, 103 and 121. The new model, a first order exponential plus logistic function (FLOG), is based on the recognition of different competitive strategies (the r-K continuum) in the soil environment. The FLOG model performs better than the first order and first order plus linear models for all amendment rates except the control. A double first order model produced a lower mean squares error for all treatments but had non-normal residuals in one case. The FLOG model performs comparably well against other common models, and can generate curves ranging from almost exponential in appearance to curves containing inflection points, a feature not possible in combined exponential and/or linear models. Further investigation into the biological significance of the new parameters may be beneficial in describing the decomposition process, such as linking the timing of the delayed pool to changes in soil enzyme activities, shifts in microbial community composition, or aspects of the nitrogen cycle for example.

KEYWORDS: carbon mineralization, soil ecology, modeling, biosolids

CHALLENGES OF PRIVATE INDUSTRY PLANT BREEDING IN CANADA

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Private industry plant breeding in Canada has undergone tremendous changes over the last several decades. Canola breeding has almost completely become a private sector breeding effort. Improvements in crop maturity and yield have driven increased corn and soybean breeding efforts. Private industry cereal breeding continues to show growth as value-added traits show promise. One of the largest drivers of private industry plant breeding in Canada has been the adoption of technology in crops and the use of crops as platforms for traits. Technology development and patent protection can limit access to technology, but can be an opportunity to license for other technology access or to drive revenue. Technology developments have also triggered increased regulatory concerns and created barriers affecting trade. Continued industry consolidation has reduced the number of overall organizations involved in private industry plant breeding but has allowed the remaining organizations to focus their efforts on specific crops and traits. The drive to size and technology has resulted in most plant breeding organizations divisions within large multinational organizations. Additional challenges for private industry plant breeding are the successes of public plant breeding programs. Strong public breeding programs supply high quality, well-trained plant breeders. High quality public programs also supply fundamental germplasm sources that represent additional genetic diversity. Germplasm restrictions by strong MTA's and reduced access through germplasm banks may impact long-term development. Germplasm restrictions, intellectual property access, further industry consolidation, a reduction in the numbers of trained plant breeders and the continued competitive nature within and among organizations are key challenges of private industry plant breeding organizations in Canada.

GREENHOUSE GAS TURNOVER IN A RESTORING BOG IN NORTH GERMANY

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In Central Europe, most bogs have a history of drainage and many of them are currently being restored. Success of restoration as well as greenhouse gas exchange of these bogs is influenced by environmental stress factors as drought and atmospheric nitrogen deposition. We conducted carbon dioxide efflux and methane and nitrous oxide exchange measurements in the Pietzmoor bog in NW Germany. Also, we examined the methane and nitrous oxide exchange of mesocosms before, during, and following a drainage experiment as well as carbon dioxide release from disturbed unfertilized and nitrogen fertilized surface peat and analyzed auxiliary parameters.

In July 2003, the water table in the Pietzmoor subsided to >42 cm below the surface and in situ soil CO_2 efflux rose to 23.4 g m^{-2} d^{-1} compared to 15.7 g m^{-2} d^{-1} in September. Methane fluxes ranged from 0 to 3.8 mg m^{-2} h^{-1} and were highest from hollows. Field nitrous oxide fluxes ranged from 0 to 574 $\mu g m^{-2}$ h^{-1} and were elevated at the edge. A large cottongrass tussock showed decreasing nitrous oxide release as the season progressed. Drainage of mesocosms decreased methane release to 0, even during rewetting. There was a tendency for a decrease of nitrous oxide release during drainage and for an increase in nitrous oxide release during rewetting. Nitrogen fertilization did not increase decomposition of surface peat. Our examinations suggest a competition between vascular vegetation and denitrifiers for excess nitrogen. We also provide evidence that the von Post humification index can be used to explain nitrous oxide release from bogs, if the role of vascular vegetation is also considered. An assessment of the greenhouse gas release from nitrogen saturated restoring bogs needs to take into account elevated release from fresh Sphagnum peat as well as from sedges growing on decomposed peat.

KEYWORDS: peat bog, greenhouse gases, nitrogen, carbon dioxide, methane, nitrous oxide, restoration

CSSS - TWINNING PROJECTS IN SRI LANKA, VIETNAM, AND ETHIOPIA

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International aid to developing countries takes many forms and is facilitated through many government and non-government organizations. One of these agencies is the Agricultural Institute of Canada, a non-government organization of professional agriculturalists in Canada. With funding from the Canadian International Development Agency (CIDA), professional agriculturalists in soil science, are making a difference building the capacity of respective professional societies as well as to the farming and rural communities in three developing countries. CSSS has a long history with AIC International Twinning Partnership Program and CIDA and have forged a broad spectrum of local and international experience in a large array of disciplines.

This presentation will highlight the goals, objectives and progress of three of the six current international Twinning projects where professionals in Canada are twinned with professionals in host countries to assist them in designing, developing and implementing locally relevant technologies for agricultural and rural community development. The three soils projects are located in Sri Lanka Vietnam, and a new one in Ethiopia. In each country, soil scientists from Canada are helping local counterparts to build capacity within their respective societies and to mobilize their knowledge and skills to enable them to work with other agencies, local groups of farmers and rural communities to improve incomes and living standards. Examples of the activities and demonstrations show how these projects are helping to improve the health and living standards of local farmers and villagers. Support is being provided for soil, water, and plant management, and methods of technology development and delivery to the field level. Working with local farmers and agricultural extension agents and assisting the communities to implement these ideas, results in a good return for the effort and resources expended.

KEYWORDS: International Development, Partnerships

RECLAMATION AND MANAGEMENT STRATEGIES FOR SALT AFFECTED AGRICULTURAL LANDS IN THE SAN JOAQUIN VALLEY, CALIFORNIA

Dave Goorahoo, Florence Cassel S., & Sharon Benes

KEYWORDS: soil salinity, EM technology, integrated on farm drainage

ENHANCED CARBON SEQUESTRATION AND GREENHOUSE-GAS FLUXES FOLLOWING FERTILIZATION OF B.C. CONIFEROUS FORESTS

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We assessed the potential for N-fertilization of young forests to increase carbon sequestration and storage without enhancing greenhouse gas flux. We compared C storage in trees and soil, greenhouse-gas fluxes, soil nutrients and microbial communities in three 25-year-old forests (lodgepole pine, Douglas-fir and western hemlock) following fertilization with urea (200Kg N) or fertilizer mix (N, P and micronutrients) and unfertilized controls. Nitrogen fertilization increased individual tree biomass and increased soil C sequestration in the lodgepole pine and western hemlock soils. Modelling indicated that N fertilization resulted in 12-16% (45-60 t/ha) and 24-25% (59-62 t/ha) increases in total ecosystem C storage at rotation (80 years) in the hemlock and pine forests, respectively. We measured soil fluxes of CO_2, CH_4, and N_2O and soil N, P, and microbial biomass dynamics for 7 months following fertilization. Fertilization resulted in an initial increase in CO_2 efflux as urea was mineralized, but rates returned to control levels within 14 days in all forests. Soil NH_4^+ concentrations increased concomitantly, but there was little transformation of N over the measurement period. NH_4^+ was largely retained in the soil organic horizons with moderate uptake by microbial biomass and little oxidation to nitrite and nitrate. In the pine forest, fertilization with urea led to a brief suppression of soil CH_4 uptake, presumably due to NH_4 inhibition of CH_4-monoxygenases. N_2O efflux in fertilized plots was significantly greater than zero on only one measurement date in one forest type (Douglas-fir). Stable-isotope-probing of microbial PLFA and DNA revealed that variation in CH_4 oxidation in pine forests is due to methanotroph community composition. We conclude that fertilization of these forest types has the potential to increase C sequestration, and that the initial impacts of fertilization on soil greenhouse gas dynamics are small and short-lived.

KEYWORDS: forests, greenhouse gases, fertilization, C sequestration, soil nutrients, microbial biomass, stable-isotope-probing

THE INFLUENCE OF INTENSIFYING FIELD PEA PRODUCTION ON NITROUS OXIDE EMISSIONS AND SOIL ORGANIC CARBON STATUS

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Limited literature suggests that nitrous oxide (N_2O) emissions from field pea crops are lower than from oilseed or cereal crops that receive nitrogen fertilizer. Conversely, N_2O emissions may be higher from a crop grown on field pea residue as compared to the same crop grown on oilseed or cereal residue. Therefore the net impact on N_2O emissions of including field pea in a crop rotation is unclear. It is equally unclear how field pea may influence the soil organic carbon status of the rotation. A field experiment consisting of different frequencies of field pea under no-till management was established in 1995 at the Indian Head Research Farm located in the thin Black soil zone on a heavy clay (Rego Black Chernozem) soil type. The study provided an excellent opportunity to assess the impacts of increasing the frequency of field pea on soil organic carbon (SOC) and N_2O emissions. Soil-atmospheric exchange N_2O was measured weekly from spring thaw to fall freeze-up using nonflow-through nonsteady-state chambers in each phase of the following rotations: continuous pea (C-Pea); wheat-pea (W-P); wheat-wheat-pea (W-W-P). To determine changes in SOC, soil samples were collected in fall 1994 (before this study) and in May 2005. The results showed that: 1) overall mean N_2O emissions tended to decrease with increased frequency of field pea in the rotation; and 2) increased frequency of field pea in the rotation enhanced SOC values. Consequently, the opportunity exists to increase the frequency of field pea in the cropping system to reduce N_2O emissions and accelerate C sequestration.

KEYWORDS: field pea, wheat, nitrous oxide emissions, soil organic carbon

SHOULD MOORSH-FORMING PROCESS BE CONSIDERED IN THE CANADIAN SYSTEM OF SOIL CLASSIFICATION FOR ORGANIC SOILS?

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The criteria for the classification of Organic soils by the Canadian System of Soil Classification (CSSC) are based mainly on the degree of decomposition of the control section between 40 and 120 cm depth, with minimal attention to surface horizons and the effect of cultivation. The Polish Soil Classification System includes properties of the first organic horizon (0-35 cm), namely the formation of a moorsh horizon. We suggest that the introduction of the moorsh horizon as additional criteria in the CSSC will strengthen the classification, especially for cultivated peatlands. The moorsh-forming process (MFP) includes the chemical, physical and biological processes that transform the surface horizons, resulting in horizons that are more strongly decomposed, generally hydrophobic, with a coarse granular structure and an enhanced capability to complex nitrogen (N). Several countries have included this distinction in their classification of Organic soils, but not the CSSC. A general review of the Polish classification of Organic soils will be presented as well as discussing the usefulness of including the moorsh horizon in the CSSC, in terms of pedology, soil quality and agronomy. Organic soils release large amounts of nutrients and carbon dioxide (CO_2) after drainage and aeration and present a risk for N and phosphorus (P) contamination of watercourses and increased CO_2 losses to the atmosphere. The rate of N accumulation in the surface layer depends on duration of the MFP after drainage and on the degree of decomposition of the original peat material. Therefore, including the moorsh horizon and recognizing the MFP, particularly in agricultural peatlands, will make the CSSC more useful to management. There is a potential to manage N fertilizer additions more effectively and reduce nutrient loss to surface waters.

KEYWORDS: organic soil, secondary transformation of peat, organic matter, horizon

INFLUENCE OF CONSTANT VERSUS FLUCTUATING WATER CONTENTS AND CROP ROTATION ON NITROUS OXIDE EMISSIONS FROM SOILS

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Soil water contents and cropping history influence soil organic matter decomposition, nitrogen cycling and nitrate losses. However soil water content fluctuates within and between seasons which adds complexity to these biochemical processes. We investigated the impacts of constant soil water contents (30%, 45%, 60%, 75%, and 90% water-filled pore space) and wet-dry (WD) cycles (varying between 90 to 30% WFPS) on nitrous oxide emissions, denitrification enzyme activity (DEA) and changes in inorganic N in soils under monoculture corn or corn in either a 2-yr corn-soybean (C-S) or a 3-yr corn-soybean-winter wheat (C-S-WW) rotation over 50 days. All soil in the 30% WFPS treatment resulted in a net accumulation of inorganic N. Inorganic N concentrations decreased with increasing WFPS. The WD treatments resulted in the greatest decreases in inorganic N for both C-S and C-S-WW rotations whereas the decreases in inorganic N were similar to the decreases observed for the 75% WFPS treatment in the soil from monoculture corn. DEA and N_2O emissions generally increased with increasing water contents for all 3 cropping treatments. The DEA in the WD treatment was comparatively high and fell within the range of the higher WFPS treatments; however it was somewhat surprising to find that the N_2O emissions for the WD treatment were low and similar to the 30% WFPS treatment in spite of high DEA values and large decreases in inorganic N.

KEYWORDS: nitrous oxide emissions, wet-dry cycles, carbon subtrate, denitrifier enzyme activity

DNA STABLE-ISOTOPE PROBING TO IDENTIFY ACTIVE METHANOTROPHS IN NORTHERN PEATLANDS

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Wetlands are the largest global source of atmospheric methane, an important trace gas contributing to the greenhouse effect, and microbial methane oxidation in wetland soils greatly reduces net methane emissions. Aerobic methane oxidation has been moderately well studied, but knowledge of in situ active methanotrophs is still scant. This work used incubation approaches and ^{13}C DNA stable-isotope probing (SIP) to label active bacteria responsible for aerobic methane oxidation. Soils from a nutrient rich sedge fen and nutrient poor Sphagnum bog were aerobically incubated, where ^{13}C labeled or unlabeled methane was added over four months. Aerobic oxidation was faster in the fen than the bog and DNA-SIP definitively labeled 16S rDNA sequences related to purported methanotrophic members of the phylogenetic class *Alphaproteobacteria*. In the bog, a *Methylocella* sp. like bacterium and *Methylocystis heyeri*, type II methanotrophs that utilizes the serine pathway for carbon assimilation, were shown to be most active. *Methylocella* sp. only utilize non-copper containing soluble-methane monooxygenase, in contrast to particulate-methane monoxygenase, which may be an adaptation to nutrient poor conditions in the bog. *Methylocella* sp. were not detected in the fen, rather *Methylobacter* and *Methylocystis* were the two primary methanotrophic genera. *Methylobacter* is a type I methanotroph genus that utilizes the ribulose monophosphate (RuMP) pathway for carbon assimilation, while *Methylocystis* is type II methanotroph. Furthermore, *Methylobacterium*-like bacteria were also present, which are facultative methylotrophs and takes part in methanol oxidation (the first by-product of methane oxidation). In addition, other non-methanotrophic bacteria, such as those similar to *Acetobacteraceae* and *Acidobacteria* were also labeled, most likely due to the rapid recycling of labeled biomass in the nutrient rich environment. In conclusion, DNA-SIP was viable approach for labeling active aerobic soil methanotrophs and there were clear differences in active communities between two contrasting peatland types.

KEYWORDS: methane oxidation, DNA-SIP, peatlands

CONTINUOUS NO-TILL ORGANIC GRAIN PRODUCTION: POSSIBLE?

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Weed control is rated one of the top issues by Canadian organic growers (OACC, 2008). The use of chemical herbicides been restricted in organic production, organic farmers rely on mechanical practices to control weeds, such as tillage. However, frequent tillage leads to soil degradation and environmental pollution, and it requires fossil fuel energy. Our research team has been exploring ways of reducing tillage in organic fields. The research project examines the possibilities of implementing no-tillage practices in organic production systems in the Prairies. The use of a roller-crimper has been tested at the Organic Crops Field Laboratory, in Carman, MB, since 2007. In 2008, we initiated a long-term tillage versus no-till experiment under organic conditions at Carman, MB. The crop rotation consists of green manure (barley, hairy vetch) - flax - oat. The green manure crop is rolled in order to produce a thick mulch to suppress weeds. The green manure was rolled in late-summer 2008, and flax was directly seeded into the green manure residues in spring 2009. In 2009, flax yields in the tilled systems (2264 kg ha^{-1}) were significantly higher than in the no-till treatment (1983 kg ha^{-1}), at $P = 0.0403$. Future research will examine effects of tillage systems on soil biota, mycorrhizal colonization, soil aggregate stability and crop residue decomposition. Future studies will also consider novel weed control strategies including animal grazing.

KEYWORDS: no-till, organic agriculture, weed control, roller-crimper

CHEMICAL CHARACTERISTICS OF NUTRIENTS IN THROUGHFALL AND STEMFLOW OF BIGLEAF MAPLE AND DOUGLAS-FIR IN A TEMPERATE CONIFEROUS FOREST

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Forest tree species may influence forest floor and mineral soil properties differently due to differences in the elemental characteristics of their litterfall, barkfall, throughfall and stemflow. This study concerned the influence of bigleaf maple (*Acer Macrophyllum* Pursh) and Douglas-fir (*Pseudotsuga menziessi* (Mirb.) Franco) throughfall and stemflow in a mixed conifer forest. Eight bigleaf maple plots were paired with eight Douglas-fir plots and throughfall and stemflow samples were collected over a period of seven months. Compared to conifer, the throughfall samples of bigleaf maple showed significantly lower Al3+ concentration and significantly higher Total Dissolved P and K+ concentrations. As for stemflow samples, bigleaf maple showed significantly lower Al3+ and Fe2+ and higher K+ concentration. The obtained results enhances our understanding of the factors behind the differences in forest floor properties under distinct species, especially, the higher acidity reported under conifers and the higher K+ concentration associated with deciduous species.

KEYWORDS: bigleaf maple, douglas-fir, throughfall, stemflow, forest soil

MAINSTREAMING ORGANIC RESEARCH: CANADA'S NEW ORGANIC SCIENCE CLUSTER

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Organic research in Canada over the past few decades has been led by a relatively small group of researchers who's dedication to finding ecological approaches to crop production has helped to build the credibility for the science and practice of organic agriculture. The fruit of these efforts has now been recognized with the development of Canada's new Organic Science Cluster (OSC). Research priorities for this cluster were developed from consultation with farmers across Canada in all areas of organic production. The OSC has identified 10 sub-projects including 30 research activities that will be conducted by over 50 researchers plus 30 collaborators in approximately 45 research institutions. The OSC is part of the Canadian Agri-Science Clusters Initiative of Agriculture and Agri-Food Canada's Growing Forward Policy Framework, with additional support from industry partners across Canada. Activities of the OSC will include work in fruit horticulture, agronomy, cereal crop breeding, soil fertility management, vegetable production, greenhouse production, dairy production systems, parasite control in ruminants, environmental sustainability, and food processing. This research comes at a time when there is renewed emphasis on innovation, efficiency (energy, labour, economics), and capturing value-added markets. Most of this research directed toward organic agriculture can also be applied to conventional production systems, drawing interest to this cluster from producers across Canada. Here an overview of the OSC will be provided, with examples of linkages between organic and conventional.

KEYWORDS: organic science cluster, agronomy, soil science, horticulture, livestock, greenhouse

SCREENING WILLOW CLONES FOR SALT TOLERANCE

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Dryland salinity is a significant agronomic problem across the Canadian prairies, with an estimated four million hectares of salt-affected land. The potential exists to make better use of saline marginal lands by developing them into willow plantations as a bionergy feedstock; however, relatively little is known about the salt tolerance of willow. Apart from limited anecdotal information, no empirical work has been done to examine willow growth on saline soil. The objective of this study was to compare the relative salt tolerance of 37 different native and exotic hybrid willow clones grown under controlled environment conditions on soils with varying salinity. The soils were collected along a hillslope catena influenced by saline seep salinity, containing high concentrations of sulfate salts, which commonly occurs within western Canada. Most willow clones tested in this study were able to tolerate slightly saline conditions (≤ 5.0 dS/m). In addition, several clones (Alpha, India, Owasco, Tully Champion, and 01X-268-015) showed no reduction in growth with moderate salinity (≤ 8.0 dS/m). This work should help to fill the current knowledge gap regarding the salt tolerance of willow and thus provide recommendations for which clones are best suited for establishment on salt-affected soils in Saskatchewan and abroad.

KEYWORDS: biomass energy, *Salix* spp., salt tolerance, shrub willow, sulfate salts

RESPONSE OF WILLOW GROWTH TO IRRIGATION AND FERTILIZATION IN SASKATCHEWAN

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Purpose-grown shrub willow (*Salix* spp.) represents a viable bioenergy feedstock, especially if these plantations can be successfully grown on unproductive land that is marginal for annual crop production. The objective of this study is to determine the effect of irrigation and fertilization on willow biomass feedstock quantity, in order to meet specific bioenergy conversion industry productivity requirements. A split-split-plot experimental design is being used and consists of two clones (SV1 and Charlie), three irrigation treatments (no irrigation, 75%, and 100% field capacity), and three fertilization treatments (no fertilizer, 1x, and 2x recommended fertilizer rate). For both willow clones, after two years there was a highly significant (P values < 0.0001) growth response to irrigation, with no significant (P values > 0.05) effects of fertilization or irrigation x fertilization except for the 2x recommended fertilizer rate at 100% field capacity with the clone SV1. The positive willow growth response to irrigation is indicative of the importance of soil moisture within the semi-arid climate of Saskatchewan. The lack of fertilizer effect, reflects the relatively fertile soil at the site and the low fertilizer use efficiency of broadcasted fertilizer within these agroforestry systems. This work builds on the agronomy of growing willow plantations in Saskatchewan and, therefore, should help support effective management decisions regarding their successful establishment and growth.

KEYWORDS: biomass energy, fertilization, irrigation, *Salix* spp., willow productivity

EDDY COVARIANCE MEASUREMENTS OF SPRING MELT METHANE EMISSIONS FOR A SUBARCTIC FEN AT CHURCHILL, MB

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An ecosystem-scale methane (CH_4) flux measurement system was used at a eutrophic subarctic fen located at Churchill, Manitoba (58°45'N 94°4'W) during the spring of 2009. Reliable determinations of net carbon and greenhouse gas emissions for northern ecosystems are of great value to determine the impact of climate change on future emissions. It is known that gas released from submerged peat is trapped in ice during fall freeze-up. However, the consequence of this trapping to CH_4 flux during spring snow melt is unknown; do CH_4 emission bursts occur? Our previous studies at the site showed that conventional chamber-based methods were problematic to use during snow melt, and measurements of CH_4 emission were highly variable. Thus, an eddy covariance flux station was developed and used from late May to mid-July of 2009, to determine ecosystem-scale CH_4 and carbon dioxide (CO_2) emissions for the fen from the pre-melt snow period to the post-melt "green-up" period. The measurement system consisted of a closed-path RMT-200 Fast Methane Analyzer (Los Gatos Research Inc.) along with a LI-7500 open-path CO_2 /H_2O gas analyzer (LI-COR Biosci.) and a CSAT3 3-dimensional sonic anemometer (Campbell Sci.). The system was operated using wind, solar, and gas power generation. Methane emissions were negligible, -6 to 8 nmol m^{-2} s^{-1}, during the pre-melt period (May 30-June 10), increased during melt (June 11-22) being -7 to 26 nmol m^{-2} s^{-1}, and highest, 7 to 95 nmol m^{-2} s^{-1}, during the post-melt period (June 23-July 9). There was a net emission of CO_2 over the study period because of a lack of photosynthesis that ranged from -1 to 4 µmol m^{-2} s^{-1}. A melt-period CH_4 emission burst was not observed; rather a gradual increase in emission over the spring period was driven by increasing soil temperature at the 5 cm depth ($r^2 = 0.87$).

KEYWORDS: methane carbon dioxide spring emissions subarctic fen eddy covariance

RATE OF AVAILABLE PHOSPHORUS RELEASE FROM PREVIOUSLY MANURED LOAMY SAND SOIL

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Livestock manure application increases phosphorus levels and availability in soil with environmental implications. This study investigated the rate of available P (AP) released from a loamy sand soil that previously received six-repeated cattle manure applications at rates 30, 60, 120 and 180 Mg ha^{-1} (wet weight). Barley (Hordeum vulgare) forage (soft dough) was grown and harvested six times over 297d in a growth chamber (20ºC). The manure was either from feedlot cattle fed a diet containing dried distillers grains with solubles (DDGS30, DDGS60, DDGS120 and DDGS180) or from cattle fed typical barley grain diet (REG30, REG60, REG120 and REG180). There was also a commercial fertilizer treatment (Fert) that received 100 kg N ha^{-1} and 50 kg P_2O_5 ha^{-1} and an un-amended control (CK). After six-cycles of amendment applications and barley crop production, soils were incubated at 90% field capacity in a growth chamber (20ºC) over six-month and soil AP was determined (Olsen-P). Initially, soil AP (mg kg^{-1}) was 0.6 (CK), 6 (Fert), 25 (REG30), 53 (REG60), 98 (REG120), 108 (REG180), 42 (DDGS30), 68 (DDGS60), 122 (DDGS120), 177 (DDGS180). After six-month incubation, soil AP content increased and ranged from 24 (CK) to 589 (DDGS180) mg kg^{-1} . The amount of AP released over six-month represented 2% of fertilizer P applied and 20 to 30% of either REG or DDGS manure P previously applied. Results suggest that once applied to soil, there are no differences in manure P behaviour regardless of animal P dietary source. The high level of soil AP released in previously manured soil reflects continued mineralization of organic-P and the low P fixation ability of loamy sand soil. While greater AP released from the residual manure in soil is beneficial to crop production, it also poses a greater risk of environmental pollution.

KEYWORDS: DDGS, cattle manure, available phosphorus

INFLUENCE OF LIQUID WATER ON GAS DIFFUSION COEFFICIENT AND NUTRIENT FLUX IN PHC CONTAMINATED SOIL UNDER FROZEN CONDITIONS

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The amount of liquid water in frozen soil is not only important for microbial activity but may also influence soil physical properties such as gas diffusion and nutrient flux. These physical parameters determine the oxygen content and nutrient availability, respectively, which in turn also affect microbial activity. In petroleum hydrocarbon (PHC) contaminated soil, microbial activity is essential for bioremediation and thus understanding how other factors of the soil are altered from PHC will aid in the management of contaminated sites in Polar Regions. In this study we examine the influence of liquid water on gas diffusion coefficient and nutrient flux on PHC contaminated soil collected from Casey Station, East Antarctica ranging from 0 – 8000 ppm. The liquid water content was altered by packing soil cores at three different bulk densities (1.4, 1.7, and 2.0 g/cm^3). The gas diffusion coefficient and nutrient flux (NH_4^+ and NO_3^-) were measured at room temperature and -5°C. Preliminary results indicate that the gas diffusion coefficient is reduced under frozen conditions and the nutrient flux, particularly for NO_3^-, is reduced by both temperature and increases in PHC contamination.

KEYWORDS: soil contamination, diesel, Antarctica

FERTILIZER-INDUCED CHANGES IN SOIL NUTRIENT CYCLING IN IMMATURE PINE AND SPRUCE FORESTS IN BRITISH COLUMBIA

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Extensive research throughout the interior of British Columbia has confirmed widespread nutrient deficiencies and favourable growth responses to a range of fertilizer treatments in interior spruce (*Picea glauca* [Moench] Voss and *Picea engelmannii*Parry) and lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm) forests. Both species appear to respond reasonably well to repeated fertilization in the short-term; however, it is unclear how large nutrient additions will affect aspects of soil chemistry or the impact these changes will have on long-term site productivity. Our study makes use of a 15-year fertilizer study in immature pine and spruce forests in the central interior of British Columbia subject to two levels (annual and periodic) of nitrogen (N)-based fertilization. Cumulative N inputs were 600 kg N/ha in the periodic treatments and 800-1125 kg N/ha in the annual treatments. Nutrients other than N were also added in both treatments to prevent secondary deficiencies. The central goal of our project is to assess fertilizer-induced changes in soluble, extractable and total soil nutrient pools to determine the extent to which repeated fertilization has modified soil nutrient availability and cycling patterns in these forests. Soil and foliar nutrient regimes were quantified throughout the 2008 and 2009 growing seasons using PRS-probes and traditional soil and foliar analyses. Seasonal, inter-annual and inter-site trends in soil and foliar nutrient dynamics will be discussed and related to previous and ongoing research at these sites.

KEYWORDS: soil nutrient cycling, forest fertilization, foliar nutrition, PRS-probes

DEVELOPMENT OF MORPHOMETRIC INDICATORS OF SOIL QUALITY BASED ON 3D X-RAY CT IMAGERY

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Over the past quarter century, X-ray computed tomography (CT) imaging has been gaining widespread popularity among soil scientists studying various aspects of soils and their behaviour. In contrast to 2D digital imaging techniques based on soil thin sections, X-ray CT scanning can yield 3D models of the spatial configuration of solid components and associated voids. Ongoing advances in scanner technologies, and computerized data processing capacity, current allow imaging of intact soil samples, several centimetres in dimension, discretized to between 3 and 4 orders of magnitude, yielding voxels sizes of several micrometres. With the adoption of standardized approaches to the classification and quantification of soil components, it becomes possible to undertake a systematic evaluation of soils, and the impact of management regimes or rehabilitation strategies. Our current research is focussed on the identification of morphometric characteristics of the pore network, in surface and diagnostic horizons of major soil types, as well as the impact of common tillage and rotation practices. The goal is to contribute to the established of a soil quality indicator based on the nature and configuration of pedofeatures in intact soil. Where possible, this research is being conducted at well characterized benchmark sites or within the context of current multi-disciplinary studies.

KEYWORDS: x-ray computed tomography, soil quality, soil micromorphology, soil porosity, soil management, soil rehabilitation, benchmark soils

INFLUENCE OF EXTRACTION METHOD ON DNA AND RNA RECOVERY FROM SOILS OF VARYING TEXTURES AND ORGANIC MATTER CONTENTS

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Nucleic acid extraction bias is a commonly acknowledged but poorly understood factor influencing the use of molecular methods for studying soil microbial communities. Extraction bias is known to affect both the yield and quality of DNA, and in some cases bacterial 16S rDNA community fingerprints. However, less information is available regarding the bias of RNA extraction methods among different soils. Gene transcript analysis is becoming a more prominent means for determining potential microbial activity and functioning in soil. It is important to understand how different RNA extraction methods perform across a variety of soil types in order to minimize bias when comparing different soils. Our objective was to investigate the effect of two different extraction methods on DNA and RNA yield and downstream analyses for agricultural soils from 10 locations across Canada. The soils studied have a variety of textures and organic matter contents, two factors known to affect the extraction of DNA. DNA and RNA yield as well as gene copy and transcript numbers of bacterial 16S and fungal 18S genes and DGGE community fingerprints will be presented.

KEYWORDS: RNA, extraction efficiency, method, bias

HYDROPEDOLOG: AN EMERGING SCIENCE AND PARADIGM SHIFT FOR SOIL SCIENCE ALIAS: THE PIEZOMETRIC SURFACE AS A SOIL FORMING FACTOR

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Since Dukochaev described the soil forming factors, the soil profile has been the control section i.e. from the soil surface down to the more or less unweathered parent material.
Hydropedology defines a control section from the top of the biota to the bottom of the aquifer. This paper will use examples from the Canadian Prairies to illustrate how the expanded concept can refine our understanding of how soils develop and how they can be managed.
Soil salinity has long been recognized as a groundwater discharge phenomenon and specific examples of discharge from both glacial and bedrock aquifers will be presented. The sodium in Solonetzic soils developed on lacustrine deposits can be traced to sodium in bedrock aquifers with piezometric surface at or above the soil surface.
The genesis of Grey Luvisol soils is usually related to the cool, moist climate and presence of forest vegetation. It can be demonstrated that internal drainage, as affected by the low piezometric surface of aquifers, is a major factor in formation of highly eluviated soils. Examples will include well known sites such as the Loon Lake, Saskatchewan Substation of AAFC and the Breton Plots of Alberta.
The paper will also provide an example of how hydropedology can serve urban development planning. The new Rosewood subdivision in southeast Saskatoon utilized hydrogeology and hydropedology to insure dry basements for future home owners.
The paradigm shift required is to change the control section from the soil profile to the entire length from the top of the biota to the bottom of the aquifer. Soil scientists must dig a little deeper and think outside the box (soil profile).

KEYWORDS: soil genesis, soil salinity, luvisol, hydropedology, piezometric surface

THE EFFECT OF DIET ON METHANE EMISSIONS FROM LIQUID MANURE STORAGE

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In Canada, around 14% of livestock operations use liquid manure storage systems with various pits and lagoons serving as storage facilities. Methane (CH_4) is the main greenhouse gas (GHG) emitted from liquid manure storage systems. Appropriate manure management and treatment practices have been encouraged to achieve the goal of reducing the net GHG emission from storages. This study focused on the effect of swine diet manipulation on GHG emission from liquid manure storage. Ten 25 L anaerobic digesters were monitored for this study. The digestors were continuously monitored for CH_4 and carbon dioxide (CO_2) emissions as well as their contents routinely monitored for temperature, pH, electrical conductivity, volatile fatty acids and ammonia. Fifteen pigs were randomly grouped into three pens and the pigs in each pen fed with a diet of different fibre contents (12%, 16%, and 20%). One litre of liquid manure from each pen was added to digestors each week with 3 replicate digestors per diet treatment. Over 20 weeks, CH_4 emissions for the treatments were 154,146, and 178 L digester-1 containing low, medium, and high fibre diets, respectively. Manure from the high fibre diet had significantly higher fibre content than manures from low, and medium fibre diets. Consequently, under liquid manure storage conditions, manure from high fibre diet produced significant higher amount of CH_4 than manures from the low and medium fibre diets. On average, manures from low, medium, and high fibre diet has a CH_4 emission rate of 95, 90, and 113 ml L-1(Digesta) d-1 respectively. This study demonstrated three factors determining CH_4 emission rates, temperature, feeding schedule, and digesta age, these will be presented.

KEYWORDS: Swine, Manure, Methane, Manure storage

PLANT-ASSOCIATED FUNGI ENHANCE WHEAT ABIOTIC STRESS TOLERANCE UNDER CONTROLLED CONDITIONS

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Plant-associated fungi, or fungal endophytes, are distinct from mycorrhizae in that they can colonize not only roots, but also other plant organs and can form colonization structures different from those produced by mycorrhizae. Fungal endophytes can benefit plant hosts in a variety of ways, including "mycovitality", "mycoheterotrophy" and enhanced tolerance to environmental stresses. This study aims to determine if selected fungal endophytes from the Saskatchewan Microbial Collection Database (SMCD) can enhance drought or heat tolerance in wheat in co-culture, and to investigate the ability of the same fungal endophytes to tolerate drought or heat as free-living organisms in vitro</i>. Fungi were grown on agar medium supplemented with 8% polyethylene glycol (PEG) to simulate drought stress. Heat stress was induced in an incubator held at 36 ºC. Wheat stress tolerance was measured in terms of percent seed germination at 3 days and seedling fresh weight at 7 days. The stress tolerance of free-living fungal organisms was measured in terms of survival and colony growth rate. Three of the 6 fungal endophytes studied showed potential to improve wheat tolerance for heat and drought in vitro .

KEYWORDS: Fungal endophytes, abiotic stress, wheat

BLACKPOINT INCIDENCE IN CANADIAN AND NEW ZEALAND HARD WHITE WHEAT

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Blackpoint describes the black or dark brown discoloration of the embryo end of wheat seeds. In severe cases, when more than half the seed is discoloured, it is referred to as 'smudge'. Blackpoint has been attributed to certain fungi species such as Alternaria sp. and blackpoint incidence has been associated with moist conditions after flowering and at harvest. Fungicide has not been found to be effective to control blackpoint so resistant cultivars are required. When wheat with high levels of blackpoint is milled, undesirable black specks can appear in the flour or semolina adversely affecting the appearance of flour and end products; thus, in western Canada more than 10 percent blackpoint results in downgrading. A group of 20 hard white wheat lines were evaluated in Lincoln, New Zealand and Glenlea, Manitoba in 2008 for blackpoint reaction and flour colour attributes. The lines varied significantly for several agronomic characteristics (grain yield, plant height, maturity, test weight, 1000 kernel weight). Blackpoint incidence was generally low, ranging from 0.9 to 16.2 percent at Glenlea and 0.8 to 20.4% at Lincoln. Nevertheless, significant differences were observed among entries. In Manitoba, Canadian hard white wheat lines had generally higher levels of blackpoint than the New Zealand entries; whereas, in Lincoln, New Zealand entries had higher average blackpoint scores. Blackpoint scores were not highly correlated with flour brightness (L*) in Glenlea or Lincoln, probably due to low disease incidence.

KEYWORDS: blackpoint, hard white wheat, disease reaction, flour quality

SOIL WATER REPELLENCY AND CRITICAL WATER CONTENT OF SOIL AND ORGANIC MATERIALS IN OIL SANDS RECLAMATION

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Soil water repellency may cause erosion and reduced infiltration and storage. Excessive drying often exacerbates soil hydrophobicity. Soil water repellency is dependant on soil water content. As such, soil water repellency is diminished with increased water content. The water content at which soil is no longer water repellent is called the critical water content (CWC). There is little information available on the CWC of reclamation materials used in the Athabasca Oil Sands Region. This information is needed to make informed decisions about transport, storage, and placement of these materials. The objectives of this study were to evaluate the 1) CWC of LFH, fibric, mesic and humic peat; 2) CWC of sandy mineral soil and tailings sand and 3) affect of disturbance on CWC of these materials. In 2008 and 2009 samples were collected from the Athabasca Oil Sands Region. Surface mineral soil samples included two undisturbed sites, one tailings sand, one course sand with tar balls and one course sand without tarballs. Fibric, mesic and humic peat was collected from a 120 cm pit. LFH was collected from five undisturbed A ecosites. Samples were collected in replicates of five. The CWC was assessed by measuring the contact angle and water droplet penetration time (WDPT) at a range of moisture contents. The CWC and intra sample variability is highest in organic materials. This information will be valuable to the oil sands industry for making decisions about handling, storage and placement of reclamation materials.

KEYWORDS: soil water repellency, soil hydrophobicity, oil sands, reclamation

DOES FOREST HARVESTING AFFECT SOIL MICROBIAL DIVERSITY AND NITROGEN FLUXES IN FIELD SITES ON THE BOREAL PLAIN OF ALBERTA?

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Timber harvesting causes changes to the entire forest ecosystem, especially soil quality and health. The Forest and Watershed Riparian Disturbance (FORWARD) project is investigating the impact of tree harvesting and fire disturbance on boreal forest watersheds. The objective of this component of FORWARD was to monitor differences in soil microbial diversity, biomass and bioavailable nitrogen (N) fluxes in harvested soils over a chronosequence of 18 years. Soil forest litter (LFH) and mineral (Ae) horizons were sampled in summer 2009 from harvested cutblocks at various stages of regrowth (1, 2, 3, 4, 5 and 18 yrs post-harvest) on the Boreal Plain of Alberta, Canada. We analyzed the diversity and biomass of the soil microbial community using phospholipid fatty acid profiles. Bioavailable N flux was measured using Plant Root Simulator ™ probes. Preliminary results show that soil microbial diversity differed ($p<0.01$) between cutblocks at various stages of regrowth and between LFH and Ae horizons. In addition, total microbial biomass was at least 3 times greater in the LFH than Ae horizon. Nitrate (NO_3^-) and ammonium (NH_4^+) fluxes show no clear trend throughout the chronosequence, though the 18 yr old cutblock exhibited lower NO_3^- and NH_4^+ fluxes than other cutblocks. Nitrogen fluxes were generally higher in the Ae than LFH horizon. This study suggests that soil microbial community structure shifts in response to harvesting disturbance, but there is no clear trend regarding N fluxes. The impact of microbial shifts on nutrient turnover in soils and water quality in streams draining these boreal forest watersheds requires further assessment.

