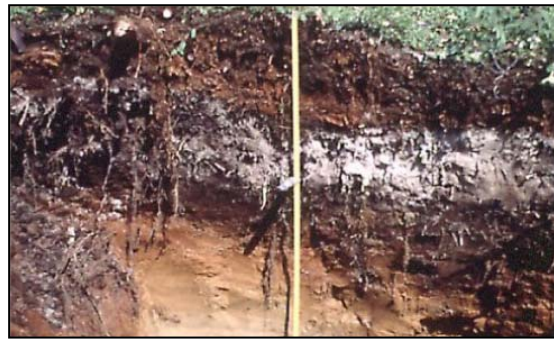


AQSSS – SCSS / CSSS

Congrès annuel · Annual Meeting

Les sols en milieux froids · Soils in Cold Environments

Programme scientifique et résumés Scientific Program and Abstracts



Station Touristique



Sainte-Catherine-de-la-Jacques-Cartier

3 - 7 Juin · June 2007



Association québécoise de spécialistes en
sciences du sol

Société canadienne de la science du sol /
Canadian Society of Soil Science



Avant propos

Pour la deuxième fois de sa jeune histoire, l'Association québécoise de spécialistes en science du sol organise son congrès annuel de façon conjointe avec la Société canadienne de science du sol. Le premier congrès conjoint, organisé à Québec en 1995 sous la présidence du regretté Régis Simard, avait connu un vif succès.

Le thème du congrès de cette année porte sur **les sols en milieux froids**. Lors de la plénière du lundi matin, trois conférences thématiques seront présentées sur ce sujet d'actualité en cette période d'évolution rapide de notre climat. Le programme scientifique se terminera mercredi par la présentation du **Symposium Régis Simard**. En plus d'un hommage à la mémoire de notre collègue, trois conférences thématiques sur différents aspects de la chimie et de la fertilité des sols seront présentées. Au total, **150 communications** scientifiques, incluant 62 affiches, portant sur tous les aspects de la science du sol et provenant de toutes les régions du Québec et du Canada, seront offertes aux participants. Fait à remarquer, **50 communications** seront présentées **par des étudiants** participant à l'un ou l'autre des prix remis par nos deux associations. **L'excursion** du jeudi permettra d'observer les sols du comté de Portneuf et de discuter des activités agricoles et forestières de cette région.

Le congrès se déroule sur le site de la Station de Duchesnay, cadre enchanteur propice aux rencontres, à la réflexion et aux échanges scientifiques. Au nom du comité d'organisation, je vous souhaite donc la bienvenue et un fructueux et enrichissant congrès.

Foreword

For the second time in its young history, the Association québécoise de spécialistes en science du sol is holding its annual meeting jointly with the Canadian Society of Soil Science. The first joint meeting, organized under the leadership of the late Régis Simard, was held in 1995 in Québec City and was a great success.

The theme of the meeting is **Soils in Cold Environments**. During the Monday morning plenary session, three keynote papers will be presented on this subject which is very timely in the current period of rapid climate change. The scientific program will end on Wednesday with the **Régis Simard Symposium**. In addition to an introduction to the memory of our colleague, this symposium will feature three keynote presentations on various aspects of soil chemistry and fertility. In total, **150 communications** (of which 62 posters) will be presented during this congress, on all aspects of soil science, and from all regions of Québec and Canada. Of note, a total of **50 communications** will be presented **by students** participating in the various award programs of both societies. On Thursday, the **field tour** will feature soil profiles from Portneuf but also forest and agricultural activities of this region.

The congress is held at the enchanting Duchesnay Station which is a site that will certainly encourage scientific discussion and reflection but also allow participants to enjoy some of the beauty that Québec has to offer. On behalf of the organizing committee, I warmly welcome you and wish you a fruitful and productive congress.

Denis Angers

Au nom du comité d'organisation / On behalf of the organizing committee

COMITÉ ORGANISATEUR – ORGANIZING COMMITTEE

| | |
|------------------|---|
| Denis Angers | Président / Chair |
| Martin Chantigny | Programme scientifique / Scientific Program |
| Isabelle Royer | Secrétaire / Secretary |
| Rock Ouimet | Webmestre et excursion / Webmaster & Field Tour |
| Isabelle Perron | Communication |
| Lucie Grenon | Trésorière / Treasurer |

Sommaire du programme / Program-at-a-glance

| <i>Dimanche / Sunday</i> | <i>Lundi / Monday</i> | <i>Mardi / Tuesday</i> | <i>Mercredi / Wednesday</i> | <i>Jeudi / Thursday</i> |
|--|---|---|---|---|
| AM | <p>7:00 - 8:30 Pavillon Boisé Inscription / Registration</p> <p>8:30 - 10:30 Pavillon Boisé Session plénière / Plenary Session</p> <p>11:00 - 12:30 Pavillon Forestier Affiches / Posters</p> | <p>7:00 - 8:00 Auberge Inscription / Registration</p> <p>8:00 - 10:50 Pavillon Forestier & Auberge Sessions orales / Oral Sessions <i>Gestion résidus / Waste Manag.</i> <i>Microbiologie / Microbiology</i> <i>Physique du sol / Soil Physics</i></p> <p>11:00 - 12:30 Pavillon Forestier Affiches / Posters</p> | <p>7:00 - 8:00 Auberge Inscription / Registration</p> <p>8:00 - 10:20 Pavillon Forestier & Auberge Sessions orales / Oral Sessions <i>Matière org. sol / Soil Org Matter</i> <i>Gaz du sol / Soil Gases</i> <i>Bassins-versants / Watersheds</i></p> <p>10:30 - 12:00 Pavillon Forestier Affiches / Posters</p> | <p>8:00 - 17:00 Auberge <i>Tournée post-congrès /</i> <i>Post-congress tour</i></p> |
| PM | <p>12:30-13:45 Pavillon Boisé Dîner / Lunch</p> <p>13:45 - 15:05 Pavillon Forestier & Auberge Sessions orales / Oral Sessions <i>Matière org. sol / Soil Org. Matter</i> <i>Gestion résidus / Waste Manag.</i> <i>Bassins-versants / Watersheds</i></p> <p>15:30 - 16:50 Pavillon Forestier & Auberge Sessions orales / Oral Sessions <i>Gaz du sol / Soil Gases</i> <i>Fertilité du sol / Soil Fertility</i> <i>Indicateurs / Indicators</i></p> | <p>12:30 - 14:00 Pavillon Boisé Dîner / Lunch</p> <p>14:00 - 16:20 Pavillon Forestier & Auberge Sessions orales / Oral Sessions <i>Matière org. sol / Soil Org. Matter</i> <i>Fertilité du sol / Soil Fertility</i> <i>Substrats Org. / Org. Substrates</i></p> | <p>12:00 - 13:15 Pavillon Boisé Dîner / Lunch</p> <p>14:15 - 16:15 Pavillon Boisé Symposium Régis Simard / Régis Simard Symposium</p> | |
| <p>17:00 Auberge <i>Inscription /</i> <i>Registration</i></p> | <p>17:30 - 18:30 Pavillon Horizon <i>Assemblée générale AQSSS</i> <i>AQSSS Business Meeting</i></p> <p>17:30 - 23:30 Pavillon Horizon <i>Dégustation de bière et souper /</i> <i>Beer tasting and dinner</i></p> | <p>16:30 - 18:00 Auberge (Room Maïanthème) <i>Assemblée générale SCSS</i> <i>CSSS Business Meeting</i></p> <p>18:00 - 22:00 Pavillon Boisé Banquet et remise de prix / <i>Banquet and awards presentation</i></p> | <p><i>Temps libre / Free time</i></p> | |

DIMANCHE 3 JUIN / SUNDAY JUNE 3

17:00 – 20:00

**Inscription / Registration - Auberge
Bar payant / Cash bar**

LUNDI 4 JUIN / MONDAY JUNE 4

7:00 – 8:30

Inscription / Registration - Pavillon Boisé

8:30 – 8:50

Ouverture / Opening – Pavillon Boisé

- Denis Angers, président du congrès / Congress Chair
- Gerry Neilsen, président SCSS / CSSS president
- Martin Chantigny, président AQSSS / AQSSS president