KEYWORDS: forest soil, disturbance, microbial diversity, nitrogen flux

DETERMINATION OF PHOSPHORUS REQUIREMENT OF GROWING PIGS FOR ENVIRONMENTAL MANAGEMENT OF MANURE PHOSPHORUS

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Over-supplementation of pig feed with phosphorus (P) to ensure adequate supply to the animals, results in excessive excretion of P in feces and urine which is of environmental concern when manure is land-applied. The objective of this study was to determine the optimum P requirement of growing pigs to facilitate accurate feed formulation to better balance supply and requirements and therefore minimize P excretion. Forty-eight pigs (BW ≈ 25 ± 2 kg) were housed in pairs in 24 pens and each pen was randomly assigned to 1 of 6 diets to give 4 replicates per treatment. The diets were formulated to supply P at 80, 90, 95, 100, 105 and 110% of NRC requirement for growing pigs. Feed-intake and weight gain were monitored weekly as a measure of performance. Upon reaching the target body weight of 50 kg, one pig from each pen was transferred into a metabolism crate for quantitative fecal and urine collection. Samples of feces, urine and feed were analyzed for P content. Daily weight gain increased quadratically with increasing dietary P but most of the increases were not statistically significant. A 20% decrease in NRC recommended P requirement resulted in significantly smaller daily weight gain of the pigs compared to the NRC-recommended diet. Urine and fecal P concentrations increased quadratically with increasing dietary P content with a surge in P excretion occurring at around the 90% NRC recommended P level for growing P. A 10% reduction in NRC recommended P resulted in 51% reduction in urine P and only 2% reduction in fecal P. Because there was no statistical difference in the performance of pigs fed the NRC and 90% NRC recommended P diet, a 10% reduction in dietary P could reduce the load of P to soil from land application of manure.

KEYWORDS: manure, phosphorus requirement, phosphorus

TRANSGENIC CROPS AND THEIR IMPACT ON NUTRIENT AVAILABILITY, METAL STATUS AND ISOTOPE SIGNATURE IN SOILS

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Transgenic crops are increasingly grown in many places for higher yields and other benefits. Although soil microbiological effects have been reported, the impacts of transgenic crops on soil nutrient uptake and metal status has not been well documented. This study investigated nutrient and metal status as well as C and N isotope signature in soils following growth of transgenic crops. The field experiment started in 1999 in Lethbridge, Alberta, with four types of corn (Roundup Ready (RR), LibertyLink (LL), Bt, and conventional) and three types of canola (RR, LL and conventional). Corn was grown either in continuous monoculture or in rotation with canola. All treatments were replicated four times. Soil samples were taken from the surface (0-15 cm) and subsurface (15-30 cm) at the completion of two four-year rotation cycles in 2007. Soil samples were analyzed for total P, total S, total metals (Zn, Cu, Mn, Fe, Ni, Cd, Pb, Co, Cr and Al), available nutrients (P, K, Ca, Mg, Zn, Cu, Mn, S and B), total N contents and organic C $\delta^{13}C$ levels. There were no significant differences in total P, total N and organic C content among treatments, but their values were higher in surface than subsurface soil. In contrast, the total S content was significantly higher in Continuous RR corn (no herbicide) than Continuous conventional corn (no herbicide) or Continuous conventional corn (insecticide applied). None of the soil total metal and available nutrient contents were affected by crop treatment. The $\delta^{13}C$ levels in both surface and subsurface soil were significantly lower in the Bt corn in rotation with RR canola than Continuous conventional corn (no insecticide), indicating possible biological differences in C accumulation in soil between transgenic and conventional corn production. Our study suggests that overall transgenic crop production had minimal effects on soil chemical properties.

KEYWORDS: transgenic corn, soil nutrients, metal, availability

CATION, ELECTRICAL CONDUCTIVITY, PH, AND TOTAL AND ORGANIC CARBON ANALYSIS OF SEVEN HORIZONS IN A DRY POND SOIL, KAMLOOPS, BRITISH COLUMBIA

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Kamloops is located in a semi-arid climate in the interior of British Columbia. This environment has been experiencing drought conditions over the last number of years. Water levels have been dropping in BC interior lakes and many ponds have completely dried out. This has provided a unique opportunity to study the physical and chemical properties of soils which otherwise would be under water. At its high water mark Batchelor Lake is covered by two metres of water. A soil pit was established in the fall of 2008 when the pond was dry. Electrical conductivity, pH, total carbon and organic carbon values were determined in 2009 for seven horizons. In 2010 the cation analysis was performed by extraction with ammonium acetate and flame atomic absorption spectrometry. In this procedure, careful attention was paid to preventing potential interferences with the cation analysis. The extractable and soluble cations analyzed were Mg+2, Na+, Ca+2, and K+. The total and organic carbon values increased with depth. Sodium and potassium values were higher in the top three horizons (A and B) and dropped in the bottom four C horizons. Calcium carbonate values were high throughout the profile. Magnesium was high in the top three horizons and dropped dramatically in the C horizons. Initial results indicate that Batchelor Lake has had dry periods in the past as indicated by plant material trapped in layers within and between some horizons along with snail shells concentrated along horizon boundaries. It also appears that there have been different sediment depositional events. The B horizons are composed of vertic clays while the C horizons are not. The method development along with the chemical and physical properties will be presented.

KEYWORDS: saline ponds, chemical, flame atomic absorption spectrometry, soil classification

DIAGNOSIS OF NUTRIENT IMBALANCES WITH VECTOR ANALYSIS IN AGROFORESTRY SYSTEMS

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Agricultural intensification has had unintended environmental consequences including increased leaching and surface runoff of nutrients and other nonpoint source pollutants. However, by linking crop performance to appropriate nutrient application as well as quantifying existing nutrient cycles will not only have the economic advantage of increasing yields and diversifying production but will also diminish financial and environmental costs. To achieve this, a management support system that allows for site-specific rapid evaluation of nutrient-production imbalances and subsequent management prescriptions is needed for agroecological designs. This type of approach is particularly important for agroforestry systems since understanding mechanisms of resource partitioning among the interacting components (trees and crops) is essential for persistent systems that are ecologically sound, economically viable and socially acceptable. We demonstrate the application of a vector technique for analysis of nutrient and non-nutrient interactions in agroforestry and extend the theory of vector analysis to develop a management support system for wider applications. We use two case studies to support this conceptual hypothesis; quantitative data from field experiments and farm trials were re-evaluated in order to investigate nutrient dilution effects in response to ameliorated light and soil moisture in agroforestry systems. Vector analysis utilizes a bivariate model to depict changes in yield and nutritional (nutrient concentrations and nutrients) response simultaneously in a single graph, facilitating identification of specific nutritional status such as growth dilution, deficiency, sufficiency, luxury uptake, toxicity and multi-nutrient imbalances. Such a diagnostic technique can advance management decision making in order to reduce current environmental issues associated with agrarian-derived soil contamination.

KEYWORDS: Agroecosystem sustainability, Ghana,Nutrient diagnosis, Tanzania,Tree-crop interactions.

DIAGNOSTIC SURFACE HORIZONS USED IN THE BRAZILIAN SYSTEM OF SOIL CLASSIFICATION

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Both the WRB and the Brazilian System of Soil Classification (BSSC) use concepts of diagnostic surface horizons as key characteristics for soil classification. So far it was recognized, in Brazil, seven types of surface diagnostic horizons. They are: humic A, chernozemic A, prominent A, anthropic A, moderate A, weak A, and Histic H. The latter is an organic horizon and may also occur as a subsurface horizon. Such diagnostic surface horizons are used as criteria for discriminating classes of soils in various categorical levels of the BSSC mainly as order, suborder, great group and subgroup. At the highest category level (order), we use the chernozemic A horizon as key criterion to distinguish the order of Chernossolos. At lower levels, for example, in suborder (second level), the humic A, chernozemic A, and prominent A horizons are used as the main criterion to separate the class of Gleissolos Melânicos. At great group level (third level) the humic A, prominent A, and Histic H horizons are used to distinguish classes in the order of Neossolos, for examples: Neossolos Litólicos Húmicos (with humic A), Neossolos Litólicos Eutro-úmbricos (with prominent A) and Neossolos Litólicos Hísticos (with Histic H). In the fourth category level (subgroup), that corresponds to the last organized level of the BSCS (Second Edition), the humic A, anthropic A, chenozemic A, prominent A, and Histic H surface horizons have been used to separate various classes of soils. In the order of the Latossolos, for example, are distinguished classes such as Latossolos Amarelos Distróficos húmicos (with humic A), Latossolos Amarelos Distróficos antrópicos (with anthropic A), Latossolos Vermelhos Eutroférricos chernossólicos (with chernozemic A), and Latossolos Amarelos Distróficos úmbricos (with prominent A). The moderate and weak A surface horizons are the ones that have not been used within the first four levels of the BSSC.

KEYWORDS: Brazilian System of Soil Classification, Surface Horizons, Diagnostic Surface Horizons.

AVAILABILITY AND FRACTIONATION OF TRACE ELEMENTS IN ARID CALCAREOUS SOILS

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Thirty seven calcareous soil samples depth (0-20 cm) were collected from 7 major agricultural regions in Saudi Arabia. They were analyzed for DTPA extractable micronutrients. DTPA - extractable Fe ranged from 1.1 to 11.5 µg g-1, Zn from 0.2 to 3.7 µg g-1, Mn from 0.48 to 13.0 µg g-1, and Cu from 0.2 to 3.7 µg g -1 . Based on published critical levels of this method, none of the 37 sampled soils was deficient in Cu. Four soil samples were low in Mn, 28 samples were low in Zn, and 31 samples were low in Fe. Fractionation of micronutrients in 7 soil samples, one sample per major region, was carried out according to Tessier et al., (1979); 5 fractions for each element were estimated. Exchangeable, CO3-bound, Fe-Mn oxide-bound, organic bound, and residual. The exchangeable fractions of the elements was by far the least among all fractions, with Zn and Cu below the detection limits of the AA. The carbonate bound fractions resulted in Mn > Fe > Cu > Zn. The Fe-Mn oxide bound fraction was higher than the previous two fractions, since micronutrients are preferentially adsorbed on Fe oxide surfaces in soils. The order of the metals was Fe > Mn > Zn > Cu. For the organic bound fractions, the order of the metals was Fe > Mn > Zn > Cu. The residual fraction of micronutrients was by far the largest among all fractions. The order of occurrence of residual micronutrients was Fe > Mn > Zn> Cu. Non-available constituted 90-98% of total Fe and Zn, 53-78% of total Mn and 72-91% of total Cu. Across all trace elements, the order of the 5 fractions was: Residual > Fe - Mn oxide bound > CO3 bound ≥ organic bound> exchangeable.

KEYWORDS: Micronutrients, Fractions, calcareous, Exchangeable, Carbonate bound, Iron-Manganese oxide bound, Organic bound, Residual

APPLICATION OF A C18 MEMBRANE AS A LIPID SINK FOR EVALUATING BIOACCESSIBILITY OF PAHS IN SOIL

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Polycyclic Aromatic Hydrocarbons (PAHs) are a class of lipophilic organic contaminants commonly found in soil. Eight of these PAH compounds have been identified as known carcinogens. PAH exposure from soil primarily occurs through the incidental ingestion of soil that adheres to an individual's hands and is subsequently ingested. Human Health Risk Assessment (HHRA) is in part based on the bioaccessibility of contaminants from soil, where bioaccessibility is the fraction of contaminant that is released from soil into the gastric fluid and is accessible to the organism. In-vitro digestion models, such as the Simulator of the Human Intestinal Microbial Ecosystem (SHIME) and Relative Bioaccessibility Leaching Procedure (RBALP), can be used to evaluate the bioaccessibility of ingested environmental contaminants. Due to their lipophilic nature, PAHs are likely to partition to lipophilic phases, however current in-vitro digestion models to not include a lipophilic phase which may lead to an under-estimation of the bioaccessibility. Here we add a C18 (carbon octadecyl) membrane as a lipid sink to two in-vitro digestion models, the SHIME and RBALP, and evaluate the PAH bioaccessibility with and without a lipid sink. Using eight PAH contaminated soils from various sources; median bioaccessibility with a lipid sink was significantly higher than median bioaccessibility without a lipid sink. PAH release from soil was found to be dependent upon the total soil loading and soil type.

KEYWORDS: polycyclic aromatic hydrocarbons (PAHs), bioaccessibility,

USING BIOMASS WISELY: REFLECTING ON THE LONG-TERM PROSPECTS

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Humanity has always had a bioeconomy, using energy invested in biomass by photosynthesis to fuel itself, its animals, and its machines. In recent decades, however, we have depended more and more on ancient reserves of such energy – fossil carbon accumulated from photosynthesis long ago. The renewed interest in using more recently-fixed carbon again offers many potential advantages, including possible mitigation of atmospheric CO_2 increases. But the merits of using biomass this way will be decided, eventually, over the long term, measured on scales of decades rather than years. My objective is to pose some questions we might want to ask, reflecting on the longer term. For example: Given that recently-fixed carbon is finite, how do we best allocate it among various short- and long-term uses, including food, fuel, and building soil carbon? What measures might we use to determine if our proposed new ecosystems can persist and flourish over the long term? How might such systems alter the landscape of coming generations, thereby affecting other ecosystem services? The questions presented are neither definitive nor exhaustive, and are posed mainly to elicit further thoughts about the long term functioning of our ecosystems.

MONITORING SOIL NUTRIENT AND WATER QUALITY ON SOILS IRRIGATED WITH LIQUID SWINE EFFLUENT

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Elite Stock Farm is an intensively managed swine barn located near Outlook, SK that has been injecting the liquid fraction of swine manure and river water into irrigation pivots for application to agricultural land since 1994. Monitoring of soil nutrient concentration and water quality has been ongoing since 1994. The monitoring data has been summarized three times, most recently in 2008. This poster will provide a summary of findings since 1994.

KEYWORDS: swine, effluent, soil nutrients, groundwater, SAR

ADAPTING MECHANICAL WEED CONTROL TO CONVENTIONAL CROPPING SYSTEMS: WHAT ARE THE POSSIBILITIES?

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Studies on mechanical weed control for managing weeds in organic cropping systems have been conducted at the Scott Research Farm since 1995. Mechanical weed control can be effective if timed properly. Mechanical weed control is generally not compatible with no-till systems which have been widely adapted by Canadian Prairie producers. Few mechanical weed control tools can satisfy no-till requirements such as high work rates, good weed control and conservation of surface crop residues. One tool that satisfies most of these requirements is a min-till rotary hoe. In studies conducted at Scott, SK., pre-seed or pre-emergence rotary hoeing in standing cereal stubble did not cause a significant reduction in surface crop residues even after six consecutive passes were conducted. Spring wheat (*Triticum aestivum* L.), field pea (*Pisum sativum* L.), and lentil (*Lens culinaris* L.) have exhibited good tolerance to both pre- and post-emergence rotary hoeing. Rotary hoeing reduced the density and biomass of shallow rooted, small-seeded weeds such as wild mustard (*Sinapis arvensis* L.). Rotary hoeing may be an option for controlling herbicide resistant broadleaf weeds in crops with few herbicide options. A min-till rotary hoe may also incorporate soil applied herbicides without burying much surface residue. This may resurrect some older chemistries such as dinitroanilines and provide an alternative mode of action for managing weed resistance.

Keywords: Mechanical Weed Control, rotary hoeing, tillage, weed, weed control

COMPARISON OF PERFORMANCE OF FOUR, PRESSURIZED, ONSITE, SOIL-BASED DISPERSAL SYSTEMS AT AN AT-GRADE INSTALLATION IN LEDUC COUNTY, ALBERTA

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A pressurized, at-grade, private sewage treatment system was established in Leduc County, Alberta in the Fall 2007 to test treatment effectiveness of four designs for dispersing treated sewage effluent in soil. A 4-zone valve was used to cyclically distribute equal volumes of treated sewage effluent, and for a daily effluent flow per lateral at design peak flow of 510 L, the calculated daily effluent flow at peak design flow per orifice was: Lateral C (46 L) > Lateral D (32 L) > Lateral A (23 L) > Lateral B (16 L). The soil was sampled in the summer 2008 at the orifice (OL) and mid-point (ML) positions along the laterals and at 90 cm perpendicular to the laterals at OP3 and MP3 positions. Wastewater moved under transient saturated conditions in Laterals C and D but under transient unsaturated conditions under Laterals A and B. Although the soil temperatures of the bare control soil at the 5, 20 and 50 cm were below 0 °C for most of the winter months especially in the 2008-2009, the soil temperatures at the orifice and mid-point positions of Laterals C and D at these depths were above 1 °C. However, saturated flow caused vertical as well as lateral movement of fecal coliforms (FC) and somatic coliphages (SC) which were detected in the OL, ML, OP3 and MP3 positions. FC and SC were attenuated soil under Laterals A and B and soil temperatures at the orifice and mid-point positions at the 5, 20 and 50 cm were above 0.2 °C over the winter months. Lateral B system had the best performance among the four lateral systems tested. Therefore, the best way to refine at-grade designs in Alberta is to reduce the daily effluent flow flow per orifice.

KEYWORDS: soil-based sewage treatment, loading rates, orifice spacing, fecal coliforms. somatic coliphages, ammonium, nitrate, Kelowna P, soil temperature

PHOSPHORUS SOURCE AND BAND APPLICATION EFFECTS ON SPATIAL DISTRIBUTION AND CHEMICAL SPECIATION OF SOIL

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Knowledge of phosphorus (P) dynamics in soil is essential for predicting its bioavailability and for assessing the risk of P transfer from soil to water bodies. This study is conducted to assess the behaviour of P in the vicinity of the point application of different manures and inorganic fertilizer P in a band, as assessed by macroscopic-scale studies and synchrotron radiation techniques. The goal of this project is to investigate the nature of P release and chemical speciation of P in the vicinity of the point application of different manures and inorganic fertilizer P in a band. To assess the behaviour of P, soil samples were collected from long-term solid cattle, liquid hog manure, and inorganic fertilizer applied plots in two different research sites and analyzed using sulfuric acid-hydrogen peroxide digestion method, resin membrane technique, and X-ray Absorption Near Edge Spectroscopy technique. It was observed that that spatial distribution and chemical speciation of soil P in inorganic fertilizer, and different manured soils is quite different.

KEYWORDS: spatial distribution, speciation, p-xanes

ON THE TRANSPORT OF VIABLE BUT NON-CULTURABLE (VBNC) *E. COLI* O157:H7 IN SOIL AND GROUNDWATER

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Enterohemorrhagic Escherichia coli O157:H7 (EHEC) is a human pathogen capable of entering a viable but non-culturable (VBNC) state following exposure to sublethal stress. In the VBNC state, E.coli O157:H7 is not detectable by standard culture techniques, yet is able to retain its virulence and ability to cause illness in humans. To date there is no in-depth information regarding the transport of VBNC E.coli species in soil or groundwater. Due to the public health risk, it becomes important to examine whether discrepancies exist between the transport behaviours of culturable and VBNC E.coli O157:H7 to help decide if current protocols for detecting this pathogen are accurate. This study identifies and contrasts transport-related properties of the two cell stages including hydrophobicity, extracellular polymeric substance (EPS) composition, and cell widths/lengths. Transport behaviours of the two cellular states are quantified and compared using column transport assays. As well, soil cores from feedlots exposed to varying degrees of livestock manure contamination will be used to map the ratio of culturable to VBNC E.coli O157:H7 cells from the surface sources incrementally downwards towards the water table. If it is determined that VBNC E.coli O157:H7 is able to transport more quickly through soils and groundwater aquifers, then it may be concluded that the traditionally utilized culture tests for detecting and quantifying E.coli O157:H7 contamination are not as accurate as initially assumed, and other detection methods may have to be explored. In addition, if it is found that the proportion of E.coli O157:H7 VBNC cells reaching the water table is directly related to the density of source contamination, then this research may also lead to revised best management practices concerning livestock densities and the land application of manure.

KEYWORDS: microbiology, soil physics, contamination, risk assessment, pathogen load

CONDENSED TANNINS IN TAME FORAGE AGRONOMY

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Condensed tannins play an integral role in terrestrial nutrient cycling, and are produced in response to predation and stress in a variety of plants. The defining characteristic of condensed tannins is their affinity for protein binding, though they willingly interact with minerals, carbohydrates, and other polyphenolic compounds. Previous tannin investigations have centred on bioactivity related to ruminant digestive physiology and pathology. We have explored how tannin-containing resident plant material and exogenously applied manure derived from tannin-containing beef cattle diets influences tannin production, proximate analysis, and yield in tame forages, as well as soil nutrient status, in southern Manitoba. To test these parameters, we conducted an experiment over two growing seasons (2007-2008) where in the fall of 2007, both tannin-derived (sainfoin, Onobrychis viciifolia) and non-tannin (alfalfa, Medicago sativa) composted beef manures were applied at a rate of 8.9t/ha in a randomized split plot fashion, including a manure-free control, on a randomized complete block design with both tannin-containing and non-tannin containing forage monocultures and mixtures. Plant samples were harvested in two cuts, and soil measurements were taken in the fall of both years. It was found that across all sainfoin treatments, manure origin did not have a significant effect on plant tannin concentration. In most cases, the presence of either manure type did not significantly affect soil nitrogen or forage yield, though results were extremely variable. Using a stepwise regression which included all soil and plant measurements across all cuts and treatments, it was found that NDF (R^2=0.548) and plant phosphorous (R^2=0.126) were the only significant contributors to tannin concentration in sainfoin. These findings suggest that nutrient effects of beef cattle manure are not realized in either plant or soil in the year following application, and consequently, that tannin agronomy requires longer-term analysis.

KEYWORDS: condensed tannin, sainfoin, alfalfa, manure

EARTHWORM MEDIATED SOIL CARBON AND NITROGEN TRANSFORMATIONS IN RIPARIAN BUFFERS

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Earthworms stimulate litter decomposition and soil nutrient transformation processes, which may contribute to CO_2 and N_2O production and nutrient leaching in riparian areas. In a laboratory microcosm experiment we studied the effects of earthworms and riparian plant litter (from Riviere-aux-Brochets, Quebec) on soil C and N cycling. The microcosms were made of PVC pipe (10cm dia. x 35cm tall), hand packed with soil to a bulk density of 1.0 g cm-3 and wetted to 20% soil moisture content. The experiment was a replicated (n=4) complete factorial design with twelve treatments comprising three levels of earthworms (Lumbricus terrestris, Aporrectodea turgida, no earthworm) and four levels of plant litter (soybean, switchgrass, deciduous tree, no litter). The 48 microcosms were kept at 12ºC. At regular intervals during the 20 wk experiment, soil in each microcosm was moistened with 150 mL water, cores were covered with a vented lid equipped with a septa and incubated 24 h at 20ºC. Headspace air in each core was analyzed for CO_2 and N_2O, soil leachate was analyzed for DOC and NO3. At week 20, earthworms were removed and soil was mixed with 1.6 g cm-3 Na-polytungstate to isolate the light fraction of organic matter and assess the effect of treatments on C humification. Preliminary data indicate higher NO_3^- leaching and CO_2 production in microcosms with L. terrestris, compared to microcosms without earthworms. Greater CO_2 production was observed in microcosms with soybean litter than other litters. These results highlight the important contributions of earthworms and plant litter quality to soil C and N transformations in periodically flooded soils. Results from this study will be linked with field measurements of earthworm demographics and soil properties to develop a landscape-level model of earthworm-mediated nutrient cycling in riparian buffers.

KEYWORDS: lumbricus terrestris, apporrectodea turgida, nitrogen cycling, carbon cycling, riparian zones, microcosm experiment

APPLICATION OF PYROLYSIS-FIELD IONIZATION MASS SPECTROMETRY (PY-FIMS) AND SYNCHROTRON-BASED X-RAY ABSORPTION SPECTROSCOPY (C- UND N-XANES) TO DETERMINE HEAT EFFECTS ON SOIL ORGANIC MATTER

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The organic carbon (C) and nitrogen (N) in soil form large pools of C and N on Earth's surface and control soil fertility, plant productivity, biodiversity, C sequestration, and many other ecosystem services. Global warming caused more frequent and severe vegetation fires in parts of the world, and effects on bulk soil organic matter (SOM) were studied occasionally. Analytical methods with molecular resolution and quantification of such changes are unsatisfactory because of methodological limitations in the flash pyrolysis-gas chromatography coupled to mass spectrometry (MS), nuclear magnetic resonance spectroscopy, and thermal and chemical oxidation applied to this topic so far. Therefore, new methods are required to gain deeper insights into molecular-structural SOM changes arising from vegetation fire heat impact. The general objective of the research is to test and optimize methods for the determination of pyrolyzed organic matter (PyOM) in soils. As a first step we compared various MS and XANES methods to characterize SOM in samples from a long term field experiment in Germany, in which plots were periodically burned, mulched or left to natural succession. Results showed a larger sensitivity of temperature-resolved pyrolysis - field ionization MS (Py-FIMS) than for other MS and XANES methods in the detection of molecular differences among treatments. A principal component analysis of the Py-FIMS data separated the burned variants at two different locations from the others. The direct comparison of the variants showed a larger relative amount of m/z > 150 and a shift of thermal release of compounds to higher temperatures for the burned plots. Relative enrichments of heterocyclic N compounds in the N-XANES spectra of the burned plots can be explained by their heat-induced synthesis. Moreover, in a controlled burning experiment in the laboratory, the C- and N-XANES also showed characteristic formations of cyclic and heterocyclic molecules in SOM.

KEYWORDS: global warming, vegetation fire, Black Carbon, pyrolyzed organic matter

RELATIONSHIP OF SOLID CATTLE MANURE PLACEMENT METHOD IN A BLACK CHERNOZEM TO PHOSPHORUS AND NITROGEN MOVEMENT IN SIMULATED SNOWMELT WATER.

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In Saskatchewan, the annual spring snowmelt is often the major run-off event of the season. However, little is known about transport of nitrogen (N) and phosphorus (P) in snowmelt from manured soils in this region. The objective of this experiment was to determine what effect solid cattle manure application method had on run-off/ leachate collected from intact soil monoliths subjected to simulated snowmelt conditions in the laboratory. Intact soil monoliths were collected in the fall (post-harvest) from a loamy textured black Chernozem soil that had solid cattle manure field applied in the spring at a rate of 60 tonnes ha^{-1} using broadcast, broadcast and incorporation, and subsurface band injection placement methods. Soil monoliths were kept frozen, placed into insulated boxes, and field collected snow was applied to the monoliths. The snow was allowed to melt under simulated spring temperature conditions over a period of 5-7 days. Runoff/leachate was collected and analyzed for orthophosphate (PO_4-P), nitrate-nitrogen (NO_3^- N), total nitrogen and total carbon. Cattle manure addition significantly ($p<0.10$) increased phosphate concentration in the runoff/leachate collected. Broadcast, and broadcast & incorporated treatments had about 0.3 kg P ha^{-1} removed in snowmelt run-off versus 0.6 kg P ha^{-1} in the injected treatments. Nitrate-N removed was ~ 0.6 kg N03-N ha^{-1} in the broadcast and incorporated and subsurface injected treatments, and was significantly ($p<0.10$) higher than the 0.1 kg NO_3-N ha^{-1} removed by the snowmelt water in the broadcast treatment. Total N, total carbon, NO_3^- N and PO_4 in snowmelt runoff/leachate from the monolith slabs tended to be highest in the subsurface injected band treatment, suggesting that movement of these constituents may possibly be accentuated by placement at depth in bands.

KEYWORDS: runoff leachate soil monoliths nitrate-nitrogen orthophosphate total carbon

LEACHING OF NITROGEN AND PHOSPHORUS FROM INTACT SOIL CORES OF A BLACK CHERNOZEM AS INFLUENCED BY MANURE MANAGEMENT.

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The leaching of nutrients from manured soils is potentially influenced by application method. The effect of application of distiller grain fed and conventional ration fed cattle manure on nitrate-nitrogen (NO_3^- N) and orthophosphate (PO_4-P) removal in leaching water and on soil nutrient supply rates was evaluated in this study. Using PVC pipe, intact soil cores (0-15 cm) were taken from a field experiment on a cultivated black Chernozem in east-central Saskatchewan. Treatments were 30 tonnes ha^{-1} distiller's grain and barley fed solid cattle manure in comparison to an unmanured control treatment. The manure was applied using either mechanical subsurface injection in bands or by conventional broadcasting and incorporation. The intact soil cores were leached with 4 cm of water and the leachate was collected and analyzed for NO_3^- N and PO_4-P concentrations. Twenty-four h soil NO_3^- N and PO_4-P supply rates were also determined using PRS™ anion probes placed in situ in the cores. Solid cattle manure addition significantly ($p<0.10$) increased soil NO_3^- N removed in leaching water from 1.1 µg NO_3^- N g-1 of soil in the control to 4.4 µg g-1 and 6.2 µg g-1 in the barley fed solid cattle manure and distiller's grain fed cattle manure treatments, respectively. Similarly, manure addition increased the PO_4 removed in leaching water from 0.01 µg PO_4-P g-1 in the control treatment to 0.44 µg g-1 and 0.57 µg g-1 in the distiller's grain and barley fed solid cattle manure treatments, respectively. For both manures, injection tended to increase the amount of nitrate and phosphate leached compared to broadcast and incorporation. This may reflect greater retention of nitrogen in the soil when injected, as well as less fixation of P by soil constituents. Manure addition significantly increased soil nitrate and phosphate supply rates but there were no differences among placement methods.

SEASONAL VARIATION AND TEMPORAL DYNAMICS OF ARBUSCULAR MYCORRHIZAL (AM) AND NON-AM ENDOPHYTES IN DIFFERENT PLANT COMMUNITIES OF NATIVE FORAGE STANDS

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Colonization of plant root systems by arbuscular mycorhizal (AM) fungi improves plant nitrogen uptake. In forage stands, we tested if AM fungi could influence the nitrogen nutrition of mixed communities of forage plants grown in southwest Saskatchewan. Roots were sampled in July and August, in 2008 and 2009, from four plant mixtures composed of (1) seven natives' grasses, (2) these grasses plus alfalfa, (3) these grasses plus purple prairie clover, or (4) meadow brome plus alfalfa. These plant stands had received 0, 50 or 200 kg/ha of P_2O_5 as triple super-phosphate at establishment in 2006. The roots were washed, cleared, and stained, and their percentage of fungal colonization was determined under the microscope. Fungal hyphae were extracted by density gradient centrifugation from soil cores from theses stands, stained with trypan blue and measured on a grid under a dissecting microscope. AM root colonization was low in early summer and increased during the growing season. We also found non-AM endophytic fungi in plant roots. These fungi were more abundant than AM fungi in the forage plant roots. They were always seen in large amount in roots and seasonal variation in their abundance was much smaller than that seen with AM fungi. In July, AM fungal hyphae were an important component of the soil mycelia pool, despite the low AM root colonization at that time. Results suggested that nitrogen was limiting herbage production in 2008, a rainy year, when plant nitrogen nutrition was inversely related with the abundance of non-AM fungi in roots and plant productivity, with extraradicular AM mycelia. We conclude that AM and non AM fungi living in perennial forage plant roots are seasonally and annually dynamics, but the influence of these fungi on plant nitrogen nutrition and productivity is unclear.

KEYWORDS: AMF, non AM endophytic fungi, colonization, plant community, hyphae, mycelia pool, nitrogen nutrition

PHOSPHORUS FERTILITY MANAGEMENT ON PRAIRIE ORGANIC FARMS

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The use of synthetic chemicals as inorganic fertilizers is strictly prohibited in organic management systems presenting unique challenges for managing soil fertility. Water limitations, extreme temperatures and relatively short growing seasons, present additional challenges to organic growers in the Canadian Prairies. Furthermore, relatively large farm sizes, and the predominance of grain farms complicate soil fertility management because of the lack of animal manures for use as nutrient sources. Reliance on tillage for weed control must be balanced against the detrimental effects on soil structure. Phosphorus fertility management on Saskatchewan organic farms will be discussed highlighting ongoing research activities at the U. of S.

KEYWORDS: organic amendments, phosphorus deficiency, manure

DNA MARKERS ASSOCIATED WITH COMMON BUNT RESISTANCE IN MCKENZIE WHEAT

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Common bunt caused by Tilletia tritici and T. levis is a disease of wheat (Triticum aestivum L.) with the potential to cause substantial losses in grain yield and quality. Common bunt is effectively controlled by genetic resistance in Canada. DNA markers associated with genes for resistance are useful in selecting for resistance in breeding lines, and stacking resistance genes to improve the durability of resistance. Expression of common bunt resistance from McKenzie wheat is quantitative, whereas BW711 possesses gene Bt10. From a cross of McKenzie x BW711, 338 doubled haploid lines were studied. After excluding lines possessing Bt10 based on marker analysis 174 lines remained for further genetic analysis. DNA from lines resistant to common bunt was pooled to create two resistant DNA bulks and DNA from susceptible lines was pooled to create a susceptible bulk for bulk segregant analysis. Microsatellite markers were applied to the bulks and parents to identify putative trait related markers for resistance. These markers were further evaluated on individual lines of the population to confirm trait relatedness using quantitative trait locus (QTL) analysis. A major QTL for bunt resistance in McKenzie wheat was discovered around Xgwm573 and Xwmc17. Although additional genes are required to explain the inheritance, this major locus controlling common bunt resistance in McKenzie wheat was located on chromosome 7B.

KEYWORDS: common bunt, genetics, marker, DNA, tilletia, wheat, triticum

A PROSPECTUS OF MOLECULAR BREEDING IN CANADA

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Plant breeding will continue to play a major role in maintaining the security of the food supply and increasing production to meet growing needs. A multitude of biotic and abiotic stresses challenge crop production. Furthermore, increased specialization in production and processing technologies along with discriminating consumer demands for food quality put tremendous pressure on plant breeding programs. Breeders are faced with an increasing list of traits that they must combine into a single cultivar. Fortunately modern technologies of molecular genetics and bioinformatics can be applied to plant breeding to increase the precision of selection. These technologies applied to plant breeding form the basis for molecular breeding. In breeding, genetic variation generated by natural or artificial hybridization is selected upon at the phenotypic level to recover, within one or a few breeding lines, traits that meet the desired objectives. Selection at the phenotypic level is complicated by the environmental component of the variation. With molecular breeding, efficiency is gained through direct selection at the genotypic level. Not only does molecular breeding aid in the selection of desirable traits, it can generate genetic variation in a targeted way through plant transformation. Recently, molecular breeding has begun to focus on quantitatively inherited traits. Molecular breeding is now effectively developing genotypes with highly penetrant and expressive genes for qualitative traits. With quantitative traits, traits with epistatic interactions, and traits controlled by genes that are influenced by the environment, the quantity of trait related molecular data will increase dramatically. The future advancement of molecular breeding in Canada will depend as much on management of the trait related molecular information as it will molecular technologies per se.

KEYWORDS: molecular breeding, future, DNA, markers, marker assisted selection, crop, Canada

THE IMPACT OF CROPPING HISTORY ON GLOMALIN-RELATED SOIL PROTEIN AND WATER AGGREGATE

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Glomalin-related soil protein (GRSP), an operationally defined glycoprotein reportedly produced in copius quantities by arbuscular mycorrhizal fungi (AMF), is thought to be a major contributor to soil carbon stocks and thereby to influence soil structure. We examined the relationship between GRSP and water aggregate stability as affected by long-term crop rotations at Swift Current (AAFC SPARC) and Scott (AAFC Scott Research Farm). Cropping history influenced water aggregate stability, although glomalin levels remained largely unaffected. There was no relationship between water aggregate stability and measured glomalin levels. Relatively high levels of glomalin associated with a continuous canola rotation suggests that non-AMF soil proteins are extracted by the current glomalin extraction procedure.

KEYWORDS: AMF, aggregates, soil quality

EMERGING APPROACHES TO SOIL SCIENCE EDUCATION

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At a time when soil resources are becoming increasingly recognized as significant in societal issues such as climate change, food security and water management, the soil is facing increased degradation. This is unfortunately accompanied with a decrease in the numbers of soil science students in post secondary education. Decreasing student enrolment can be ascribed to a number of social and cultural trends such as ongoing urbanization, lack of soil science visibility in high school and/or elementary education, and use of traditional and often dated curriculum in post secondary soil science education. Employment demands dictate that graduates and professionals of the 21st century need to possess content knowledge and to be skilled in communication, problem solving, and critical thinking. To address the declining enrolment and learning needs for the 21st century, universities begun curriculum review and are seeking innovation in program development to address these emerging concerns. Some examples of these initiatives include more emphasis on interdisciplinary programs, inclusion of active and collaborative learning approaches (e.g., problem-based learning), and development of web-based, interactive teaching resources. The focus of soil science curriculum redesign must be on soil's relevancy to current global issues (e.g., climate change, food shortages, land degradation, migrations), providing students with a strong foundation in basic science, and higher order thinking skills to meet current professional and global citizenship needs. Innovative educational approaches are critical to achieve these emergent concerns and these innovations are needed to convey that soil is an essential natural resource, one that must be managed in a sustainable manner. The larger scientific community has to be more involved with how soil science is taught and scientific societies should play a integral role in this process.

KEYWORDS: teaching of soil science, collaborative learning approaches, soil science curriculum

EFFECT OF THE SOIL-TONGUE'S SHAPE ON WATER AND SOLUTE TRANSPORT IN LAYERED SOILS

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Preferential flow of pollutants through soil may result in rapid pollution of groundwater. The flow of water and solutes through layered soils are always affected by the heterogeneities in the soil characteristics within the layers as well as the irregularities at the interface between the soil layers. Soil-tongues create a variable thickness soil horizon at the location of its occurrence and increase the surface area of the interface between the layers while potentially providing a preferential pathway to soil-water and solutes. This study examines the effect of different soil-tongue shapes on preferential transporting of water and solutes.

The US Geological Survey's interactive finite difference modelling software for water, solute and heat transport in variably saturated porous media, VS2DTI, was used to model water and solute movement through different configurations of soil-tongues created between two layers of soils (fine sand on coarse sand) under the same initial hydraulic and boundary conditions. Flow through soil-tongues having different cross-sectional shapes (triangular, rectangular, circular bottom, etc) of varying depth and width were simulated and the time taken for the solute front to reach the bottom of the control section was determined.

The shortest travel time for solute front was observed with the triangular shaped soil-tongues while rectangular shaped tongues resulted in the highest estimated travel time. The travel times through soil tongues decreased as the width of the tongue decreases. The solute travel time with triangular shaped tongue having a 0.2 m width was similar to 0.16 m wide rectangular tongue. In circular bottomed soil-tongues, the travel time increased as the length of the tongue decreases, but the volume of soil containing solutes increased.

KEYWORDS: preferential flow, VS2DTI, soil-tongues, layered soils

LEACHING LOSSES OF PHOSPHORUS FROM MANURED AND FERTILIZED SOILS

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Buildup of P in manured and P fertilized soils increases the potential for leaching of environmentally significant quantities of P into groundwater. The objectives of this study were to compare P leaching losses from manured and fertilized soils and to relate P losses to soil test P concentrations. We compared P leaching losses in ten treatments (4 sources of solid cattle manure (SCM), 4 sources of liquid swine manure (LSM), monoammonium phosphate (MAP) and check) in two soils (Lone Sand and Newdale Clay Loam) with two replicates by conducting a column leaching study. Manure or fertilizer was applied to soil at the rate of 50 mg P kg^{-1}</sup) soil, mixed, moistened to 90% field capacity and incubated for 6 weeks. After incubation, treated soils were analyzed for Olsen-P (OP), Mehlich 3-P (M3P) Modified Kelowna- P (KP) and water extractable P (WEP). Incubated soils were packed into PVC columns, and water was supplied through a rain-drip system at an intensity of 12.5 mm h^{-1}. Leachate samples collected to a total of 4 pore volumes were analyzed for dissolved reactive phosphorus (DRP). Breakthrough curves of DRP in Lone Sand, showed a higher peak concentration with LSM and MAP treatments than with SCM and check treatments, but this effect was not observed in the Newdale CL. In Lone Sand, P extracted by M3P, KP, OP and WEP predicted total DRP loss well, explaining 61-67% of total variation. In Newdale CL, however, the correlation coefficients between M3P, KP and OP with DRP loss were low, but significant, while WEP showed a highly significant correlation with DRP loss explaining 54% of the variation. WEP proved to be the best method to predict DRP leaching loss, contrasting with results from previous studies where OP was the best method for predicting DRP losses in runoff.

KEYWORDS: liquid swine manure, monoammonium phosphate, phosphorus leaching, solid cattle manure

NUTRIENT RELEASE FROM SOLID CATTLE MANURE IN A PERENNIAL FORAGE SYSTEM

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Manure generated from cattle operations in Manitoba is often applied to land representing a range of soil types and uses. More information on nutrient release from soil applied cattle manure is needed to optimize the use of manure in improving soil fertility and minimizing the risk to the environment. The objectives of this study were to monitor the release of N, P and K over two years after applying solid cattle manure onto a perennial forage field and compare the residual nutrients in soil in N- fertilized and manured plots. Nutrient release over 2 years was monitored in a perennial forage field at Lake Francis, Manitoba having six treatments (three rates of available N; 0-check, 75 and 150 kg N ha^{-1} supplied as urea or cattle manure) with 4 replicates arranged in a Randomized Block Design. The same six treatments were repeated in different plots in the second year and monitored for another 2 years. Soil samples taken before manure application, during early spring, at haying stage and in fall for 0-15, 15-30, 30-60 and 60-90 depths were analyzed for ammonium-N, nitrate-N, Olsen P and Modified Kelowna extractable K. Application of urea or solid cattle manure at both rates increased forage yield, forage N accumulation and residual nitrate N in soils (0-15 cm only) compared to the check treatment. At the end of the second year of monitoring, significantly greater nitrate-N and ammonium-N remained in the surface soils (0-15 depth) of manured plots compared to fertilized plots. Olsen P and Modified Kelowna extractable K of surface soils were significantly ($p \leq 0.05$) greater in manured plots than fertilized plots throughout the monitoring period. Increase in Olsen P in manured plots was significant, even for 15-30 cm depth samples indicating significant amounts of P leaching.

KEYWORDS: forage, nutrient release, solid cattle manure

EFFECTS OF PLANT SPECIES RICHNESS AND EVENNESS ON SOIL COMMUNITY DIVERSITY AND FUNCTION

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Understanding the links between plant diversity and soil communities is critical to disentangling the mechanisms by which plant communities modulate ecosystem function. Experimental plant communities varying in species richness, evenness, and density were established and soil community properties including bacterial and archaeal abundance, richness, and evenness were measured. A representative soil ecosystem function, oxidiation of ammonium to nitrite, was measured via archaeal and bacterial amoA genes. Structural equation modeling was used to separate the direct and indirect effects of the plant community on soil diversity and function. Plant communities influenced archaea and bacteria via different pathways. Species richness had direct positive effects on archaeal amoA prevalence, but only indirect impacts on bacterial communities through modulation of plant evenness. Increased plant evenness increased bacterial abundance which in turn increased bacterial amoA abundance. These results provide the first evidence for a strong impact of plant community evenness on soil ecosystem function. We show that a more even plant community increased bacterial abundance, which then increased the potential for bacterial nitrification. A more even plant community also increased total dissolved nitrogen in the soil, which decreased the potential for archaeal nitrification. The role of plant evenness in structuring the soil community suggests mechanisms including complementarity in root exudate profiles or root foraging patterns.

KEYWORDS: ammonia oxidation, amoA, archaeal amoA, bacterial diversity, diversity – ecosystem function, plant community structure, soil community structure, structural equation modeling (SEM)

AFFECT OF CULTIVATION PERIOD ON SOME OIL QUALITY INDEXS

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Identification of soil quality indicators is important to sustainable management of natural resources. The properties of soils may be characterized by many attributes. However, there is not a systematic procedure to objectively select the measurement parameters that maybe used to asses soil quality. To investigate the effects of cultivation period on soil quality, Mahyar area in Isfahan province in central Iran was selected. The treatments including soil with zero cultivation, 10 years cultivation period, 30 years cultivation period, in six depths were used. The experimental design was laid in factorial with three replicates. Results showed that bulk density increased with depth and cultivation period. Aggregate stability decreased with cultivation period. Electrical conductivity and K increased with cultivation period. Cation exchangeable capacity, N, P, Fe, Cu and Zn decreased with cultivation period. It could be due to no use of fertilizers, calcareous parent material and low organic matter. Organic matter decreased with increasing cultivation period and depth. Decreasing in organic matter could be related to plowing and decrease of returning of plant residue. Cultivation period didn't affect mineralogy and texture of soils

KEYWORDS: cultivation period, soil quality, organic matter

TOPSOIL REPLACEMENT DEPTHS AND ORGANIC AMENDMENTS ON RECLAIMED WELLSITES: RESIDUAL EFFECTS AFTER TEN YEARS

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Soil samples were taken from three wellsites (Strathmore, Hesketh, and Rosedale) in south-central Alberta in 2007, ~10 yr after reclamation with combinations of four different topsoil replacement depths (0%, 50%, 100%, 150%) and five amendments (compost, manure, straw, alfalfa, check). The 2007 samples were analyzed in the laboratory for soil organic carbon, total nitrogen, nitrate-nitrogen, available phosphorus and inorganic carbon alongside archived samples from the same wellsites from 1998 (15 mo after treatment establishment). The study showed that residual effects of topsoil replacement depth and organic amendments were present 10 yr after reclamation. However, even though residual effects, particularly of compost and manure, were still measured, their magnitude declined over time.

KEYWORDS: soil reclamation, organic amendments

SOIL PROPERTIES OF AN IRRIGATED ROTATION STUDY WITH SUSTAINABLE AND CONVENTIONAL MANAGEMENT PRACTICES

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Common irrigated crops in southern Alberta, Canada, such as potatoes (Solanum tuberosum L.), sugar beets (Beta vulgaris L.) and dry beans (Phaseolus vulgaris L.) produce little crop residue for return to the soil. Growing these crops in tight rotations may have long-term detrimental effects on soil quality. An irrigated rotation study was initiated in 2000 to examine the impact of conventional and sustainable rotations on crop and soil response. The sustainable rotations (3 to 6 yr in length) were built around four specific soil management practices: (1) reduced tillage; (2) cover crops; (3) feedlot manure compost application and (4) where beans occurred in the rotation, solid-seeded narrow-row beans vs. conventional wide row beans. Most soil parameters pointed to beneficial effects of sustainable soil management (e.g. increased soil organic carbon (SOC), microbial activity, and available water). Nematode populations were higher in shorter rotations. Sustainable management increased soil organic carbon on the 3- and 4-yr rotations by an average of 11% (0-15 cm depth) after 9 yr. In contrast, conventional management led to a 10% decline in SOC after 9 yr. The 3- and 4-yr sustainable rotations averaged 26% higher than their conventional counterparts for microbial biomass C in bulk soil.

KEYWORDS: soil organic carbon, sustainable agriculture, irrigation, potatoes, dry beans, wheat, sugar beet

ADVANCES IN SOIL ORGANIC NITROGEN RESEARCH BY MASS SPECTROMETRY AND SYNCHROTRON TECHNIQUES

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The speciation of organic nitrogen (N) compounds in soil and related environmental samples is still a challenge for soil chemistry. While limitations in ^{15}N nuclear magnetic resonance (NMR) spectroscopy were mentioned (Smernik & Baldoch 2005) synchrotron-based X-ray absorption near-edge structure (XANES) spectroscopy at the N K-edge became a powerful new tool in soil organic N research (Leinweber et al. 2010). Applied in conjunction with pyrolysis-field ionization mass spectrometry (Py-FIMS), N-XANES provided unequivocal evidence for up to 30 to 40% of non-protein N in soil clay fractions. Since much of this N occurred in heterocyclic compounds research efforts were undertaken to uncover various possible pathways for the formation of heteroaromatic N compounds in soils. It will be highlighted that Dr. Huang and co-workers (Dept. Soil Science, University of Saskatchewan) used Py-FIMS and N-XANES to identify N-heteroaromatics which were formed by abiotically catalyzed Maillard reactions in soil environments. Native heteroaromatic N (uracil) compounds can be transformed microbially, and this will be demonstrated by recent Py-FIMS and N-XANES results. Ongoing research looks at vegetation fire impacts to soil organic N. In order to improve the methods and data evaluation we studied the thermal degradation of peptides and quantified the proportion of "artificial" N heterocycles formed during Py-FIMS. Finally, examples will be given for the different sensitivity of Py-FIMS and N-XANES in the detection of heterocycles formed during real fire events in ecosystems.

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KEYWORDS: soil organic nitrogen, N XANES, pyrolysis-mass spectrometry

DOES CROP TYPE INFLUENCE NITROUS OXIDE EMISSIONS FROM CROP ROTATIONS ON THE CANADIAN PRAIRIES?

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Crop production contributes substantially to the increasing concentration of atmospheric nitrous oxide (N_2O). However, it is not clear how different crop types may influence N_2O emissions from crop rotations on the Canadian prairies. We compared N_2O emissions from a cereal monoculture to emissions from rotations that include oilseed and/or pulse crops. We also examined the influence of the preceding crop (oilseed, field pea and cereal) on wheat phase emissions. The study was conducted in a long-term rotation at the Scott Research Station, on a loamy textured (Orthic Dark Brown Chernozem) soil in the Dark Brown soil zone. Chamber-based measurements of soil-atmospheric exchange of N_2O were made approximately weekly from spring thaw through fall freeze-up in the following rotations: continuous pea (cont.P); wheat-pea (W-P); pea-canola-wheat (P-C-W); canola-wheat (C-W); continuous wheat with nitrogen (N) fertilizer (cont. W); continuous wheat without N fertilizer [cont. W (-N)]. In 2008, estimated cumulative annual N_2O emissions tended to be higher from wheat grown on canola residues. The estimated cumulative N_2O emissions during the frost-free period of 2009 displayed higher emissions in wheat grown on field pea, oilseed and cereal residues. The cont.P treatment showed the lowest emissions and was not significantly different than the cont. W (-N), the pea grown on cereal residues, and the canola phase of the P-C-W rotation in 2008 and 2009. The results suggest that including field pea in rotations on the Canadian prairies could help to minimize N_2O emission from cereal and/or oilseed crop production.

MEASURING TIME-DEPENDENT CHANGES IN N_2O FLUX

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Chamber based measurements of soil-emitted nitrous oxide (N_2O) are highly variable both spatially and temporally. Frequent sampling with many replications improves the statistical power of treatment comparisons, but available labour, cost, and analysis capacity limits the number of samples that can be collected. Researchers must often trade-off statistical performance in favour of practical considerations. Soil-emitted N_2O is estimated from the change in concentration in the chamber headspace over a specified period of time. If the concentration change is linear with time, the flux can be accurately calculated based on two sampling points. However, placing a chamber over the soil surface is known to disturb the soil-atmosphere concentration gradient causing the concentration change to become non-linear with time. Thus, soil-emitted N_2O flux is generally calculated from four or five headspace measurements collected at equally spaced time intervals. Collecting multiple samples from each sampling position dramatically increases the number of samples collected on each sampling date. In order to keep the total number of samples collected to a manageable level, sampling dates, replications, or treatments must often be reduced. Additionally, the time intervals selected can vary considerably from study to study, depending upon logistics and available manpower. We used existing data sets to explore two main questions: "How much does the choice of time interval affect the final flux estimate?" and "Is it better to estimate flux based on two rather than four or five time points and commit more resources to greater replication or more sampling dates?"

KEYWORDS: nitrous oxide emission, flux measurement

INNOVATION IN SOIL COMPACTION MITIGATION: SUBSOILING AND INJECTION OF ORGANIC PELLETS

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Subsoil compaction is a widespread soil problem in mining, forestry, agriculture and other industrial operations. Thus far, subsoiling or 'deep ripping' has been the principal management technique used to break dense subsurface horizons. However, since subsoiled horizons are prone to re-compaction, the benefit of this practice is only short-term. Paragon has developed and is demonstrating a technique that combines deep subsoiling with injection of concentrated organic pellets. The subsoiling operation breaks the compacted subsoil layer and helps channel water down into the profile so that roots have easier access, and the injected organic pellets entice plant roots to penetrate deeper to feed on the nutrients. The macro pores created by the roots and organic matter will permanently alleviate the compaction problem.

The organic matter pellets used are produced by EarthRenew® from organic wastes such as manure, municipal biosolids, and green wastes, through a drying process known as 'flash vaporization' where temperatures reach far higher than what composting or other drying processes could achieve. This process breaks down and destroys pathogens, weed seeds, and chemicals including hormone, pesticide and herbicide residues. The final product is formed into safe and easy to handle pellets which replenish soil carbon, promote healthy deep root growth, increase yields and alleviate soil compaction.

Paragon with the support of Sustainable Development Technology Canada and in collaboration with several research partners initiated field scale trials of the technology in 2008 and 2009. Results show a yield increases of at least 30 to 50% in cereals and canola and even higher in forage crops. This presentation focuses on results to date conducted on farmland, pipeline rights of way, and well sites, with attention to improvements in soil root zone quality, rooting patterns, and crop productivity.

KEYWORDS: organic pellets, compaction, subsoil, deep ripping, rooting depth

NITROUS OXIDE EMISSIONS FROM AN ACID SOIL IN RESPONSE TO POLYMER-COATED UREA APPLICATION AND HERBICIDE MANAGEMENT IN A CANOLA-BARLEY CROPPING SYSTEM

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Environmentally Smart Nitrogen (ESN) has potential to reduce N_2O emissions. Our study investigated the effect of ESN and weed management on N_2O emissions from an acid soil in a cold Northern Alberta climate. Two canola (Brassica napus L.) and two barley (Hordeum vulgare L.) cultivars were used in a two-year rotation from 2005 to 2008. Urea and polymer coated urea (ESN) were applied at 1 and 1.5 times (×) the recommended agronomic rate. Crops were treated with half or full herbicide rates. Soil N_2O emissions were measured using vented static chambers at bi-weekly intervals during the growing season from 2006 to 2008. N_2O emissions were low (-0.14 to 4.22 kg N ha^{-1} yr^{-1}) during the growing season over the three years. N_2O emissions were higher ($P<0.05$) from 1.5× ESN (average, 0.77 kg N ha^{-1} yr^{-1}) than 1× ESN (0.25 kg N ha^{-1} yr^{-1}) in 2006 and 2007 with no differences in 2008. N_2O emissions were higher ($P<0.05$) from canola (average, 0.47 kg N ha^{-1} yr^{-1}) than barley (0.24 kg N ha^{-1} yr^{-1}) over the three years. N_2O emissions were not affected by fertilizer type (applied at agronomic rate) and herbicide management over the three years. However, average N_2O emissions over the three years were 139% and 28% higher ($P<0.05$) from 1.5× ESN than 1x urea and 1× ESN, while emission from 1× ESN were 27% lower ($P<0.05$) than 1x urea. Our results suggest that ESN fertilizer could play a role in reducing N_2O emissions from acid soil under barley-canola cropping systems in a cold Northern Alberta climate.

KEYWORDS: N_2O emissions, ESN, urea, polymer-coated urea, canola, barley

GERMINATION THRESHOLDS OF NATIVE AND INVASIVE SPECIES IN THE MIXED-GRASS PRAIRIE AS AFFECTED BY GLOBAL CHANGE: A FACE STUDY

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The effects of global change conditions on seed germination have been reported in many species. However, there are no consistent trends regarding how seed quality and germinability are affected by these conditions. Seeds of two native and a pair of native/invasive species were collected from the USDA-ARS Prairie Heating and Subscript CO_2 Enrichment Experimental plots in 2008, which is located in the Mixed-grass Prairie near Cheyenne, WY. Field treatments include ambient and enriched Subscript CO_2, ambient and elevated temperatures, and deep and shallow irrigation treatments. Seed quality was evaluated and germination tests were conducted under alternating temperatures. Thermal time requirements and base temperatures were determined using thermal time models. There were no treatment effects on seed fill rate of *Koeleria macrantha*, *Chenopodium leptophyllum*, and *Salsola iberica*. Heating increased seed fill rate of *Bouteloua gracilis* (C4) from 12.5% to 19.7% compared to deep irrigation. Heating, either alone or combined with enriched Subscript CO_2, increased seed viability of *K. macrantha* (C3). Irrigation decreased but heating increased seed viability and germination percentage of *B. gracilis*. Germination percentage of *C. leptophyllum* was reduced by all treatments. Thermal time requirements of *B. gracilis* were decreased by all treatments except enriched Subscript CO_2, favoring early and fast germination. Heating and deep irrigation decreased the base temperature but increased thermal time requirements in *S. iberica*. Species specific changes in seed quality and germinability were observed which may cause a shift in community composition. The distribution and abundance of C3 species *C. leptophyllum* may be reduced while native species *B. gracilis* may be favored by global change.

KEYWORDS: Global change, seed germination, Mixed-Grass Prairie

REDUCING DISSOLVED PHOSPHORUS LOSSES IN RUNOFF FROM CONSERVATION TILLAGE FIELDS.

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Recent research has shown that while conservation tillage effectively reduces nitrogen and particulate phosphorus losses to surface waters during snowmelt and rainfall runoff events, the practice can increase transport of dissolved phosphorus to receiving waters. The increase in transport of dissolved phosphorus has been attributed to accumulation of soluble phosphorus at the soil surface in the low disturbance tillage system. Potential sources of soluble P that interact with runoff water include surface soil, decomposing crop residues, straw and stubble from the most recent crop, and weed growth. In this study we have introduced bi-annual fall tillage into a long-established conservation tillage practice in an attempt to reduce P availability at the soil surface and we use snowmelt simulations to investigate the source of phosphorus in snowmelt runoff. In fall 2007, the long-term conservation tillage field in the South Tobacco Creek twin watershed study was tilled for the first time since 1995 and a second tillage pass was made in fall 2009. Preliminary indications are that the tillage pass results in a short term decrease in dissolved P transport from the conservation tillage field. After the tillage pass in 2007, dissolved P concentrations in snowmelt runoff from the conservation tillage field were comparable to those from the conventionally tilled field. When the conservation tillage field was left untilled in fall 2008, the dissolved P concentrations in snowmelt runoff in 2009 reverted to levels greater than those from the conventional field. This suggests that fresh crop residues may be more important than soil accumulations in supplying dissolved P for transport.

KEYWORDS: Tillage practice, water quality, dissolved nutrients

IMPACT OF IRRIGATION ON SURFACE AND GROUNDWATER QUALITY IN SOUTHERN ALBERTA

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Manure from livestock operations often ends up in the field as fertilizer. In areas where there is a high density of intense livestock operation over-application of manure often occurs. Furthermore, the majority of farmsteads in rural areas use septic systems for treatment of wastewater. Pathogenic microorganisms may be present in both manure and human waste and thereby becoming a potential threat to water quality; surface water as well as groundwater posing a risk to humans, aquatic life and wildlife. Better understanding of the transport of these microorganisms in soil is essential to ensure safe drinking water in rural and agricultural areas. This research looks at the temporal and spatial dynamics of microbial contaminants in relation to inorganic ions along two major transport flowpaths; an irrigation drain and general groundwater flow. Ten sampling sites were selected along the ca. 20 km Battersea Drain, southern Alberta. All sites were sampled on a bi-weekly basis during flow (August till October). Following drain shut-off (mid October) sampling shifted to monthly. To assess the impact of the drain's water quality on the groundwater a transect of eight groundwater wells, following the general flowpath of the area's groundwater, were sampled simultaneously; continuing throughout the winter. Samples were analyzed for major inorganic ions, nutrients, total coliforms, total *E. coli*, as well as pathogenic microbiological species such as *E. coli O157:H7*, *Salmonella*, *Giardia*, and *Cryptosporidium*. Results showed little variation in the inorganic chemical composition of the drain water during flow, but total coliforms and total *E. coli*, varied significantly both temporally and spatially. Following drain shut-off, significant increases (some >10 fold) were observed for inorganic ions where as microbial content decreased significantly (some to <1 MPN/100 ml). Groundwater contamination by microorganisms was localized in one area along the drain, but little temporal variation was observed in the inorganic composition.

KEYWORDS: water quality, irrigation, pathogens, microbial soil transport

USING DSSAT MODEL TO SIMULATE CROP YIELD, SOIL WATER CONTENT AND NITRATE LOSS UNDER AN INTEGRATED WETLAND-RESERVOIR SUBSURFACE IRRIGATION SYSTEM

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Soil water is a very important factor influencing crop productivity. In the southwestern Ontario, rain-fed crop production frequently cannot achieve maximum yields because of low soil water contents caused by growing-season droughts and/or poor rainfall distribution. A field-based wetland-reservoir experiment was carried out from 2000 to 2004 using crop rotation (Corn-corn-soybean-corn-soybean) and soil water management via controlled tile drainage-sub-irrigation (CDS) and traditional tile drainage (TD). The experiment was located at the Essex Region Conservation Authority demonstration farm, Holiday Beach, Ontario, and the simulation model, "The Decision Support System for Agrotechnology Transfer (DSSAT 4.5)", was used to simulate the CDS and TD system, then simulated results were evaluated by crop yields, soil water content in the top 30 cm measured by CS615 (Campbell Scientific Water Content Reflectometer) and nitrate leaching losses through tile drainage water. The Century-based soil C/N submodel of DSSAT predicted 73-88 % of the measured variation in soil water content (R^2 = 0.78 and 0.80 for CDS in 2000 and 2001, respectively; R^2 = 0.73 and 0.88 for TD in 2000 and 2001, respectively), and it yielded normalized-RMSE values between predicted and measured soil water content of 8.08 % and 9.49% for CDS in 2000 and 2001, respectively, and 8.45% and 6.48% for TD in 2000 and 2001, respectively. The model predictions of cumulative nitrate loss from 2000 to 2004 also agreed well with measurements, giving R2 values of 0.90 and 0.91 for CDS and TD, respectively, and normalized-RMSE values of 12.9% and 19.0%, respectively. The DSSAT-Maize and CROPGRO model predicted of corn and soybean yields well; ie. giving R^2 = 0.97 and R^2 = 0.97 for CDS and TD, respectively. We concluded that DSSAT model can be a useful tool for simulating corn and soybean rotation, soil water drainage and nitrate loss on controlled drainage/subirrigation system.

KEYWORDS: DSSAT 4.5 model, simulation, crop rotation, controlled drainage sub-irrigation (CDS), tile drainage (TD),

MICROBIAL COLONIZATION OF LEGUME CROP RESIDUES DURING DECOMPOSITION

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We quantified soil microbial biomass C (MBC) and bacterial diversity (Shannon index, H') on decomposing residues of two pea varieties (Camry, a semi-leafless variety, and 4010, a normal-leafed silage pea variety), faba bean grown for seed, faba bean green manure (GM) and chickling vetch GM. Nitrogen released from the residues was concurrently quantified. During 12 months of decomposition, the order of MBC on residues was faba bean GM ≥ vetch GM ≥ faba bean grown for seed ≥ Camry pea ≥ 4010 pea, and H' on Camry pea residues was less than that on the other residues. The pattern with time was a rapid increase of MBC in the first four weeks after residue placement in summer or fall, followed by a slight decrease during winter, then a gradual increase from spring to fall of the following season. The pattern for H' was similar, except that the decrease during winter was accelerated between spring and summer of the following season, and started increasing again between summer and fall. The N release pattern also followed a similar trend to that of MBC on the residues, except that N release continued to increase slowly during winter. There was positive correlation between MBC on the residues and N released from the residues even though faba bean grown for seed released the most N. H' was not related to N released, presumably because H' decreased between spring and summer when N release continued to increase. H' was negatively correlated with the residue C/N rations. When only the first month of decomposition and N release were considered, both MBC and H' were negatively correlated with %N remaining in residues. Therefore, microbial colonization of crop residues can be a good indicator of N released from the residues.

KEYWORDS: Nitrogen release, nutrient cycling, soil microbial ecology, soil microbiology.

PRODUCTIVITY, SOIL QUALITY CHANGES AND NITROGEN LOSSES UNDER EXTENDED ORGANIC VEGETABLE ROTATIONS

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Organic cropping systems are often characterized by extended rotations (4yr+) involving leguminous green manures, with benefits to soil quality/soil health. Much less is known regarding nitrogen losses to air and water and overall nitrogen efficiency of these systems. Since 2006, the impact of green manure type and frequency, with or without organic amendment or fertilizer, on soil quality, greenhouse gas emissions and overwinter N losses are being evaluated under four 5yr vegetable rotations at NSAC. Three pre-potato (Solanum tuberosum L.) sequences include: C1(oats underseeded with red clover-red clover), C3 (carrots-oats/pea/vetch mixture (OPV)) and C4 (beans followed by buckwheat-OPV). Soil fertility treatments include: non-amended potatoes (control), supplemented with P and N fertilizer (FERT), municipal food waste compost (MSW), or composted paper mill biosolids (PMB). In 2008, higher soil mineral N (SMN) (125 vs. 85 kg N ha^{-1}) and mineralizable N were measured prior to potatoes in C1 compared with C3 and C4 with more than 80% of the seasonal decrease in SMN attributed to potato N uptake. Spring soil N supply rate measured in-situ by PRSTM ion exchange membranes was 58% greater in C1 compared with C3. Particulate organic C averaged 21% of total soil C but was unaffected by treatment. Amendment treatments but not rotations influenced microbial biomass and microbial quotient, with 50% higher values measured for MSW compared with FERT and PMB. About 30 kg N ha^{-1} was SMN estimated lost from the root zone (0- 30 cm) over winter (2008-2009) and was unaffected by treatments. N_2O emissions under potatoes ranged from 1.30 to 0.28 kg N_2O-N ha^{-1} for C1 and C3 sequences. In control sub-plots, emissions were 31% lower than under the FERT treatment (1.31 vs. 1.72 kg N_2O-N ha^{-1}) but double that obtained for a standing red clover crop. Additional data for 2009 will also be presented.

KEYWORDS: organic potato, soil quality, greenhouse gases, soil N, plant root simulator probes

AGRICULTURE AND CLIMATE CHANGE – THE ROLE OF BIOREFINING'

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Concerns have been raised about the international impacts of biofuel projects, including higher food prices, as well as indirect land use change which contribute to a negative carbon footprint. This has led discussions around the sustainability criteria required for renewable energy policy biofuel policy. As the proportion of renewable energy within total primary energy supply increases, these criteria will become more important. A regional analysis methodology is used to explore the likely impacts of renewable fuel development. Eastern Ontario is selected as a region that has significant potential for biomass production, including both agricultural and forest feedstocks. The potential for biomass production across all lands within this region have been mapped and quantified, as have the human capital resources found within the local population. Potential platforms for biofuel generation, including 1st- and 2nd-generation technologies, were used to build potential scenarios of future biofuel use. The impacts of existing and potential biofuel development are measured using environmental, economic, and social parameters. Specific tools applied include life cycle assessment and techno-economic modeling, which quantify economic and environmental measures to inform policy assessment and recommendations. This paper also considers recent international developments in measuring biofuel sustainability, including efforts at the European Commission level as well as examples from individual countries. Models for ensuring sustainability, including certification systems, are discussed. In order to inform a framework that will permit the bioenergy industry to develop at a rapid but sustainable rate, criteria for measuring the sustainability of biofuel solutions at the regional level are proposed.

DOES CHARCOAL AFFECT THE SPATIAL PATTERN OF SOIL PROCESSES IN FOREST ECOSYSTEMS?

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Recently, there has been increasing interest in the use of biochar as a potential fertility treatment for the production of everything from agricultural species, to quick rotation silviculture. The use of biochar as a soil conditioner for the reduction of greenhouse gases and long-term carbon (C) sequestration is also being investigated. Much of this interest has been generated by results from tropical regions, referring specifically to Tera Preta do Indio soils. Naturally pyrogenic ecosystems of both temperate and boreal latitudes produce charcoal, however very little is known about charcoal quantity in these ecosystems, it's spatial distribution, and the effect of that distribution on soil processes. Part of this lack of knowledge stems form the difficulty in quantifying a substrate defined by a gradient of recalcitrance and elemental ratios (black C), and part is due to the historic belief that charcoal is inert in soils. Recent evidence suggests that wildfire produced charcoal is not inert and plays a role in plant nutrient availability. New methods, including, but not limited to digestion techniques and FT mid-infrared spectroscopy, have proven effective in quantifying charcoal in soils. Geostatistical analysis has also been shown to be an effective means of quantifying spatial dependence and is more robust than simple correlations. Two studies will be discussed with regard to wildfire produced charcoal and the spatial dependence of related soil processes in temperate and boreal ecosystems.

KEYWORDS: fire ecology, disturbance, spatial analysis

LIFECYCLE AND SOCIO-ECONOMIC ANALYSIS OF PULSE CROP PRODUCTION IN WESTERN CANADA

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As consumers regard for corporate responsibly increases, governments, industries and organizations have begun to assess the sustainability of their activities. As such, the environmental, social and economic effects of pulse crop production in western Canada are being examined via lifecycle assessment (LCA) and farm level rotation-based profit functions. There are many pulse crops produced worldwide; however, those produced in noteworthy amounts in Canada include dry pea, lentil, dry bean and chickpea. Pulse crops are desirable as they are known to break disease and pest cycles, as well as fix atmospheric nitrogen through symbiotic association with Rhizobia. By including pulse crops in a rotation, requirements of fertilizer, pesticide and insecticide application may be reduced. These changes may have major financial implications for the producers. In addition, reduction in the demand for inputs may reduce input price and associated environmental effects through production and transportation. The effects of introducing dry pea and lentil into canola-wheat rotations were investigated in this study. The results demonstrated lower environmental impacts in all categories compared to the business as usual scenario. The results of the economic analysis indicated that pulse crop-containing rotations generated higher net return over variable as well as total costs. Sensitivity analyses were performed on all major assumptions in the study. The results of the study will help pulse producers to identify the most sustainable production activities and, thus, make changes in operations.

INFLUENCE OF TILLAGE, CROP RESIDUE, N FERTILIZER AND LIQUID SWINE MANURE MANAGEMENT ON GREENHOUSE GAS EMISSIONS

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We summarized results of field experiments in Saskatchewan to determine the impact of Tillage, crop residue, fertilizer and manure management practices on nitrous oxide (N_2O) emissions and ammonia (NH_3) volatilization. In an 8-year study at Star City with no-tillage and conventional tillage, straw retained and straw removed, and 4 N rates (0, 40, 80, and 120 kg N ha^{-1} N_2O emissions were usually higher under conventional than no-tillage. At Star City, where alfalfa was terminated with 3 methods (herbicide – NT, tillage, and herbicide + tillage), 3 timings (after first cut, after second cut, and spring) and followed with 4 N rates (0, 40, 80, and 120 kg N ha^{-1}) herbicide-NT termination method had the lowest N_2O loss in the termination year or in the first crop year following termination. In a 3-year polymer-coated urea (PCU) study at Star City, (N_2O loss was lower on PCU compared to urea. In a liquid swine manure (LSM) study with LSM application at 1x (annually), 2x (after every 2 years) and 3x (after every 3 years) rates (1x = 3000 L ha^{-1}), (N_2O emissions from LSM were higher than on urea, and for LSM at 3x compared to 1x rate. In a 3-year study at two sites (Star City and Swift Current) with application of anaerobically digested swine manure (ADSM) and conventionally treated swine manure (CTSM) at 1x and 3x rates in autumn and spring, and annual spring application of urea-ammonium nitrate (UAN) solution at 1x rate, NH_3 O loss from ADSM was equal to CTSM, except for CTSM at 3x rate which was higher than other treatments. Nitrous oxide losses were highest from CTSM > ADSM = UAN. In conclusion, proper soil, crop, fertilizer and manure management practices can reduce the potential for gaseous N loss, and this is good for the environment.

KEYWORDS: nitrous oxide, tillage, manure, ammonia volatilization, forage termination

THE GAIN OR LOSS OF SOIL: A MATTER OF MOISTURE AND CARBON

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Soil moisture is one factor that affects plant carbon input and soil mineralization simultaneously, and is important to understand in the current analysis of gas exchange from soil. The relationship of soil moisture to soil organic carbon (C) was analyzed across three years of data from microplots in southern Ontario, Canada, where oats (Avena sativa) were grown in a comparison of plant (presence/absence), residue of varying quality (present/absent) and residue placement (mixed in/surface applied). Soil physical properties, fungal indices, and water repellency were also measured to assess specific relationships between soil variables. Our study found surface residue instrumental in soil C increases in wet conditions and in limiting soil C decreases in dry conditions. Surface residue reduced the loss of water repellency from plant mineralization 50% in dry conditions, which corresponded to the reduction in soil C loss as well. With all treatments, over a wide range of soil moisture conditions, there was a strong correlation between soil moisture, percentage macroaggregates, soil C and water repellency. The significant correlation of soil C to AM colonization and water repellency in treatments with plants supports the theory that soil C increases when carbon input is also associated with increased resistance to decomposition. By including surface residue in agriculture there is increased moisture retention with larger pore space and aggregate size, while mineralization is inhibited at finer scales. This theory needs to be confirmed and developed to optimize soil moisture retention in highly variable weather conditions.

KEYWORDS: soil organic carbon, crop residue, fungal hyphae, soil moisture, macroaggregate, water repellency

CHARACTERIZATION OF ARSENIC-BEARING CO-PRECIPITATION PRODUCTS FORMED IN BANGLADESH GROUNDWATER

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In many areas of Bangladesh, groundwater is severely contaminated by arsenic (As) and other solutes, such as iron. After water withdrawal, the bivalent iron is re-oxidized and precipitates in reddish-brown flocks scavenging As from the water. Great amounts of these co-precipitates are formed in water reservoirs, water treatment plants and in paddy fields after irrigation. The characteristics of these As-bearing materials are not yet clear and their environmental impact is thus hard to predict. The aim of this work was the chemical, physical and mineralogical characterization of co-precipitates formed from groundwaters in Bangladesh. Samples of co-precipitates were taken from different sites in Satkhira District, SW Bangladesh. XRD, specific surface area, surface charge, and elemental analyses were conducted for the characterization of the bulk samples. The As speciation in the solid was obtained by XANES spectroscopy. AFM, TEM-EDS, and SEM-EDS analyses allowed detailed observations. The co-precipitates are composed by a heterogeneous material, mainly consisting in amorphous and poorly-crystalline phases, with 30-40% Fe, 5-10% Ca, 2.5-6% P, 2.5-4% organic C (2-4%) and inorganic C (1-4%). Arsenic (0.2-0.5%) is present in both tri- and pentavalent forms, mainly diffusely distributed within the amorphous matrix. Particular amorphous aggregates with bacillar and spherulitic forms were observed. The crystalline phases consist of calcite, Ca- and Fe-phosphates. The complex distribution of P, As, Fe and Ca between the co-precipitate components suggests the adsorption of P and As on the iron oxides surfaces, but does not exclude the possible nucleation of Ca-Fe arseno-phosphates. It appears that ageing does not increase the crystallinity of these materials. Therefore, the high surface reactivity may persist in several natural environments.

KEYWORDS: arsenic, iron, co-precipitation, Bangladesh, groundwater

IRON-RICH SNOW AND WATER IN AN ALPINE SITE (NW-ITALY): EFFECTS OF SOIL-SNOW INTERACTION ON MICROBIAL REDOX PROCESSES

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Reddish-coloured snow appears every year at the snow melting in an alpine marshland/spring area located at Fontainemore, 1750 m a.s.l., Aosta Valley, Italy. The reddish material is mainly built up by iron oxides. In the zone, high Fe concentrations in drinking water are often reported. To identify the forms and sources of iron, the water was periodically sampled from soil-snow interface and from soil solution. Three soil profiles were studied in a toposequence on the mountain slope where the reddish snow was observed. The presence of iron-reducing bacteria in soil was verified. High concentrations of bivalent iron [Fe(II)] (up to 14 mg/l) were dissolved in the water, even before the beginning of the snow melting. As the snow melting proceeded, the Fe(II) concentration remained high in the soil solution and varied irregularly at the soil-snow interface with a decreasing trend. The iron concentrations in soil were higher in the upper, organic horizons of the marshland zone, and decreased with depth; a reverse trend was observed in the two profiles at higher elevation. In the marshland profile, the poorly crystalline iron forms prevailed, possibly with the formation of organic matter-Fe complexes. In the other two profiles, the total iron was lower and the crystalline forms prevailed. Populations of iron reducing bacteria were enriched and isolated from the soil, suggesting that the iron enrichment of the water may be a microbially-driven reduction process allowed by the insulating properties of the snow cover during the winter season, and enhanced by the water saturation at the snow melting. Therefore, soil-water-snow interaction could have a relevant although scarcely studied impact on pedogenetic processes and mobility of nutrients and contaminants.

KEYWORDS: iron, redox processes, soil-snow interaction, water, microorganisms

COMPETITIVE ADSORPTION OF ARSENITE AND ARSENATE WITH ORGANIC PHOSPHORUS ON GOETHITE

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Inorganic arsenite and arsenate are among the most diffused and toxic As forms in soils. Inorganic phosphate is known to strongly compete with arsenic for adsorption in soil environments. Although organic forms, mainly inositol phosphates, can represent over 50% of total soil phosphorus, the competition between organic P forms and arsenic is still to be investigated.

The aim of this work was to study the effects of pH and interaction time on the competitive adsorption of arsenite or arsenate with inositol hexaphosphate (IHP) on goethite. Arsenite, arsenate, and/or IHP were adsorbed on goethite in succession or in mixture at pH 4.5, 6.5 or 8.5. The interaction time varied from 2 hours to 10 days. IHP strongly competed with arsenic for adsorption at all the investigated pH. The pre-adsorbed IHP inhibited arsenate more than arsenite adsorption and was not removed by arsenic at any pH. A great part of both pre-adsorbed arsenic forms was removed by IHP, particularly at low pH and short interaction times. When added simultaneously, the adsorption of IHP prevailed and reached a more rapid equilibrium compared with arsenic. At short interaction times, some arsenite and almost no arsenate were adsorbed; at increasing times, however, some arsenic adsorption, but not IHP adsorption, continued to occur, possibly for the diffusion inside the small pores of the oxide, not accessible to the bigger IHP molecule. A gradual decrease in the electrostatic repulsion also occurred, since IHP adsorption made goethite surfaces strongly negative; however, the negative charge progressively decreased with time. The results suggest that organic forms of phosphorus, such as inositol phosphates, can strongly affect arsenic adsorption/desorption on/from soil surfaces, as well as arsenic speciation in solution. Hence, inorganic phosphate is not the only P form to be considered when assessing arsenic mobility at the soil-solution interface.

KEYWORDS: arsenic, organic phosphorus, adsorption, desorption, competition

ARSENIC OXIDATION AND REDUCTION IN THE GROWTH MEDIA AND BIOMASS OF HYPERACCUMULATOR *PTERIS VITTATA* L.

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The study determined the role of plant and microbes in arsenite (AsIII) oxidation in the growth media and the location of AsIII oxidation and arsenate (AsV) reduction in P. vittata biomass. P. vittata grew in 0.10-0.27 mM AsV or AsIII solution under aerated or sterile condition for 1 h to 14 d. Arsenic speciation was conducted in the growth media, roots, rhizomes, rachis, pinnae, fronds, and sap of rhizomes and fronds. Arsenite was rapidly oxidized in the growth media by microbes (18-67% after 1 d) and was then further oxidized in the roots of P. vittata (35% AsV in the roots growing in AsIII media). While limited reduction occurred in the roots (92-93% AsV), AsV reduction mostly occurred in the rhizomes (68-71% AsIII) and pinnae (>90 AsIII) of P. vittata. Regardless AsIII or AsV was supplied, AsV dominated in the roots while AsIII dominated in the fronds. AsIII translocation from the roots to the fronds was more rapid than AsV. This study shed new insights into arsenic transformation in the growth media and P. vittata biomass and raise new question into the tissue distribution of arsenate reducing and oxidizing enzymes in P. vittata.