8:50 – 10:30

**Session Plénière / Plenary Session – Pavillon Boisé
*Les sols en milieux froids / Soils in Cold Environment***

Modérateur / Chair : Martin H. Chantigny, Agric. & Agroalimentaire Canada

8:50 *Evolution of boreal forest soils / L'évolution des sols forestiers boréaux*
ROCK OUIMET

9:20 *Le pergélisol: un phénomène géologique, climatique...et pédologique*
MICHEL ALLARD

9:50 *Soils and ecosystem functioning in Antarctic dry valleys*
EDWARD G. GREGORICH, D.W. HOPKINS, B. ELBERLING, A. SPARROW, P. NOVIS,
L.G.GREENFIELD

10:30 Pause / Recess

11:00 – 12:30 (Auteurs présents / Authors present)

SESSION I – Pavillon Forestier

Affiches / Posters

- 1- *Use of sodium for potassium in sugar beet growing on potassium-fixing soils.*
ABDUL WAKEEL, DIEDRICH STEFFENS, SVEN SCHUBERT
- 4- *Relation entre le pH et le rapport $(P/Al)_{M3}$ de quelques sols sablonneux amendés avec de la chaux.*
LUC MICHELOT CASSÉUS, A. KARAM, L.-É. PARENT
- 7- *Sorption characteristics of zinc and copper in some calcareous soils of western Iran.*
F. DANDANMOZD, A.R. HOSSEIN PUR (RETIRÉ / WITHDRAWN)
- 10- *Can the utilization of fall-applied manure nitrogen be increased by combination with paper mill bio-solids?*
KHALED ALOTAIBI, MICHAEL GOSS
- 13- *Soil water balance and retention on a long term cattle manure plot.*
ABIMBOLA A. OJEKANMI, HAO XIYING, OLALEKAN O. AKINREMI
- 16- *Long-term tillage treatments affect soil nitrogen mineralization and denitrification potentials in a corn agroecosystem.*
SHARIF IBEID, JOANN K. WHALEN, LYLE G. WHYTE, CHANDRA A. MADRAMOOTOO
- 19- *Minéralisation de l'azote de la biomasse microbienne dans quelques sols de prairie de la région de Québec.*
MAHTALI SBIH, ANTOINE KARAM, LOTFI KHIARI, ADRIEN N'DAYEGAMIYE
- 22- *Compaction effects on soil properties, biogenic gas emissions and crop production.*
BERT VANDENBYGAART, ED G. GREGORICH, NEIL MCLAUGHLIN, DAVID LAPEN,
BAO-LUO MA
- 25- *Use of micro-CT imagery to study biopore formation in clay, silt loam and sandy soils.*
PAUL VORONEY, ALI MAHBOUBI, RICHARD J. HECK, TOM ELLIOT
- 28- *Characterizing scale- and location- dependent correlation of water retention parameters with soil physical properties using wavelet techniques.*
LIU ZUOXIN, QIAOSHENG SHU, BINGCHENG SI
- 31- *Evaluation of heat pulse probe method for measuring soil thermal physical properties during freeze-thaw in agricultural soils.*
JENNA O. RAPAI, JON WARLAND, CLAUDIA WAGNER-RIDDLE
- 34- *Tillage erosivity of potato production systems in Canada.*
DAVID A. LOBB, KEVIN TIESSEN, GUY MEHUYS, SHENG LI

- 37- *Changes in Soil Health throughout an Organic Potato Rotation.*
KAREN NELSON, DEREK LYNCH, GILLES BOITEAU, RALPH MARTIN
- 40- *Soil organic matter quality in the oil sands reclamation area.*
ISABELLE TURCOTTE, SYLVIE A. QUIDEAU
- 43- *Réduction des pertes d'herbicides par ruissellement à l'aide de bandes végétalisées : importance des premiers événements pluviaux suivant le traitement phytosanitaire.*
EMMANUELLE CARON, PIERRE LAFRANCE, JEAN-CHRISTIAN AUCLAIR, MARC DUCHEMIN
- 46- *Les données de relief de précision LiDAR au service de la prospection pédologique détaillée à l'échelle du parcellaire agricole.*
KARINE VÉZINA, AUBERT MICHAUD, JULIE DESLANDES, LUCIE GRENON, GILLES GAGNÉ
- 49- *Variation spatiale de la qualité de la matière organique du sol dans deux champs agricoles du bassin versant du Bras d'Henri (Québec, Canada).*
MATHIEU QUENUM, MICHEL C. NOLIN, ADRIEN N'DAYEGAMIYE, DANIEL CLUIS, MONIQUE BERNIER
- 52- *Saisie des données pédologiques au champ à partir du carnet électronique GeoExplorer XT 2005 de Trimble – Développement et application.*
ISABELLE PERRON, JEAN-DANIEL SYLVAIN, MICHEL C. NOLIN, OUMAR KA, LUCIE GRENON, ANDRÉ MARTIN, CATHERINE BOSSÉ, LUC LAMONTAGNE, ATHYNA CAMBOURIS, GILLES GAGNÉ, JULIE DESLANDES
- 55- *Cartographie et interprétation des sols à l'échelle du microbassin versant agricole, rivière Bras d'Henri (Québec).*
CATHERINE BOSSÉ, ISABELLE PERRON, MICHEL C. NOLIN, ANDRÉ MARTIN, LUC LAMONTAGNE, OUMAR KA
- 58- *Évaluation des infiltrations dans les sols boréaux du moyen-nord québécois, région de la Baie de James.*
GREGOR LEVREL, ALAIN N. ROUSSEAU, JONATHAN PRICE, SYLVAIN JUTRAS
- 61- *Impact of harvesting and forest floor removal on N mineralization in jack pine forest soils: a combined sequential sampling and chronosequence approach.*
PAUL W. HAZLETT, ROBERT L. FLEMING

12:30 – 13:45 - Dîner / Lunch – Pavillon Boisé

13:45 – 15:05

SESSION II

**Auberge,
Salle / Room Maïanthème**
*Utilisation et gestion des résidus
Waste Use and Management*

SESSION III

**Auberge,
Salle / Room Myosotis**
*Processus et gestion du
parcellaire et des bassins-
versants
Watershed and Landscape
Processes and Management*

SESSION IV

**Pavillon Forestier
Salle / Room Henry Roy**
*Matière organique du sol
Soil Organic Matter*

SESSION II – Auberge, Salle / Room Maïanthème

Utilisation et gestion des résidus / Waste Use and Management

Modérateur / Chair : Antoine Karam, Université Laval

- 13:45 *Estimating manure N losses from storage systems and land application methods across Canada.*
JINGYI Y. YANG, T. HUFFMAN, C.F. DRURY, R. DE JONG, X.M. YANG, Y.C. LIU, V. KIRKWOOD
- 14:05 *Disponibilité à la plante et solubilité à l'eau du phosphore provenant des fractions solides de lisiers traités.*
MARC-OLIVIER GASSER, MARTIN H. CHANTIGNY, SHABTAI BITTMAN, KATHERINE E. BUCKLEY
- 14:25 *Corn response to preplant and sidedress N applications of Mg-treated liquid swine manure.*
GAÉTAN PARENT, GILLES BÉLANGER, NOURA ZIADI, JEAN-PIERRE DELAND, JEAN LAPERRIÈRE
- 14:45 *Suivi de la contamination par Escherichia coli des eaux de ruissellement et de drainage dans des parcelles de maïs-grain fertilisées au lisier de porc.*
RICHARD HOGUE, MARC DUCHEMIN
- 15:05 *Pause / Recess*
-

SESSION III – Auberge, Salle / Room Myosotis

Processus et gestion du parcellaire et des bassins-versants / Watershed and Landscape Processes and Management

Modérateur / Chair : Aubert Michaud, Inst. de Recherche et Développement en Agroenvironnement