KEYWORDS: sap, speciation, reduction, oxidation

A 2020 VISION FOR FOREST SOIL RESEARCH: BUILDING ON THE WORK OF OUR PREDECESSORS

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Diverse types of forests and forest management approaches are required to meet increasing socio-economic demands on ecosystem services. Widespread threats to forest soils such as acid deposition, nitrogen saturation, inappropriate harvesting practices and deposition and accumulation of toxic compounds present increasingly complex management challenges. While modeling has and will continue to be an integral part of our research it is essential that we include monitoring, soil surveys and long-term research installations as part of our future research. Long-term measurements provide the foundation for building and validating models and are necessary to assess current and future trends of forest soil conditions. The drivers of research, such as bioenergy and rehabilitation of degraded lands, are continually changing; however, the fundamental processes remain the same. For example, previous studies of N dynamics concerned primarily with tree growth and productivity provided the knowledge required to understand and study the effects of N on soil microbial populations and plant diversity, leaching losses of cations, eutrophication and denitrification. Vulnerability, resilience and soil health are emerging concepts that will enable greater understanding and assessment of long-term effects on forest soils. This presentation will build on these ideas to consider potential directions of forest soil research.

KEYWORDS: forest soils, long-term research, soil disturbance, future directions

ECOSYSTEM SERVICES IN THE BIOECONOMY: BALANCING SUSTAINABLE DEVELOPMENT PRIORITIES

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The economic impact of biotechnology has been growing rapidly for several decades. While this growth is beneficial in terms of increasing the global food supply, careful policy development to guide the continued bioeconomy growth can have multiple public benefits. With sustainable development as an underlying objective, this can also lead to increased revenue streams for farmers by creating markets for biomass from wetlands and forests, as well as markets for Ecosystem Goods and Services. Biotechnology can support sustainable development by improving the environmental efficiency of primary production and industrial processing, and by helping to repair degraded soil and water.

This presentation will explore new value chains possible in the bioeconomy and how effective policy implementation can target this potential towards multiple sustainability objectives, from greenhouse gas mitigation to improving water and food security. The presentation will conclude with a description of a new IISD initiative to examine advanced biorefining from an Ecological Goods and Services perspective.

DYNAMICS OF DIFFUSIVE PHOSPHATE IONS IN THE TOP-SOIL OF NO-TILL VS. MOULDBOARD PLOUGHING

Aimé J. Messiga, Noura Ziadi, Agriculture and Agri-Food Canada (AAFC), Christian Morel, Institut National de la Recherche Agronomique Cynthia Grant, Agriculture and Agri-Food Canada (AAFC) and Léon-Etienne Parent, Laval University

Soil P bioavailability is controlled by two important components, the dissolved phosphate ions of the solution (Pi) and the diffusive phosphate ions (Pr) of the solid phase. Molecular diffusion is the main mechanism of P biogeochemical cycle governing Pr transfer at the solid-solution interface. In the no-till (NT), Pi accumulates in the first 5 cm below the soil surface. Our objective was to determine the effect of tillage on the dynamics of Pr at the solid-solution interface in the topsoil. Soils were sampled (0-5 cm) in a long term corn/soybean rotation under NT and mouldboard plough (MP). Soil suspensions (M/V:1/10) with increasing P rates (0, 10, 20, 50 and 100 mg P kg–1 soil) were shaken for 40 hours to reach a steady state condition. The Pi were marked with a quantity R of 32P ion and the remaining radioactivity r in solution was measured at three time (t) intervals (4, 40 and 400 min). The kinetic Freundlich equation that describes the transfer of Pr from the solid phase into the solution was influenced by the tillage system. The Pr values varied with the concentration of Pi (Cp) and t and were described by the equations, Pr=23.20Cp0.43t0.27 for the NT (r^2=0.97), and Pr=19.90Cp0.42t0.30 for the MP (r2=0.99). For similar Cp values, the amount Pr obtained with increasing periods of transfer was always lower in the NT than the MP, while for the respective measured initial Cp the amount of Pr with increasing periods of transfer was higher in the NT than the MP. The characteristics of the diffusive P supply derived from the kinetic Freundlich equation showed that the NT soil has a greater ability to supply P and therefore to maintain higher levels of Pi in the topsoil.

KEYWORDS: Diffusive P ions, Solution P ions, Tillage, Topsoil

CHANGES IN SOIL PHOSPHORUS AVAILABILITY AND OTHER NUTRIENT ELEMENTS AS AFFECTED BY TILLAGE AND P FERTILIZATION

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Tillage management and cropping intensification influence soil nutrients supply and demand including P. Our objective was to investigate in a 2-year corn (*Zea mays* L.) and soybean (*Glycine max* L. (Merr.)) rotation, the long term effects on soil P status and other soil nutrients of an annual P application. The study was conducted in Quebec, Canada, on an experiment established since 1992 on a clay loam soil. Two tillage systems, no-till (NT) and mouldboard ploughing (MP), and three P fertilizer regimes (0, 17.5 and 35 kg P ha^{-1} applied during the corn phase of the rotation) were implemented. Soil (0-15 cm) was sampled in the fall and spring at the end of four successive cycles of the 2-year corn and soybean rotation (2000-2001, 2002-2003, 2004-2005, and 2006-2007). Crop yields were affected by tillage in 2 rotation cycles. Higher yields were obtained in the MP and higher level of exchangeable K was observed under NT compared with MP probably as a result of K released by crop residues not incorporated in the soil. For the soil test Mehlich-3 P (PM3), the general trend was an increase from fall to spring in NT plots receiving the 35 P treatment. Soil test PM3 decreased across P treatments during the successive 4 rotation cycles. For the treatment 0 P, soil test PM3 decreased until reaching 30 and 25 mg P kg^{-1} in the NT and MP, respectively. Decreasing soil test PM3 could be explained by the P budgets which were negative across P rates. In these 2-year corn/soybean rotation cycles where P was applied according to corn P requirements, the P budget for the whole cycle showed that crop P exportation by the grain exceeded the P supplied by fertilizers. A direct consequence was PM3 depletion in the soil.

KEYWORDS: corn/soybean rotation, P budget, P availability, tillage

ATMOSPHERIC CONCENTRATIONS OF CURRENTLY USED PESTICIDES IN RELATION TO WETLAND WATER QUALITY IN MANITOBA, CANADA

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The purpose of this study was to determine air concentrations of pesticides and also assess the impact of atmospheric deposition of pesticides on wetland water quality. The study included taking weekly air samples and bulk atmospheric deposition (rainfall + particulate deposition) samples from May 26 to September 15, 2008 at the Manitoba Zero Till Research Association (MZTRA) Farm, Brandon, Manitoba. Water samples were taken from four on-site wetlands (approximate sizes 0.15 - 0.45 ha) every second week. The samples were analyzed for 11 currently used herbicides and three legacy pesticides. In addition, the bulk deposition and wetland water samples were also analyzed for the herbicides glyphosate and glufosinate. 12 pesticides were detected in the air, with MCPA, triallate, and gamma-HCH being detected every week. Nine pesticides were detected in bulk deposition samples with MCPA again being the most frequently detected compound (76%) followed by 2,4-D (65%). Nine pesticides were found in the wetland samples but the detection frequencies were very low with the exception of clopyralid (100%) and MCPA (57%). Maximum concentrations in wetland water was 0.34 µg L^{-1} for clopyralid and 0.17 µg L^{-1} for MCPA with maximum air concentrations of 3.71 ng m-3 and 1.84 ng m^{-3}, respectively, and maximum bulk depositions of 16.99 µg m^{-2} $week^{-1}$ and 70.87 µg m^{-2} $week^{-1}$, respectively. Calculations were performed to predict wetland concentrations of MCPA, clopyralid, glyphosate, 2,4-D, and bromoxynil due to the atmospheric deposition of these chemicals. The estimated concentrations were close to actual concentrations for MCPA, 2,4-D, and bromoxynil, but not for clopyralid or glyphosate suggesting a source other than atmospheric deposition.

KEYWORDS: pesticides, water quality, wetland, atmosphere

THE IMPACT OF EIGHT HERBICIDES AT ENVIRONMENTALLY RELEVANT CONCENTRATIONS IN PRAIRIE POTHOLE WETLANDS ON AQUATIC INVERTEBRATES

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There are several reports showing that wetlands within the Prairie Pothole Region of Canada are widely contaminated with a suite of herbicides. There is a lack of eco-toxicological field data on the effects of herbicide mixtures and other contaminants on aquatic organisms. The study objective was to determine the effects of elevated levels of herbicides on zooplankton and nekton communities within spiked wetlands. One permanent and one ephemeral wetland were selected at the Manitoba Zero Till Research Association Farm, near Brandon, MB. The wetlands were divided with lake-dividing curtains and sweep net samples were taken on each side to collect aquatic invertebrates once a week for three weeks beginning May 26, 2008. Following the third week of sampling a mixture of eight herbicides were added to one side of each wetland at levels ranging for individual herbicides from 62–179 µg/L. These concentrations were selected to simulate the concentration that would be found in the wetland following an accidental direct overspray event of a farmer applying herbicide products on the field at manufacturer recommended application rates.

Nine weeks of invertebrate sampling on both sides of each curtain followed. The invertebrate data were analyzed using principal component analysis (PCA) biplots to visualize differences between the species composition for the 12 sampling dates by treatment (herbicide added versus control). Invertebrate assemblage abundances were also used to assess the effects of the herbicides over the sampling period. The fates of the eight herbicides in the wetlands were examined by determining weekly herbicide concentrations in both the water-column and bottom sediments. Based on the PCA analyses, no differences in invertebrate abundances or composition were seen in either the ephemeral or permanent wetland, suggesting that the herbicides studied have no short-term effects on the invertebrate community. However, differences in invertebrate composition were evident between the ephemeral and permanent wetlands.

KEYWORDS: pesticides, wetlands, invertebrates

YIELD AND SOYBEAN CHARACTERS UNDER SOME INTERCROPPING PATTERNS WITH CORN

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Two experiments were conducted at Gemmeiza Agric. Exp. and Res. Station, ARC, El-Gharbia Governorate,Egypt,during 2006 and 2007 summer seasons to investigate the possibility of increasing intercropped soybean yield by raising each of soybean plant density and intercepted light on soybean through intercropping patterns. Intercropping pattern comprised alternating and mixed ridges between corn and soybean. Alternating ridges (70 cm/ridge) between corn and soybean were used as 2:2 and 2:4, respectively, soybean was grown in alternating ridges by two rows/ridge (N) in normal plant population density (2:2 and 2:4),in addition to another single row on the other adjacent side of corn ridges to increase the density of the intercropped soybean plants (H) by about 25% than normal density (N) for the two intercropping patterns 2:2 and 2:4. In mixed pattern, four rows of soybean were planted on the wide ridge (140 cm/ridge) by two rows on each side,while,corn was grown on middle of the ridge.Two patterns of solid planting were adopted as those of alternating and mixed patterns. Soybean plants were grown in 2 plants/hill (15 cm apart),while,corn was distributed in two plants/hill (30 cm apart) and four plants/hill (60 cm apart).Corn variety T.W.C.310 and two soybean varieties (Giza22 and Giza111) were used.Solid planting patterns had higher values for soybean seed yield and its components than those of intercropping patterns,whereas,the reverse was true for seed protein content.Growing corn and soybean in 2:4 ridges by using high soybean density (2:4 H) gave higher values for yields of seed, oil and protein/ha as compared with those of normal population of 2:4 (N) and other patterns. The soybean variety Giza22 had higher values for all the studied parameters, except seed index,than the other variety. All the studied parameters were increased by doubling distance between corn hills from 30 to 60 cm apart, whereas,the reverse was true for seed protein content.

KEYWORDS: Intercropping, Soybean, Corn, Soybean plant densities, Seed oil and protein contents

INFLUENCE OF OFF-STREAM WATERING WITH AND WITHOUT FENCING ON ENVIRONMENTAL QUALITY OF THE LOWER LITTLE BOW RIVER AND ASSOCIATED LANDSCAPE IN SOUTHERN ALBERTA

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The goal of beneficial management practices (BMPs) such as off-stream watering with and without fencing is to prevent or reduce water pollution of surface water bodies. We conducted a four year (2004-2007) study on a fenced and unfenced reach with off-stream watering located on the Lower Little Bow (LLB) River in southern Alberta. Our hypothesis was that riparian health would be improved by streambank fencing, and that cattle exclusion would prevent water pollution within the fenced reach. Physical, chemical, and microbiological variables in the river were determined throughout the four years, and water quality variables at the upstream (control) and downstream (BMP-impact) sites during the post-BMP phase were evaluated using a paired t-test. The overall health of the riparian area, based on a visual assessment of vegetative, soils, and hydrologic features, was improved from a score of 65% (healthy but with problems) for pre-BMP phase in 2001 to 81% (healthy) for post-BMP phase in 2005. The majority of water quality variables were not significantly ($P > 0.10$) different at the downstream and upstream sites during streambank fencing. The evidence from our study indicated that streambank fencing improved the riparian health, and that the BMP prevented the majority of water quality variables from increasing downstream. Results on the effect of cattle-excluded pastures associated with streambank fencing on environmental quality and runoff, and the influence of natural and artificial watering systems on soil nutrients, will also be discussed.

KEYWORDS: streambank fencing, off-stream watering, riparian health, water quality, cattle-excluded pastures

LEACHING OF NITRATE, CHLORIDE, AND PHOSPHORUS FROM UNDISTURBED SOIL CORES AMENDED WITH FRESH OR COMPOSTED BEEF CATTLE MANURE

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Although fresh beef cattle (Bos Taurus) manure has traditionally been applied to cropland in southern Alberta, Canada, in application of composted manure has recently increased in this region. The implications of fresh manure (FM) versus composted (CM) beef cattle manure on N and P leaching has not been investigated. Our objective was to compare N and P leaching potential under FM and CM annually applied at 77 Mg ha^{-1} dry wt. for nine years to a clay loam soil compared with a non-amended control (CON). Intact soil cores were taken from a field experiment in the spring of 2007. Deionized water was applied to the soil cores in the laboratory under steady-state (4.9 cm d-1) and near-saturated conditions. Concentrations of NO_3^- N, Cl, and dissolved reactive P (DRP) were measured in the leachate and breakthrough curves, flow-weighted mean concentrations (FWMC), and cumulative mass loss curves obtained. Peak concentrations of NO_3^- N, Cl, and DRP were greater for CM than FM. For example, the peak concentration of NO_3^- N was 27% to 3 fold greater for CM (400 mg L^{-1}) than FM (315 mg L^{-1}) and the CON (142 mg L^{-1}). The FWMC and total mass loss of these four chemicals were similar for FM and CM, but values were significantly ($P \leq 0.05$) greater for the amended than unamended cores. Recovery of N and P in leachate as a percentage of total N or P in the soil prior to leaching was negligible ($\leq 1\%$) for FM and CM. Macropore flow, as evident by early peak concentrations before one pore volume, was evident for NO_3^- N and Cl under CM than FM, but was not evident for DRP.

KEYWORDS: fresh cattle manure, composted manure, leaching, nitrate, chloride, phosphorus, soil cores

ORGANIC LESSONS FOR CONVENTIONAL AG IN WHEAT-FALLOW MONTANA: DO GREEN MANURES MAKE AGRONOMIC SENSE?

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Legume green manure (LGM) common to organic systems, may fit in no-till (NT) wheat-fallow cropping systems. Fallow in the northern Great Plains declined from a 1971 peak of 16.8 to 4.8 million ha in 2007. The wheat growing area of north central MT is an exception with fallow steady at 0.8 million ha from 1998 to 2009. Desire to manage this staid wheat-fallow system more sustainably, coupled with high N fertilizer cost, is prompting NT farmers to seek biological N. Management is a knife-edge balance between LGM growth (and N2 fixation) and soil water use. Key issues for LGM's are growth period, associated seed and weed management costs, and optimal tillage methods. Organic research near Big Sandy, MT, showed a marked advantage for winter pea compared with spring pea for water-use-efficient N contribution to winter wheat. Although winter pea conferred the most WUE N contribution, winter survival remains a key adoption risk. Current NT research near Bozeman investigates economic and energetic budgets associated with alternative LGM strategies, varying growth period for pea and lentil (fall, spring, and summer sown) and tillage. Soil water use by LGM has been partially offset by reduced evaporative loss during June-September compared with bare fallow. In 2007-08 there was no effect of LGM species or tillage on wheat yield, but pea green manure improved wheat grain protein by 1%-unit. In 2008-09, pea and lentil green manures increased wheat yield by an amount > 25 kg ha^{-1} of N fertilizer, and tillage affected that benefit. Tilled LGM treatments accumulated 25 mm less soil water over winter than NT treatments. Current field-scale research in north central MT is tracking plot-scale results. However, it is apparent that seeding rates used for pea and lentil production are too great to make LGM economically viable, except at high fertilizer N prices.

KEYWORDS: fallow, legume green manure, nitrogen, semiarid, water

CANADIAN PEATLANDS AND GLOBAL CHANGE

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Canadian and other northern peatlands have stored large amounts of organic carbon, sequestered from atmospheric carbon dioxide, and are significant sources of methane. They, along with other ecosystems, are facing changes associated with climate change, land use change and atmospheric deposition. Based on work conducted at the Mer Bleue peatland near Ottawa, I examine three aspects of the response of this system to change. First, the multi-year budget of carbon dioxide, methane and dissolved organic carbon in this system. Second, a five-year record of methane flux from sites within the peatland and the control of intrinsic versus extrinsic factors. Finally, the effect of elevated rates of atmospheric nitrogen deposition on vegetation and carbon dioxide exchange.

KEYWORDS: greenhouse gases, climate change, boreal, arctic

A METHOD FOR SELECTING LOW CADMIUM (CD) ACCUMULATING SOYBEAN VARIETIES

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There are variety differences for seed Cd concentration in soybean. Research has shown that high Cd accumulation is likely a recessive characteristic controlled by a single gene with modifiers. Breeding for food type soybean with low Cd concentration will be facilitated if a method can be developed to select for low Cd accumulating plants in the vegetative stage, rather than waiting until seed development. Soybean varieties from a cross between high and low accumulating varieties were grown in the field and the seed tested for Cd concentration. These lines were grown in hydroponic conditions in a growth cabinet. At the appearance of the first trifoliate, 250 ppb Cd was added to the water. Within three days, symptoms of Cd toxicity appeared on the high accumulating lines. Eleven days after treatment the first trifoliate leaf was sampled, dried, digested and analyzed on a furnace atomic absorbance spectrophotometer. Cabinet leaf Cd results were higher than field seed Cd concentrations but reflected the Cd uptake ability of the plants.

KEYWORDS: soybean, cadmium, selection

PROBABILITY DISTRIBUTION FUNCTIONS FOR NITROUS OXIDE FLUXES

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Quantitative analysis of probability and statistics for N_2O fluxes is difficult due to variability of environmental factors reflected in statistical distributions. The most common approach to statistical analyses in the scientific literature is to transform data with a log function, or to conduct non-parametric tests. Alternative probability functions for N_2O fluxes should be considered for calculation of statistics and probability.

KEYWORDS: cumulative probability distribution function, mean, variability

ELECTRICAL CONDUCTIVITY AS AN INDICATOR OF WETLAND HYDROLOGY

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The Prairie Pothole Region of North America is home to several million wetlands which filter water and provide wildlife habitat. Wetland hydrology is important to wetland function as it drives the transport of organisms and contaminants between basins. The objective of this study was to determine if electrical conductivity (EC), a measure of dissolved ion concentration in wetland water, can be used as an indicator of wetland hydrology within the Prairie Pothole Region. 283 basins near Brandon, Manitoba were identified by northing, easting, and elevation. Each basin was classified by permanence (Class 1 to 5, with 5 being more permanent), farm-scale catchment (Group A to AG), and position within the farm-scale catchment flow pattern (Drainage Order 1 to 18, with high-order basins receiving water from low-order basins). From 2007 to 2009, the EC of each basin holding water was measured from May to August. EC was found to increase linearly with elevation, indicating that the basins are connected mainly by surface and near-surface flow. Spring EC values had a positive linear relationship with Drainage Order indicating that the interbasin connectivity is a spring phenomenon. Also, EC can be used as an indicator of spring flow pattern. No relationship was observed between EC and wetland Class or Group. The findings from this study have implications for the timing of chemical applications to agricultural land within the Prairie Pothole Region since late-winter and early-spring applications have the potential to be transported between wetlands and to nearby streams via surface and near-surface flow.

KEYWORDS: wetlands, electrical conductivity, hydrology, prairie pothole region

CHARACTERIZING SOIL CARBON AND NITROGEN STATUS IN A SMELTER-AFFECTED AREA OF THE CANADIAN BOREAL SHIELD

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The Canadian Boreal Shield area surrounding Flin Flon, Manitoba and Creighton, Saskatchewan has suffered forest dieback due, in part, to anthropogenic disturbances related to the local mining and smelting industry. These disturbances have included tree harvesting for fuel and lumber to support the mine and smelter operations and metal and acid deposition from smelter emissions. Since the late 1990s, limestone has been applied to soil in an attempt to re-vegetate barren landscapes; however only moderate success has been achieved. The inconsistent vegetation response to liming may be attributed to variations in soil organic matter (SOM) quality and overall soil nutrient status. In order to determine why vegetation growth is not consistent in all areas, two 3 km transects were established North and South of the smelting stack. Samples were taken at 0 – 5 cm and 5 – 15 cm increments every 100 m for the purpose of characterizing select physical, chemical and microbial SOM fractions. This includes measurement of dissolved organic carbon (C) and nitrogen (N), light and heavy fraction C and N and microbial biomass C and N. In addition, whole soil C and N concentrations, pH, cation exchange capacity and particle size distribution will also be measured. Results will be summarized with respect to distance from the smelting stack and extent of vegetation growth (% ground cover and % woody cover). Findings will identify C and N variations in SOM and whole soils in the Flin Flon-Creighton area and help support the development of future eco-restoration and revegetation strategies.

KEYWORDS: carbon, nitrogen, soil organic matter, revegetation

EFFECT OF CORN (ZEA MAYS L.) BIOMASS REMOVAL ON SOIL NITRIFYING MICROBES, DENITRIFYING MICROBES AND N_2O EMISSIONS DURING A SPRING THAW EVENT

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Fluxes of N_2O from the soil surface diffused to the atmosphere are influenced by factors that affect microbial processes within the soil profile. These factors include soil temperature and available moisture, which have been shown to influence denitrification and the nitrous oxide flux from soil during freezing and thawing. For this reason, the timing of this study was during the spring thaw of 2010. Understanding how soil microorganism populations are controlled by crop production practices, such as biomass removal, provides greater insight into potential nutrient loss by denitrification and N_2O emissions. The objective of this study was to relate the timing of N_2O flux during a spring thaw event to the presence of active nitrifying and denitrifying microorganisms in soil with corn biomass harvested and returned. N_2O fluxes were measured half hourly using a tunable diode laser trace gas analyzer. Soil samples were collected every 24-48 hours over a two week period during the spring thaw event. From the soil samples, RNA/DNA was extracted and genes associated with nitrification and denitrification were quantified using RT PCR. The previous fall, corn biomass was harvested as dry silage in the first plot, and grain was harvested, with the corn biomass returned to the soil on the second plot. Both plots were conventionally tilled. Determining the abundance of soil nitrifying and denitrifying populations will help determine the short term impacts of corn biomass removal, on soil microbial activity, denitrification and N_2O emissions.

KEYWORDS: nitrous oxide flux, spring thaw, soil nitrifying microorganisms, soil denitrifying microorganisms, corn biomass removal

ON-FARM REMEDIATION OF PESTICIDES WASTE USING BIOBEDS

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Pesticides play an active role in modern agriculture and have been in use for years to increase agricultural productivity. However, pesticide waste disposal is a major concern to producers. Recent studies in Canada and other countries have found pesticides in surface and underground water, sometimes at concentrations higher than allowed by regulatory authorities. To address this situation, biobeds were introduced in Sweden in 1993. A biobed is an on-farm installation that serves to contain and degrade pesticide waste. The biobed substrate is a mixture of compost, topsoil and straw (1:1:2 v/v/v). The components of this mix serve to hold high moisture and create an environment suitable for microbial degradation of pesticides. The objective of this study is to quantify the breakdown of pesticides in biobeds and to understand the microbial dynamics associated with this breakdown under Canadian climatic conditions. Initial studies showed that the half-life of the herbicide 2,4-D was reduced five-fold in a biobed substrate compared to topsoil. Laboratory studies showed that CO_2 evolution lagged several days after initial addition of 2,4-D, but then spiked sharply above background levels for several days before returning to normal levels. Subsequent additions of 2,4-D to the same substrate resulted in an immediate release of CO_2 in a similar spike, suggesting a build-up of degrading microbes after the first addition. The quantity of CO_2 evolved from the biobed substrate increased with the quantity of herbicide applied. In soil, an overall increase in CO_2 evolution was also observed after 2,4-D addition, but evolution did not increase sharply at the time of application. Laboratory and field studies are currently underway to study some practical aspects (temperature and moisture requirements) for implementing biobeds on a farm-scale in Canada.

KEYWORDS: biobeds, pesticides degradation, carbon dioxide

NUTRIENT FLOWS ON MARITIME DAIRY FARMS

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Whole farm nutrient budgets can be useful management tools in assessing the nutrient status of dairy farms. Following a whole farm approach, the flows of Nitrogen, Phosphorous, and Potassium on two dairy farms have been studied since January 2009. Farms in Havelock NB and Foxley River PEI were selected as representative farms for their regions. The budgets are calculated by quantifying managed nutrients imported, exported, and transferred between the farm components. The field components include all crop producing land and the animal components encompass all of the animal production units and waste storages. Inputs and outputs not quantifiable through farmer records were assessed through on-farm quadrat and composite sampling. Nutrients lost from the farms through unmanaged processes such as leaching or volatization are not being included in the budgets. Preliminary results from the NB study site reveal Nitrogen, Phosphorous, and Potassium use efficiencies of 23%, 14%, and 23%, respectively. A study of biological nitrogen fixation (BNF) on selected fields is attempting to provide a clearer estimate of the contribution of BNF to nitrogen inputs. The results of this study aim to highlight the usefulness of a whole farm approach for nutrient management in Atlantic Canada.

KEYWORDS: nutrient management, dairy, biological nitrogen fixation

SOIL CARBON DYNAMICS IN COMPLEX AGROECOSYSTEMS OF LATIN AMERICA

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The conversion of forests and natural grasslands to agricultural production systems has accelerated the mineralization of soil organic carbon (SOC). The objectives of this paper are to outline the most recent findings on the potential of complex agroecosystems in Latin America to sequester C and to greenhouse gas production rates. Results showed that an 18-year old agroforestry system with E. poeppigiana in Costa Rica increased its SOC at a rate of 1.1 Mg C ha^{-1} y-1 (40 cm). Soil from a Costa Rican silvopasture was not significantly different in C and N concentrations with time, but that of a conventional pasture decreased significantly with time. Correspondingly, soil microbial community structure, species diversity and richness were not significantly different in the silvopastoral system. We also observed that landowners in Costa Rica readily implemented agroforestry practices for soil conservation and C sequestration, especially as part of a payment for ecological services (PES). These landowners also noted a greater resilience of agroforestry systems during intense dry seasons. Preliminary results after the first three years of maize-legume intercropping in Argentina showed no significant differences in SOC content between the intercrop and maize or soybean sole crops two years after initiating these experiments. However, results showed that maize-legume intercropping systems had a significantly greater soil microbial biomass C compared to either sole crop maize or soybean treatments. Greenhouse gas production rates, over a 3-year period, showed no significant differences between treatments for CO_2, but the intercrops had significantly lower N_2O production rates compared to the sole crops. Results for CH_4 were variable. Research in Latin America suggests that over time, complex agroecosystems have the potential to sequester C, mitigate GHG production rates and show greater resilience to global warming compared to conventional agroecosystem land management practices.

KEYWORDS: Soil carbon, greenhouse gas, soil micobial biomass, microbial communities, agroforestry, intercropping

FIELD VERSUS FACTORY CALIBRATION OF FREQUENCY DOMAIN REFLECTOMETRY SOIL MOISTURE PROBES

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The value of soil moisture content for a broad range of applications has led to the development of many different soil moisture sensors. Frequency domain reflectometers (FDR) are instruments that can be deployed for in situ soil moisture measurements and tracked with a data logger. These probes work on the principle of the dielectric permittivity of the soil, a function mainly of the soil moisture volume. This provides high frequency updates on soil moisture status, which are critical for the development and testing of other methods for soil moisture determination, such as models and remote sensing. A network of soil moisture monitoring sites was established using the Steven's hydraprobe in central and eastern Manitoba for the purpose of testing soil moisture models. Prior to their deployment, in the field, each hydraprobe was tested using a laboratory calibration technique to ensure that they perform uniformly under controlled conditions based on the default factory calibration. However, absolute values of soil moisture are expected to differ with varying soil conditions in the field especially soil texture and bulk density. At each of the monitoring sites, four hydraprobes have been installed to monitor moisture levels at 4 depths (5, 20, 50 and 100 cm). Soil moisture readings from the hydraprobes are obtained using q = a (e)0.5 + b, where q is volumetric soil moisture content and e is the temperature-corrected real dielectric permittivity. The values for the coefficients (a, b) will be calculated from gravimetrically derived soil moisture content. These coefficients will be compared to the factory calibration for each soil textural class to determine the reliability of the factory calibrations and the extent of adjustment required to obtain accurate volumetric soil moisture readings.

KEYWORDS: hydraprobe, frequency domain reflectometer, FDR, soil moisture, calibration

TWO-DIMENSIONAL REDISTRIBUTION OF BROMIDE AS INFLUENCED BY NITROGEN FERTILIZATION AND LANDSCAPE POSITION

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Bromide has been widely used in field studies to estimate nitrate leaching in agricultural soils. This study examined the impacts of N fertilization on the vertical and lateral redistribution of bromide, and the subsequent recovery of Br^- in fall and spring seasons in a no-till hummocky landscape. The study was carried out near Brandon, Manitoba during the growing seasons of 2007-2008 and 2008-2009, denoted as Site-2007 and Site-2008, respectively. The plot was delineated into three discrete landscape positions as upper (UPP), middle (MID) and lower (LOW) slope. A microplot demarcated at each landscape position received ^{15}N labelled fertilizer in form of KNO3 at the rates of 0, 90 and 135 kg N ha^{-1}, and Br^- (KBr) at the rate of 200 kg Br^- ha^{-1} . Site-2007 was seeded to canola while Site-2008 was seeded to winter wheat. Soil samples were collected in the fall and spring seasons in both site-years and were analyzed for Br^-. Soil samples were taken within the microplot to a depth of 120 cm to obtain vertical distribution and up to 200 cm away from the microplot to obtain the lateral distribution of Br^-. The results showed that N fertilization reduced the downward movement of Br^- in the soil profile. This reduction resulted in the accumulation of Br^- in the fertilized plot, resulting in greater lateral movement of Br^- with N fertilization compared to the unfertilized plots. The greatest leaching loss of Br- was at the lower slope position, while the lateral movement of Br^- was considerably large at the lower landscape in both site-years. This study provided an experimental verification of the 'Campbell hypothesis' which states that proper nitrogen fertilization reduces nitrate leaching.

KEYWORDS: Bromide, leaching, landscape, vertical distribution, lateral distribution

ADSORPTION AND DESORPION OF FOMESAFEN IN LATOSOLS

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Fomesafen is registered, in Brazil, for post-emergent weed control in dry beans and soybeans; it has shown some carry-over effect on corn crops. The objective of this study was to determine the sorption and desorption of fomesafen in samples of a dystrophic Red-Yellow Latosol (LVAd) and a distroferric Red Latosol (LVdf), to acquire information that can be helpful to understand the carry-over effect observed in Brazil. Sorption isotherms were determined using a batch equilibrium method. Triplicate air-dried soil samples were equilibrated with 10ml of fomesafen solutions (0.5-15.0µg/ml) by shaking mechanically, during 4h. Equilibrium concentrations in the supernatants were determined by HPLC. Desorption was also evaluated, immediately after sorption, with 10mL of 0.01M $CaCl_2$. Sorption and desorption data were fit to the empirical Freundlich equation, $Cs=KfCe^{1/n}$. Correlation coefficients ranged between 0.90-0.95, and 0.64-0.91, for sorption and desorption, respectively. The Kf values for sorption ranged between 1.88 and 2.36. Sorption was greater for the LVdf than for the LVAd samples, and higher in the surface than the in the subsurface samples. The multiple linear regression of organic matter content (OM), soil pH and iron oxide content (IOx) vs. the distribution constant (Kd), for initial concentration of 5.0µg/ml, was performed: $Kd=19.247+0.128OM–3.490pH–0.00181IOx$ ($r^2=0.80$). The results showed that soil pH plays an important role in adsorption of fomesafen by the Latosols. Kd were determined in buffer solution at pH 4 and 5. These results showed that the decrease of one unit of pH caused a two-fold increase of the Kd for both Latosols. At low pH, most of the weakly acidic herbicides (fomesafen pKa=2.7) are present in the molecular rather than the anionic form. This result shows that fomesafen applied to agriculture soils (pH≈6) might be susceptible to redistribution within the soil profile, indicating greater potential of contamination of ground and surface water.

KEYWORDS: Pesticide, Freundlich equation, soil

POTENTIAL USE OF ENDOPHYTIC BACTERIA AS PLANT GROWTH PROMOTING INOCULANTS

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Endophytic bacteria can be recovered from inside plant tissues such as roots, stems and leaves. Some of these endophytes have beneficial effects on their host plants and stimulate plant growth or reduce disease symptoms, apparently through mechanisms that are similar to those proposed for plant growth promoting rhizobacteria. The objective of this study was to screen a collection of endophytic bacterial isolates for different direct and indirect plant growth-promoting mechanisms commonly found in soil rhizobacteria. Forty isolates obtained from the roots of canola and wheat plants were identified using 16S RNA gene sequencing, and the majority (i.e., 75%) identified as Pseudomonas species. Results indicate that 75-80% of isolates solubilized phosphate, synthesized siderophores, and produced IAA hormone. Some isolates exhibited ACC deaminase activity, and many (N=13) exhibited antifungal activity against several soil-borne pathogenic fungi under in vitro conditions. Of these 40 isolates, only 4 had the ability to perform all of the plant growth promoting mechanisms investigated here. The potential use of endophytic bacteria exhibiting multiple plant growth promoting traits as biofertilizers or biocontrol agents will be discussed.

KEYWORDS: endophytic bacteria, plant growth-promotion, P-solubilization, siderophores, IAA, ACC deaminase.

EFFECTS OF METAL CONTAMINATION ON SURVIVAL AND REPRODUCTION OF THE ORIBATID MITE *OPPIA NITENS* AND COLLEMBOLA *FOLSOMIA CANDIDA*

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Contamination of soil is often the most common form of anthropogenic stress in ecosystems and can pose threats to human health and the environment. This is especially worrisome in areas where mining activities have left backlog of metals in the soil and remediation efforts have not yielded much result. We therefore studied the effect of soils collected in the Flin flon area MB on the survival and reproduction of the oribatid mite Oppia nitens and collembolan Folsomia candida. Ten mineral soils were collected in the Flin flon area along a transect marked away from the smelter. The soils were analysed for physico-chemical properties and metal contents. Ecotoxicological evaluation with the O nitens and F. Candida were conducted for 28 days after which survival and reproduction of the invertebrates were assessed. Analysis with ICP-MS showed that the concentrations of Cu (62-2871 mg/kg) and Zn (378-5519 mg/kg) were the highest among the smelter metals detected in the soils but less than values earlier reported in the area. These soils could therefore only be considered as partly contaminated. There was no relationship between Cu and Zn concentrations of soil and survival and reproduction of O. nitens as well as survival of F. candida. However, significant positive relationship was found between Cu and Zn concentrations and reproduction of F. candida. Lack of metal effect on life-cycle parameters of the mite in comparison with the collembolan could be explained by the complicating effect of differences in OM content of the soils used, since reproduction of mites is mainly influenced by OM content and that of collembolan much less so. The results of this study has shown that metal contamination in the FLIN FLON area could have negative effects on soil invertebrates, and therefore affect ecosystem activities supplied by these organisms.

KEYWORDS: copper, zinc, soil organisms,

ECOTYPIC VARIATION IN REPRODUCTIVE PHENOLOGY AND SEED PRODUCTION OF FESTUCA HALLII

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Plains rough fescue (Festuca hallii (Vasey) Piper) is a native perennial grass in Western Canada. There is an increasing demand for seeds of this species for habitats restoration and forage production, but seed production in native prairies is very inconsistent. Preliminary analysis on the relationship between weather pattern and reproductive success indicates that fall and/or spring temperature and/or moisture may be related to the flowering. The objective of this study was to determine the morphological and phenological diversity among selected ecotypes of Festuca hallii from the Fescue Prairie of Western Canada. Seeds were collected from six sites in Saskatchewan and Manitoba and sowed in the field and seedlings were transplanted from field to greenhouse in early winter. Those seedlings did not produce flowers in the greenhouse, indicating natural vernalization was not sufficient to induce flowering. Therefore, they were subject to artificial vernalization treatment. Five of the six collections produced seeds after artificial vernalization treatment. Seedlings obtained from the Macrorie seed collection did not produce any seed. In comparison to other five sites the mean annual temperature, and growing degree days above 50C are highest at Macrorie and the mean annual precipitation is lowest. This study showed that field conditions and artificial vernalization did not accomplish the vernalization requirement in the Festuca halli population from Macrorie. Variations in morphological and growth attributes among ecotypes were found such as the number of vegetative tillers per plant, leaf size, aboveground/belowground biomass, and seed mass. These differences in the morphological and phenological characteristics among the ecotypes suggested that parental environment has a strong influence on the morphological and phonological development of this species. To overcome the inconsistency in seed production in this species it is essential to study the influence of different environmental factors on the reproductive characteristics of Festuca hallii.

KEYWORDS: plains rough fescue, ecotype, diversity, seed production

QUANTIFYING MERCURY AND GREENHOUSE GAS FLUXES FROM SOILS IN RESPONSE TO INCREASING WATER FILLED PORE SPACE

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Mercury is a volatile element that is atmospherically transported around the earth, deposited in ecosystems and can be transformed into several species some of which are persistent, bio-accumulative and highly toxic. Natural emissions and re-emissions of mercury from soils have been identified as a major contributor to the global atmospheric mercury budget and conservative estimates of global mercury fluxes suggest a total of 700 to 1000 ta-1 volatilized from soils (Lindqvist, 1991). The green house gas (CO_2, CH_4, N_2O) exchange between soils and the atmosphere is an important contributing factor to global climate change (Bouwman, 1990). soil moisture content is considered to be an important factor affecting GHG and Hg volatilization however, there has been no controlled analysis of soil moisture manipulation studies on mercury and GHG emissions from natural surfaces. This research is focusing to quantify the effect of water filled pore space on potential soil-air fluxes of Hg(0) and GHG from soils under controlled conditions. A controlled experiment was performed on a natural soil for investigating the effect of increasing WFPS (30, 40, 50, 60, 70 and 80 percent) on the volatilization of mercury and GHG emissions. The system consists of a Tekran 2537B gaseous mercury analyzer and FTIR spectroscope for GHG quantification combined with a Li-Cor flux chamber. Short term flux analysis consists of placing 200 g soil sample at 20% WFPS at the base of collar while maintaining a bulk density of 1.65 g cm^{-3}. Five ambient air readings were collected before running sample for blank correction. The chamber was closed thereafter and five soil flux readings were taken every 5 minutes interval. We will present preliminary data on the effect of soil moisture manipulation experiment on Hg(0), CO_2, N_2O and CH_4 fluxes from a soil sample under controlled conditions.

KEYWORDS: soils, mercury flux, green house gases, soil moisture

DOES THE QUALITY OF ORGANIC MATTER INFLUENCE MINERALIZATION IN CRYOSOLS? A FIELD-BASED STUDY OF SUB- TO HIGH ARCTIC SOILS

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Permafrost-affected soils store a large quantity (~16% of the world's soil carbon) of soil organic matter (SOM). However, warmer temperature trends already measured throughout Arctic are changing this reality. Therefore, studying parameters that might influence the SOM mineralization is fundamental to predict the global warming feedbacks on both SOM balance and plant communities. The objective of this study was to investigate the influence of soil organic matter quality on soil organic matter mineralization. This study was conducted in three distinct Arctic ecosystems: High-Arctic (Truelove Lowlands, NU), Low-Arctic (Daring Lake, NWT), and Sub-Arctic (Churchill, MB). On each site, the sampling locations were evenly distributed along a soil moisture gradient from dry heath to wet sedge plant/soil ecosystems. Truelove Lowlands and Daring Lake were sampled in 2008 and Churchill was sampled in 2009. All sites were sampled at the end of their growing seasons (~2 to 3 weeks before plant senescence). Organic matter mineralization was measured using 2 field-based methods: i) net soil surface carbon dioxide (CO_2) emissions using a multicomponent fourier transform infrared gas analyzer combined with an automated dark chamber; and ii) soil gross N mineralization determination using $^{15}N\ H_4^+$ dilution technique. Organic matter quality was assessed by measuring: i) water-extractable dissolved organic N (DON) and carbon (DOC); ii) solid SOM density fractions (light fraction < 1.55 g ml^{-1} < heavy fraction); and iii) relative content of Alkyl-C, O-Alkyl-C, Carbohydrates, Aromatic-C, and Carbonyl-C in the solid SOM (using solid-state CPMAS ^{13}C Nuclear Magnetic Resonance (NMR) spectroscopy). Results and their implications will be discussed.

KEYWORDS: Soil Carbon; Carbon Quality; Gas Emissions

EVOLUTION OF SPECIFIC YIELD (DRAINABLE POROSITY) WITH RESPECT TO ITS USE IN ESTIMATING GROUNDWATER RECHARGE

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For a century, the term specific yield (or drainable porosity) has been used in soil physics to define the amount of water that is drained due to gravity per unit of horizontal cross-sectional area of an unconfined aquifer per unit change in water table elevation. It is often used along with the change in water table elevation, in estimating ground water recharge using water table fluctuation method. Here an attempt is made to track the historical evolution of the term's definitions as used in ground water recharge calculations and mathematical modeling. A particular thought is given to the limitations associated with the use of the term and a suggested use of an alternative term of "fillable porosity" is presented.

KEYWORDS: specific yield, drainable porosity, water table fluctuation, groundwater recharge, fillabe porosity, unconfined aquifer

THE EFFECT OF HYSTERESIS ON SPECIFIC YIELD (DRAINABLE POROSITY) AND FILLABLE POROSITY

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Specific yield is an important component in estimating ground water recharge using the water table fluctuation method. Some suggest using soil fillable porosity instead of specific yield due to the effect of hysteresis on the soil retention characteristic curve, which shows that the specific yield is larger than the fillable porosity, resulting in overestimation of ground water recharge. Here, an attempt is made to compare both terms, the specific yield and the fillable porosity, mathematically, using an equation(s) for the soil-water characteristic curve (including hysteresis) from the literature. As well, the implication of using either the specific yield or the fillable porosity on ground water recharge estimation in three different soil textural classes is shown.

KEYWORDS: hysteresis; specific yield, drainable porosity, fillable porosity, water table fluctuation, groundwater recharge, soil-water (retention) characteristic curve, unconfined aquifer

SURFACE CHEMISTRY OF SOILS: INSIGHTS FROM OXYANION ADSORPTION AND SPECTROSCOPIC STUDIES

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The fate and mobility of many oxyanions of both agronomic and environmental importance is determined by reactions at the solid/water interface in soils and sediments. For this reason, oxyanion adsorption in soils is often studied. Additionally, one may think of oxyanions reactants as molecular probes into the surface chemistry of important minerals. In this presentation, a variety of spectroscopic investigations of sulfate, selenate, and selenite reactivity on different aluminum and iron oxides of a range of crystallinity and structure. From these studies, we will support the overall conclusion that the surface structure of metal oxide minerals has a rather dramatic (and predictable) effect on reactivity with oxyanions.

KEYWORDS: sulfate, selenate, selenite, oxyanion adsorption, XANES, EXAFS, ATR-FTIR, surface chemistry

BIOAVAILABILITY OF PAH CONTAMINATED SOIL IN SWINE

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Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous compounds that are believed to be carcinogenic. These compounds are a widespread contaminant in soil and are compounds of concern in the case of soil ingestion, particularly in toddlers who are at high risk to be adversely affected due to the quantity of soil they ingest as well as their sensitivity to carcinogens. Traditionally, bioavailability of PAHs in soil is assumed to be 1. This study was conducted to expand the juvenile swine model to include organic compounds, as well as to use the model to determine the bioavailability of PAHs in soil. Swine were dosed with reference soil and sacrificed at 1, 2, 3, 4, 5, 6, and 8 hours post-dosing to create a time course. Blood, gastrointestinal (GI) and liver samples were taken at sacrifice time, extracted, and PAH levels quantified with HPLC. The time course generated a dose-response curve, resulting in an area under the curve (AUC) bioavailability. There was a wide range of bioavailability between the different PAHs, but bioavailability for each PAH was related to the octanol fugacity capacity of that compound. According to this study bioavailability of PAHs in soil is lower than assumed when developing soil quality guidelines, leading to conservative estimates of risk. This conservatism is appropriate as it protects parts of the population that are most at risk like toddlers, but is also detrimental as it requires extensive remediation of contaminated sites.

KEYWORDS: bioavailability, soil, swine, PAH

THE ROLE OF CRYOTURBATION IN THE DEPTH DISTRIBUTION OF SOIL ORGANIC CARBON AT TWO CANADIAN ARCTIC SITES

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Changes in the global climate system have stimulated a recent scientific focus on the measurement and relationships of environmental carbon pools. Soils are an important reservoir of carbon, and arctic soils contain vast amounts of organic carbon. This carbon is believed to be sensitive to climate change, and regional warming could allow the release of large amounts of soil carbon to the atmosphere as carbon dioxide and methane. While there has been much work investigating the size of carbon pools in northern regions, there has been relatively little work done on the contribution of the process of cryoturbation to carbon sequestration. Cryoturbation refers to soil movement and mixing due to frost processes, and can lead to the translocation of organic carbon to greater depth. Organic soil carbon at greater depth is subjected to conditions that are less favourable for decomposition, and as such, is less likely to be released to the atmosphere as carbon dioxide or methane. Research is needed to elucidate the role that cryoturbation may play in soil carbon dynamics.

The objective of this study is to compare the depth distribution of soil organic carbon in arctic soils subject to cryoturbation and arctic soils not subject to cryoturbation. The depth distribution of soil organic carbon was determined by examining the organic carbon density in cross sections of permafrost-affected pedons. Pedons with cryoturbation-affected organic carbon were compared to nearby pedons without cryoturbation-affected organic carbon. Results from soils at two locations in the Canadian Arctic will be presented, and the implications of these results will be discussed, including the importance of cryoturbation as a feedback mechanism to climate change.

KEYWORDS: Cryoturbation, Soil Organic Carbon, Cryosols, Tundra, Arctic

FIELD-SCALE ASSESSMENT OF PHYTOREMEDIATION AT A FORMER OIL TANK BATTERY IN BRUDERHEIM, ALBERTA

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A 3-yr study to assess the effectiveness of plant-based systems to reduce contaminant levels to environmentally acceptable endpoints (as defined by the Canadian Council of Ministers of the Environment; CCME) was established at a former tank battery near Bruderheim, Alberta. Four treatments (unplanted, unfertilized control; unplanted, fertilized control; a standard cool-season grass/legume mixture; and a locally optimized grass/legume mixture) were compared in a randomized complete block design (n=4). The site was monitored for three years, with soils sampled (0–15 cm and 15–45 cm) at the end of each growing season. Analyses included total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAHs), and CCME PHC-fractions. Plant assessments (species composition, above- and below-ground biomass) also were conducted at the end of each growing season. After three growing seasons, TPH concentrations averaged across the site had been reduced by 62% in the surface and 64% subsurface soils. Reductions in PHC concentrations were generally greater in the plots amended with fertilizer and compost, but were similar in the planted and unplanted plots. Reductions in the F2 (C6–C10) fraction, however, generally occurred more rapidly in the planted treatments. There were no significant differences between the standard and locally optimized plant mixes.

KEYWORDS: phytotechnology, plant–assisted bioremediation, enhanced rhizodegradation, petroleum hydrocarbons

INFLUENCE OF LONG-TERM FERTILIZATION ON CARBON CYCLING IN FOREST SOILS

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In British Columbia, over 13.5 million ha of lodgepole pine (Pinus contorta var latifolia) have been killed by the pine beetle epidemic, with losses of over 80% of mature stands projected within the next 5 years. One proposed strategy to mitigate anticipated shortages in timber supplies is large-scale fertilization of young conifer stands. It is not known however, what impact fertilization will have on carbon cycling processes in these soils. In this study, we examined how fertilization affected microbial decomposition of detrital inputs at conifer plantations under three different fertilization regimes (control, annual, every 6 years). Soil organic matter (SOM) was characterized using a combination of ^{13}C-NMR, proximate analysis, and isotopic (^{13}C and ^{15}N) assessment. Enzyme assays (ß-glucosidase, chitinase, laccase, peroxidase) were used to assess the capacity of soil microbial communities to mineralize organic C and expose other organic nutrients. SOM chemical and biological parameters were found to be quantifiably related. Fertilization increased annual litter inputs, which led to a relative enrichment of cellulose and hemicellulose in SOM. Enrichment in these compounds was in turn associated with an increase in the activity of enzymes involved in their breakdown. Our findings show that carbon cycling processes have adjusted to increased detrital inputs in fertilized plantations, and suggest that fertilization will not negatively impact long-term forest soil productivity. Further, these integrated results provide a better understanding of how soil microbial and soil chemical parameters interact to produce healthy sustainable forest soils.

KEYWORDS: carbon cycling, fertilization, long-term soil productivity, forests

RAPID CHANGES IN SOIL CARBON AND ROOT BIOMASS WITH FOREST ENCROACHMENT IN THE ASPEN PARKLAND ECOREGION OF SASKATCHEWAN

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Forest encroachment of grasslands is a common phenomenon worldwide but the consequences of this encroachment to ecosystem carbon storage, particularly belowground, is not clear. We quantified total ecosystem carbon pools in the three major natural upland vegetation communities, those being grassland, shrubland, and forest, in the aspen parkland ecoregion of Saskatchewan. Total ecosystem carbon storage was greater in forest (125.3 Mg C ha^{-1}) than in shrubland (92.4 Mg C ha^{-1}) or grassland (80.7 Mg C ha^{-1}) and this difference was due mainly to greater aboveground mass, coarse root mass, and the presence of a forest floor layer. Mineral soil carbon was greater in shrubland (80.6 Mg C ha^{-1}) and grassland (75.4 Mg C ha^{-1}) than forest (48.6 Mg C ha^{-1}) while total soil carbon, including both mineral soil and forest floor, was not different among vegetation types. Fine and total root mass was greater in forest than shrubland or grassland. Soil carbon was best modeled from aboveground characteristics across all vegetation types using herbaceous mass. This underscores the importance of herbaceous vegetation in the development and maintenance of Chernozemic soils since forest sites with high levels of herbaceous vegetation maintained high soil carbon levels. Fine root and total root mass were best modeled using foliar mass and aboveground mass respectively, which represent simple and effective predictors of root biomass which is relatively difficult to measure. These rapid shifts in ecosystem, soil, and root carbon pools with forest encroachment represents a significant change in ecosystem structure.

KEYWORDS: forest encroachment, trembling aspen, soil carbon, root biomass

SOIL ENZYME ACTIVITES IN BOREAL FOREST SOILS UP TO 18 YEARS AFTER HARVEST

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Timber harvesting represents one of the largest disturbances facing Canadian boreal forest ecosystems today. As well as removing the dominant vegetation, harvesting disturbs the soil microbial community. As part of the Forest Watershed and Riparian Disturbance (FORWARD) project established in 2001, this study examines changes in soil microbial enzyme activities in relation to years after clear-cut harvest. Soil enzymes may be an important indicator of soil quality due to their relationship to biological activity and nutrient cycling. Soil samples were collected in June 2009 from clear-cut sites that represented 1, 2, 3, 4, 5 and 18 years post-harvest on the Boreal Plain of Alberta, Canada. Acid and alkaline phosphomonoesterase, arylsulfatase and urease activities were measured using standard assay procedures. There was a significant effect of time since disturbance on all enzyme activities in the upper organic (LFH) horizon, and a significant effect on acid phosphomonoesterase and arylsulfatase in the lower mineral (Ae) horizon. However, only acid phosphomonoesterase showed a clear trend in relation to site age. Soils in sites at 1, 2 and 3 years post-harvest exhibited higher acid phosphomonoesterase activity than the 18 year old site. Enzyme kinetic parameters (Km and Vmax) of acid phosphomonoesterase may also provide additional information on the status and substrate-affinity of soil enzymes, and their potential use as an indicator of soil quality.

KEYWORDS: timber harvesting, forest soil, enzyme activity, microbial community, enzyme kinetics, soil quality

SIGNATURE OF HURRICANES IN FOREST SOILS OF THE MARITIMES

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Modern hurricanes of category 2 and higher cause mass tree uprooting in forested areas. According to our findings, tree uprooting caused by hurricane-speed winds has some specific features that allows one to distinguish it from the common tree uprooting. The affected trees fall down, detaching and rotating the earth clot. Due to the high power of wind in the canopy, crowns are hit by the hurricane stronger than the root collar part of the trees. It creates a torque, which pushes the earth clot backwards into the uprooting scar. This process, named rotational slide uprooting, creates a recognizable, long-lasting image (tracefossil) in the soil. The morphological study of soils in Kejimkujik National Park (Nova Scotia) revealed presence of three to four generations of overlapped rotational uprooting structures in different sites within the area of 400 square kilometres Each new uprooting event partially erased structures that had been created by previous events, therefore the depth of retrospective in each site was limited by the intensity of pedoturbation. Some hurricanes were followed by fires, as indicated by the presence of charcoal within the uprooting structures and reddening of soil groundmass due to high-temperature burning. AMS-radiocarbon dating of charcoal allowed us to determine timing of the hurricane events, ranging from 10000 to 300 years ago. The area has been affected by 18 hurricanes during the Holocene, with the frequency of coupled hurricane-fire events averaging 200 years during the last millennium. Up to 40% of soil surface can be disturbed by pedoturbation during a single mass uprooting event. After three to four events most of the surface becomes disturbed. In most sites located within the hurricane track, frequency of phytoturbation is so high that morphological features associated with the previous stages of soil formation become completely erased within 500 to 3000 years.

KEYWORDS: natural disturbances, paleo-hurricanes, pedoturbation, trace fossil

CHARCOAL-CORED CONCRETIONS IN PRAIRIE SOILS

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Rounded iron-manganese concretions a few millimetres in diameter occur often in Gleysolic soils in prairie depressions, particularly in Aeg horizons. Modern methods of SEM and microprobe analysis show that the concretions are a potential, new paleoenvironmental indicator. Many of the concretions are built around a charcoal fragment. The concretions have a complex structure that consists of a 'core' enriched in manganese, with fragments of charred wood preserved within the core, and mineral coating enriched in iron oxides. Preserved charcoal fragments are impregnated by silica. The mineral coating contains clusters of phytoliths typical of the insoluble fraction of ash from fires. Cross-sections show that their pebble-like shape is a result of superposing mineral coatings over an initially asymmetric charcoal fragment. This suggests lateral transport of charcoal fragments in a slurry of mud and perhaps ash for a significant distance, possible only when the soil surface is bare of vegetation along the migration path. We postulate that the deposition of mud and ash-coated charcoal fragments was the result of large-scale, high-intensity fire events, followed by transport of charred material downslope and its deposition in closed depressions. Impregnation of charcoal fragments by silica occurs with the desiccation of ash-enriched, alkaline sloughs. The deposition of the iron and manganese oxides is likely a secondary process under alternating reduced and oxidized conditions related to periodic flooding. Finding radiocarbon-datable objects in prairie soils is always a challenge. Our discovery allows for radiocarbon dating the concretion-encasing deposits and mapping paleo-dynamics of forested areas within the grasslands. The first dates obtained for concretions from several sites in Saskatchewan suggest a transition from forest to grassland vegetation approximately 10 thousand years ago in the southernmost part of the prairies, and approximately 1300 years ago at the northernmost part of the prairies/southern border of parklands.

KEYWORDS: iron-manganese concretions, forest-steppe transition, holocene, paleoclimate

RESULTS FROM STABL-U/ESN BLEND STUDIES COMBINED WITH MINERAL DUST, GYPSUM PAM AND SOIL IMPRINTING

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Nitrogen use efficiency is important to corn farmers in the Midwest as they deal with issues of drinking water standards for nitrate, economics of fertilizer management and nitrate as one of the three main probable causes of hypoxia in the Gulf of Mexico. This poster focuses on the use of Plant Root Simulator PRS™ probes to monitor bioavailability of nutrients under intensive management systems of maize. One system included a mixture of a new stabilized urea Stabl-U™ and a controlled release urea ESN, within an intensively managed system including geometric ordered roughness soil imprinting to reduce soil erosion improve infiltration and provide microwells of biological activity, banded mineral dust to feed soil microbes, and gypsum/PAM pellets to reduce soil erosion and reduce soil crusting. Probes were replaced weekly for the first ten weeks after planting. Results indicated major changes in bioavailable nitrate-N from week to week as affected by rainfall, cloudy periods and night time temperatures. The PRS probes identified the timing of N release and overall increases in nitrate bioavailability from the intensive management system vs. the control system. Results for P, K, Mg and Zn in weeks 9 and 10 all correlated better with both leaf analysis and ear weights than conventional soil tests.

KEYWORDS: nitrogen, NUE, PRS probes, ESN, mineral dust, corn, nitrate, bioavailability

UTILIZATION OF MUTATION BREEDING FOR IMPROVEMENT OF FENUGREEK (*TRIGONELLA FOENUM-GRAECUM* L.)

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Plant products such as phytonutraceuticals are now in high demand for their functional food and pharmaceutical uses. To increase their use many medicinally important plants are being introduced to countries where they are not naturally adapted. Fenugreek, a tropical crop species, recognized for its medicinal value, has been introduced recently to Canada. Three medicinal components, namely diosgenin, galactomannan and 4–hydroxyisoleucine are most valued among those found in fenugreek. These three components are most concentrated in the seed. Forage type fenugreek selected for high biomass production in western Canada needs 120 to 140 days to produce high proportion of mature and high quality seed in this area. However, in western Canada on an average only 100 frost free days are available. Therefore, production for high quality seed requires early maturing type fenugreek. Our search for early maturing fenugreek accessions in the world collection was not successful. To generate variability for early maturity trait in the western Canada adapted germplasm we used mutation breeding. This mutation breeding effort has resulted in plants with early maturity (about 15 days earlier than the base population Tristar), double pods, altered height and growth, and uniform seeds, in the mutated populations. Proper characterization and judicial selection among the mutated populations may lead to the development of cultivars with early maturity that can serve as a source for the phytonutraceutical industry.

KEYWORDS: mutation breeding, fenugreek,early maturity

RESPONSE OF SOIL ORGANISMS TO RETENTION OF LIVING TREES AFTER FOREST HARVEST

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Variable levels of retention of living trees is increasingly being favored as an alternative to clearcut-harvesting of forests, and preservation of a functioning soil community may be an important advantage of this management practice. The aim of this project is to assess the potential of green-tree retention (GTR) to maintain soil microbial and faunal diversity and function after harvesting and to determine the optimal size and pattern (aggregated or dispersed) of retention for this purpose. We sampled pre-harvest, 4 months and 5 years following harvesting of a second-growth Douglas-fir and western hemlock forest on Vancouver Island. We determined how soil communities change, whether key species are lost, and if GTR of different aggregate sizes (5 - 40 m diameter (1-60 trees)) and distribution (dispersed vs aggregated) cast different size 'shadows' of influence. Prior to harvest, 95% of the soil fauna and a distinct microbial community were found in the forest floor, indicating GTR could serve as refugia for colonization of disturbed areas following harvest. Four months after harvest most soil macrofauna and collembola were influenced more by forest floor disturbance than by presence of living trees. However, mites and pauropods declined from patch centres out into the cut area. Mycorrhizal diversity and enzyme activities decreased 10-15 m from the edge of all but the smallest patch. There was no effect of harvest on fungal richness, but a shift from mycorrhizal to saprophytic dominance. Five years after harvest fungi were more abundant than bacteria in GTR compared to the uncut forest, and dispersed retention was better than aggregated for maintenance of microbial biomass and enzyme activities across the cut block. The results suggest that retention of large patches is not necessary; retention of single trees located within 20 m of each other will ameliorate change in soil organisms and their functions.

KEYWORDS: forests, variable retention harvesting, soil microorganisms, soil fauna, mycorrhizae, enzymes, nutrient cycling

MICROBIAL ACTIVITY AND DIVERSITY IN JAMES BAY PEATLANDS

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Northern peatlands are globally important sinks of atmospheric carbon, due to the relative imbalance between primary production and microbial decomposition allowing for the potential accumulation of organic matter up to several metres in depth over vast areas of land. The James Bay lowlands represent the second largest peatland area in the world but remain largely unstudied. It is essential that we understand the current and future carbon stability of the area as climate change predictions estimate an average mean annual temperature increase of 4 – 7 degrees C by 2080. Such environmental change will undoubtedly impact the functioning of the microbial communities and therefore carbon cycling, as a limiting step in soil organic matter decomposition is the activity of extracellular enzymes. This preliminary research characterized the effects of predicted environmental temperature change on microbial processes and community structure regulating peat decomposition and greenhouse gas production in James Bay lowlands sites. Peat cores were collected from two bogs and one fen in the Attiwapiskat and Moose River catchments. Several microbial extracellular enzyme activities were estimated using fluorescence and absorbance spectroscopy and microbial community composition was characterized with PCR-DGGE at three depths.

KEYWORDS: peatlands, carbon, microbial community, microbial activity, climate

EFFECT OF LONG-TERM FERTILIZATION ON NITROGEN LEACH OF GROUNDWATER IN RICE PADDY--- A CASE STUDY OF HUNAN, CHINA

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To investigate the effect of long-term fertilization (1980-2007) on N contamination (Nitrate-N and Ammonium-N) of groundwater from rice field, a two year's (2006-2007) case study was conducted by using the suction-cup method to extract percolation water from different strata (20-30cm, 50-60cm and 80-90cm) of double rice field in Hunan, China. Three treatments were selected from a long-term fertilization field study: NPKS (Nitrogen, Phosphorus, Potassium and Straw), NPK and CK. We found both of the two forms of N leach have a pronounced seasonal variation, there is a strong relationship between concentration of Ammonium-N (C_a) and Nitrate-N (C_n) and seasonal days (days after fertilization (d)), the correlation can be expressed using a regression of exponential and polynomial respectively: $C_a=14.136e^{-0.0481d}$, $R^2=0.9772^{***}$; $C_n=-0.0002d^3+0.0175d^2-0.2198d+1.0072$, $R^2=0.9344^{***}$. Moreover, there is also spatial variation of $C_a$and C_n in different depth of aquifers, the relationship between N concentration and groundwater depth vary with different rice growth season, but significant difference of N leach among 3 given depth was observed only in NPKS. Additionally, as incorporated with organic fertilizer, effect of NPKS on C_a and C_n in subsurface water is more significant than NPK in 4 rice seasons, and no significant difference was discovered in CK. Ammonium-N is the principal form of N loss in rice paddy of study area, it accounts for 75.44% of total N leach in groundwater, only 24.56% of it contributed by Nitrate-N. Total N leach ratio for NPKS in 4 growth seasons varied from 9.05% to 59.05%, but for NPK, its 9.20%~28.35%. The largest N loss amount in groundwater occurs in later 2007, i.e. 106.30kgN/ha and 51.03kgN/ha for NPKS and NPK respectively. More studies should be focused on N leach contamination in groundwater due to rice production.

KEYWORDS: N leach, Long-term fertilization, suction-cup method, rice paddy, nitrate, ammonium

SEGMENTATION STRATEGIES OF AGRICULTURAL PLOTS IN MANAGEMENT ZONES ACCORDING TO THEIR PHOSPHORUS SORPTION CAPACITY

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Management units and land properties pedogenic homogeneous, also called management zones (Fridgen et al. 2004), offer an alternative between the ongoing management and the uniform management of agricultural inputs. The Phosphorus Sorption Capacity (PSC) is an important factor to include in the management of inputs such as phosphorus-based fertilizers, manure and slurry. The objective of this poster is to evaluate the effectiveness of some strategies for segmentation of three contiguous agricultural fields in management zones (MZ) according to the PSC from auxiliary variables, here called stratificators. For this purpose, 164 soil samples were dried and analyzed to measure their contents of Al and Fe extracted in Mehlich-3 (AlM3+ FeM3), ammonium oxalate (Alox + Feox) and Phosphorus Index Sorption (PSI). Four indicators of the PSC, AlM3, AlM3 + FeM3, Alox + Feox and PSI have been studied. The stratificators used for the delineation of MZ are the soil electrical conductivity (EC) measured from electrical resistivity and electromagnetic induction in continuous mode with the VERIS 3100 (depth 0-30 and 0-100 cm) or the EM 38 Geonics (depth 0-130 cm); the elevation data from the digital elevation model (DEM); spectral information (blue, green, red and near infra red) extracted from an IKONOS image with high spatial resolution (4m x 4m) and Vegetation Index Adjusted to the Soil (SAVI). The MZA software (Management Zone Analyst) developed by Fridgen and al. (2004) performs with plots segmentation (MZ) from unsupervised fuzzy algorithm (Fuzzy c-means). Among the three similarity measures available in MZA, the Mahalanobis distance was the most appropriate data set to the study. The choice of optimal number of MZ is based on analysis of four parameters: The fuzzy performance index (FPI), the normalized classification entropy (NCE), the percentage of variance reduction (VR) and the analysis of variance (ANOVA). Among the stratificators used, it is the EC measured with the VERIS 3100 (0-100 cm) and the SAVI index generated by kriging from the IKONOS image which led to the largest PSC indicators RV. By stratifying agricultural fields into two plots with the EM 38 and the elevation parameter, the AlM3 variance was reduced to 55 % of the variance measured for the entire field. With five MZ, AlM3 variance is reduced to 45 % an increase of 10 %. It is Alox + Feox who benefits most from the stratification for variance in this measure of the PSC and is reduced to 35% for two MZ and 25% for five MZ. However, the results of the ANOVA showed that only three MZ are significantly different from each other for AlM3 + AlM3, Alox + Alox and two MZ for PSI. The management of agricultural inputs (phosphorus-based fertilizers, manure and slurry) defined by MZ from auxiliary variables seems a priori approach adapted to the Québec agricultural context; it remains to verify its agro environmental effectiveness.

KEYWORDS: phosphorus sorption capacity, SAVI, MZA, management zones, stratificators.

BUILDING ORGANIC MATTER IN RECONSTRUCTED OIL SANDS SOILS

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Following mining, land reclamation entails the creation of soil-like profiles using salvaged soil materials and mining by-products. In the Athabasca Oil Sands region, peat is the main source of soil organic amendment due to its availability in large portions of the mining footprint. This research program aimed to assess the long-term sustainability of reconstructed Oil Sands soils by comparing their range of structural and functional variability with that of undisturbed boreal forest soils. Reconstructed soils covering different reclamation treatments and age classes were compared to forest soils spanning a range of ecosites in the region. Soil biogeochemical criteria included nutrient availability, organic matter quality, and microbial communities. Significant differences in these criteria were detected among natural ecosites, and all reclamation treatments differed significantly from the range of natural variability. In addition, several parameters showed an evolution with time since restoration towards conditions observed at the undisturbed forest soils. In particular, the surficial organic matter layer reflected a shift in composition from peat to woody plant inputs. Results underlie the importance of re-establishing biocycling processes within the reconstructed soils, e.g. through the build-up of a forest floor layer. In turn, these will alleviate vegetation reliance on the original peat amendment to meet its nutrient needs.

KEYWORDS: soil organic matter restoration reclamation oil sands

CONVENTIONAL AND NO-TILLAGE EFFECTS ON THE QUANTITY AND $\delta^{13}C$ SIGNATURE OF SOM FRACTIONS

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Soil management practices such as tillage can affect the decomposition of crop residues and soil organic matter (SOM) components. The objective of this study was to compare the $\delta^{13}C$ signature in physically and chemically protected SOM pools in order to better understand C substrates which contribute to CO_2 emissions. Research was conducted in Ontario, Canada on silty loam soils derived from calcareous till. The cropping system consisted of a corn (Zea mays L.), soybean [Glycine max (L.) Merr.] and winter wheat (Triticum aestivum L.) rotation. This sequence of C3 and C4 crops allowed for the use of the ^{13}C natural abundance technique. Soil samples (0-50 cm) and crop residues were taken at harvest for analysis. Density separation followed by acid hydrolysis was used to separate the SOM pools into labile and recalcitrant fractions from soil samples in the 0-30 cm depth. Results indicate that after six years of no-tillage, total organic C and N contents for the 0-10 or 0-50 cm depths of CT and NT soils were not significantly different. $\delta^{13}C$ of total SOC and light, heavy, hydrolysable and non-hydrolysable fractions for the total 0-30 cm depth were -24.1‰, -19.0‰, -23.8‰, -21.7‰ and -26.1‰ in CT and -23.1‰, -18.1‰, -23.5‰, -21.2‰ and -25.9‰, in NT, respectively. Differences in the isotopic signature of light fraction OM showed a preservation of newly-derived C in the NT soils compared to the CT soils. After corn harvest in fall, respired CO_2 from CT plots was more enriched (-16.7‰) compared to NT (-20.6‰), reflecting that a significant portion of the total CO_2 flux was from the decay of corn stover (-12.2‰). This study indicates that the carbon substrates contributing to seasonal CO_2 fluxes are from the labile pools of SOM and not from the stabilised organic matter fractions.

KEYWORDS: tillage, soil organic matter, $\delta^{13}C$, light and heavy fraction

CONTRIBUTION OF CARBONATES TO $\delta^{13}C$-CO_2 EMISSIONS IN LABORATORY-INCUBATED SOIL

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A challenge in determining the source of CO_2 emitted from calcareous soil samples is differentiating CO_2 originating from carbonates to that released by SOM decomposition (microbial respiration). The $\delta^{13}C$ of pedogenic carbonates range from −10% to 0‰, while lithogenic carbonates range from –2 to +2‰. The isotopic signature of SOM is similar to the plant residues from which they originate, with C3 and C4 plants having mean $\delta^{13}C$ values of −27‰ and −13‰, respectively. The goal of this study was to measure the isotopic signature of the CO_2 produced from microbial respiration, in order to determine the nature of the carbon substrates respired in the soil. Calcareous soil samples (<2mm) were incubated for two weeks in air-tight sealed jars under standard laboratory conditions. CO_2 released was trapped in NaOH, precipitated with SrCl2 and measured using isotope ratio mass spectrometry. The proportion of CO_2 evolved from inorganic carbon was estimated using a two-end member mixing model. Results indicate that a significant contribution to the $\delta^{13}C$ value of CO_2 emitted from soils is derived from soil carbonates enriched in ^{13}C . The $\delta^{13}C$-CO_2 from soil samples ranged from –11.1‰ to –8.6‰, for the 0-10 and 30-50 cm depths, respectively. The proportion of CO_2 evolved from inorganic carbon for the 0-10 cm depth was 0.74 and 0.64, when SOC or light fraction C was assumed to be the respired C substrate, respectively. The enrichment observed in the $\delta^{13}C$-CO_2 was attributed to the release of CO_2 from the dissolution of carbonates enhanced by soil sieving. The use of the $\delta^{13}C$ natural abundance technique as a means to partition CO_2 released from the decomposition of SOM and that from inorganic carbonates is advantageous since it identifies that organic carbon substrates are not the only contributors to CO_2 flux from calcareous soils.

KEYWORDS: microbial respiration, carbonates, $\delta^{13}C$, soil organic matter

GREEN APPROACHES FOR SOIL REMEDIATION AND A LOOK TOWARDS THE FUTURE

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The number of techniques for soil remediation and their acceptance has increased significantly. These changes have been especially important for situations where the location, acreage, climate, and lack of infrastructure combine to make some remediation choices cost prohibitive. Knowing the benefits and limitations of different technologies is a key to their acceptance. Predicting the likely success of a method and selecting the appropriate technique are based on both research and field experience, and are interdisciplinary endeavors. Emergence of increasingly Green approaches for soil remediation can be described in both historical and scientific contexts, with numerous reasons driving the changes. Coupling these perspectives with allied advances in soil science may be a useful tool for looking to the future.

KEYWORDS: green remediation natural bioremediation phytoremediation

MEASURING SOIL HYDRAULIC PROPERTIES USING A CASED BOREHOLE PERMEAMETER: FALLING HEAD ANALYSES

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New and extended falling head analyses are presented for measuring field-saturated hydraulic conductivity (Kfs) and sorptive number (α*) using cased boreholes finished in the unsaturated zone. The new analyses are derived from the constant head, steady flow relationships of Reynolds (2010), and represent a "succession of steady states" approach. The extended analyses generalize the original Philip (1993) relationship for a fully lined borehole to include a basal "well screen" of variable dimensions, and both small drawdown and large drawdown expressions. The various analyses are compared, and their accuracies are assessed using HYDRUS-2D simulations of borehole infiltration. Advantages gained by using falling head analyses to determine Kfs and α* rather than constant head, steady flow analyses include simpler equipment, reduced water usage, and shorter measurement times. Disadvantages include potentially non-unique solutions in some situations, and possibly greater sensitivity of Kfs and α* to measurement error and/or soil heterogeneity.

KEYWORDS: borehole permeameter, falling head analyses, hydraulic conductivity, sorptive number

PLANT GENETIC RESOURCES: BUILDING BLOCKS FOR PLANT BREEDERS

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Canada manages a distributed repository system for plant genetic resources, integrated to increase efficiency through commonality of functions. This public-good service-oriented research provides high quality germplasm and well documented information to national and international clients dealing with crop improvement and bio-based product development. The presentation will provide examples of all the basic functions (acquisition, distribution, maintenance, characterization, evaluation, documentation) of genebanks and research representing Canada's efforts to conserve and enhance utilization of genetic resources. Genetic resources and associated information play a fundamental role on an ongoing basis to most fields of biological science because, they provide insurance of supply of basic materials for agriculture and agro-food against future adverse conditions; preserve germplasm of useful traits such as resistance to new pests, adaptability to climate change, other environmental conditions or compounds for bio-based products; inputs into inspection and regulatory matters; and provide stability to farming systems at the local, national and international levels by smoothing yield variability through maintenance of a wide range of genetic diversity. All these ultimately impact Canada's ability to trade internationally. Canada's research effort in the conservation and utilization of genetic resources is worthy as generates positive policy, environmental and social impacts. As biodiversity has been identified as an important contributor to society's mental and physical well-being, being able to conserve and describe the genetic diversity and variation of plants plays a major role in support of this well-being.

KEYWORDS: plant genetic resources, conservation, management, utilization

ASSESSING THE BIO-ENVIRONMENTAL DEGRADABILITY OF LIGHT-WEIGHT PACKAGING MATERIALS IN CONTROLLED COMPOSTING ENVIRONMENTS

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Over the past two decades, considerable research has focused on the development of biodegradable (compostable) plastics and hybrid paper/biodegradable polymer composites as replacements for traditional paper-based packaging materials. Oddly, however, whereas there have been intensive efforts to evaluate the biodegradability of these new biopolymers and bioplastics, relatively little attention has been focused on the biodegradability of paper and cardboard products themselves. Thus, the goal of this study was to demonstrate the bio-environmental degradability of new "biodegradable" fiberboard and paperboard products that incorporate biodegradable polymer coatings (e.g., PHA) and recently developed bioadhesives along with materials such as wood fibers, chicken feather fibers, cheese cloth, straw fibers, cotton and kenaf fibers. The compostability of fiberboard is being assessed using a testing scheme involving both laboratory and field components. These tests are being conducted in accordance with the protocols described in ASTM Standard Guide D6002. Laboratory-scale reactors were used to simulate bioactive disposal sites in which the biodegradability of the test materials was evaluated under controlled aerobic composting conditions. Standard (ASTM or ISO equivalent) laboratory test methods were used to assess degradation/disintegration (measured as weight loss; Tier II test) and mineralization (conversion of polymer-C into CO_2 ; Tier I test) of the test materials. Field trials (Tier III tests) were conducted to determine the compostability of selected test materials as well as to assess the quality of the compost derived from the Tier III test.

KEYWORDS: Compost, biodegradation, paperboard, fiberboard

PRS™-PROBES DETERMINE SOIL NUTRIENT SUPPLY RATES IN ORGANIC AND CONVENTIONAL SNAP BEAN ROTATION EXPERIMENTS

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The demand for organic vegetables and the need for expanding organic acreage of vegetable crops in Canada have been increasing over the past few years. However, there is very little information to guide organic growers on the timeline of bioavailable nutrients during the growing season. Organic snap bean cropping systems contain dynamic nutrient cycling due to additions of compost and disturbance of soil though mechanical weeding. PRS™-probes have the ability to functionally measure soil nutrient dynamics and were chosen to access the nutrient fluxes in this system. The PRS™ technology uses an ion exchange membrane that mimics a plant root in the soil, adsorbing available ions. The experimental design included continuous snap beans and a fully phased snap beans/fall rye rotation, in the context of two, three, and four years. Treatments consisted of combinations of fertilizer (1x compost, 3x compost, and chemical fertilizer) and weed control (mechanical weeding/herbicide). The effects of mechanical weeding on soil nutrient supply rate were monitored beginning 12 hours post mechanical weeding in all organic snap bean rotations. Two week burial of the PRS™-probes also allowed the construction of nutrient release over the entire season in all plots. Results showed that available NH_4-N was not affected by weeding treatment, but NO_3^- N was repeatedly lower in mechanically weeded plots relative to plots treated with herbicide. The season long supply of plant nutrients was influenced mainly by year than by fertility regime or rotation. Compost application resulted in less available NH_4-N and greater amounts of P, K, Ca, and Mg. Overall PRS™-probes showed that applying 3x compost increased P, Ca and K supplies but other gains in nutrients were minimal relative to the 1x rate. Therefore, no real advantage warrants the cost of amending at greater than the 1x rate of compost.