- 13:45 *The biogeochemical cycling of manganese in a forested ecosystem of the Canadian shield.*
NATHALIE GINGRAS, FRANÇOIS COURCHESNE

- 14:05 *Using ¹³⁷Cs to identify the relative contribution of tillage and water erosion within cultivated potato fields in New Brunswick.*
KEVIN TIESSEN, GUY MEHUYS, DAVID LOBB, SHENG LI, HERB REES, LIEN CHOW
- 14:25 *Développement d'une méthode de détermination de la présence de pesticides dans l'eau souterraine basée sur des indicateurs physico-chimiques.*
CÉCILE DOUKOURÉ, PIERRE LAFRANCE, OLIVIER BANTON
- 14:45 *Using the SWAT Model for BMP implementation and diffuse source phosphorus reductions: Results from Pike River Watershed.*
ISABELLE BEAUDIN, JULIE DESLANDES, AUBERT MICHAUD, JACQUES DESJARDINS
- 15:05 *Pause / Recess*
-

SESSION IV – Pavillon Forestier, Salle / Room Henry Roy
Matière organique du sol / Soil Organic Matter

Modérateur / Chair: Benoît Côté, Université McGill

- 13:45 *Séquestration de l'azote par des complexes protéines-tanins dans l'humus de la forêt boréale.*
GILLES D. JOANISSE, ROBERT L. BRADLEY, CAROLINE M. PRESTON
- 14:05 *Comparison of three methods estimating nitrogen mineralization rates along a climatic gradient encompassing three forest biomes.*
DAVID PARÉ, ROBERT BOUTIN
- 14:25 *The effect of glucose on glycine-catechol polycondensation as catalyzed by birnessite.*
AILS A G. HARDIE, J.J. DYNES, L.M. KOZAK, P.M. HUANG
- 14:45 *Controls on the adsorption and desorption of dissolved organic carbon to Canadian mineral soils.*
DOLLY N. KOTHAWALA, TIM R. MOORE
- 15:05 *Pause / Recess*
-

15:30 – 16:50

SESSION V
Auberge
Salle / Room Maïanthème
*Indicateurs du sol et
environnementaux*
*Soil and Environmental
Indicators*

SESSION VI
Auberge
Salle / Room Myosotis
Émissions gazeuses du sol
Soil Gas Emissions

SESSION VII
Pavillon Forestier
Salle / Room Henry Roy
*Fertilité du sol et nutrition des
cultures*
Soil Fertility and Plant Nutrition

SESSION V – Auberge, Salle / Room Maïanthème
Indicateurs du sol et environnementaux /
Soil and Environmental Indicators

Modérateur / Chair : Éric van Bochove, Agric. & Agroalimentaire Canada

- 15:30 *Relation entre les teneurs en P total et assimilable d'un sol limoneux et celles en P dans les sédiments et dans les eaux de ruissellement selon différentes cultures.*
MARCEL GIROUX, MARC DUCHEMIN, AUBERT MICHAUD, ISABELLE BEAUDIN, CHRISTINE. LANDRY
- 15:50 *The estimation of the risk of water contamination by pesticides in Manitoba using the Pesticide Fate Model PRZM.*
ANNEMIEKE FARENHORST, D.A. ROSS MCQUEEN, JEANETTE GAUTHIER, ALLAN J. CESSNA, CLAUDIA SHEEDY
- 16:10 *Validating the Canadian residual soil nitrogen (RSN) indicator with on-farm data.*
CRAIG F. DRURY, JINGYI YANG, REINDER DE JONG, XUEMING YANG, KEITH REID, CHRIS DUKE, GREG STEWART, E. (TED) HUFFMAN, DAVID LAPEN, VALERIE KIRKWOOD
- 16:30 *Updating soil data information to facilitate the National Land and Water Information Service (NLWIS).*
YOU JIAO, SHERIF FAHMY
-

SESSION VI – Auberge, Salle / Room Myosotis
Émissions gazeuses du sol / Soil Gas Emissions

Modérateur / Chair : Suzanne Allaire, Université Laval

- 15:30 *Greenhouse gas production and emissions in Saskatchewan boreal forest soils.*
AMANDA L. MATSON, DAN PENNOCK, ANGELA BEDARD-HAUGHN

- 15:50 *Soil greenhouse gas, nutrient, and microbial biomass dynamics in recently fertilized western Canadian plantation forests.*
NATHAN BASILIKO, SUE GRAYSTON, AMER KHAN, CINDY PRESCOTT, RÉAL ROY, GORDON WEETMAN
- 16:10 *Spatial variability of CO₂ emission from sandy loam soils under potato production.*
SÉBASTIEN LANGE, SUZANNE E. ALLAIRE, JONATHAN LAFOND
- 16:30 *Spatial variability of gas diffusion in agricultural soils.*
JONATHAN LAFOND, SUZANNE E. ALLAIRE, SÉBASTIEN LANGE
-

SESSION VII – Pavillon Forestier, Salle / Room Henry Roy
Fertilité du sol et nutrition des cultures /
Soil Fertility and Plant Nutrition

Modérateur / Chair : Noura Ziadi, Agric. & Agroalimentaire Canada

- 15:30 *Harrowing for weed control: impact on soil structure, mineral nitrogen and wheat production.*
PIERRE-ANTOINE GILBERT, ANNE VANASSE, DENIS A. ANGERS
- 15:50 *Nitrates du sol et besoin en azote du blé panifiable.*
LOUIS LEFEBVRE, NOURA ZIADI, GILLES BÉLANGER, LÉON-ÉTIENNE PARENT
- 16:10 *Spatial analysis of N-NO₃ levels in the soil profile as a function of N fertilization and terrain attributes.*
NICOLAS TREMBLAY, MOHAMMED YACINE BOUROUBI, PHILIPPE VIGNEAULT, CARL BÉLEC, MARCEL TÉTREAU
- 16:30 *Évaluation de la CEC des sols minéraux acides par la somme des bases extraites par Mehlich III et par la baisse du pH tampon SMP : une approche nouvelle.*
MICHEL P. CESCAS
-

17:30 – 18:30

Pavillon Horizon
Assemblée générale de l'AQSSS / AQSSS Business Meeting

17:30 – 23:30

Pavillon Horizon
Dégustation de bière et souper / Beer tasting and dinner

MARDI 5 JUIN / TUESDAY JUNE 5

7:00 – 8:00

Inscription / Registration - Auberge

8:00 – 10:50

SESSION VIII

Auberge

Salle / Room Maïanthème

Utilisation et gestion des résidus

Waste Use and Management

SESSION IX

Auberge

Salle / Room Myosotis

Qualité et physique du sol

Soil Physical Quality

SESSION X

Pavillon Forestier

Salle / Room Henry Roy

Microbiologie du sol

Soil Microbiology

Session VIII – Auberge, Salle / Room Maïanthème

Utilisation et gestion des résidus / Waste Use and Management

Modérateur / Chair : Joann K. Whalen, Université McGill

- 8:00 *Nitrification and immobilization of ammonium in cold soils after application of ¹⁵N-enriched pig slurry.*
KAREN CLARK, MARTIN H. CHANTIGNY, DENIS A. ANGERS, PHILIPPE ROCHETTE, LÉON-ÉTIENNE PARENT
- 8:20 *Portrait statistique et évolution de la teneur en éléments traces métalliques (ÉTM) et en éléments fertilisants des biosolides municipaux du Québec.*
VINCENT PERRON, MARC HÉBERT
- 8:40 *Bio-disponibilité des métaux lourds suite à l'application répétée de biosolides papetiers et résidus forestiers alcalins en grandes cultures.*
BERNARD GAGNON, NOURA ZIADI
- 9:00 *Phosphorus solubility and mobility due to the salination effect of long term cattle manure application in a calcareous clay loam soil.*
ABIMBOLA A. OJEKANMI, OLALEKAN.O AKINREMI, HAO XIYING
- 9:20 *Potentiel des MRF pour la fertilisation et le chaulage de plantation de peupliers hybrides : trois années de suivi en parcelles de démonstration.*
JEAN VIGNEUX, KEN DUBÉ
- 9:40 *Pause / Recess*
- 10:10 *Estimation of nitrogen availability by means of carbon stability in organic amendments and fertilizers.*
CARGELE NDUWAMUNGU, LÉON E. PARENT
- 10:30 *Physical properties of organo-mineral fertilizers made with stabilized pig slurry.*
MAXIME PARÉ, SUZANNE E. ALLAIRE, LOTFI KHIARI (RETIRÉ / WITHDRAWN)