CRITERIA DEFINITION FOR DETERMINING THE EXTENSION AND USE OF THE RIBEIRA TOURISTIC STATE PARK (PETAR) BUFFER ZONE (SÃO PAULO-BRAZIL)

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Conservation units in Brazil are defined as areas with relevant natural characteristics created by national or state authorities that have defined limits and the objective of protecting and preserving the natural environment. In some cases, these units admit an indirect use of their natural resources which have to be sustainable and preserve their characteristics. The object of this study is the buffer zone of the Alto Ribeira Touristic State Park (PETAR), São Paulo, Brazil. This area has been suffering changes due to human activities mainly related to the land use and occupation which are distant from environmental preservation and conservation. Human interferences have modified the landscape and the local geomorphologic characteristics through the acceleration of erosive processes and mass movements, resulting in an acute degree of environmental degradation. The lack of an environmental management project for PETAR's buffer zone will transform this park into an island surrounded by inhospitable land. This reality has reduced biological diversity as human beings consume natural resources. The objective of this work is to develop technical criteria that define the extension, use and occupation of the Ribeira Touristic State Park (PETAR) buffer zone. The limit of the buffer zone was determined using the digital elevation model (DEM) of the region together with the relation between the total area occupied by the buffer zone and the distribution of the preserved forest fragments in this area. The results of show the importance of the presence of the buffer zones defined on the basis of geomorphological principles, using the limits of the main watersheds and the gravity and extent of the degradation processes of the regional biomes.

KEYWORDS: soil conservation, buffer zone, PETAR, land use, environment

POSITIVE INFLUENCES ON ROOT SYMBIOSES BY BIOCHAR ENHANCES SEEDLING GROWTH IN SUB-BOREAL FOREST SOILS

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Western Canada, with its close proximity to forest residues and pine beetle-killed trees, is a promising location for bioenergy development and the production of biochar for use in nursery, restoration, and reforestation applications. Potential benefits of soil amendment with biochar include enhanced soil fertility, improved plant productivity, and long-term carbon storage; these have not been adequately studied in boreal ecosystems. Impacts of biochar on plant-microbe symbioses mediating plant nutrient uptake are not known. We planted lodgepole pine (*Pinus contorta* var. *latifolia*) or sitka alder (*Alnus crispa* var. *sinuata*) seeds in mesocosms containing field-collected forest soils (upper 15 cm, homogenized) amended with 0, 5, or 10% (by weight) biochar, (produced from pine @ 410°C) with and without urea fertilizer (150 mg N/kg). Pine seedlings were harvested after 4 months and roots were assessed for abundance and diversity of ectomycorrhizal (ECM) morphotypes using light microscopy. Alder seedlings were harvested at 2, 3 and 4 months to measure N fixation in root nodules using acetylene reductase assay (ARA). Plant biomass and soil properties (pH, CEC, C, N, exchangeable cations) were also measured. We found that pine and alder seedlings had significantly greater biomass after 4 months when grown in biochar amended soils. For pine, this corresponded to a general decrease in the proportion of uncolonized (non-mycorrhizal) roots and significant increases in the relative abundance of some ECMs (E-strain, *Cenococcum, Rhizopogon-Suillus* 2) that dominate root systems and play large roles in nutrient uptake. For alder, N fixation (ARA) rates were significantly lower in unamended (control) soils after 4 months. Biochar amendment raised soil pH, CEC and exchangeable cations. Results emphasize the need for further research on soil microbial ecology, and on properties of different biochars before widespread application in boreal forest soils.

KEYWORDS: ectomycorrhiza, sitka alder, lodgepole pine, biochar, forest soil, N fixation

MODELING OF SPRING HYDROLOGY DYNAMICS IN NORTHERN PRAIRIE WETLANDS IN RELATION TO VEGETATION, SOIL PROPERTIES AND LAND-USE

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The presence or absence of wetlands in any given year is influenced by annual variations in precipitation. Little is known about the degree to which precipitation influences both wetland vegetation and the distribution of soils and carbonation and salinity around wetlands. In prairie Canada, wetland vegetation is currently used as the only tool for delineating and classifying wetlands. However, in agricultural landscapes wetland vegetation is often impacted or missing. This study explores the spatial relationships that exist between wetland hydrology, wetland vegetation, soil formation and soil salinity/carbonation. Wetlands on two study sites in Manitoba and Saskatchewan were studied. Three wetlands were surrounded by native vegetation while six wetlands were surrounded by croplands. Vegetation and soil surveys were conducted on each wetland to identify their riparian zones using the Stewart and Kantrud (1971) system of wetland classification. These vegetative zones and long-term water level data were used to verify the long-term average annual snowmelt runoff into each wetland using a wetland hydrology model developed at the University of Saskatchewan. Wetland spatial data was then compared to the extent of soil salinity or carbonates around each wetland. The findings in this study suggest that a similar snowmelt runoff event across wetlands in both provinces best predicted the vegetative zones of all wetlands, and that a consistent relationship occurs between each wetland and the spatial extent of soil salinity or carbonates around the basin, regardless of wetland class.

KEYWORDS: snowmelt hydrology, wetland soils, soil salinity, soil carbonate distribution, prairie wetlands, hydrological modeling, soil distribution

THE VEGETATION OF PRAIRIE WETLANDS IN NATIVE AND AGRICULTURAL LANDSCAPES: IMPLICATIONS FOR WETLAND HEALTH AND RESTORATION

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Prairie wetlands collectively represent a significant portion of the total inland wetland area in Canada. Eighty-five percent of prairie wetlands have been lost due to urban expansion or agriculture. Seventy-nine percent of the wetlands that remain have vegetative margins impacted by cropping, grazing, or haying. We are positioned in western Canada to protect and restore thousands of impacted wetlands through incentive programs. The success of these programs will be determined, in part, by our ability to predict desired outcomes using the science from studies on wetland restoration and conservation. Wetland plants distribute themselves into distinct vegetation zones based on their ability to tolerate flooding, to germinate during drought periods, and to compete with other plant species. Previous studies in the northern United States comparing natural to restored wetlands found the recovery of vegetation unsuccessful decades after restoration. Native plants in the outer vegetation zones had difficulty re-establishing while invasive species flourished. No study to date has compared the vegetation communities of impacted wetlands to natural wetlands. Our ability to predict or plan for successful restorations is limited without this information. In this study the vegetative communities of 21 wetlands surrounded by agriculture and native vegetation at six study sites in western Canada were compared. Ninety-two percent of the wetlands surrounded by agriculture had at least one outer vegetation zone missing. This resulted in decreased plant biodiversity and allowed invasive and exotic species to spread to inner zones. In comparison, outer zones of native wetlands functioned as filters against the encroachment of invasive species. We propose that agricultural practices influenced soil bulk densities and increased sediment and nitrogen loading to outer zones and that these factors play an important role in permanently reducing native plant species while favoring invasive species' growth.

KEYWORDS: agricultural practices, soil disturbance, wetland vegetation, wetland restoration, tillage erosion, invasive plants, native plants, wetland conservation

THE FORAGE VALUE OF SEVEN ANNUAL CROPS HARVESTED AT 10 WEEKS GROWTH

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More information is needed about the forage value of annual crops that are terminated early due to drought. A cropping system study at 2 sites in central Alberta was used to assess the forage value of seven annual crops at 10 weeks after seeding in 2009. The crops grown were barley, canola, flax, peas, triticale, CWRS wheat and CPS wheat. The crops followed peas in the rotation and no N fertilizer was added. Spring rainfall was less than normal at both sites in 2009. Dry matter (DM) biomass yields at 10 weeks after seeding averaged 3.29 Mg ha^{-1} at Barrhead and 3.54 Mg ha^{-1} at St. Albert, with the nitrogen (N) content of the biomass ranging from 2.1 to 4.0 %N. Flax had lower DM yields than the other crops. Barley and triticale were among the higher yielding crops but had lower N content. The N yields of biomass averaged 85 kg N ha^{-1} at Barrhead and 106 kg N ha^{-1} at St. Albert. Canola biomass had higher N yields (117 kg N ha^{-1} at Barrhead and 162 kg N ha^{-1} at St Albert) than the other crops. Forage quality indicies ranged from: 28 to 56% NDF, 20 to 31% ADF, and 2 to 7% lignin. Dicot crops (canola, flax and pea) had lower NDF values (28 to 40%) than the monocot crops (barley, triticale and wheat) (48 to 56%). Lignin values were higher for the dicot crops (4 to 7%) than the monocot crops (2 to 3%). Barley had ADF values (22 to 24%) that were similar to peas (20 to 26%) and less than triticale and CWRS wheat (27 to 31%).

KEYWORDS: forage value, annual crops

SOIL PHOSPHORUS DYNAMICS AFTER PLOUGHING AN OLD GRASSLAND

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Perennial forage crops occupy nearly 50% of the cultivated land in Quebec and may receive repeated applications of manure, resulting in P accumulation in surface soils. However, we have little information about the effects of occasional tillage on the lability of added soil P. Two long-term forage plots were studied. One plot had received 100 m3 ha^{-1} of liquid swine manure annually since 1978, and the other remained unmanured. Each plot were subdivided into 16 subplots in autumn 2007. The subplots were designated one of four treatments: left with vegetation (control), or chemically killed with herbicide and either not-tilled (chemical fallow), autumn ploughed by full inversion tillage, or spring ploughed. Soils were sampled periodically and tension lysimeters were installed (15, 30 and 45 cm) to monitor soil P fractions and P in solution. In the manured plot, water-soluble P (Pw) and Mehlich-3-extractable P (M3P) were higher in the untilled (chemical fallow and control) than in the tilled treatments. In the untilled treatments, the concentrations of Pw and M3-P, and the P saturation at the soil surface (0-5 cm) were high compared to values at lower depths; tillage reduced this stratification of P. Tillage also modified the P distribution between the solid and soluble phases, with Pw being greater in the untilled than in the tilled treatments. Phosphorus concentration in the soil solution was variable (0 to >1.0 mg L^{-1}), often exceeding the standard of 0.03 mg L^{-1} for surface water quality in Québec, and tended to be higher in the untilled treatments. In long-term manured grassland, P accumulates in labile forms that present an environmental risk to surface waters. Tillage appears to change the solubility of P. A more complete understanding of how tillage changes P fractions in the soil profile is required to optimise management practices to reduce P loss to surface waters.

KEYWORDS: phosphorus, tillage, soil and water content

STRAW PRODUCTION POTENTIAL OF SPRING AND WINTER CEREAL VARIETIES AT THUNDER BAY

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Spring and winter cereal varieties were evaluated for their straw production at Thunder Bay Agricultural Research Station, Thunder Bay, during 2004-2009. The number of varieties in each crop/year ranged from 12-30. Straw production ranged from 3.56 Mg ha^{-1} to 8.38 Mg ha^{-1} in spring barley (weighted mean; 5.52 Mg ha^{-1}), 4.14 Mg ha^{-1} to 10.00 Mg ha^{-1} in spring wheat (weighted mean; 6.97 Mg ha^{-1}), and 2.97 Mg ha^{-1} to 8.31 Mg ha^{-1} in spring oats (weighted mean; 5.35 Mg ha^{-1}). Straw yield in winter wheat varied between 7.89 Mg ha^{-1} to 14.20 Mg ha^{-1} (weighted mean; 11.23 Mg ha^{-1}). Winter barley (McGregor) straw yield in 2006 varied with the seeding dates (3.85 Mg ha^{-1} to 6.03 Mg ha^{-1} ; August 25 to September 5; mean 5.23 Mg ha^{-1}). High straw yielding spring barley varieties were: AC Klinck, AC Metcalfe, Amberly, CDC Copeland, CDC Mindon, Cyane, Encore, Oceanic and Paidia. AC Klinck, Amberly, Cyane, Encore and Oceanic were good for both grain and straw production. Millhouse (food barley) and Binscarth (silage barley) fared well in straw and grain yield. Spring wheat varieties that recorded high straw yield were: AC Avonlea, Alvena, Batiscan, Brookfield, Hoffman, 5602 HR, Megantic, Nass, Quantum, Strongfield, Winfield, and to a lesser extent Sable. Out of these, AC Avonlea, Alvena, Batiscan, Hoffman, Megantic, and Sable produced high grain yields. In general, durum wheat varieties (AC Avonlea and Strongfield) were good for both grain and straw production. This was found true for AC Andrew; a soft white spring wheat. Soft red winter wheat (25R47) produced more grain, but less straw yield than hard red winter wheat varieties; high yielding being Accipiter, AC Radiant, AC Morley, CDC Buteo, CDC Harrier, CDC Ptarmigan and McClintock. Except CDC Harrier, all gave high grain yield.

KEYWORDS: spring barley, spring wheat, durum wheat, winter wheat, spring oats, straw yield

COMPARATIVE PERFORMANCE OF UREA AND ESN IN RAINFED SPRING WHEAT IN NORTHERN ONTARIO

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Field experiments were conducted at Thunder Bay (2007-2009) and New Liskeard (2009) to study comparative performance of urea and ESN in rainfed spring wheat. Treatments included zero N, and urea and ESN each @ 40, 80 and 120 kg ha^{-1} at Thunder Bay and @ 35, 70 and 105 kg ha^{-1} at New Liskeard. Interactions between the sources and rates of N were not significant. With the exception of higher straw yield with urea than that with ESN in 2008 (Thunder Bay), grain, straw and biomass yields didn't vary with the fertilizers in any of the years/locations. Application of 120 kg N ha^{-1} did not improve grain yield except in 2009 at Thunder Bay. Straw yield increased with the increasing rates of N up to 120 kg ha^{-1} in 2008 and up to 80 kg ha^{-1} in 2009 at Thunder Bay. Biomass yield was highest at 120 kg N ha^{-1} at Thunder Bay in 2008 and 2009. Grain N/protein content was not influenced by sources of N in any of the years/locations. In the first two years, application of N @ 80 or 120 kg ha^{-1} improved grain protein content up to 1 % point or more at Thunder Bay. Application of N @ 35-105 kg ha^{-1} increased the grain protein content by 2-3 % point at New Liskeard. In normal years, spring wheat removed ~200 kg N ha^{-1} at Thunder Bay and 170 kg N ha^{-1} at New Liskeard. Generally, post harvest residual nitrate N was higher from urea than that from ESN; the reverse was true for ammoniacal N. Total residual N (nitrate + ammoniacal) from the two fertilizers was more or less the same in two out of three years.

KEYWORDS: urea, ESN, spring wheat, grain, straw, biomass, protein content, N removal

DRAINAGE EFFECTS ON SITE PRODUCTIVITY AND SOIL CARBON STORES IN A CEDAR-SWAMP ECOSYSTEM IN COASTAL BRITISH COLUMBIA

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Extensive portions of the productive forests in coastal B.C., Canada, display below-average timber productivity, which may result from excess soil water as a consequence of poor drainage coupled with high levels of precipitation; yet no studies have assessed drainage as a potential silvicultural treatment for such sites. In this study, we investigated the effects of drainage on tree growth, vegetation, and soil carbon stores and fluxes in a cedar-swamp forest. Based on conclusions from other drainage trials, we hypothesize that drainage will alter the composition of plant species, increase tree growth, and CO_2 flux, microbial biomass, and carbon store in the soil. Water-level draw down decreased moisture content of the forest floor by 100% overall and improved aeration in the rooting zone, expressed as redox; however the redox values remained below +300 mV, a threshold below which anaerobic condition exist. Drainage clearly improved productivity of the site measured as height and diameter of regeneration by 25%. Tree growth was positively correlated with redox potential. There was also a shift in the composition of plant communities after drainage. Drainage significantly increased soil C storage; however microbial biomass C and C mineralization measured as CO_2 efflux were not affected. The lack of increase in CO_2 release and microbial biomass in our drained sites may indicate that oxygen limitation was not entirely overcome through drainage. Our results indicate that drainage could be a useful silvicultural practice for improving the productivity of cedar-swamp ecosystems in coastal B.C. and that it may be possible to improve tree growth without stimulating loss of soil C. This requires that drainage improve aeration in the rooting zone while maintaining redox levels of less than +300 mV in the bulk soil, a condition where oxygen level may be sufficient for plant growth but not for aerobic microbial decomposition.

KEYWORDS: drainage, soil carbon store, CO_2 efflux, microbial biomass, redox potential.

PEDOLOGICAL DIVERSITY IN CORDILLERAN BASALTIC SOILS AND PALEOSOLS

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Basaltic lava and tephra have been important parent materials at many sites in the Cordillera. Paleosols and soils display considerable morphological diversity, reflecting environmental history and variability in eruptive products. Sequences of relatively horizontal basalt flows can provide exceptional opportunities to study well-preserved paleosols and associated features of ancient land surfaces. On the Porcupine River near the Alaska-Yukon border, middle Miocene (14.4-16.8 Ma) basalts host a variety of paleosol types, including peats and reddish saprolites, that reflect localized variability in soil drainage conditions. The younger Chilcotin Group basalts (8.72-10.00 Ma) exposed at Chasm Provincial Park in central British Columbia (BC) display > 8 km of lateral variation in multiple paleosols, and associated transitions between subaerial and subaqueous environments. Elsewhere, geomorphic processes may have removed or modified soils formed on Quaternary basaltic materials. In the Fort Selkirk volcanic field (central Yukon), the surfaces of middle (441 ka) and early (1.36 Ma) Pleistocene valley-filling basalt flows display little evidence of pedogenesis. Some combination of early Pleistocene glaciation, fluvial erosion after volcanic damming of the Yukon River, and inputs of highly calcareous loess may have removed older soils and/or suppressed soil formation. Near Quesnel Lake (central BC), the latest Cordilleran ice sheet appears to have largely removed unconsolidated eruptive products of the Abbott Creek cinder cone, where Holocene soils have formed on complex materials including colluvium, till, tuff, and basalt. Texture and surface expression of basaltic materials strongly influence rates of soil formation and accumulation. At Volcano Mountain (central Yukon) and Nazko Cone (central BC), reddish-brown Brunisols have formed on fine gravelly Holocene tephra deposits and support closed-canopy forests. Adjacent blocky basalt flows of similar age have little soil, with vegetation cover limited to lichens and scattered trees.

KEYWORDS: basalt, paleosols, tephra, chemical weathering, quaternary, miocene

MODIFICATION OF THE BRADFORD AND ELISA METHODS FOR QUANTIFICATION OF GLOMALIN-RELATED SOIL PROTEIN

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Arbuscular mycorrhizal fungi (AMF) produce large amount of glomalin, a glycoprotein that can sequester carbon. Glomalin contains 30-40% C incorporated in its protein and carbohydrate subunits and is a sticky substance that enhances soil structure, further promotes soil C storage and influences pore size and connectivity. Glomalin was first documented in 1996 and is thought to be important to soil carbon sequestration and nitrous oxide emission cycles. However, glomalin is only operationally defined as the protein extracted from soil by autoclaving with a citric acid buffer. The assumption is that the harsh extraction procedure destroys most other proteins with the exception of glomalin. Because glomalin is operationally defined, the preferred terminology is glomalin-related soil protein (GRSP). Easily extractable GRSP is extracted from the soil by a single autoclave cycle. Total extractable GRSP is extracted from the soil through multiple autoclave cycles. The Bradford protein assay (Bradford, 1976 and Wright et al., 1996) and the enzyme-linked immunosorbent assay (ELISA) (Wright and Upadhyaya, 1998) are both used to quantify GRSP extracted from soil. A study was undertaken in 2009 to quantify GRSP using the Bradford protein assay and the ELISA on soils from two field studies. Troubleshooting the procedures for both assays occurred throughout the study. The lessons learned and results obtained from using these two assays will be discussed.

KEYWORDS: glomalin, Bradford protein assay, ELISA, AMF

EVALUATING THE INFLUENCE OF TILLAGE AND CROP ROATION ON SOIL VOIDS NETWORK BY X-RAY COMPUTED TOMOGRAPHY ANALYSIS

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As a tool for the three-dimensional analysis of intact soil cores, X-ray computed tomography permits the quantification of soil voids characteristics at the meso- and macropore scale. The technique extends beyond the two dimensional perspective that has been the limitation of traditional soil thin section analysis, and unlike traditional, destructive laboratory analysis, is inclusive of both the interconnected and isolated fractions of the voids network. It is possible to quantify the frequency, spatial distribution, size, shape, and orientation of voids within a core sample, all of which reflect the interactions of soil forming factors. Of particular interest in this study is the influence of agricultural management regimes (tillage and crop rotation) on those morphometric measures. We understand that management influences soil structure, and by association, the voids network. What we don't know is if those influences are characteristic of specific management regimes, or if the differences are quantifiable. This study aspires to quantify the abovementioned voids characteristics, in samples of medium and fine textured soils from the University of Guelph Elora Research Station, and the Agriculture and Agri-Food Canada Woodslee Research Farm, representing a range of established long term tillage and crop rotation regimes.

KEYWORDS: soil quality, long term soil management, Canadian soils, soil porosity, soil physics, soil structure, x-ray, computed tomography, morphometric analysis, spatial analysis

BIOLOGICAL CONTRIBUTIONS TO PLANT PHOSPHORUS UPTAKE IN ORGANIC AND CONVENTIONAL DAIRY FARM SOILS

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Recent studies exploring soil fertility on organic dairy farms in Ontario have reported low soil test phosphorus (P) values. However, soil test P values were not found to significantly correlate with yield, with some farms showing acceptable yields, despite the soil tests indicating low P availability. It has been suggested that increased soil biological activity in organically-managed systems is involved in providing the crop with P not measured by the standard soil test. The objective of this research was to explore the relationships between arbuscular mycorrhizal fungi (AMF) root colonization, AMF diversity, phosphatase activity, and productivity of organic farming systems. Three long-term (>20 years) organically managed dairy farms in south western Ontario were selected from an initial screening of 10 farms. These farms had forage fields showing low soil test P values, but relatively high yields. From each farm, one second or third year forage field was selected having a relatively flat topography and as close to uniform management as possible. Three conventional dairy farm fields with a long-term history of water-soluble P fertilizer application and located in close proximity to the organic sites were included in the study to enable a comparison. Just prior to the first cut of hay (June 2009), root, plant, and soil samples were collected from each field. Additional plant samples were collected at each subsequent cut of hay to obtain a measure of total forage yield and plant P uptake. Initial results support that while yields were generally lower on the organic fields, AMF root colonization and alkaline phosphatase activity were greater in organic systems, both of which may contribute to crop P nutrition. It is anticipated that this research will assist in understanding P fertility and cycling in low-input agricultural systems.

KEYWORDS: phosphorus availability, organic farming systesm, mycorrhiza, forages, phosphatase

PLACEMENT OF SOLID CATTLE MANURE: EFFECTS ON CROP YIELD AND NUTRIENTS IN A BLACK CHERNOZEM IN EAST-CENTRAL SASKATCHEWAN

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A study was conducted in the Black soil zone near Humboldt, Saskatchewan to evaluate the effect of different solid cattle manure (SCM) placement methods on crop yield, plant and soil nutrient concentrations. The SCM was applied in April each year using four methods: broadcast, broadcast and incorporation, injection in bands, and injection with added urea. Three application rates were used: 20, 40 and 60 T/ha. Crops grown over the three years (2007-2009) were oats and canola. Grain and straw yield and N and P concentrations were measured every fall. Soils were sampled after harvest and analyzed for extractable nutrients and organic carbon. The crop yields over the three years responded positively to cattle manure addition. However, low availability of N in cattle manure due to low content of available ammonium and slow mineralization of organic N contributed to lower yields of manure treatments compared to urea. Highest yields and plant N concentrations were generally obtained when manure was combined with urea. Addition of urea along with manure also helped to reduce the P accumulation in the soil. Especially in the first two years of the study, there was little difference between broadcast, broadcast and incorporate, and band injection of the solid manure in terms of effects on crop yield. There was some evidence for slightly increased recovery of manure N and P when placed in the soil versus broadcast. In the last year of the study some additional benefit of injection in bands versus the other two placements was evident in crop yield and N recovery. SCM injection may reduce loss on application, enhance decomposition of the manure and allow better root access to nutrients. Still, for this manure source and under the conditions at this site, the overall benefits of in-soil placement of SCM were relatively limited.

KEYWORDS: manure placement, manure nutrients, broadcast, injection, nutrient recovery, yield

EFFECT OF DIFFERENT SOIL REGIMES ON NITROGEN AND CARBON CYCLES IN ARABLE AND GRASSLAND SOILS

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Green house gases emission has been increased during last century due to anthropogenic activities like agricultural practices, fossil fuel burning and industrial activities, however the formation of N_2O in arable soil is strongly controlled by the soil temperature and soil moisture as well as fertilizer practices. A laboratory study was conducted to investigate the fluxes of N_2O and CO_2 from two different soils one from annual grassland and the other from arable land from Hiefeldhof, Hohenheim university Stuttgart Germany. The aim was to investigate the effect of temperature and soil moisture content on N_2O and CO_2 emission and N mineralization in arable and grassland soils. Sampling was done from Hifeldhof (8000 m walking distance from Hohenheim University).Two fields were selected one from grass land and other was arable land (wheat cropping) soil samples from 0-20 cm were taken from each soil,. Each soil had 4 treatments T1: control (continues moist) T2: having short drying cycles T3 having medium drying cycles T4 having long drying cycles. Gas samples were collected from the microcosms manually during different time intervals. The results indicate that in grass land soil the treatment receiving short drying cycles had high cumulative fluxes comparatively T1, T3 and T4; However arable soil behaved differently, the treatment having continues moist conditions had high fluxes .As far as CO_2 fluxes are concerned both soils behaved similarly, the treatment receiving short drying cycles had more cumulative fluxes followed by T4 having long drying cycles. Nitrogen mineralization was highly influenced by drying-rewetting.

KEYWORDS: drying-rewetting, CO_2,N_2O

SOILS: CHARTING NEW TERRITORY IN HIGH-SCHOOL EDUCATION

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Referred far too often as simply "dirt", soil is an under-appreciated and valuable natural resource that provides a vast array of essential ecosystem and agricultural functions. Increasing atmospheric deposition of pollutants and ever-intensifying land-use through mining, deforestation, wetland drainage, and intensive agriculture have degraded soils globally and continue to threaten this essential natural resource. Yet enrolment in soil science courses in undergraduate programs across the country has been declining in recent years. One of the reasons for this trend is due to lack of exposure of elementary and high school students to the study of soil science. To address this, we are aiming to introduce soil science concepts and potential career paths into high school science curricula across Canada. Our NSERC-funded initiative will include promoting learning about the importance of soil as a natural resource through the development of engaging, interactive online resources for both high school teachers (in the form of lesson plans) and students, and through development of an open-access website. Our national collaboration includes faculty and graduate students from six Canadian universities with select high schools in the Greater Toronto Area and Vancouver slated to be initial "test markets" for implementing and improving the educational resources. The website will showcase a variety of Canadian research projects that address a wide range of land-use impacts on soil and illustrate career paths of soil scientists. The estimated number of students to be reached is about 5000 per year. This project will be carried out in three annual phases with a projected deadline for the final product by December 2012. Upon its completion, the website will be administered and maintained by the CSSS.

KEYWORDS: soil science, education, high school, teachers, online resources

NITROGEN MINERALIZATION POTENTIAL IN A SOIL WITH LONG-TERM HISTORY OF FRESH AND COMPOSTED MANURE CONTAINING STRAW OR WOOD-CHIP BEDDING

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Long-term effects of fresh (FM) versus composted (CM) beef manure application to barley (Hordeumvulgare L.) on potentially mineralizable N (N0), and mineralizable N pools were evaluated in a clay loam soil in southern Alberta. The treatments were three rates (13, 39, 77 Mg ha^{-1} dry wt.) of FM or CM containing either straw or wood-chip bedding, 100 kg N ha^{-1} inorganic fertilizer treatment, and a unfertilized control. Treatments were applied annually for 8 yr in the fall of 1998 to 2005. Soil samples (top 15 cm) were collected in spring 2006 and were used to estimate *N0* using a 44-week aerobic incubation at 25°C. Organic amendment (OA) rate of application and bedding type were the most important factors controlling soil N mineralization in this system. Medium and high rates of OA resulted in 131 and 337% increases in *N0*, respectively, compared with the control (204 mg N kg^{-1}). The *N0* was not affected by the other treatments. Fertilizer application and wood-chip bedding resulted in greatest (0.094 wk^{1}) and lowest (0.043 wk^{-1}) mineralization rate (*k*), respectively. High rate of OA resulted in 83% greater readily mineralizable N pool (Pool I; flush in mineral N in the first 2 weeks of incubation) compared with average of the medium and low rates of OA (44 mg N kg-^{1}). Pool I was not affected by bedding type. Medium and high rates of OA resulted in 86 and 230% increases in intermediate mineralizable N pool (Pool II; cumulative N mineralized between weeks 2 and 44 of incubation), respectively compared with the low rate of OA and fertilizer. Pool II size increased by 165 and 220% using straw and wood-chip bedding, respectively, compared with the control (171 mg N kg^{-1}). Fertilizer application did not have any influence on *N0* or on mineralizable N pools.

KEYWORDS: bedding, compost, manure, mineralization, nitrogen

QUANTIFYING TRACE ELEMENT TRANSFER FOR RISK ASSESSMENTS – INTERPRETATION BASED ON 40 ELEMENTS IN 25 PLANT SPECIES

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To estimate risks associated with contaminated soil, simple plant/soil concentration ratios (CRs) are common used. There is an inevitable need for extrapolation, but few studies compare CR among plant types that encompass both field and garden crops. Here, CRs for 40 elements were measured for 25 crops from farm and garden sites in close proximity. For many elements, there was consistency in CR among crop types, with leafy crops > root crops ≥ fruit crops ≈ seed crops. Only As, K, Se and Zn appeared to be 'seed seekers', with probable links to analogue elements: P for As and S for Se. The rare earth elements (REE) seemed to deviate from the general pattern, in that the CRs for REE in root and leafy crops converged to minima. This was attributed to soil adhesion, despite the samples being washed, and the average soil adhesion for roots was 500 mg soil kg 1 dry plant and for leafy crops was 5 g kg 1. This is consistent with other studies, and direct contamination by soil dust may be unavoidable regardless of washing. Across elements, the log CR was negatively correlated to log Kd (the soil solid/liquid partition coefficient), as expected, and the results suggest that r ≈ -0.7 would be an appropriate level of correlation for probabilistic risk assessment.

KEYWORDS: risk assessment, partition coefficient

DAILY VARIATION OF CO_2 EFFLUX AND PREDICTION MODELS UNDER TWO TILLAGE SYSTEMS OF A BLACK SOIL IN NORTHEAST CHINA

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In order to set up a measuring time window which can delegate daily average CO_2 emission from soils under different tillage managements, we continuously measured soil CO_2 efflux rate for 48 hours (2 h in time step) four times in the 2008 growing season on a Black soil in Northeast China. Results showed that soil CO_2 efflux rate was greater under no tillage (NT) than moldboard plow (MP). The average Q_{10} value ranged from 1.42 to 2.79 for the NT and 1.33 to 1.68 for the MP, respectively, and the former was significantly greater than the latter. By comparing daily variation and daily average of soil CO_2 efflux, we suggested that soil CO_2 efflux rate measured between 9:00 and 11:00 am could be used to estimate the daily average CO_2 efflux for both NT and MP in sunny days. We also tested the possibility of prediction models, which we developed using soil CO_2 efflux rate measured during 7:00 am to 9:00 pm, to predict daily average CO_2 efflux rate. The prediction models yield better estimates of daily average CO_2 efflux rate compared with the measured CO_2 efflux rate obtained using the data from 9:00 to 11:00 am. This study indicates that in order to evaluate daily average CO_2 efflux rate, it is necessary to conduct the measurement from 9:00 to 11:00 or if another time is chosen, then those data should be adjusted using the predictive model.

KEYWORDS: soil CO_2 efflux rate, no tillage, black soil, prediction models, adjustment

EFFECT OF ZONE TILLAGE ON THE DISTRIBUTION OF SOIL ORGANIC CARBON IN A BROOKSTON CLAY LOAM SOIL

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No tillage (NT) can reduce corn (*Zea mays* L.) performance on fine-textured soils in cool humid temperature climates, especially when corn is planted into residues from a previous crop such as winter wheat (*Triticum aestivum* L.). A 10 year tillage study including zone tillage (ZT), conventional tillage (MP) and no-tillage (NT) showed an improvement in corn performance with ZT relative to NT. Compared with soil under MP management, NT resulted in obvious SOC stratification with significantly higher SOC in surface soil (0-5 cm) but lower in subsurface soil (10 to 30 cm). However, ZT favoured SOC accumulation in the surface soil similar to NT but did not cause the acute decrease in SOC in the subsurface. The weighted average of SOC in 0-30 cm were similar for NT and MP, which was 9.45 % less than ZT soil. We concluded that in addition with ZT enhancing corn production relative to NT, it also exceeded NT on SOC sequestration for Brookston clay loam soil in southwestern Ontario.

KEYWORDS: zone tillage, no tillage, soil organic carbon, soil strength, Southwestern Ontario

THE NITRIFIER/DENITRIFIER COMMUNITIES IN ARCTIC AND ANTARCTIC SOILS: WHO IS THERE AND WHAT ARE THEY DOING?

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It has been widely assumed that bacterial denitrifiers dominate nitrous oxide flux from polar soils. It has also been assumed that nitrous oxide flux from polar soils is largely inconsequential. Here I will discuss the results of a long term collaborative effort to characterize nitrous oxide flux from northern soils and the communities responsible for these fluxes. Specifically, flux estimates from two years of Arctic will be discussed in relation to global estimates of greenhouse gas fluxes. The microbial and fungal communities responsible for these fluxes will be described and the primary drivers of nitrous oxide flux from these communities will be described. Surprisingly, nitrous oxide fluxes from Arctic soils account for up to 52% of the CO_2 equivalents emitted from these ecosystems. These fluxes appear to be occurring through a combination of plant root exudates interacting with eukaryotic routes of nitrous oxide flux. These root exudate driven pathways limit the potential of denitrifier derived nitrous oxide flux in major Arctic ecosystems. Despite these differences in flux pathways from temperate systems, community analysis indicated relatively little difference between Arctic/Antarctic and temperate denitrifier communities. The results from this long term project suggest that nitrous oxide emissions in polar soils are occurring due to typical organisms but are regulated in unusual manners.

KEYWORDS: Arctic, denitrification, nitrification, greenhouse gas, microbial communities

PESTICIDE ROOT ZONE MODELING (PRZM) IN SOIL PROFILES OF TWO RESEARCH SITES IN MANITOBA AND SASKATCHEWAN, CANADA

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Agrochemicals like atrazine, glyphosate and 2,4-D are among the herbicides most frequently used in Canadian agriculture. Understanding the fate of these herbicides in Canadian soils is important for refining weed management practices and assessing risks of herbicide off-site. The objective of this study was to quantify the effect of soil characteristics and sorption input parameters on estimates of atrazine, glyphosate and 2,4-D movement to depth in soil profiles. Approximately 300 soil samples were collected from 70 soil profiles across 7 landscape elements at both St. Denis Research site, Saskatoon, SK and Manitoba Zero Tillage Research Association research site, Brandon, MB. Samples were analyzed for a range of soil characteristics and herbicide sorption parameters to obtain a set of input parameters for pesticide fate modeling. The landform elements, as well as model input parameters related to terrain characteristics, were derived by applying a series of digital terrain modeling programs to a Digital Elevation Model ($5x5m^2$) established for the research site. Pesticide movement to 10 and 100 cm depth was estimated in each soil profile under two climate scenarios using the PRZM (Pesticide Root Zone Model) version 3.12.2, a one-dimensional pesticide fate model used in regulatory or environmental risk assessments by Health Canada, Agriculture and Agri-Food Canada and the United States Environmental Protection Agency. This poster will show preliminary results of PRZM outputs in relation to soil profile characteristics.

KEYWORDS: PRZM, soil properties, herbicides, sorption, spatial variability, soil depth

RAPID QUANTITATIVE ANALYSIS OF HERBICIDES SORPTION BY NEAR INFRARED REFLECTANCE SPECTROSCOPY (NIRS): A RAY OF EVOLUTION IN PESTICIDE SCIENCE

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Near-infrared reflectance spectroscopy (NIRS) can be used to predict the concentration of constituents in a soil sample, including soil organic carbon content. Agrochemicals such as atrazine, glyphosate and 2,4-D are herbicides used in Canada. Rapid and non-chemical prediction of the fate of these herbicides in soils is important for refining weed management practices and assessing risks of herbicide off-site movement. The sorption of these herbicides by soil is in part controlled by soil organic carbon content. The objective of this study was to determine whether the soil sorption parameters of these herbicides can be predicted using NIRS. A study was conducted on 316 soil samples from 70 soil profiles across 7 landscape elements at the Manitoba Zero Tillage Research Association (MZTRA) Research Farm. Soil was air-dried and sieved (<0.2 mm) and placed (25 g) in a petri dish. Samples were scanned on a Zeiss Corona 45VISNIR spectrometer at wavelengths ranging from 380 to 1690 nm. Samples were also analyzed for a range of soil characteristics, soil organic carbon content, pH, sand, silt, and clay %, and herbicide (atrazine, glyphosate, 2,4-D) sorption parameters. Calibrations were developed between the spectral and the physical/chemical data using Unscrambler® Software version 9.8 (2008, CAMO Software AS, Norway) and Principal Component Analysis/Partial Least Square Regression. Optimal calibrations were those with highest coefficient of determination (r2) between the NIR-predicted values and the laboratory analytical values, lowest Root Mean Square of Prediction (RMSEP), and lowest difference between mean NIR-predicted value and mean laboratory analytical value. The results of the calibrations using the 316 samples from A, B and C-horizons will be discussed.

KEYWORDS: calibrations, herbicides, NIRS, soil properties, sorption

RELATIVE MRNA TRANSCRIPT LEVELS OF MAIN SEED DEVELOPMENT TRANSCRIPTION FACTORS IN HIGH OIL VERSUS LOW OIL PHENOTYPES OF *BRASSCA NAPUS*

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Brassica napus oil synthesis is composed of a plastidal fatty acid synthesis (FAS) component, a cytosol pool, and an ER-based triacylglycerol (TAG) component. A number of the main embryogenic transcription factors in seed development appear to affect the plastidal FAS component. This research shows an increase in the transcript concentration of WRINKLED1 (WRI1) and FUSCA3 (FUS3) at 21 days after pollination (DAP) in high oil lines compared to low oil lines, and a decrease in the concentrations of mRNA of LEAFY COTYLEDON2 (LEC2) at 28 DAP in high oil versus low oil phenotypes. This link between a high oil phenotype and variation in the transcript concentration of embryogenic transcription factors, which affect the plastidal component of B. napus oil synthesis, highlights the potential use of manipulating oil synthesis through the manipulation of embryogenic transcription factors.

KEYWORDS: transcription factors, brassica napus, oil synthesis

NUTRIENT EXPORT IN RUN-OFF FROM AN IN-FIELD CATTLE OVERWINTERING SITE IN EAST-CENTRAL SASKATCHEWAN

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On the Canadian prairies, many cow-calf producers are adopting an in-field overwintering system. This system has shown to increase retention and recycling of nutrients from feed. Increased return of nutrients raises the concern with potential transport of nutrient in runoff. The study was on a Russian wild ryegrass pasture at the Western Beef Development Center near Lanigan, Saskatchewan. The field terrain is hummocky, creating ephemeral wetlands for runoff water to collect. The pasture was divided into control and winterfeeding portions, each containing four basins. Wells and piezometers were installed in all eight basins. Soil samples were collected in the fall 2008 before winterfeeding and again after runoff was complete in the spring 2009. During the runoff melt, water samples were collected daily from the basins. Piezometer samples were collected weekly starting in April until July. Concentrations of orthophosphate and ammonium in the snowmelt runoff water from the in-field overwintering sites were significantly elevated compared to the control watersheds. There was no significant difference in nitrate concentrations in water from the overwintering sites versus the control. Piezometer samples showed elevation of ammonium and orthophosphate in the overwintering sites. There was no significant difference in soluble or exchangeable phosphate in the soil samples taken from overwintering and control watersheds. Elevated ammonium and orthophosphate concentrations in runoff water from winter feeding sites indicate that they should be located to avoid run-off water entering into sensitive water bodies. Similar nitrate concentrations in runoff water from control and winterfeeding sites may be explained by cool spring temperatures limiting microbial conversion of ammonium to nitrate. Lower soluble and exchangeable soil phosphate in spring compared to fall is attributed to rapid plant and microbial uptake of P in spring.