SESSION IX – Auberge, Salle / Room Myosotis
Qualité et physique du sol / Soil Physical Quality

Chair / Modérateur : Guy R. Mehuys, Université McGill

- 8:00 *Integration of a new model of soil-water retention to obtain the hydraulic conductivity function.*
CAMERON D. GRANT, PIETER H. GROENEVELT, NEVILLE I. ROBINSON
- 8:20 *Effects of consistent and changing land management on the physical quality of a clay loam soil.*
DAN REYNOLDS, C.F. DRURY, X.M. YANG, C.A. FOX, C.S. TAN, T.Q. ZHANG
- 8:40 *Measuring impacts of tillage on soil water and temperature dynamics.*
GARY PARKIN, PETER VON BERTOLDI
- 9:00 *Nouveau carottier manuel pour l'échantillonnage de sol non remanié – Efficacité et fiabilité de la mesure de la masse volumique apparente.*
ATHYNA N. CAMBOURIS, MICHEL C. NOLIN, MARIO J. DESCHÊNES
- 9:20 *Measurement of thermal physical properties of agricultural soils during freeze-thaw using heat pulse probe method.*
JENNA O. RAPAI, JON WARLAND, CLAUDIA WAGNER-RIDDLE
- 9:40 *Pause / Recess*
- 10:10 *Spatial and temporal variability of soil moisture regimes under different soil management practices.*
PRIYANTHA B. KULASEKERA, GARY W. PARKIN
- 10:30 *Effect of freeze-drying on soil aggregate stability.*
DARYL F. DAGESSE

SESSION X – Pavillon Forestier, Salle / Room Henry Roy
Microbiologie du sol / Soil Microbiology

Chair / Modérateur : Roger Lalande, Agric. & Agroalimentaire Canada

- 8:00 *Phosphate Rock Solubilization by *Aspergillus niger*: Potential for an Alternative P-Fertilizer.*
KIM D. SCHNEIDER, PETER VAN STRAATEN

- 8:20 *N and C K-edge XANES and pyrolysis field-ionization mass spectrometry of rhizosphere and non-rhizosphere soils.*
ADAM W. GILLESPIE, T. REGIER, R.I.R. BLYTH, P. LEINWEBER, R.E. FARRELL, F.L. WALLEY.
- 8:40 *The Diversity of Nitrifiers and Denitrifiers Associated with Spring Thaw in an Ontario Agricultural Soil.*
JILLIAN M. SMITH, CLAUDIA WAGNER-RIDDLE, KARI E. DUNFIELD
- 9:00 *Response of soil organisms to varying sizes of aggregated green-tree retention.*
SUSAN J. GRAYSTON, JANET A. ADDISON, NATHAN BASILIKO, SHANNON BERCH, NORA BERG, SHANNON DARADICK, KATE DEL BEL, DANIEL DURALL, BILL MOHN, LOUISE DEMONTIGNY, TOCHI PANESAR, CINDY E. PRESCOTT, DIANE S. SRIVASTAVA
- 9:20 *Influence of microbial activity and trace metal speciation in the rhizosphere on metal uptake by wheat.*
MARIE-CLAUDE TURMEL, FRANÇOIS COURCHESNE
- 9:40 *Pause / Recess*
- 10:10 *Long-term trends (1959-2006) in soil temperature, evidence for sub-soil warming and microbial responses.*
DAVID W. HOPKINS, I.P.HARTLEY
- 10:30 *Effets des apports de différents types d'engrais ammoniacaux sur la structure et la diversité des communautés des bactéries oxydant l'ammoniac (Ammonia-Oxidizing Bacteria).*
MARIE BIPFUBUSA, LALANDE, R., GAGNON, B., ZIADI, N.

11:00 – 12:30 (Auteurs présents / Authors present)

SESSION XI – Pavillon Forestier *Affiches / Posters*

- 2- *Le chaulage : un traitement efficace pour revigorer les érablières déperissantes.*
JEAN-DAVID MOORE, ROCK OUMET
- 5- *Influence du chaulage des sols limoneux et argileux sur la saturation des sols en phosphore (extrait au Mehlich III).*
NICOLAS SAMSON, LÉON ETIENNE PARENT, JEAN MATHIEU LACHAPELLE
- 8- *Determination of sorption thermodynamic parameters of zinc and copper in some calcareous soils of western Iran.*
F. DANDANMOZD, A.R. HOSSEIN PUR (RETIRÉ / WITHDRAWN)
- 11- *Désorption du cuivre de résidus miniers amendés par deux matériaux organiques.*
ANAIS CHARLES, ANTOINE KARAM

- 14- *Croissance du maïs dans un résidu minier légèrement alcalin amendé par de la tourbe de sphaigne.*
ARNAUD S. DE CONINCK, ANTOINE KARAM
- 17- *Composting broadleaved tree branches: An innovative alternative to conventional forest nursery substrates in developing countries.*
MUSTAPHA BAKRY, MOHAMMED S. LAMHAMEDI, HANK MARGOLIS, JEAN CARON,
ZINE EL ABIDINE ABDENABI, DEBRA C. STOWE
- 20- *Improvement of water use efficiency and yield of greenhouse tomato using matrix potential sensors.*
JEAN CARON, ISABELLE LEMAY, MARTINE DORAIS, STEEVE PEPIN
- 23- *Évaluation des effets d'un revêtement de mousse et de différents couverts forestiers, sur les propriétés hydriques d'un Podzol tourbeux.*
GREGOR LEVREL, JEAN CARON, SUZANNE ALLAIRE, ALAIN N. ROUSSEAU
- 26- *Remontée des sels et de l'eau en substrat tourbeux sur matelas capillaire.*
CAROLE BOILY, JEAN CARON
- 29- *Time domain reflectometry: Développement d'un modèle pour déterminer le contenu en eau volumique des substrats organiques.*
REZA NEMATI, JEAN-PIERRE FORTIN, JENNIFER ARPIN
- 32- *Nitrogen-fixing community profiles determined by PCR-DGGE: differences and similarities between southern Vancouver Island old-growth, mature, and variable retention Douglas-fir stands.*
PHYLLIS L. DALE, RICHARD S. WINDER
- 35- *Assess selected endophytic bacterial strains for some (PGPR) characteristics.*
FAHAD AL OTAIBI
- 38- *Soil Analysis Bordering Some Saline Ponds in the Surrounding Kamloops Area.*
IAN VAUGHN, SHARON BREWER, KENT WATSON
- 41- *Prescribed burning: Effects upon microbial communities within boreal forest floors.*
MATHEW J.B. SWALLOW, SYLVIE A. QUIDEAU, M. DEREK MACKENZIE
- 44- *Regional variation of 17-beta-estradiol sorption in Alberta soils.*
EMMANUELLE CARON, JEANETTE GAULTIER, ANNEMIEKE FARENHORST, NICOLE RANK, ALLAN J. CESSNA, JON BAILEY, CLAUDIA SHEEDY, MARK HANSON, TOM GODDART
- 47- *Root organic acid exudates and properties of rhizospheres of Picea glauca and Abies lasiocarpa.*
MELISSA MARIE S. TUASON, JOSELITO AROCENA
- 50- *Leaching of Litterfall Collecting in Litterfall traps and its Impact on Forest Ecosystem Nutrient Cycling.*
CASSIE CORRIGAN, MAREN OELBERMANN

53- *Development of floodplain soils in humid and cold climate conditions.*
DIANE SAINT-LAURENT, LUC LAVOIE

56- *Soil Organic Matter in Riparian Areas of Prairie Pothole Wetlands.*
SUZANNE M. CARD, S.A. QUIDEAU

59- *DOC production, C mineralization and microbial biomass during decomposition of litter from 10 Canadian forests.*
JULIE M.L. TURGEON, TIM R. MOORE, EDWARD G. GREGORICH

62- *From peat amendment to functioning forest soil: can we do it?*
SARA ROWLAND, CINDY PRESCOTT, SUE GRAYSTON, SYLVIE QUIDEAU

12:30 – 14:00 - Dîner / Lunch – Pavillon Boisé

14:00 – 16:20

SESSION XII
Auberge
Salle / Room Maïanthème
Matière organique du sol
Soil Organic Matter

SESSION XIII
Auberge
Salle / Room Myosotis
Sols et substrats organiques
Organic Soils and Substrates

SESSION XIV
Pavillon Forestier
Salle / Room Henry Roy
Fertilité du sol et nutrition des cultures
Soil Fertility and Plant Nutrition

SESSION XII – Auberge, Salle / Room Maïanthème
Matière organique du sol / Soil Organic Matter

Modérateur / Chair : Josée Fortin, Université Laval

- 14:00 *Contributions of organic and mineral soil fractions to soil carbon and nitrogen dynamics in tilled and minimum-tilled arable land.*
AIMÉ J. MESSIGA, KAROLIEN DENEFF, DRIES HUYGENS, PASCAL BOECKX,
OSWALD V. CLEEMPUT
- 14:20 *Intermittent Tillage Effect on Soil Biochemical Properties of Continuous No-Till Cropping systems in Saskatchewan.*
MORGAN W. JASTER, MIKE GREVERS, DIANE KNIGHT
- 14:40 *Soil Carbon Sequestration: The Potential of Abandoned Agricultural Land in Eastern Canada.*
ROBYN L. FOOTE, PAUL GROGAN
- 15:00 *Pause / Recess*

- 15:20 *Carbonate removal for analysis of total and $\delta^{13}\text{C}$ soil organic carbon.*
RAVINDRA RAMNARINE, PAUL VORONEY
- 15:40 *Carbon and nitrogen in particle size fractions separated by ultrasonic dispersion of a clay loam soil under mouldboard plough and no-tillage.*
XUEMING YANG, CRAIG F. DRURY, W. DANIEL REYNOLDS, DONALD C. MACTAVISH
-

SESSION XIII – Auberge, Salle / Room Myosotis
Sols et substrats organiques / Organic Soils and Substrates

Modérateur / Chair : Jean Caron, Université Laval

- 14:00 *Apparent phytotoxicity of boreal bark substrates on two horticultural species: terpenes, metals or aeration.*
REMI NAASZ, JEAN CARON, ANDRÉ PICHETTE, DOMINIC DUFOUR
- 14:20 *Évapotranspiration quotidienne d'une culture de canneberge déterminée à l'aide du bilan hydrique estimé par des tensiomètres et des sondes TDR en sols organique et en sol sableux.*
SIMON BONIN, JEAN CARON, STEEVE PÉPIN
- 14:40 *Indice de saturation en phosphore des sols organiques.*
JULIE É. GUÉRIN, LÉON-ÉTIENNE PARENT
- 15:00 *Pause / Recess*
- 15:20 *Solute Transport in Sub-irrigated Growing Media.*
DAVID E. ELRICK, JEAN CARON, JOCELYN BOUDREAU
- 15:40 *Estimation de l'eau mobile immobile dans les milieux artificiels : efficacité du lessivage.*
JEAN CARON, R. NAASZ, D. E. ELRICK, C. BOILY
- 16:00 *Mesures de teneur en eau par TDR: Calibrations adaptées aux substrats organiques.*
MARIE-CLAUDE DESBIENS, VALÉRIE LAVOIE, PHILIPPE BUSSIÈRES
-

SESSION XIV – Pavillon Forestier, Salle / Room Henry Roy
*Fertilité du sol et nutrition des cultures /
Soil Fertility and Plant Nutrition*

Modérateur / Chair : Nicolas Tremblay, Agric. & Agroalimentaire Canada

- 14:00 *Validation par les analyses foliaires du statut nutritif du bleuet nain sauvage.*
JEAN LAFOND

- 14:20 *Timing and Rate of N Fertigation Affect Nutrition, Yield and Quality of Apples in High Density Orchards.*
GERRY H. NEILSEN, DENISE NEILSEN
- 14:40 *Engrais Minéraux Azotés : Efficacité De Leur Utilisation Et Leur Impact Agro-Environnemental Dans La Culture Du Maïs Grain.*
NOURA ZIADI, BERNARD GAGNON, PHILIPPE ROCHETTE, MARTIN CHANTIGNY, DENIS ANGERS.
- 15:00 *Recess / Pause*
- 15:20 *Critical P concentration in spring wheat.*
GILLES BÉLANGER, NOURA ZIADI, ATHYNA CAMBOURIS, NICOLAS TREMBLAY, MICHEL NOLIN, ANNIE CLAESSENS
- 15:40 *Prédiction du rendement de maïs (Zea mays L.) et de la nutrition azotée par l'analyse en composantes principales.*
JUDITH NYIRANEZA, ADRIEN N'DAYEGAMIYE, MARTIN H. CHANTIGNY, MARC R. LAVERDIERE
-

16:30 – 18:00

Auberge, Salle / Room Maïanthème
Assemblée générale SCSS / CSSS Business Meeting

18:00 – 22:00

Pavillon Boisé
Banquet et remise des prix / Banquet and Awards presentation

MERCREDI 6 JUIN / WEDNESDAY JUNE 6

7:00 – 8:00

Inscription / Registration - Auberge

8:00 – 10:20

SESSION XV
Auberge
Salle / Room Maïanthème
Matière organique du sol
Soil Organic Matter

SESSION XVI
Auberge
Salle / Room Myosotis
Processus et gestion du
parcellaire et des bassins-
versants
Watershed and Landscape
Processes and Management

SESSION XVII
Pavillon Forestier
Salle / Room Henry Roy
Émissions gazeuses du sol
Soil Gas Emissions

SESSION XV – Auberge, Salle / Room Maïanthème *Matière organique du sol / Soil Organic Matter*

Modérateur / Chair : David Paré, Ressources Naturelles Canada; Service canadien des forêts

- 8:00 *Litter decomposition in temperate peatland ecosystems: the effect of substrate and site.*
TIM MOORE, JILL BUBIER, LESZEK BLEDZKI
- 8:20 *Decomposition-induced changes in soil organic matter composition.*
SYLVIE A. QUIDEAU, SE-WOUNG O. H., DAVID PARÉ
- 8:40 *Long-Term Effects of Tillage System on Soil Nitrogen Mineralization Potential in Semi-Arid and Humid Environments.*
MEHDI SHARIFI, BERNIE J. ZEBARTH, DAVID L. BURTON, CYNTHIA A. GRANT, SHABTAI BITTMAN, GEORGE W. CLAYTON, CRAIG F. DRURY, BRIAN G. MCCONKEY, NOURA ZIADI
- 9:00 *Soil Changes in the First Six Years of an Irrigated Rotation Study in Southern Alberta.*
FRANCIS J. LARNEY, NEWTON Z. LUPWAYI, ROBERT E. BLACKSHAW, DRUSILLA C. PEARSON
- 9:20 *Pause / Recess*
- 9:40 *Changes in soil carbon contents in long-term experimental grassland plots in northern England between the 1980s and 2006.*
DAVID W. HOPKINS, I.S. WAITE, A.G. O'DONNELL
- 10:00 *Predicting a Ceiling in Soil Organic Carbon Stocks for Carbon Sequestration Under No-till.*
BEV D. KAY, CATHY CHAN, E.G. GREGORICH

SESSION XVI – Auberge, Salle / Room Myosotis

Processus et gestion du parcellaire et des bassins-versants / Watershed and Landscape Processes and Management