KEYWORDS: run-off, nitrate, ammonium, orthophosphate, winterfeeding, Saskatchewan

CLIMATE CHANGE AND AGRICULTURE: THE ROAD AHEAD

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Climate change and crop production interact in at least four ways: 1) crop production results in greenhouse gas production, 2) changes in climate affect the ability of crop plants to grow, 3) as climate change progresses we will have to adapt both our crops and the systems we use to produce them and 4) the correct changes in crops and their production systems can reduce net greenhouse gas production. Currently the agriculture sector produces about 10% of Canadian greenhouse gas emissions. Almost all of this is in the forms of nitrous oxide (310 times more effective at heat trapping than CO_2) and methane (21 times more effective). Agriculture is a small net sink for CO_2 . Increasing atmospheric CO_2 levels will improve crop growth and/or water use efficiency, however the resulting changes to climate will cause potentially detrimental increases in temperature, the frequency of drought, the frequency of flooding, wind speed, soil erosion, incidences of disease and insect problems and other more subtle effects on agro-ecosystems. In general, global food production will decrease as climate change effects become more pronounced. Some of the ways crop production can be adapted to climate change are: 1) alterations in the management systems used to produce crops and in the genetic make of up the crop plants, 2) policy, legal economic changes that facilitate the required changes to crops and their production systems and 4) development and implementation of crop production practices that actually mitigate climate change effects. The mitigation effects can come through cropping systems and crops that increase soil organic matter (including through biochar application to soils), emit less nitrous oxide and facilitate more efficient production of bio-fuels and other bioproducts.

DIGITAL SOIL MAPPING IN THE OKANAGAN BASIN, BRITISH COLUMBIA TO SUPPORT FOREST BIOMASS HARVESTING SUITABILITY ASSESSMENT

Scott Smith, Eve Flager, and Grace Frank, Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada, Chuck Bulmer, Research Branch, BC Ministry of Forests and Range, and Deepa Filatow, Ecosystem Information Section, BC Ministry of Environment

Digital soil mapping techniques are being implemented to improve accessibility of soil survey information for intensive water supply modelling in the Okanagan Basin of southern British Columbia and most recently, to provide a basis for harvest biomass harvesting site suitability. This paper reports on progress made in the spatial disaggregation of detailed (1:20,000 - 1:50,000), harmonized, legacy soil survey information using a 25 m DEM and several automated landform classification systems including a fuzzy land element approach, unsupervised nested-means algorithm and a simple topographic position index. Selective landform facet classes and additional co-variants including land cover and ecological zones are used as input variables to the SoLIM inference engine (and related ArcSIE software) to predict the occurrence of individual soil series and their attributes over a semi-arid high relief watershed of approximately 8,200 km^2 in southern British Columbia. The result is a first approximation of a high resolution soil series map and related attribute data in raster (gridded) format. This will provide a range of spatially-explicit soil attributes (pH, % sand, silt clay, bulk density, organic C, CEC) suitable for input to various environmental models that can be more easily merged with other forms of raster input data like land cover, climate and elevation.

KEYWORDS: digital soil mapping modelling Okanagan

INFLUENCE OF NITROGEN POOLS AND MICROBIAL ACTIVITY ON CROP N INFLUENCE OF NITROGEN POOLS AND MICROBIAL ACTIVITY ON CROP UTAKE FOLLOWING LEGUME CROPS

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Crop following legumes are believed to derive benefits resulting from 'spared nitrogen' (due to dinitrogen fixation) and crop rotation. In this report, we assessed the influence of soil N pools and microbial activity on wheat growth and N uptake following field peas and fababean grown for seed as well as legume green manure crops using correlation and stepwise regressions. Without exception wheat yields were significantly higher following legumes than wheat following barley. In general, soil nitrate content after the legume crop was the important factor affecting N uptake by wheat. Mineralizable soil N followed by soluble organic N content also increased wheat N uaptke. Ammonium content, soil glucosidase activity and microbial diversity were also factors that improved predictions of N uptake but on an inverse relationship. It thus appears that a higher level of microbial activity and diversity resulted in competiton for N.

KEYWORDS: nitrogen pool, microbial activity, microbial diversity, legume, crop N uptake

SPATIAL PATTERNS IN FOREST FLOOR DEVELOPMENT ON RECLAIMED SITES IN NORTHERN ALBERTA

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We assessed spatial patterns in the development of forest floor depth and nutrient availability in three different reclaimed stand types (Populus tremuloides, Pinus banksiana, and Picea glauca) of the Athabasca Oil Sands Region. Oil sands extraction has currently disturbed over 450 square kilometers of forest and wetlands, and the reclamation and re-establishment of ecosystem function represents a major ongoing challenge. Spatial heterogeneity of soil processes was investigated as it is related to ecosystem function and species diversity. A spatially explicit sampling protocol, based on a random walk model designed to maximize pairwise comparisons at spatial lags between 1 and 40m, was used to measure forest floor depths and nutrient availability. Nutrient availability was measured using three sets of plant root simulator probes (Western Ag Innovations, Saskatoon, SK) placed and subsequently removed at the beginning of August 2008, November 2008, May 2009, and August 2009. Tree locations were mapped on each site in June 2009, and canopy area was recorded for each tree. Preliminary analysis of spatial autocorrelation suggests a potential relationship between soil nitrate availability and forest floor thickness in the P. tremuloides stand. Further analyses, including kriging and estimates of spatial dependence, are expected to reveal seasonal relationships between nutrient availability, forest floor depth, and canopy area that vary among stand types.

KEYWORDS: forest floor, nutrient availability, reclamation, spatial

EVALUATION OF NEW SAINFOIN GERMPLASM FOR USE IN BLOAT-FREE GRAZING SYSTEMS

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Beef cattle production can be maximized through the use of alfalfa (Medicago sativa) as a monoculture or dominant species in a forage mixture. However, pasture bloat serves as a major deterrent to the grazing of alfalfa-based pasture despite the high growths that are obtainable. Sainfoin (Ononbrychis viciifolia) is known to lower the incidence of pasture bloat when grown in mixed stands with alfalfa. The sainfoin varieties currently available in Canada, grow back slowly after grazing or cutting and die-out quickly when planted in a mixed stand with alfalfa. Three new populations of sainfoin (LRC05-3900, LRC05-3901 and LRC05-3902) were developed at Lethbridge Research Centre (LRC) for their improved ability to compete with alfalfa and grow back after cutting at the same rate as alfalfa. These three new populations and 'Nova' sainfoin were established in mixed stands with AC Blue J alfalfa (in alternate rows) for simulated and actual grazing at Lethbridge in 2008. The field plot arrangement used was a four times replicated completely randomized design. In the simulated grazing trial the three new populations had higher total biomass yields than alfalfa in the stands after three cuts. The yields of LRC05-3900 and LRC05-3902 were significantly ($p<0.05$) higher than alfalfa and they both had yields about 25% more than Nova. After the third cut, the yields of LRC05-3900 and alfalfa were about the same in the stands whereas the yields of the other sainfoin populations were significantly lower ($p<0.05$). Among the sainfoin populations LRC05-3900 seems to have persisted better than others. The alfalfa samples collected from these plots had higher crude protein (24.3 g/kg DM) compared to all the sainfoin populations which had values ranging between 18 – 21 g/kg DM.

KEYWORDS: bloat free grazing, sainfoin, alfalfa

SHINING LIGHT ON BIOGEOCHEMICAL PROCESSES AT SOIL INTERFACES

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The use of in-situ, molecular scale techniques, especially those that employ synchrotron radiation, has greatly advanced our understanding of biogeochemical reactivity and speciation at soil interfaces. These tools enable one to make measurements at small spatial and rapid temporal scales and simulate natural environmental conditions. The use of small scale techniques in the soil and environmental sciences has resulted in a new multidisciplinary field- molecular environmental science. There are a number of areas dealing with biogeochemistry of contaminants and nutrients where the application of molecular environmental science is resulting in major scientific frontiers. A number of these, involving speciation and reactivity at important environmental interfaces including the soil/water, plant/soil, and mineral/microbe, will be discussed in this paper. Emphasis will be placed on speciation of metal(loids) in soils and plants, surface complexation and precipitation, mineral transformations, and rapid redox processes at mineral surfaces.

KEYWORDS: synchrotron-based spectroscopic techniques, environmental interfaces, kinetics

BIOPHYSICAL PARAMETERS FOR EVALUATING LAND RECLAMATION IN THE ROCKY MOUNTAINS

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The goal of this project is to determine if past reclamation of land disturbances in Jasper National Park have successfully established native plant communities in montane and subalpine natural subregions. Land disturbance creates an opportunity for non-native plant species to invade bare ground. Invasions of aggressive species tend to simplify the composition and function of plant communities. Failure of plant communities of any kind to re-establish is another risk; this is the simplest structure possible. Loss of primary producer populations is linked to reduction in wildlife biodiversity, soil erosion, and a lesser visitor experience at degraded recreation sites. Ecosystem management, based on widely accepted science-based practices, has minimized the impacts of routine human disturbances on biodiversity. However, no monitoring method currently exists to judge whether reclamation practices are effectively maintaining native plant biodiversity and preventing soil erosion. A monitoring method, using key biophysical criteria, is designed to achieve the project goal.

KEYWORDS: land reclamation, biophysical parameters, ecological monitoring, Canadian Rocky Mountains, montane, subalpine

SOIL TYPE AFFECTS N_2O EMISSIONS AND POPULATIONS OF NITRIFYING AND DENITRYIFYING BACTERIA IN MYCORRHIZAL-INOCULATED WILLOWS

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Nitrous oxide (N_2O) is a potent greenhouse gas emitted from soil ecosystems by nitrifying and denitrifying bacteria. It is well established that N_2O emissions are influenced by the soil physical environment, but attempts to correlate emission rates to soil microbial communities have been inconclusive. The soil physical characteristics, along with nitrogen availability, may be altered by the presence of mycorrhizal fungi. We hypothesized that by establishing a more efficient nutrient cycle in the rhizosphere, mycorrhizae may alter emission rates of N_2O from soils. A greenhouse experiment was designed to test the effects of different soil types and mycorrhizal inoculation on N_2O emission rates and populations of N_2O emitting bacteria from potted soils containing willow (*Salix* spp.) trees. Willow cuttings were potted in 6 Southern Ontario soils representing a range of soil textures. Mycorrhizal fungal inoculant was added in 1 of 4 treatments: 1) Arbuscular Mycorrhizae (AM) (*Glomus intraradice*s), 2) Ectomycorrhizae (EM) (*Hebeloma cylindrosporum*), 3) AM and EM, or 4) uninoculated. Four month old potted trees were placed in flow-through chambers for 72 hours to determine N_2O fluxes using tunable diode laser technology. N_2O emissions and concentrations of nitrate (NO_3^-) and ammonium (NH_4^+) were significantly influenced by soil type, plant presence and inoculation type. Soil DNA was extracted and quantitative polymerase chain reaction (qPCR) was used to quantify genes coding for bacterial nitrification and denitrification. Sandy soils exhibited the lowest N_2O emission rates and lowest denitrifying gene copy numbers. Our data indicates that mycorrhizal inoculation does affect N cycling in soil. This may be due to the interactive effect that we see between microbial populations, soil type and N_2O emissions. However, this did not result in significantly lower N_2O emissions from soils containing the inoculated willows.

KEYWORDS: nitrous oxide, nitrifiers, denitrifiers, bacteria, real time quantitative PCR, tunable diode laser, mycorrhizae

COMPOSTED VERSUS FRESH DISTILLERS GRAIN DERIVED MANURE AS NUTRIENT SOURCE FOR CANOLA.

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Recent research has shown distillers' grains and solubles (DDGS), a by-product of ethanol production, to be a high protein feed source for beef cattle. The fecal material from the cattle fed DDGS contains higher N and P contents, so composting DDGS manure may further concentrate the N and P and other constituents compared to conventional grain ration fed cattle manure. Consequently, composting may influence nutrient availability and crop response in cropping systems. This study compares amendment with two different types of manure, DDGS wheat fed fresh manure and DDGS wheat fed composted manure, on canola growth and nutrient uptake in Saskatchewan soils under controlled environment conditions. The two manure types were incorporated into a loamy textured black Chernozem soil at five rates: 0, 60, 120, 180, and 240 t/ha. The pots were seeded with canola and grown under controlled conditions for a period of five weeks. Canola biomass yield was significantly increased by the addition of the two different manure forms, with maximum yield achieved at a rate of 120 t/ha for composted manure versus 240 t/ha for fresh manure. There were significant differences between canola biomass yield for the DDGS compost and the DDGS fresh manure treatments that varied with the rate of application. The composted manure produced higher canola biomass than fresh manure at the lowest rate of 60 t/ha, similar biomass to fresh manure at 120 t/ha, and lower biomass at the higher rates. These effects are attributed to higher nutrient and salt content of the composted manure, with toxicity becoming apparent at the higher application rates.

KEYWORDS: Distillers' grains, manure, compost, soil amendment

PERENNIAL FORAGE IMPACT ON CARBON DIOXIDE AND NITROUS OXIDE EMISSIONS IN THE RED RIVER VALLEY, MANITOBA

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Studies have shown that including perennial forages in rotations can increase soil carbon (C) and lower nitrous oxide (N_2O) emissions when compared to continuous annual cropping. Although there is evidence that perennials may reduce net greenhouse gas (GHG) emissions from agricultural systems, there is a lack of simultaneous carbon dioxide (CO_2) and N_2O flux measurements from forage crops. The study is part of a long-term experiment that began in Fall 2005 to determine GHG budgets for cropping systems in the Red River Valley, Manitoba. Located at the University of Manitoba's National Centre for Livestock and the Environment, south of Winnipeg, Manitoba, the site consists of four 4-ha plots with a history of annual rotation management. Nitrous oxide and CO_2 emissions were measured continuously using the flux gradient micrometeorological method. Two cropping rotations, annual-perennial and continuous-annual, each with two replicate plots were examined. In 2008, the year of forage establishment (annual-perennial rotation) the perennial plots accumulated 1250 ±250 kg C ha^{-1} (no forage removed), and emitted 0.9 ±0.2 kg N_2O-N ha^{-1} . The continuous-annual plots were a net C sink of 480 ±110 kg C ha^{-1}, after accounting for harvested spring-wheat grain and straw, and released 2.6 ±0.5 kg N_2O-N ha^{-1} . In the second year of the perennial phase (until September 1st, 2009), the annual-perennial plots were a cumulative net sink of 2200 kg C ha^{-1} after accounting for one hay harvest. Over the same period, the continuous-annual plots had a net accumulation of 850 kg C ha^{-1} at harvest, including rapeseed grain removal in 2009. The annual-perennial rotation reduced net GHG emissions overall due to the combined effect of reduced N_2O emissions and greater CO_2 -C uptake. Cumulative GHG fluxes (CO_2 and N_2O) will also be presented for the four years of this study contrasting the continuous-grain and annual-perennial rotation systems.

KEYWORDS: nitrous oxide, carbon dioxide, alfalfa, flux gradient method

DEVELOPMENT OF AN INNOVATIVE COMMUNITY OF PRACTICE PLATFORM FOR SOILS PROFESSIONALS IN BRITISH COLUMBIA

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Soil science professionals in British Columbia (BC) are faced with the issue of a relatively small community scattered across the large area of the province. At the same time, student learning is somewhat limited to soil types, landscapes, and management issues typically found in the region where students attend school, and they experience little connection with expertise outside of their immediate region. The goal of our project is to develop a dynamic, sustainable web-based learning platform to enhance and support a distributed community of practice within the discipline of soil science in BC. The platform will allow for the networking and professional development of soil science students and professionals in post-secondary institutions, provincial and federal agencies, and the private sector. The project is executed in conjunction with the Pacific Regional Society of Soil Science (PRSSS), a well-established non-profit organization focused on promoting discussion and awareness of soil issues in various land resource management scenario. The platform will be based in a UBC WordPress blog (http://blogs.ubc.ca/). We will take existing PRSSS web content and combine it with a user-friendly site that includes professional networking options, an inventory of web-based soil science resources (e.g., soil maps and surveys, online animations, video footage), examples of lesson plans, and discussion forums and blogs that will focus on teaching and learning ideas, topics for future professional events, ideas for newsletter articles, and scientific questions of pressing importance in the province. The platform will substantially enhance communication among not just soil scientists in BC but also in North America, since currently only one soil science society (Soil & Water Conservation Society) in North America is using blogs to enhance communication among its members. The platform is planned to be launched in October 2010.

KEYWORDS: non-profit society, professional networking, soil science education, web-based, community of practice

MANAGING ANNUAL GREEN MANURES TO IMPROVE YIELD AND SOIL HEALTH IN ORGANIC PRODUCTION SYSTEMS

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Organic grain producers rely on green manures (GM) to return essential nutrients to their cropping systems; however, growers on the semiarid prairies are concerned with the tillage and depletion of soil moisture reserves associated with using GM. Legume green manures supplying high amounts of N and P, and management techniques optimizing nutrient cycling and soil moisture retention are needed for successful GM use. This two-year field study conducted in Saskatoon and Vonda, SK explores the effect of termination timing and method of field pea *Pisum sativum* on subsequent wheat *Triticum aestivum* yield and soil health indicators. Field pea was terminated at early flower, late flower and budding of 2009 by either tillage or rolling/crimping. The roller-crimper kills GM by crimping the stems, leaving a layer of mulch on the soil surface expected to reduce surface evaporation. Soil and plant samples were taken from those plots being terminated within one week of termination, with soil sampling repeated in October 2009. Green manure total N and P uptake and soil concentrations of NO_3^-, NH_4^+ and PO_4 - and moisture content will be presented for 2009. Microbial biomass C, N and P, metabolic quotient, alkaline phosphatase, protease, and dehydrogenase determined for the fall soil samples will be presented as indicators of soil health and potential N and P availability. In 2010 spring wheat will be planted on all of the treatment plots and a subsample analyzed for total N and P uptake three times throughout the summer. At harvest, yield, grain protein content, and total N and P of the wheat will be determined. Soil sampled at wheat sampling and in fall will be analyzed for NO_3^-, NH_4^+ and PO_4 concentrations and gravimetric soil moisture content. Effects of GM management on nutrient availability, soil moisture and soil health indicators from 2009 will be discussed.

KEYWORDS: green manure, organic agriculture, roller/crimper, nutrient cycling, nitrogen, phosphorus, microbial biomass, enzymes

MOISTURE MEDIATED ALTERATIONS OF MICROBIAL COMMUNITIES IN BOREAL FOREST FLOORS

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Stand level factors such as overstory composition can have a profound effect on the ecology of microbial communities in boreal forest floors. However, factors influencing community composition at the microsite scale are still poorly described and understood. Here we explored moisture effects on microbial communities in forest floor derived from undisturbed trembling aspen and white spruce stands. Forest floor samples were incubated in a laboratory experiment for a period of one month under a moisture regime ranging from moist to dry (field capacity (FC), sixty percent field capacity (60%FC) and wilting point (WP). As in previous studies we found that the origin of the forest floor material had a strong effect on the microbial community. Additionally, we found that the microbial communities from the white spruce forest floor appeared to be less impacted by moisture limitations, and all moisture regimes shared similar structure and function. On the other hand, moisture had a profound effect in the aspen forest floor as FC, 60%FC and WP treatments had structurally and functionally distinct microbial communities.

KEYWORDS: boreal forest, aspen, white spruce, PLFA, multi-SIR, moisture

PERSITANCE OF SULFENTRAZONE IN SASKATCHEWAN SOILS

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Laboratory and field experiments were conducted to study the factors influencing persistence of sulfentrazone and potential for carry-over in Saskatchewan soils. Dissipation was examined in five soils incubated at 25 C and moisture content of 85% field capacity. Slower dissipation was observed in soils of higher organic matter content and lower pH; estimated half-lives were relatively long (21 to 103 days) and were significantly correlated with organic carbon and soil pH. In a field study conducted at three sites, one year after sulfentrazone application residual sulfentrazone was detected in soil at 140 g ai/ha application rate and above and was significantly correlated with percent visual crop injury and with the yield of lentil. Because of its relatively long half-life, sulfentrazone may have residual properties and field application rate of 140 g ai/ha and above may result in carry-over injury to sensitive crops such as lentil in Canadian prairies.

KEYWORDS: sulfentrazone, persistance, carry-over, bioassay

FUNCTIONAL DIVERSITY OF FUNGI ASSOCIATED WITH DURUM WHEAT ROOT IN SOUTHWEST SASKATCHEWAN

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A wide spectrum of fungi from pathogens to mutualistic symbionts exists in plant roots. Improving crop production and sustainability requires comprehensive knowledge on the interaction of plant and soil with different fungal functional groups. Using the combination of classical plate culture method with molecular biology techniques we provided a comprehensive checklist of culturable fungi existing in the root of durum wheat both in healthy and diseased roots. More than 2400 fungal isolates were obtained from about 1500 pieces of surface sterilized durum root on PDA. 110 Operational Taxonomic Groups (OUTs) were made out of these isolates based on colony color, morphology and hyphal architecture. Genomic DNA extracted from pure cultures of representative isolates of each OTU and PCR amplification were done using different primers of ITS, Small and Large subunits of ribosomal genes in addition to elongation factor gene (for Fusarium spp.). More than twenty fungal taxa mainly from ascomycetes were identified. In vitro tests were done to understand the functionality of the main fungal taxa isolated from durum roots. Multivariate statistics analysis (ordination and mrpp) were applied to compare the fungal communities associated with healthy vs. diseased root and to uncover the patterns of synergistic and/or antagonistic interactions between important fungal functional groups.

KEYWORDS: fungi, durum wheat root, pathogens, endophytes, functional diversity, Saskatchewan

SMALL HEAT CAPACITY ESTIMATION ERRORS IN BENTONITE SAMPLES DUE TO VOID SPACE USING SINGLE PROBE HEAT PULSE MEASUREMENTS

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Accurate determination of soil thermal properties is critical for understanding how water and energy are partitioned in the vadose zone. Single probe heat pulse (SPHP) methods have the advantage of measuring thermal quickly, and in situ, yet to date have been limited to measurements of thermal conductivity. In order to measure soil water content, accurate estimations of soil heat capacity and the associated error must be determined. The objective of this work was to determine the effect of air-filled pore space volume on the accuracy of heat capacity measurements using SPHP methods. SPHP measurements of sodium bentonite samples ranging in mean particle diameter of 13 mm pellets to 0.053 mm powder were conducted to examine the influence of air-filled void space on the determination of heat capacity. Preliminary numerical simulations did not agree with measured temperature response curves, due to discrepancies between the homogeneous solid model, and samples with a mean air filled porosity of 0.55. Non-linear curve fitting to short time (<2 s) and long time (5 > t <600 s) data showed that heat capacity increased logarithmically with a decrease in mean particle diameter (R2 = 0.91). Heat capacity was underestimated by an average of 90% at particle diameters > 1.4 mm, while values more closely agreed those reported in the literature as well as those measured using digital scanning calorimetry, beginning at particle diameters < 1.4 mm. Results clearly indicate that for large diameter particles, thermal properties of air will dominate the measurement, resulting in an apparent decrease in heat capacity.

KEYWORDS: single probe heat pulse, heat capacity, bentonite, void space

FIELD AND NUMERICAL MODELING INVESTIGATION OF A SLOPING UNSATURATED LAYERED SOIL COVER SYSTEM

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Unsaturated soil cover systems comprised of various layers are recognized as being effective in minimizing interaction of meteoric water with underlying mine waste. Studies detailing field monitoring and numerical modeling results on layered systems in sloping landscapes are scarce. The objective of this paper was to document the field performance monitoring of a sloping layered cover system, and to use those data as a guide for a subsequent numerical modeling program. The study site was a phosphate mine in a semi-arid area of the Northwestern United States. Performance monitoring indicated that the cover thickness was sufficient in preventing net percolation into the underlying waste shale, at least partially improved by increased storage at layer interfaces. Cover water dynamics did not vary greatly with slope position, as little evidence of interflow was found. Analytical water balances found the net percolation into the underlying waste to be negative in 2007, indicating upward movement of water, and 2% of precipitation in 2008. Two-dimensional models of a simple layered cover and a cover containing a geosynthetic clay liner were simulated. Model results agreed with field observations, suggesting that sufficient cover thickness would partition the water balance toward evapotranspiration and runoff, rather than infiltration into the waste.

KEYWORDS: cover, percolation, unsaturated, model (numerical), mine

EFFORTS TOWARD SATURATING BARLEY MALTING QUALITY QTLS WITH AC/DS TRANSPOSONS

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Malting quality, a complex, multi-component trait determines the quality of beer made in the brewing industry. Molecular mapping studies in barley indicate a major QTL complex, QTL2 on the short arm of chromosome 4H, affects several malting quality parameters. In order to dissect the QTL, the maize *Ac/Ds* transposon system is used. Using this system, single-copy *Ds* insertion lines (TNPs) were generated in barley to identify, tag, and determine genes and their function. Coupled with availability of extensive genomic resources, a robust platform is available to effectively use transposons for isolating, characterizing and mapping genes in barley. Data on multi-generational *Ds* re-activation demonstrated that *Ds* transpositions in barley occur to at significant frequencies over multiple generations. Also, *Ds* is shown to have a preference of re-inserting near the original site of excision and into genic regions which will help facilitate saturation mutagenesis. Currently, sequential re-activation of Ds in plants with single *Ds* insertions (TNPs), mapping near genes of interest, is targeted at saturating the malting QTL2. Reactivation of Ds is done using two methods; 1) by crossing TNP plants with *Ac* TPase expressing plants or 2) by exposing TNP embryos to extra-chromosomally expressed *Ac* TPase through tissue culture. Several new transpositions have been identified by DNA hybridization and tagged genes are being cloned using inverse PCR (iPCR) and Thermal Asymmetric Interlaced (TAIL) PCR. This effort of saturation mutagenesis with *Ds* transposons will lead to a better understanding of malting quality traits and candidate genes that display quantitative variation.

KEYWORDS: quantitative traits

COMBINED EFFECTS OF METAL STRESS AND ELEVATED CO_2 ON CROPS: ADVANTAGES AND DISADVANTAGES

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Mining, manufacturing, use of synthetic products, and land application of industrial or domestic sludge have contaminated a large proportion of agricultural land throughout the world, causing an increase in the soil concentrations of most metals. The situation is even worse in China where approximately 2.0×10^7 hm^2 of agricultural land is contaminated with heavy metals. Such widespread land contamination poses a potential threat to plant growth and development. Therefore, plant stress biology is receiving more attention in recent years, especially from the viewpoint of food safety and clean-up technologies.

Concurrently, ongoing fossil fuel combustion has increased atmospheric carbon dioxide concentration from 280μL L^{-1} to approximately 380μL L^{-1} since the beginning of industrialization, and it is expected to continue increasing in the future, resulting in global warming and climate change. Elevated CO_2 is a new challenge for crops and its continuing increase may cause specific short-term acclimation and long-term adaptation responses. The effects of CO_2 on crop growth and development might be more important than previously thought. It is clear that elevated CO_2 affects plant growth in both unstressed and stressed environments, but little information is available concerning the combined effect of elevated CO_2 and metal contamination on crop responses. Given the expected global increases in CO_2 concentration and resulting changes in plant physiological and physiochemical processes, the effects of heavy metal contamination on crop growth, development and heavy metal uptake may differ.

Here we show that elevated CO_2 not only significantly increased aboveground plant biomass compared to the ambient CO_2 treatment, but also increased the uptake of metals. These processes are usually associated with a series of plant responses ranging from element uptake to physiological processes, variations in soil pH values, and changes in number and kind of microorganisms in the plants' rhizospheres.

Two major conclusions can be drawn from our studies: 1) Crops with significantly increased biomass and metal uptake under elevated CO_2 exhibit greater potential for phytoextraction; 2) Given expected global increases in CO_2 concentration, CO_2 -induced accumulation of metals in crops might potentially contribute to future health risks, with Cd being a more important threat to human health than Cu. The knowledge gained in these investigations constitutes an important advancement in our understanding of the interaction between soil metal contamination and atmospheric CO_2 concentration with regard to crop's ability to grow and remove metals from soils and food safety.

KEYWORDS: elevated CO_2, crops, uptake, metals, contaminated soils.

IDENTIFICATION OF GROWTH LIMITING NUTRIENT(S) IN ALFISOLS: SOIL PHYSICO-CHEMICAL PROPERTIES, NUTRIENT CONCENTRATIONS AND BIOMASS YIELD OF MAIZE

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Soil fertility diagnostic technique developed by Agro Services International (ASI), including soil testing, nutrient sorption study, and pot experiments were conducted to identify most growth limiting nutrients for maize on soil samples collected from Delbo Atwaro Watershed, southern Ethiopia. Greenhouse experiment with 19 fertilizer treatments was conducted in a completely randomized design (CRD) with four replications using maize as a test crop. Chemical analysis of composite soil samples indicated that Ca, Mg, Fe, Mn, Zn, B and were sufficient to support good crop growth, whereas total N, available P, available, B, S and K were deficient. Sorption studies of P, Cu and B indicated that the optimum levels of the nutrients for Alfisols of the Delbo Watershed were: 130 mg P, 30 mg K, 20 mg S, 3.0 mg Cu, and 1.0 mg B per kg soil. Besides, P and Cu were found to be highly fixed by the soil. The results of soil analysis, dry matter yields, nutrient concentration and uptake by maize indicated that phosphorus and nitrogen to be highly limiting nutrients to support good crop growth and development. Furthermore, Cu, K and S are also potentially limiting nutrients.

KEYWORDS: Alfisols, sorption, critical level, limiting nutrients, maize

DAMS AND RESERVOIRS: EFFECT ON STREAM WATER QUALITY AND QUANTITY IN THE CANADIAN PRAIRIES

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For years, flooding and soil erosion impacted the agricultural land surrounding the South Tobacco Creek watershed in south-central Manitoba. In response, landowners constructed a network of small dams and reservoirs in the headwaters for erosion and flood control. Between 1999 and 2007, two small reservoirs (Steppler and Madill) were intensively monitored for their effectiveness in reducing flood peaks and downstream sediment and nutrient loading during spring snowmelt and summer rainfall periods. The two reservoirs successfully attenuated peak flow as runoff waters were routed through the reservoirs, but little of the overall runoff volume was retained for a significant length of time. Both reservoirs significantly reduced annual loads of sediment, nitrogen (N) and phosphorus (P) – Steppler, average of 77, 15 and 12 % yr-1, respectively; Madill, average of 66, 20 and 9 % yr-1, respectively. They were also effective in reducing annual loads of dissolved N and P to downstream water bodies (Steppler, average of 14 and 10 % yr-1, respectively; Madill, average of 23 and 15 % yr-1, respectively), during both snowmelt and rainfall-generated runoff periods. While the reservoirs removed particulates during snowmelt-generated runoff, they were often sources of suspended nutrients during rainfall-generated events. We suspect that this was a combination of relatively few particulates in the inflow water and algal growth during the summer. However, since dissolved nutrients were the dominant form of both N and P (> 70 % in both snowmelt and rainfall-induced runoff events), the two reservoirs were successful in reducing overall nutrient loads to downstream water bodies, annually and seasonally. In combination with improving flood and erosion control for the region, the concept of small dams/reservoirs has sufficient value that deserves consideration when developing watershed management plans, especially for agricultural escarpment regions, on the prairies.

KEYWORDS: nutrient loading, snowmelt, rainfall, small dams/reservoirs, water quality

A NEW TARGET IN INSECT CONTROL: PERITROPHIC MATRIX

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Bertha armyworm, Mamestra configurata, is a major insect pest of canola. Chemical control of this pest has serious practical and environmental drawbacks such as chemical residues for consumers and negative effects on other non-target organisms and the environment, as well as resistance developed against insecticides. One alternative pest control strategy is based on the disruption of insect digestive physiology particularly functioning of the peritrophic matrix (PM), an important semi-permeable structure composed of chitin and proteins lining the midgut. The PM protects the epithelium from abrasion by food particles, regulates nutrient uptake and serves as a physical barrier to pathogens. Genomics and proteomics approaches were used to identify the PM proteins and the chitin regulatory enzymes of M. configurata . Two novel and promising approaches were utilized to disrupt the functions of these PM components: 1) use of RNAinterference to knock down the genes and 2) use of enhancin, a metalloprotease that is encoded by MacoNPV, a specific viral pathogen of M. configurata, which degrades mucin PM proteins. Ultimately, the aim of this research is the transfer of knowledge and technology using these approaches into daily agricultural practices to the benefit of producers and consumer.

KEYWORDS: pest management

NITROGEN DYNAMICS AND WHEAT YIELD IN A NO-TILL ORGANIC GREEN MANURE SYSTEM USING THE ROLLER CRIMPER

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Use of the roller crimper presents organic farmers with the opportunity to reduce tillage in green manure years. This study investigated the effects of no-till green manure management on soil conservation, wheat yield, and green manure nitrogen utilization. The study was conducted on organically managed land at the Carman Research Station, Manitoba and on a certified organic farm near Oxbow, Saskatchewan. In the spring, a pea (*Pisum sativum* L.) and oat (*Avena sativa* L.) intercrop was seeded as a green manure. Beginning at pea flowering, the green manure was terminated by rolling, tilling, or a combination of the two. In the following spring, Hard Red Spring Wheat (cv. 5602) (*Triticum aestivum* L.) was seeded into the plots. Soil cover measurements were taken before seeding the wheat. Soil nitrogen and wheat biomass were sampled at stem elongation, anthesis, and soft dough. Results showed that eliminating tillage in the green manure year a) increased soil cover in spring, b) reduced the rate of nitrogen release, and c) reduced wheat yield in two out of three site years. No till green manure management can therefore provide benefits of soil conservation but may result in decreased wheat yield.

KEYWORDS: no-till organic, roller crimper, organic agriculture, green manure, nitrogen

DEVELOPMENT OF A SIMPLE AND AFFORDABLE METHOD OF MEASURING TOTAL AMMONIA LOSS FROM LAND APPLIED MANURES

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Ammonia (NH_3) volatilization is a major source of nitrogen (N) loss from land applied manures and fertilizers, causing both environmental and economical concerns. Obtaining sound NH_3 flux measures are crucial to quantifying total N losses in order to develop optimal management practices, especially considering the increasing price of N fertilizers. Some methods used to obtain these measures are either expensive, inefficient, or of questionable accuracy. A new proposed method which utilizes a Gastec passive dosimeter tube (dositube) and a well-designed semi-open static chamber may be an economical and simple solution to measuring total NH_3 loss. This method will be especially suited for small plot studies which require several replicates, and will also be a simple management tool farmers can utilize to measure losses on site. Lab and field experiments were conducted in 2009 to compare the variability and reproducibility of the dositube method. In the field trial, four replications of eight chamber designs ranging from no chamber to a closed chamber were compared with and without manure application in a 1.5 ha field site. The presence of the chamber was found to significantly (P=0.05) affect NH_3 measured by the dositubes; however, the chambers also significantly (P=0.05) reduced contamination of NH_3 from neighbouring sources. Due to the objectives of this proposed method, the medium perforated chamber was chosen. In order to provide a meaningful measurement using the dositubes, a simultaneous independent measure of the NH_3 flux is needed to relate the ppm x hr reading to a total mass of N loss per area (kg-N ha^{-1}). A combination of lab and field experiments were used to obtain this calibration. To validate the calibration a field trial was conducted in the spring of 2010, comparing the well documented wind tunnel method, by Lockyer (1984), to the proposed dositube method.

KEYWORDS: ammonia, volatilization, manure, dosimeter tube

AN OVERVIEW OF THE PROCESSES THAT CONTROL THE WATER BALANCE AND SALINITY OF PRAIRIE WETLANDS

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The water regime and salinity of northern prairie wetlands reflect the cold semi-arid climate, the glacially formed landscape and the sulphate salts that are produced when the glacial till is oxidized. The wetland water balance is controlled by snowmelt runoff over frozen ground and snowdrift from the surrounding uplands, flow of water between wetlands and to streams by fill and spill, precipitation inputs, evapotranspiration loss, and groundwater exchange. Surface runoff from the surrounding uplands is strongly dependent on land-use. Clay-rich glacial tills, covering much of the region, have very low hydraulic conductivity, except for the top several meters where fractures and macropores greatly increase permeability. Transpiration by vegetation in the wetland margin induces infiltration and lateral flow of shallow groundwater from wetland ponds through the highly-permeable zone. This shallow lateral flow removes water from wetland ponds and plays a major role in the development and distribution of soil horizons and salinity beneath and near the wetlands. Groundwater flow in the deeper, low-permeability till has minor effects on the water balance, but has a strong influence on wetland salinity because the groundwater flow direction determines if the salts accumulate in wetlands (upward flow) or are leached out (downward flow) under wetlands. Fill and spill processes can also move salts towards lower-lying wetlands. Prairie wetland complexes and their catchments should be considered as one interacting unit for hydrology as well as for ecology. A general conceptual model and classification system is proposed as a basis for understanding prairie wetlands and the effects of human activities such as land-use changes, wetland drainage, sedimentation, and climate change.

KEYWORDS: prairie wetlands, glacial deposits, water balance, salinity

LINKING N_2O EMISSIONS IN AGRICULTURE TO CROP PRODUCTIVITY

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Agricultural soils are the main anthropogenic source of N_2O because of N fertilizer use. Commonly, N_2O emissions are expressed as a function of N application rate. Because of global demand for agricultural products will rise in the future, agronomic conditions should be included when assessing N_2O emissions. We propose the concept of linking agronomic productivity to environmental sustainability and look at the relation between N_2O emission and crop productivity. A meta analysis of studies that reported both N_2O emissions and total N accumulation in crops was carried out. Only studies were included which reported N_2O emissions and total N. When N_2O measurements was limited to a growing season no linear extrapolation across the entire year was made. Key findings revealed that yield-scaled N_2O emissions were smallest at application rates of approximately180 kg N ha^{-1} and increased sharply thereafter. If the above-ground N surplus was equal to or smaller than zero N input, yield-scaled N_2O emissions remained stable and relatively small. At a N surplus of 90 kg N ha^{-1}, yield-scaled emissions increased threefold. A negative relation between N use efficiency and N_2O emissions was found. N_2O emissions showed a negative relation with N use efficiency. This is a clear indication that agronomic aims, i.e., increasing fertilizer N use, is directly linked to GHG efficiency. Yield-scaled N_2O emissions decreased from 12.7 to 7.1 g N_2O-N kg^{-1} N uptake when NUE increased from 19 to 75%. To minimize N_2O emissions and maintain/increase crop yield, N uptake must be maximized. One kg of harvested product-N is produced with low N_2O emissions when aboveground N uptake $\geq$ N application rate. As an overall threshold, we suggest a maximum N surplus in the range of 0 to 50 kg N ha^{-1}, where N surplus is expressed as applied N minus aboveground N uptake.