Modérateur / Chair : François Courchesne, Université de Montréal

- 8:00 *Classification et cartographie du drainage des sols à partir d'images multi-temporelles RADARSAT-1.*
MICHEL C. NOLIN, MAHOMED ABOU NIANG, MONIQUE BERNIER, OUMAR KA, JIANGUI LIU, ISABELLE PERRON
- 8:20 *Soil physical and chemical properties along a boreal wetland-upland catena, coupled with LiDAR-based soil wetness modeling: a case study for central Alberta.*
PAUL N.C. MURPHY, JAE OGILVIE, PAUL A. ARP
- 8:40 *L'utilisation de données LIDAR et d'images multispectrales pour appuyer le diagnostic et l'aménagement hydro-agricole: le cas du bassin versant du ruisseau Ewing, localisé en Montérégie Est, Québec.*
JULIE DESLANDES, A. MICHAUD, J-D. SYLVAIN, K. VÉZINA, I. SAINT-LAURENT¹, A. LAVOIE, M. NOLIN, L. GRENON, G. GAGNÉ, A. VÉZINA
- 9:00 *Chronique d'une fonte printanière: érosion hydrique et qualité des eaux de ruissellement.*
MARC DUCHEMIN
- 9:20 *Pause / Recess*
- 9:40 *Factors impacting BMPs effectiveness on water quality in a Quebec agricultural intensive watershed.*
ERIC VAN BOCHOVE, MICHEL NOLIN, MARIE-JOSÉE SIMARD, MARTIN CHANTIGNY, ALLAN CESSNA, ROGER LALANDE, JIAN ZHOU, GEORGES THÉRIAULT, NADIA GOUSSARD
- 10:00 *Phosphorus export response to best management practices estimated from paired-watershed design experiments.*
AUBERT R. MICHAUD, JACQUES DESJARDINS, JULIE DESLANDES, MICHÈLE GRENIER
-

SESSION XVII – Pavillon Forestier, Salle / Room Henry Roy
Émissions gazeuses du sol / Soil Gas Emissions

Modérateur / Chair : Philippe Rochette, Agric. & Agroalimentaire Canada

- 8:00 *Chamber measurements of Soil N₂O emissions: Are they reliable?*
PHILIPPE ROCHETTE, NIKITA S. ERIKSEN-HAMEL
- 8:20 *Spatial and Temporal Variation in N₂O Emissions, Denitrification and Denitrifier Population Dynamics under Potato Production.*
CATHERINE E. DANDIE, DAVID L. BURTON, BERNIE J. ZEBARTH, SHERRI L. HENDERSON, JACK T. TREVORS, CLAUDIA GOYER
- 8:40 *Nitrous oxide and carbon dioxide emissions from continuous and rotational cropping of corn, soybean and winter wheat.*
CRAIG F. DRURY, XUEMING M. YANG, W. DANIEL REYNOLDS, NEIL B. McLAUGHLIN
- 9:00 *The Net Greenhouse Gas Balance of a Prairie Agricultural Landscape.*
DAN PENNOCK, ANGELA BEDARD-HAUGHN, KIRK ELLIOTT, RICHARD FARRELL, TOM YATES, KIM PHIPPS.
- 9:20 *Recess / Pause*
- 9:40 *Carbon dioxide flux from turfgrass covered urban lands.*
SUZANNE E. ALLAIRE, CAROLINE DUFOUR-L'ARRIVÉE, RENÉE LALANCETTE, JACQUES BRODEUR, JONATHAN LAFOND
- 10:00 *Greenhouse Gas Flux Potentials of Forests Soils in Eastern Canada.*
SAMI ULLAH, TIM MOORE, REBECCA FRAISER, LEONORA KING, NATHALIE PICOTTE-ANDERSON

10:30 – 12:00 (Auteurs présents / Authors present)

SESSION XVIII – Pavillon Forestier
Affiches / Posters

- 3- *Comparison of Colorimetry and ICP determination of Mehlich-3 Soil Phosphorus.*
NOURA ZIADI, BÉLANGER GILLES, BERNARD GAGNON, DANIELLE MONGRAIN
- 6- *Cadmium concentration in two grass species fertilised with chloride.*
SOPHIE PELLETIER, RICHARD SIMPSON, PETER RANDALL, GILLES BÉLANGER, GAËTAN TREMBLAY, PHILIPPE SÉGUIN, RAYNALD DRAPEAU, GUY ALLARD

- 9- *Effect of nitrogen fertilization and preceding crop on deoxynivalenol content (DON) in barley.*
DENIS PAGEAU, JEAN LAFOND, JULIE LAJEUNESSE, MARC SAVARD
- 12- *Utilisation du chlorophyllemètre (SPAD 502) comme outil diagnostique à la fertilisation azotée de la pomme de terre.*
NICOLAS SAMSON, LÉON ETIENNE PARENT, SAMUEL MORISSETTE
- 15- *Net primary productivity and annual plant P cycling in some common agroecosystems in Quebec.*
MARTIN A. BOLINDER, LEON ETIENNE PARENT
- 18- *Reexamination of white spruce nutrient status in Canada: are N deficiencies still prevalent?*
PIERRE-OLIVIER QUESNEL, BENOÎT CÔTÉ
- 21- *Residual soil nitrate after canola harvest.*
JEAN LAFOND, DENIS PAGEAU
- 24- *Soil Chemical and Physical Classification of Three Saline Ponds near Kamloops, BC.*
KENT WATSON, IAN VAUGHN, SHARON BREWER
- 27- *Greenhouse Gas Emissions and Soil Carbon Dynamics after Five Years of Boreal Forest Inundation.*
MAREN OELBERMANN, SHERRY E. SCHIFF
- 30- *Soil nitrogen supply rates support nitrous oxide emission studies.*
MELISSA M. ARCAND, ANDREA E.L. REDMAN
- 33- *Greenhouse gas emissions from organically managed potato rotations in Atlantic Canada.*
DEREK LYNCH, DAVID BURTON, JOSÉE OWEN
- 36- *Nutrient Availability and Microbial Community Structure in Reclaimed Oil Sand Boreal Forest Soils.*
M. DEREK MacKENZIE, SYLVIE A. QUIDEAU, JESS D. LEATHERDALE
- 39- *Are earthworm populations in Quebec agroecosystems constrained by soil physical factors or food availability? Results from two long-term tillage experiments.*
JOANN K. WHALEN, ALICIA B. SPERATTI, NIKITA S. ERIKSEN-HAMEL, HICHAM BENSLIM, ANNE VANASSE, ANNE LÉGÈRE, CHANDRA A. MADRAMOOTOO
- 42- *Reverting to conventional or zero tillage: changes in soil microbiological properties.*
NEWTON Z. LUPWAYI, B.G. MCCONKEY, C.A. GRANT
- 45- *Effect of three polycyclic aromatic hydrocarbons on nodulation of Phaseolus vulgaris by Rhizobium tropici.*
YESSICA GONZÁLEZ-PAREDES, RONALD FERRERA-CERRATO, ALEJANDRO ALARCÓN
- 48- *National Indicators of Risk of Water Contamination by Agriculture: Preferential Flow Component.*
HUMAIRA DADFAR, SUZANNE E. ALLAIRE, ERIC VAN BOCHOVE, FARIDA DECHMI, GEORGES THÉRIAULT

- 51- ODEP; *Un Outil d'aide à la Décision face au risque d'Exportation de Phosphore en provenance des champs agricoles. Vers in « P-index » pour le Québec.*
ISABELLE BEAUDIN, AUBERT MICHAUD, PIERRE BEAUDET, MARCEL GIROUX,
CHRISTINE LANDRY, MARC DUCHEMIN, GILLES GAGNÉ, JULIE DESLANDES
- 54- *Utilisation du traceur isotopique ⁷Be pour évaluer l'impact du travail du sol sur l'érosion hydrique.*
MARC DUCHEMIN, MONCEF BENMANSOUR, ASMAE NOUIRA, JACQUES
GALLICHAND
- 57- *A methodological approach for the development of a national indicator of risk of water contamination by pathogen.*
ERIC VAN BOCHOVE, GEORGES THÉRIAULT, ED TOPP, FARIDA DECHMI, DAVID
LAPEN, ALAIN N. ROUSSEAU, SUZANNE ALLAIRE, HUMAIRA DADFAH
- 60- *Variabilité spatiotemporelle des indicateurs de fertilité d'un sol organique.*
LOTFI KHIARI
- 63- *Validation of the Indicator of Risk of Water Contamination by Phosphorus for Quebec Agricultural Watersheds.*
FARIDA DECHMI, E. VAN BOCHOVE, G. THÉRIAULT, M-L. LECLERC, J.-T. DENAULT
-

12:00 – 13:15 - Dîner / Lunch – Pavillon Boisé

14:15 – 16:15

**Symposium Régis Simard sur la chimie et la fertilité du sol /
Régis Simard Symposium on Soil Chemistry and Fertility**

Modérateur / Chair : Michel C. Nolin, Agric. & Agroalimentaire Canada

- 14:30 *Régis Simard : Vingt ans au service de la science du sol / Twenty years of service to soil science.*
PHILIPPE ROCHETTE
- 14:45 *Opportunities for Improved Fertilizer Nitrogen Management in Production of Arable Crops in Eastern Canada.*
BERNIE J. ZEBARTH, CRAIG F. DRURY, NICOLAS TREMBLAY, ATHYNA N.
CAMBOURIS
- 15:15 *Organic and Mineral Fertilization of Crops and Dynamics of Soil Nutrients.*
CYNTHIA GRANT, NOURA ZIADI, BERNARD GAGNON, DON FLATEN, JEFF
SCHOENAU
- 15:45 *Environmental and agronomic phosphorus indices in soil-plant systems.*
LEON-ETIENNE PARENT, MARTIN A. BOLINDER, JACQUES GALLICHAND,
MONIQUE GOULET, LUCIE BEAULIEU

JEUDI 7 JUIN / THURSDAY JUNE 7

8:00 – 17:00

**Auberge – Stationnement / Parking
Tournée post-congrès / Post-congress Tour**

RÉSUMÉS

(par ordre alphabétique du nom de famille du premier auteur)

ABSTRACTS

(in alphabetical order of the first author's last name)

Carbon dioxide flux from turfgrass covered urban lands

SUZANNE E. ALLAIRE¹, CAROLINE DUFOUR-L'ARRIVÉE¹, RENÉE LALANCETTE¹,
JACQUES BRODEUR², JONATHAN LAFOND¹

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Keywords: gas flux, lawn, CO₂, land management

A number of ecosystems have the potential to sequester or release large quantities of CO₂ to the atmosphere (Glen et al., 1993; Schimel et al., 2000). In many grasslands, high levels of soil organic matter, microbial activity, and root mass make the soil a large source or sink of atmospheric CO₂ (Ojima et al., 1993). Turfgrass CO₂ emissions have been neglected because of the assumption that urban land area is too small to make significant contributions. However, the urban area is the most rapidly expanding type of habitat throughout the world (McKinney 2002) and lawns have become the most widely used plantings in the urban landscape (golf courses, parks, home lawns, sport fields) (Alig et al., 2004). In the US, more than 10 to 20 million hectares and more than 10% of the land surfaces in some places are covered with turfgrass (NASS, 2004), which represents surfaces three times larger than irrigated crops. The majority of large cities in Canada and the US have developed management strategies for reducing GHG emissions (e.g city of Calgary, 2003, 2006; city of Quebec, 2004). The city of Quebec owns 600 hectares of lands covered by turfgrass that are weekly mowed. Surface covered by private owners is much higher. The goal of this study was to compare different land management approaches on environmental, ecological and social aspects in Quebec City.

This paper addresses only the CO₂ emissions by turfgrass under four management approaches (5 sites per management); 1) fertilized (standard) and mowed (FFM), 2) unfertilized and mowed (UFM), 3) unfertilized and mowed three times during the growing season (UF3X), and 4) unfertilized and not mowed or mowed once (UF1X). Clippings were left on site for all the unfertilized sites rather than been transported to landfills. Closed flux chambers and gas tight syringes were used for sampling gas. The samples were immediately injected into vials, and were analyzed by GC to determine N₂O and CO₂ concentration. N₂O emission was significant only for FFM treatment. The CO₂ emission was higher under FFM and UFM than with UF3X. Considering this lower gas emission, lower fuel consumption for clipping and transporting clippings, increased carbon sequestration by standing plants and clippings, lower methane emission on site compared to landfills, cities should consider not fertilizing lawns, and mowing them much less frequently whenever possible.

Reference List

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Le pergélisol : un phénomène géologique, climatique... et pédologique.

MICHEL ALLARD

Centre d'études nordiques, Université Laval

Le pergélisol est défini comme tout sol (ou roche) dont la température demeure sous 0°C pour au moins deux années consécutives. Cependant, de façon générale, la persistance du pergélisol est de l'ordre de décennies, de siècles et de millénaires. En terme de distribution géographique, on distingue la zone de pergélisol discontinu, où tout le terrain (à l'exception du lit des lacs profonds) est gelé sur de grandes épaisseurs, lesquelles peuvent atteindre 500 m, et la zone de pergélisol continu, où le pergélisol apparaît selon une mosaïque de terrains gelés et non gelés. Plus on se dirige vers la limite sud de l'aire de distribution, plus les plaques de pergélisol dans l'environnement sont petites et dispersées ; l'épaisseur du pergélisol diminue aussi énormément pour ne plus faire que quelques mètres. À chaque été, la couche superficielle du terrain dégèle jusqu'à une certaine profondeur. Cette couche, qui bien sûr regèle en hiver, s'appelle le mollisol, ou la couche active. Mince dans les régions arctiques à pergélisol continu, le mollisol est de plus en plus épais vers le sud, dans la zone discontinu. Mesurée à l'aide de câbles à thermistances dans des trous de forage un peu partout à travers l'Arctique, la température du pergélisol est associée étroitement à celle de l'air. L'épaisseur du mollisol, quant à elle, est liée à la somme des degrés-jours de dégel dans l'été. Lorsque le climat réchauffe, le mollisol s'approfondit et la température du pergélisol augmente. Le pergélisol est donc un phénomène climatique. Par exemple, le réchauffement climatique en cours au Nunavik a provoqué l'augmentation de la température du pergélisol d'environ 2 °C depuis 1992.

La glace que contient le pergélisol est d'origine diverse et elle dépend de la texture du dépôt de surface qui compose le sol. Dans les sables et graviers, elle occupe les pores ; c'est la glace interstitielle. Les silts et les argiles contiennent le plus souvent de la glace de ségrégation en lentilles provoquées par la cryosuccion lors de la formation du pergélisol. Les coins de glace constituent une autre forme de glace extrêmement répandue dans le pergélisol ; ils sont formés par la percolation d'eau dans les fentes de contraction thermique qui s'ouvrent en hiver lors des grands froids. Les coins de glace dessinent en surface du terrain les réseaux de sols polygonaux. On trouve aussi de la glace intrusive, formée par des injections d'eau sous pression, par exemple dans les pingos. En fait, on peut considérer le pergélisol comme une roche (ex. un conglomérat) dont le minéral de liaison est la glace sous ces diverses formes. C'est donc un phénomène géologique, qui a toutefois la particularité de pouvoir changer d'état et de disparaître lorsque sa température passe au-dessus du point de congélation. Le résultat est alors une transformation géomorphologique du terrain accompagnée d'une foulée d'impacts écologiques.