KEYWORDS: N_2O, N surplus, crop-N yield, meta analysis

SPATIAL MODELLING OF PEDOGENESIS IN A HUMMOCKY LANDSCAPE OF CENTRAL SASKATCHEWAN UNDER NATIVE PRAIRIE

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Several field studies over the past two decades have shown the dominant control of topography and landform position on soil patterns in hummocky landscapes of Central Saskatchewan. Under native vegetation, soils especially differ in the content and depth distribution of organic (SOC) and inorganic carbon ($CaCO_3$). The landscape-scale processes controlling soil development are mostly understood; however their implementation into predictive modelling tools has not been achieved and remains important to provide a better and quantifiable understanding of soil-landscape relationships. This work aims at modelling the spatio-temporal evolution of SOC stocks and $CaCO_3$ depth across a catena. The model consists of three modules: The Versatile Soil Water Budget model was used to simulate water budget and water fluxes in the soil profile, the carbon module of the CENTURY model was used to simulate SOC dynamics, and decarbonization was simulated with a simplified calcium carbonate dissolution-precipitation model. The study was based on a detailed dataset from St Denis Wildlife Area (SK, Canada), including climate data, above- and belowground biomass measurements, soil survey, topography, and quantitative data on soil properties and C input in several landform locations. The model was run over 10000 years. Precipitation and temperature were simulated stochastically. Carbon inputs were considered constant and similar to the current inputs. Initial soil $CaCO_3$ content was fixed to that of the parent material. Simulation results were compared to the current values of SOC stocks and depth to $CaCO_3$.

KEYWORDS: pedological modelling, soil evolution, A-horizon, spatio-temporal model, chernozem

IMPACT OF BIOMOLECULES ON THE FORMATION AND REACTIVITY TOWARD NUTRIENTS AND POLLUTANTS OF VARIABLE CHARGE MINERALS AND ORGANOMINERAL COMPLEXES IN SOIL ENVIRONMENTS

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Humic and fulvic acids, as well as biomolecules produced by microorganisms and plants play an important role in the formation and transformation, nature, morphology and reactivity of Al and Fe precipitates and organomineral complexes. Organic ligands delay or inhibit the crystallization of Al and Fe oxides, and under certain conditions, favour the formation of short range ordered precipitates. Even small amounts of chelating ligands significantly change particle size, structural order and stability of metal oxides and oxyhydroxides.

Biological ligands play an important role in regulating the mobility of nutrients and pollutants, particularly at that soil-root interface, and also influence the adsorption of biopolymers and their residual activity. Natural organic compounds present in organomineral complexes or sorbed onto variable charge minerals may strongly influence the sorption of cations and anions. Furthermore, organic ligands in the soil solution may promote the formation of negative complexes with cationic nutrients and pollutants, thus preventing or reversing their association with phyllosilicates but favouring their sorption onto variable charge minerals. Some (phyto)siderophores may have an opposite influence. Nutrients and pollutants which exist in anionic form are sorbed primarily on the reactive sites of metal oxides and allophanes and at the edges of phyllosilicates. Thus the presence of organic ligands affects their sorption by competing for available sorption sites and/or reducing the surface charge of the variable charge minerals. Competition in sorption of nutrients and pollutants in binary or ternary systems is also affected by organic ligands. The chemical composition, concentration and chelating power of biomolecules have a significant impact on the desorption of nutrients, heavy metals and metalloids. However, a number of factors, such as the type, mineralogy and crystallinity of the sorbents, pH, surface coverage, and the residence time of nutrients and pollutants on the surfaces of soil components also contribute to affect their desorption.

KEYWORDS: biomolecules, metal oxides, variable charge minerals, organomineral complexes, adsorption/desorption, heavy metals, nutrients, enzymes

PLANT BREEDING IN CANADA – PAST, PRESENT, AND FUTURE

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The goal of plant breeding in its simplest form is to improve crop adaptation to soil and climate, and to consumer and market preferences, by the manipulation of the heritable genetic traits of the crop. What changed over the decades are the methodologies used by plant breeders. The earliest varieties in Canada were developed by extracting pure lines from mixed land races. By the end of the 19th century Charles Saunders and his son William were conducting extensive hybridization of wheat lines to create varieties more adapted to the Canadian Prairies. During the 20th century our knowledge of Mendelian genetics facilitated immensely conventional plant breeding. By the end of the 20th century breeding programs were integrating genetics, plant pathology, quality and physiology to maintain and improve crop performance. Molecular marker assisted selection was being utilized in some programs. The quantitative output of the breeding programs has been increased immeasurably by the use of computers. Do not forget that to a great degree, plant breeding is a numbers 'game'. Some trends to expect in the future are fairly certain. Plant breeding by private companies will continue to increase. There will be greater use of molecular markers for trait selection. Crop adaptation to the changing environment will be even more necessary than in the past. But how will we breed crops for what may be very unfavourable environments? We now have the tools and ability to isolate and characterize critical genes in many physiological processes such as drought and cold stress. It remains to be seen whether consumer acceptance will permit these genes to be transferred between species (GMOs), or if we must find other ways to use the genes and knowledge in crop improvement.

KEYWORDS: plant breeding, marker assisted selection, GMO

P SOLID STATE NMR SPECIATION OF PRECIPATED P FROM VARYING EXCHANGEABLE CA:MG RATIOS

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Agronomic efficiency of added P fertilizer is reduced by the precipitation reactions with exchangeable Ca and Mg in calcareous soils. We hypothesized that the ratio of Ca to Mg on the soil exchange complex will affect the species of P that is precipitated and its solubility in the soil. A column experiment was conducted using a model calcareous soil system composed of resin (Amberlite IRP69) and sand coated with $CaCO_3$. The resin was pre saturated with Ca and Mg in order to achieve five different saturation ratios of Ca:Mg approximately as 100:0, 70:30, 50:50, 30:70 and 0:100. Monoammonium phosphate (MAP) was applied at a rate of 0.4 g per column and incubated for 2 weeks. Chemical analysis for water and acid soluble P and pH were performed on the 'soil' from 2mm depth sections. The P species were identified with ^{31}P solid state Nuclear Magnetic Resonance (NMR) technique for 0-2mm, 2-4mm and 6-8mm depth sections. Water and acid extractable data showed that the presence of exchangeable Mg in soil improved P solubility and the downward transport of P. NMR data revealed that DCPD ($CaHPO_4 .2H_2O$) was the dominant P species formed in soils with 100% to 50% Ca saturation in 0-2mm, 2-4mm and 6-8mm depth sections. This indicates a dominant role of exchangeable Ca in precipitating added P. A poorly ordered anhydrous solid phase was identified in the 0-2 mm depth of 0% to 70% Mg saturated soils which was assumed to be an amorphous Ca and/or Ca-Mg phase. Newberryite ($MgHPO_4 .3H_2O$) was identified in the 0-2 mm depth of 100% Mg saturated soils after adding 0.6g of MAP per column. Such characterization of P species improves our understanding of the roles of exchangeable Ca and Mg on P precipitation, and the availability of P in calcareous soils.

KEYWORDS: MAP, Ca, Mg, model system, solid state NMR

WEB-BASED LEARNING TOOL ON SOIL PARENT MATERIAL AND LANSCAPE DEVELOPMENT

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It has been noted that students, both undergraduate and graduate alike, have difficulties grasping relationships between soil landscapes and parent material. Students also have difficulty visualizing how parent material and their corresponding landscapes are created and came to be in the present form. This task is even more difficult when an instructor solely relies on visual aids such as photos or graphs to illustrate formation of various soil landscapes over time. The objective of this project was to develop a virtual, web-based teaching tool on soil landscapes and associated parent materials to be used in various post secondary courses on natural resources. The Rocky Mountains, with their barren, glaciated landscapes, provide numerous examples of the parent material and on-going landscape development; hence all processes of parent material transportation can be observed at this location. On the other hand, the southern interior of British Columbia (BC) provides excellent examples of landscapes formed by past glacial action. To illustrate the on-going processes of parent material and landscape development, we recorded video clips of landscape features both in the Rocky Mountains and in the southern interior of BC. Soil scientists, survey specialists, and geomorphologists provided live commentary. The resulting virtual teaching tool consists of an open-access website merging video clips, sound recordings, text, and images. The primary benefit of the virtual teaching tool is to allow students to observe conditions under which future soil parent material are deposited, and to witness the transformation of a barren, sedimentary landscape into a soil landscape. The teaching tool will be used in numerous (i.e., at least 23) soil, agriculture, forestry, and natural resource management courses across BC and beyond. An interactive overview of the tool will be given during the presentation.

KEYWORDS: soil science education, transported parent material, soil formation, open learning resources

EXAMINING THE NITROGEN ECONOMY OF ORGANICALLY SELECTED WHEAT GENOTYPES

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Previous studies have shown that direct selection for the intended growing environment is useful in wheat breeding. Organic production systems have different nitrogen (N) sources than conventional agriculture. In this study the nitrogen economy of 15 organically selected advanced breeding lines was compared with 5 conventional varieties. We hypothesized that wheat selected under slow-release organic N sources (green manures) will have superior soil N capture abilities than wheats selected under conditions of highly soluble N. Field experiments were conducted in 3 locations in 2009. Nitrogen economy was assessed by measuring plant N uptake, and the seed to total plant N ratio. Preliminary results indicate that some organically bred lines have higher N uptake. A detailed analysis of year one results will be presented.

KEYWORDS: organic breeding, wheat, nitrogen uptake, nitrogen harvest index

DELIVERY OF SOIL SCIENCE TO FARMERS USING ADVANCED SIMULATION TOOLS: A 10 YEAR CASE STUDY

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For over 10 years, Western Ag Labs has provided an alternative to conventional soil testing using the Plant Root Simulator (PRS)™-probe technology. The service is delivered directly to each producer by a Western Ag Labs Field Service Representative in their area. The soil nutrient supply rates obtained from the PRS™-probes are entered into a mechanistic computer model tailored for growers called PRS™ Nutrient Forecaster. The computer model incorporates the bioavailable nutrients, soils and climate condition, and yield projection as affected by management for a specific crop. PRS™ Nutrient Forecaster has greatly extended the ability of growers to incorporate new knowledge into their mental model of the soil-climate-plant system. A case study was performed to gauge producers' satisfaction levels pertaining to the amount of relevant knowledge transferred and the perceived value of the decision support tool, PRS™ Nutrient Forecaster. Qualitative information was gathered by interviewing past customers (n=75) on their experience with Western Ag Labs services. The customer rated their satisfaction with the transfer of crop nutrition planning advice they received as 8.93 on a likert scale out of 10. The research indicates producers were generally satisfied with the level of the educational services and the impact it had on their farm business. However, growers had lower satisfaction (7.26 out of 10) with the service reliability of 'backcasting' field input and output from previous year. Improving the mechanistic model continuously, include new crops and management regimes, will provide growers with a system to improve their knowledge of crop nutrition - with the ultimate goal to increase producers' bottom line.

KEYWORDS: soil testing, nutrient supply rates, computer modeling, case study

QUANTIFYING THE BENEFITS OF COOL SEASON PULSE CROPS TO SUBSEQUENT BARLEY CROPS IN ROTATION

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Pulse crops in rotation impact the nitrogen (N) balance of the cropping system and affect the yield of the subsequent crop. Producers have identified a need for more information on the effects of integrating cool season pulse crops into current rotational practices. In 2008, a two year rotational study was initiated to investigate the effects of 'Canstar' field pea (*Pisum sativum* L.), 'Snowbird' tannin-free faba bean (*Vicia faba* L.), and 'Arabella' narrow-leafed lupin (*Lupinus angustifolius* L.) on the yield and quality of a subsequent barley crop, at two sites in central Alberta. In year 1 of the rotation (YR1), pea, faba bean, lupin, barley (with and without N fertilizer), and canola (with and without N fertilizer) were grown. The following year barley was produced across all YR1 treatments. In YR1, N fixation, removal and return were assessed for each pulse crop. In YR2, yield and N content of barley was measured at 10 weeks of growth and at grain maturity. In 2008, YR1 pulse crop N fixation ranged from 29 to 81 %, and N export ranged from 76 to 314 kg N ha^{-1} . In 2009, YR2 barley biomass yields at 10 weeks averaged 3.58 Mg ha^{-1} at Barrhead and 3.96 Mg ha^{-1} at St Albert. Barley grain yields averaged 1.06 Mg ha^{-1} at Barrhead and 2.31 Mg ha^{-1} at St Albert. At 10 weeks growth, barley biomass yields following peas and faba bean (with no N added) were less than or equal to those following barley and canola treatments with added N fertilizer. At maturity, barley grain yields following peas and faba bean were equal to or better than treatments with added N fertilizer. Barley yields following lupin were lower at 10 weeks and maturity, than barley yields following treatments with added N.

KEYWORDS: field pea, faba bean, narrow-leafed lupin, nitrogen fixation, barley, crop rotation

IMPACT OF ARBUSCULAR AND ECTO MYCORRHIZAL INOCULATION ON SOIL AGGREGATION AND ARBUSCULAR MYCORRHIZAL DIVERSITY IN WILLOW (*SALIX* SPP) RHIZOSPHERE

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Willows are known to benefit from symbioses with arbuscular and ecto-mycorrhizal fungi and are commercially inoculated to enhance their growth. Another advantage of mycorrhizal inoculation can be increased soil aggregation, however little is understood about how mycorrhizal inoculation affects the formation of aggregates and whether arbuscular mycorrhizal fungi (AMF) species associate with different aggregate size classes. A greenhouse study was established to determine the impact that mycorrhizal inoculation has on willow growth, percent water stable aggregates (WSA) and diversity of AMF in the rhizosphere. Cuttings of willows (Salix. viminalis and S. miyabeana) were potted in 6 different soils and inoculated with a commercial mycorrhizal inoculant in 1 of 4 combinations: 1) Glomus intraradices (AM), 2) Hebeloma cylindrosporum (EM) 3) both (AM & EM) 4) uninoculated (control). After 8 months, willows were harvested, WSA was determined, and aggregates were separated by dry sieving (>4mm, 4-2mm, 2-0.5mm and <0.5mm). The diversity of AMF associated with each size class was assessed by nested polymerase chain reaction –denaturing gradient gel electophoresis (Nested PCR-DGGE) targeting the 18S rDNA gene. DGGE bands were cut, sequenced, and compared with known sequences in Genbank and a phylogenetic tree was constructed. WSA was significantly affected by mycorrhizal inoculation and soil type, the highest percent was recorded in AM > AM & EM, > EM > control. The diversity of the AMF communities was significantly affected by soil type, mycorrhizal type and aggregate size class. Our results suggest that inoculation with AMF can improve water stable aggregation of soil. Furthermore, we have shown that AMF diversity differs between aggregate size classes, indicating that some populations of AMF may be associated with certain aggregate sizes. Studies are underway to determine if similar results are found under natural soil conditions.

KEYWORDS: arbuscular mycorrhiza, ecto mycorrhiza, soil aggregation, arbuscular mycorrhizal diversity, nested PCR-DGGE, willows

GREENHOUSE GAS AND SOIL NUTRIENT DYNAMICS AT HALIBURTON FOREST: NITROGEN AND PHOSPHOROUS ADDITIONS TO SOILS TO STUDY THE EFFECTS OF HIGH NITROGEN DEPOSITION

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Many of Canada's forests are currently experiencing a major environmental disturbance in the form of atmospheric nitrogen deposition from fossil fuel burning and agricultural practices. Nitrogen (N) is a major nutrient required for plants and soil microorganisms and is normally in short supply relative to biological demands. However, when N is in excess various negative impacts result including nutrient leaching, increased nitrous oxide (N_2O) emissions, and disturbances to carbon and methane cycling. Introducing soil amendments might have the potential to mitigate the negative impacts of excess nitrogen in forest soils. Previous research at Haliburton Forest has demonstrated that N is no longer a limiting nutrient for plants, but rather phosphorous (P), where the addition of P resulted in rapid increased growth in sugar maple trees. P also suppressed levels of methane oxidation in a 5 year post-addition study. We characterized initial effects of N,P and N+P additions to soils at Haliburton on the exchange of greenhouse gases (N_2O, CO_2, CH_4) from June to October, 2009. N plots were included to test if forests at Haliburton are indeed no longer N limited or in the future if soils have the potential to become N saturated. N plots exhibited increased N_2O and CO_2 efflux and suppressed CH_4 uptake relative to control plots. N+P plots exhibited only an increased N_2O efflux, and P plots were similar to control plots. Soil nutrient data will help to elucidate these findings.

KEYWORDS: climate change, greenhouse gases, soil nutrients, soil amendments, nitrogen pollution, analytical soil chemistry

COMPARATIVE PERFORMANCES OF TWO VS THREE COMPONENT INTERCROPPING SYSTEMS INVOLVING MAIZE, COMMON BEAN AND MUNG BEAN

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Most previous studies focused on intercropping systems involving two crop associations. However, there is much scope to improve the existing cropping systems by devising and evaluating modifications that allow more effective use of the season. To this effect, experiments were conducted to observe the efficiency of sequential intercropping involving maize (*Zea mays* L.), common bean (*Phaseolus vulgaris* L.) and mung bean (*Vigna radiata* (L.) Wilczek) during 2007 and 2009 seasons, in southern Ethiopia. Treatments included three and two crop associations and sole crops of components. Maize leaves below the ear were removed to improve light distribution. Intercropping advantages were evaluated using land equivalent ratios (LER). Relative sowing time of common bean influenced maize grain yield while that of mung bean had no effect. Intercropping with maize depressed grain yields of both common bean and mung bean. Defoliation of maize leaves improved radiation incident on pulses by 18% without affecting maize yield. The highest mean partial LER for maize, 0.95, was obtained from simultaneous intercropping with mung bean. Common bean had similar partial LERs irrespective of planting times. Mung bean had remarkably greater partial LER when planted together with maize than when sequentially planted. Both two and three crop associations had total LER values above one showing the advantage of intercropping. However, the three crop association involving simultaneous planting of maize with mung bean followed by common bean gave the highest mean total LER of 1.66 showing an intercropping advantage of 66%. This three crop association exceeded advantages from intercrops of maize/common bean by 41% and maize/mung bean by 24%. Thus, farmers would get greater advantage from practicing this intercropping in areas where the season is sufficient to grow long duration maize. This would also be attractive to farmers because it little affects the yield of the principal maize crop.

KEYWORDS: common bean, defoliation, maize, land equivalent ratio, mung bean, sequential intercropping

APPLICATION OF MID-INFRARED SPECTROSCOPY FOR SOIL PROPERTY PREDICTION AND IDENTIFICATION

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Mid-infrared (MIR) spectroscopy combined with chemometric methods can be used for prediction and identification of soil properties. We used these methods to evaluate soil samples collected from field sites in Ontario. Partial least squares regression (PLSR) and feed forward artificial neural networks (ANN) with back propagation algorithm were used to predict soil organic carbon (SOC), total nitrogen (TN), sand, silt and clay fractions using MIR spectroscopy. The principal component analysis (PCA) and hierarchical cluster analysis (HCA) were compared with ANN to identify the soil groups according to soil and crop types. In the prediction study, the coefficient of determination (R^2) and root mean square error of prediction (RMSEP) were determined for each of soil properties. The R^2 values for SOC, TN, in the sand and clay fractions were > 0.8 in training set for PLSR prediction. However, the silt prediction in testing set was relatively poor ($R^2 = 0.6$). The AAN method improved prediction not only in training set ($R^2 > 0.9$), but in testing set ($R^2 > 0.8$). The results suggest that both PLSR and ANN methods can predict SOC and total N concentrations for southern Ontario agricultural soils very well. In the identification study, PCA methods could not separate soils based on cropping system or soil classification. However, the HCA was able to identify soils from either crop type or soil classification origin. The soil type separation based on ANN with independent test set spectra matched the separations of soil based on the soil classification system. These results suggest that the information derived from MIR spectra can be used in quantitative and qualitative SOC studies of soils.

KEYWORDS: mid-infrared spectroscopy, partial least squares, inartificial neural networks; principal component analysis, hiearchical cluster analysis, prediction, identification

FUNGICIDE APPLICATION EFFECTS ON DIVERSITY COMPONENTS OF CHICKPEA RHIZOSPHERIC N_2-FIXING BACTERIAL COMMUNITY

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The non-target effects of agrochemicals on agro-ecosystems are not well defined. We used molecular (polymerase chain reaction – denaturing gradient gel elecrophoresis) methods to test the effects of various fungicide treatments targeting Ascochyta blight in chickpea crops on the N2-fixing bacterial communities residing in chickpea rhizospheric soil. Fungicide applications could change the components of dominant N2-fixing bacterial DNA sequences, even though the dominant species richness under each treatment did not change significantly. Beside, chickpea genotypes influenced the composition of these microbial communities. We conclude that the control of foliar disease with fungicide applications can echo on soil biology and function.

KEYWORDS: diversity, fungicide, molecular, N2-fixing bacteria, cultivar

EFFECTS OF LAND USE ON SOIL PHOSPHORUS SORPTION-DESORPTION

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Following land policy reform in the 1980s and subsequent urbanization and economic growth, the Chinese agricultural landscape has become more diverse and intensive. This change has profoundly impacted soil properties. The objectives of this study are to investigate how the type of land use affects soil phosphorus (P) sorption and desorption. Soil was collected near Kunming, Yunnan Province, from four dominant land use types: (1) rice-legume production in a two–crop, one-year rotation (Rice); (2) vegetable production in open fields (Veg); (3) recent (<3 years) conversion from open field to plastic covered vegetable and flower production (VFCS1, VFCS2); and (4) longer term (>10 years) plastic covered vegetable and flower production (VFCL). Soil samples were taken from five depths (0-20, 20-40, 40-60, 60-80, and 80-100 cm) in Dec. 2009. The P sorption was determined using the Langmuir sorption isotherm (S = Smax*k*c/(1+kc)) and desorption with eight successive extractions (0.01 M CaCl2). The P sorption maximums (Smax) were significantly affected by land use type, soil sampling depth and their interactions. For surface soil, the Smax was in the order of Rice (1380 mg kg^{-1}) > VFCL (1154 mg kg^{-1}) > VFCS2 (897 mg kg^{-1}), VFCS1 (844 mg kg^{-1}) > Veg (747 mg kg^{-1}). The lowest Smax occurred at 80-100 cm for rice (859 mg kg^{-1}), and at the surface for Veg (747 mg kg^{-1}), VFCL (1154 mg kg^{-1}), VFCS1 (845 mg kg^{-1}) and VFCS2 (897 mg kg^{-1}). The amount of P desorbed during the 8 successive extractions was in the range of 26 to 44% of sorbed P, and was not affected by land use types and sampling depths. Our study demonstrates that changes in land use could affect soil P sorption ability and potentially impact the environment.

KEYWORDS: soil P, sorption, desorption, land use type

SENSITIVITY ANALYSIS OF THE DSSAT-CERES-MAIZE MODEL TO INPUT PARAMETERS ON BLACK SOIL IN NORTHEAST CHINA

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It is more efficient to use models to find alternative ways to improve agro-ecosytem performance than to only experiment with the physical system itself. The purpose of this study was to evaluate and test the sensitivity of the DSSAT v4.5 model to changes in agricultural management parameters. Maize growth and soil N dynamics were simulated using the DSSAT CSM-CERES-Maize model in conjunction with a field experiment with maize (*Zea mays* L.) in Northeast China on black soil Mollisols). Maize cultivar parameters were calibrated using average field data, and the sensitivity of modelled outputs to input parameters was examined. Planting 8 to 10 days earlier resulted in maize yield reductions of 10%. Yields increased curveilinearly with the increases in plant density in the low to mid range (< 5 plants m^{-2}), and levelled off when the density reached 5 plants m^{-2} . Fertilizer N rate followed a diminishing yield pattern with the maximum yield being obtained at a fertilizer N rate of 250 kg N ha^{-1} . The best fertilizer N application date was 15 – 28 June. With increases of fertilizer N, soil mineral N levels increased dramatically, resulting in larger amounts of residual N in the soil, which is vulnerable to N loss and denitrification during the non-growing season.

KEYWORDS: Sensitivity analysis, DSSAT model, plant growth, plant N, soil N

ESTIMATING BIOLOGICAL N_2 FIXATION IN CANADIAN AGRICULTURAL LAND FROM 1981 TO 2006

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Annual biological N_2 fixation by legumes and by free-living non-symbiotic organisms was estimated for all Canadian farmland from 1981 to 2006 using the Canadian Agricultural Nitrogen Budget (CANB v3.0) model. Published average N_2 fixation rates were adjusted using variations in crop yield, and the total amount of N_2 fixed was estimated at the Soil Landscape of Canada polygon level (1:1,000,000) and then scaled up to provincial and national levels. The adjusted N2 fixation rates ranged from 54 to 150 kg N ha $^{-1}$ (average 95 kg N ha^{-1}) for pulse crops, 57 to 201 kg N ha^{-1} (average 118 kg N ha^{-1}) for soybean (*Glycine max* (L.) *Merr*.), 27 to 141 kg N ha^{-1} (average 79 kg N ha^{-1}) for hay [i.e., a mixture of alfalfa (*Medicago sativa* L.), clover (*Trifolium*), timothy (*Phleum pratense*) and brome (*Bromus*) grasses, etc.] and 141 to 300 kg N ha^{-1} (average 218 kg N ha^{-1}) for alfalfa. Total estimated N_2 fixation for all Canadian farmland increased from 0.996 Tg in 1981 to 1.767 Tg in 2006, primarily due to an increased legume hectare over time (from 9 to 15 Mha). These four legume crops accounted for 82–89% of total N_2 fixation in Canada. Provincial averages of N_2 fixation by total farmland area varied from 6 to 19 kg N ha^{-1} in Saskatchewan, 16 to 27 kg N ha^{-1} in Alberta and Manitoba, 44 to 79 kg N ha^{-1} in Ontario and Quebec and 27 to 47 kg N ha^{-1} in Atlantic province. Because the Prairies provinces contain 75% of total farmland, the national averages of N2 fixation by total farmland was heavily weighted by the estimates for the Prairies and ranged from 16 to 29 kg N ha^{-1} .

KEYWORDS: Biological N2 fixation, legume crop, yield, crop residue, Canadian Agricultural Nitrogen Budget (CANB) v3.0 Model

SOIL ORGANIC CARBON DYNAMICS IN PARTICLE SIZE FRACTIONS IN A BROOKSTON CLAY LOAM SOIL

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In order to better understand the impact of management on soil organic carbon (SOC) dynamics in particle size fractions of fine-textured soil, we studied the size-separated SOC pools in the plow layer of a Brookston clay loam soil (Orthic Humic Gleysol), under various management practices. In the plow layer of long-term fertilization and rotation study, SOC contents were 29.8% greater in rotation (corn-oats-alfalfa-alfalfa) than in monoculture corn soils and were 22.5% greater in fertilized than non-fertilized treatments. Ten years after a single compost application (100 Mg/ha), SOC contents in the top 30 cm showed no difference between the food waste compost relative to the control; however, SOC contents were 13% and 15% greater for leaf compost and pig manure wheat straw, respectively, relative to the control. Two decades of no-tillage did not lead to differences in SOC stock relative to conventional tillage; however, it resulted in significant stratification of SOC at the plowing layer, with 25% more SOC in the surface 0-5 cm and 15% less in the subsurface (5-20 cm) for no-tillage than mouldboard plough soils. We observed that management induced changes in SOC mainly occur in top 10 cm soil and about 80–90% of the total SOC was accumulated in the clay+silt fraction (0.053 mm). We also discovered that management induced changes in SOC show different pattern in particle fractions, an exponential increase of SOC in sand fraction (>0.53 mm), a logarithmic change in clay fraction (<0.002 mm), and a linear increase in silt fraction (<0.053 mm and >0.002 mm) with increasing total SOC. Changes in SOC stock and SOC contents in the fraction suggested that agronomic management not only alter SOC quantity but also SOC quality, and further SOC increasing would mainly occur in the sand and silt fractions for this soil.

KEYWORDS: carbon distribution, carbon dynamics, particle size fraction, management

RESIDUAL EFFECT OF ORGANIC AMENDMENTS ON THE ACCUMULATIONS OF SOIL ORGANIC CARBON AND TOTAL NITROGEN – 10 YEARS AFTER APPLICATION

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Excessive amounts of organic amendments were applied to a Brookston clay loam to ameliorate poor soil physical properties of this soil. We reported the residual effect of organic amendments on the accumulations of soil organic carbon (SOC) and total nitrogen (TN). Three organic amendments, including food waster compost (FW), leaf waste compost (LW), and pig manure plus wheat straw compost (PIGST), were used in an organic amendment experiment. The compost was applied to the plots at a rate of 75 Mg ha(sup$^{>-1}$ for all three types of compost, and two additional rates of 150 Mg ha^{-1} and 300 Mg ha^{-1} for FW were incorporated into soil in fall 1998. Soil samples were collected and the SOC and TN concentrations in the samples were determined in spring 2009. The SOC content in the top 30 cm showed no significant difference between the FW75 and the control; however, SOC increased by 18% and 24% for the FW150 and FW300, and by 13% for the LW and 15% for the PIGST, respectively. The increases in TN contents showed a similar trend. The relative retention of SOC in particle fractions was considerably higher in sand and silt than in clay fraction. The LW, PIGST and FW200 showed similar SOC retention and SOC distribution in particle fractions, and the treatment with highest amendment application (FW300) indicated a significant accumulation of SOC in the silt fraction relative to other treatments. Our results suggest that the FW compost was not as efficient as the LF and PIGST compost on SOC build up and the increased SOC generally occurred in the sand and silt fractions.

KEYWORDS: organic amendments, soil organic carbon, total nitrogen, residual effect

METHANOGENS IN TEMPERATE TO BOREAL PEATLANDS

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Methanogenic Archaea microorganisms inhabit wet, highly reduced environments, and they produce the atmospheric methane emitted from peat soils in northern wetlands (peatlands). However, the diversity and distribution of methanogens are poorly known, and a better understanding of community structure would help us forecast future emissions of methane from these ecosystems. I will describe methanogen ecology in a broad range of northern peatlands. For example, biogeochemical studies show that potential rates of methanogenesis range across five orders of magnitude. Consequently, relationships between methanogenesis and methane emissions are complex. Molecular microbiological techniques have revolutionized our understanding of methanogen identity. For instance, we have found that a novel group of hydrogenotrophic methanogens (E1), that is they make methane from H_2/CO_2, are the dominant group in acidic bogs in cool temperate peatlands; however, they give way to a different novel group of hydrogenotrophic methanogens (E2) in poor fens. In minerotrophic fens, E2 and acetate-metabolizing methanogens in the Methanosaetaceae are co-dominants. Moving northward, however, we find acetate users in the Methanosarcinaceae and a novel group of methanogens called Rice Cluster-II. My presentation will demonstrate that methanogen diversity is much greater than expected, but community structure does have affinities along ecological (bog to fen) and geographical (temperate to boreal) gradients. Linking methanogen diversity to methane emissions is the challenge that we face.

KEYWORDS: wetlands, methane, boreal

LENTIL LEAF NITROGEN AND SPAD: A NON-LINEAR ESTIMATION USING ARTIFICIAL NEURAL NETWORKS

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In field studies, plant nitrogen status can be linearly associated with SPAD (chlorophyll) readings but factors like diurnal time of sampling, leaf position and environmental conditions can interfere with this association. A non-linear multivariate technique of data computing, such as artificial neural networks (ANN), is capable of recognizing complex associations and patterns among variables, and is used to estimate and predict results. Similar to the neuron system of the human brain, learning from data patterns occurs during model iteration. An ANN model is especially preferred when data are not appropriate for linear analysis, or recognition of patterns and associations in a large data set is required. This study compared estimation from simple linear regression analysis with the feed-forward back-propagation ANN technique for estimating lentil leaf nitrogen concentration from SPAD readings. Data (N=912) were randomly divided into training (80%) and testing (20%) sets. Variables were SPAD readings, leaf nitrogen concentration and leaf thickness (specific leaf weight). Prediction models from the training set were validated with the test set. A model was considered more accurate when it produced a greater regression coefficient in the testing set. Estimated models by ANN had strong associations with the recorded values in the training set, but the testing set performance had a lower level of accuracy. Including sampling time and leaf thickness as second and third independent variables improved estimates compared to only nitrogen concentration and SPAD. The ANN model performed similarly to the simple linear regression model. The advantages of ANN over linear regression are model refinement through the choice of layers and neurons, and the capacity to find hidden associations within the data.

KEYWORDS: SPAD chlorophyll meter, leaf nitrogen concentration, regression analysis, artificial neural networks

WATER DEFICIT AND HIGH TEMPERATURE AFFECTED WATER USE EFFICIENCY AND ARABINOXYLANS CONCENTRATIONS IN SPRING WHEAT

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This study was conducted in a controlled environment to evaluate the combined effects of water deficit (imposed at the stem elongation stage) and high temperature (imposed at the booting stage) on the water use efficiency (WUE) and Arabinoxylans contents of two spring wheat varieties (‘Superb’ (G1) and ‘AC Crystal’ (G2)) commonly grown in Canada. The temperature treatments were 22/12 °C (day/night, T1) and 32/22 °C (T2). Overall, time to maturity under high temperature was 10 days shorter for Superb than for AC Crystal, indicating that Superb is more sensitive to high temperature stress. Leaf relative water content (RWC) and specific leaf area (SLA) were more sensitive to drought than to high temperature for both varieties. Drought and high temperature significantly ($P \leq 0.05$) decreased biomass, water use and grain yield but increased WUE of the two varieties. Without temperature stress, significant ($P \leq 0.05$) drought and variety effects were found on CID (carbon isotope discrimination) and it was negatively correlated with WUE. All gas exchange parameters declined under drought and high temperature. High temperature increased the grain arabinoxylans (especially the Water-extractable Arabinoxylans contents. Arabinoxylans contents were positively correlated with WUE suggesting that the trait can be increased by selecting for increased WUE.

KEYWORDS: water use efficiency, arabinoxylans, carbon isotope discrimination, gas exchange

CROP GROWTH AND PHOSPHORUS LOSS IN CLAY LOAM SOIL AMENDED WITH ENVIROPIG LOW-P MANURE

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Genetically enhanced pigs, EnviropigsTM, that use efficiently phytate P in cereals and excrete manures with up to 75% reduction of P contained, provide an excellent option for reduction of P loading to water resources from agricultural lands. Understanding both the agronomic and environmental impacts of Enviropig low-P manure (ELPM) is essential to validate this innovative technology and to develop BMPs for best use of the manure. Studies were conducted to determine crop (rye grass) growth and soil P leaching loss in a Brookston clay loam soil amended with Enviropig manure, in comparison with the conventional pig manure (CPM). With the same amount of P added, rye grass growth and development and consequently the dry matter performed identically in the soil added with ELPM, relative to CPM. Soil P leaching loss was conducted using an undisturbed large soil core technique. Treatments included manures from four combinations of two pig genotypes (conventional pig - CPig and transgenic pig - TPig) with two diet formulas (conventional diet - CD and low P diet - LPD). Manure application increased concentrations of all forms of P in soil leachete, regardless of pig genotype and diet formula. Compared with the soil amended with manure from CPig that was fed with CD, contents of leachete total P decreased by 29% in the soil amended with manure from TPig that was fed with LPD, but increased by 3% in the soil amended with manure from TPig that was fed with CD, an indication of excessive P supply. Content reduction of leachete total P was predominately accounted by dissolved reactive P (72% reduction), with a small portion by particular P (6% reduction). Adoption of the Enviropig technology can be an environmental friendly approach, but has to be in combination with low P diet.

KEYWORDS: phosphorus, Enviropig, manure, soil phosphorus loss

EFFECTS OF IRRIGATION AND ORGANIC FERTILIZATION ON THE MOBILITY AND DRAINAGE OF P FROM A LYSIMETER SOIL

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We investigated the effect of fertilization and irrigation practices on soil P translocation and drainage from a Skaha loamy sand. Six replicated treatments were established in 2005 in a 24 chamber drainage lysimeter, each containing a 'Skeena' Gisela 6 sweet cherry. Treatments included three fertilizers (NH4NO3, municipal (Ogogrow) and poultry composts) applied at 100kg N ha^{-1} with standard daily drip irrigation. Also the same quantity of irrigation but at high (4×/day) and low frequency (every second day) was applied to Ogogrow and at low frequency to poultry compost. The soil was sampled prior to the 5th growing season and drainage sampled weekly from June to October, 2009. Water extractable P (WEP), Mehlich 3 extractable P (M3-P) and CaCl2 extractable P (CaCl2-P) were measured throughout the soil profile and dissolved reactive P (DRP) in drainage. WEP and M3-P but not CaCl2-P were affected by composts and irrigation practices. WEP and M3-P concentration decreased with soil depth in Ogogrow and Poultry treatment under three irrigation frequencies and were significantly higher than NH4NO3 treatment to 40cm depth. Ogogrow had significantly less WEP and M3-P concentration relative to Poultry under both standard and low frequency irrigation. Treatments did not affect the total amount of DRP in drainage, which account for less than 0.5% of total P applied. NH4NO3 treatment had the lowest DRP concentration and DRP concentration decreased with time in all treatments. Ogogrow at low and Poultry at standard irrigation had reduced DRP concentration compare to other treatments.

KEYWORDS: irrigation, organic fertilization, P, mobility

THE EFFECT OF LONG-TERM FERTILIZATION ON SOIL WATER STORAGE AND WATER DEFICIT IN THE BLACK SOIL ZONE

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The black soil zone in Northeast China is one of the most important areas of agricultural production in China and plays a crucial role in food supply. Fertilization is one important practice influencing soil water conditions. Higher crop yields could be obtained by applying fertilizer, whereas water is also vital for crop growth at the study site. Experiments about soil water storage and water deficit as affected by long-term fertilization was carried out at the National Field Research Station of Agro-ecosystem in Chinese Academy of Science in Hailun County in Heilongjiang province in Northeast China from 1999 to 2008. Three fertilizer treatments including no fertilizer (CK), chemical fertilizer (NP) and chemical fertilizer plus organic material (NPM) was considered. The results showed that soil water storage decreased in the order of CK > NP > NPM during the growing season, but there was no significant decrease in soil water storage with time in 10 years of experimentation with three treatments. The low value in soil water storage within the 0-70 cm soil profile and high value in soil water deficit were both found in June and July. Therefore, the management of soil water in June and July was very important for guaranteeing crop yield. Crop with fertilizer application increased availability of water stored in the soil profile which resulted in greater observed soil water deficit, however the significant effect was found in NPM. Considering the importance of soil water storage and mitigating soil water deficit NPM was a sustainable management practice in the black soil zone in Northeast China.

KEYWORDS: long-term fertilization; black soil zone; soil water storage; water deficit

NONLINEARITY DETECTION IN THE SPATIAL VARIATION OF NITROUS OXIDE EMISSION BY DELAY VECTOR VARIANCE

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High in spatial variance of N_2O emissions from soil is common, nonstationarity, spatial dependence and intermittence in nitrous oxide emission from soil have been observed. The nonlinearity in N_2O is another important nature which is associated with the spatial variance. In this paper delay vector variance (DVV) and iterative amplitude adjusted Fourier transform (IAAFT) based on surrogates have been firstly applied to detect the nonlinearity in N_2O emissions from soil along one transect under different sampling times over two years. The results from scatter graphs and DVV rank test showed that nine out of fifteen of N_2O flux datasets were associated with nonlinearity, they were 19 June 2003, 16 July 2003, 10 September 2003, 15 October 2003, 30 March 2004, 4 April 2004, 29 April 2004, 3 June 2004 and 7 October 2004, and others were linearity. The key factor that caused the presence of nonlinearity in N_2O flux was topography, which redistribute water, snow and energy along the transect. It was worth to note that nonlinearity in N_2O flux would rather show at the end of growing season and early spring than growing season, at that time the surface soil temperature was lower than that in other sampling times, sometimes accompanied by higher water filled pore space (WFPS).

KEYWORDS: Nonlinearity, Delay vector variance method, Spatial variance, Nitrous oxide

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