Sur le plan pédologique, les processus de gel et de dégel, les pressions et les perturbations qui se produisent dans le mollisol, appelées cryoturbations, sont la caractéristique principale de l'ordre cryosolique. Les cryoturbations sont étroitement reliées aux micro-formes que l'on retrouve à la surface du terrain comme les fentes de gel, les ostioles, les thufurs, les sols striés et les coulées de gélifluxion, elles-mêmes associées aux matériaux géologiques de surface. La présence d'horizons organiques ainsi que la profondeur du front de dégel annuel (contact mollisol/pergélisol) sont aussi des paramètres physiques qui définissent les grands groupes de l'ordre. Les processus physiques et mécaniques sont donc dominants dans la définition des cryosols.

Potential use of Endophytic Bacteria as Plant Growth Promoting Inoculants

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Keywords: Endophytic bacteria, plant growth-promoting rhizobacteria. Phosphate solubilization, siderophores.

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, likely through mechanisms similar to those proposed for plant growth promoting rhizobacteria (PGPR). The objective of this study was to assess a collection of endophytic bacteria for PGPR traits and potential use to enhance the rhizobial-legume symbiosis. Fifty isolates obtained from the roots of various plants were identified by fatty acid methyl ester (FAME) analysis, and the majority (i.e., 75%) identified as *Pseudomonas* species. Many of these isolates solubilized phosphate or produced siderophores. A growth chamber study is currently assessing the ability of selected isolated to enhance nodulation of alfalfa. Preliminary results suggest that some endophytic bacteria may be useful as biofertilizers or biocontrol agents.

Can the Utilization of Fall-applied Manure Nitrogen be Increased by Combination with Paper Mill Bio-Solids?

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Keywords: Paper Mill Bio-Solids, Liquid Swine Manure, N Mineralization.

A field experiment was carried out on a fine sandy loam soil at Simcoe Research Station field, Ontario, Canada, to identify whether the combined application of Paper Mill

Bio-Solids (PMB) and fall-applied manure-N would benefit corn yield in the following growing season by slowing N mineralization and thereby reducing nitrate loss by leaching. Experimental treatments consisted of 5 rates of PMB (0, 30, 60, 120, 150 Mg ha⁻¹) combined with 4 rates of liquid swine manure-N (LSM) (0, 50, 100 or 200 kg ha⁻¹). Control plots received no PMB or LSM. Two sets of soil cores were incubated in the field together with ion exchange resin bags. The first set was installed for the period from fall 2004 till the beginning of spring 2005. The second set covered the period of summer 2005 (May – Nov.). The cores allowed the determination of changes in mineral N (Nitrogen net mineralization) during these two periods of incubation. Ceramic soil solution samplers were installed at a depth of 90 cm to monitor NO₃-N leaching over the period of spring and winter.

To help interpret results from the field experiment, we investigated PMB carbon availability in a laboratory experiment. In this study the release of CO₂ from PMB was assessed under anaerobic conditions using rumen microflora collected from a fistulated cow. The resin core estimates of N mineralization from Dec. to May showed that the treatment which received 30 Mg ha⁻¹ PMB and 100 kg ha⁻¹ N had greater N mineralization (5 kg N ha⁻¹) than did the control or when PMB alone was applied (0.52 kg N ha⁻¹). Summer (May to Nov. 2005) incubation of resin cores showed that for the treatment receiving no manure-N, the rate of N mineralization did not seem to be affected by PMB application. Soil solution samples at a depth of 90 cm showed that NO₃-N content increased over the sampling periods (Dec. 2004-May 2005) at plots received manure-N with or without PMB. PMB applied alone tended to increase corn yields by 0.42-1.41 Mg ha⁻¹, compared to the control. Statistical analysis showed that PMB applied alone or combined with manure had no significant effect on nitrogen mineralization, nitrate leaching and corn yields at $P < 0.05$. The laboratory study suggested the absence of any effect from adding PMB was because its decomposition rate was very slow; with less than 1% of the PMB sample being mineralized over 4 days.

Soil nitrogen supply rates support nitrous oxide emission studies

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Keywords: PRSTM-probes, nitrous oxide, nitrate-N, ammonium-N, ion exchange membrane

Nitrous oxide (N₂O), a significant greenhouse gas emitted from soils, is produced by the microbial transformation of soil ammonium N (NH₄-N) and nitrate N (NO₃-N) through nitrification and denitrification processes, respectively. The supply rate of NO₃-N and NH₄-N in soil can be monitored using Plant Root Simulator (PRS)TM-probes, which are constructed of ion exchange membrane encased in a plastic probe. When directly buried in soil, the anion and cation PRSTM-probes adsorb NO₃-N and NH₄-N, respectively. Burial periods can extend for weeks at a time or may be shortened and continuously repeated to gain information on the temporal changes in nutrient supply. Under repeated burial, the data obtained by PRSTM-probes can indicate when NO₃-N and NH₄-N supply rates increase or decrease as a result of temporal changes in soil moisture and temperature or following treatment application or management practice. Therefore, soil NO₃-N and NH₄-N supply rates may be continuously monitored with PRSTM-probes in conjunction with N₂O flux data measured by micrometeorological methods. The purpose of this poster is to highlight the application of PRSTM-probes to determine soil NO₃-N and NH₄-N in nitrous oxide emission studies.

Perennial vegetation established in wetland fringes in the Canadian prairies may be returned to agricultural production during dry cycles, with the risk of subsequent flooding following heavy rains. Nelson et al. (2007) determined two-day N₂O flux and NO₃-N supply rate from soils at field capacity and following simulated flooding conditions (saturation) in a controlled environment. Response of N₂O flux to changes in soil moisture was site specific and inconsistent (Nelson et al. 2007). PRSTM-probe NO₃-N supplies (0 to 20 days) were consistently higher under field capacity. Decreases in NO₃-N were only occasionally correlated with increased N₂O, suggesting that the decrease in NO₃-N was not only a result of denitrification, but also due to a reduced rate of nitrification in the saturated soils (Nelson et al. 2007).

Nitrogen fertilization increases the total amount of N in the soil that may be transformed to N₂O. Increases in nitrous oxide emissions were consistent with decreases in NH₄-N supply within 20 days following subsurface banded and broadcast incorporated application of urea-N (Bembenek et al. 2006). Application of KNO₃ did not significantly increase N₂O emissions in comparison to the unfertilized control indicating that the increase in N₂O emissions in the urea-N fertilized soils was a result of nitrification. The decrease in NH₄-N supply supports this conclusion as it indicates that the NH₄-N produced from the urea application was likely nitrified (Bembenek et al. 2006).

These two studies highlight the value of PRSTM-probes in N₂O emission studies as they can detect changes in both NH₄-N and NO₃-N supply rates as a result of management practices, such as cultivation and treatment applications, as well as temporal changes in soil moisture and temperature.

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Composting broadleaved tree branches: An innovative alternative to conventional forest nursery substrates in developing countries.

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Keywords: Forest soil, mineral soil, *Acacia sp.*, physio-chemical properties, developing countries.

Topsoil collected under forest stands and mineral soil mixed with manure, clay and straw are still the basic growing media used in the majority of forest nurseries in developing countries such as Morocco where peatlands are either protected, or non-existent. The large variability in the physio-chemical properties of these materials, given that they are collected from multiple sites, inhibits the standardization of cultural regimes and the control of morpho-physiological qualities of seedlings produced in forest nurseries. These soil mixtures, which are usually dense, negatively affect normal seedling root development and constitute a potential source of pathogens and weed seeds. The removal of forest and mineral soil contributes to the depletion of local forest and agricultural soils, and consequently, decreases their productivity.

Composting chipped branches from fast growing broadleaved forest species, particularly *Acacia cyanophylla* and *Acacia Cyclops*, which are both abundant and frequently used for reforestation in semi-arid and arid zones, constitutes an innovative and viable alternative over the long term. This composting technique eliminates the need to import peat and vermiculite as well as the excessive use of forest soil. Moreover, it has been adapted to the resources and infrastructure of forest nurseries in the targeted countries. The compost meets the principal quality criteria for standard artificial substrates. Its physical properties include high water-holding capacity and air porosity. It exhibits good drainage and is well suited for use as a substrate for containerized seedling production. The chemical characteristics of the material evolve normally during the composting process, resulting in a neutral to slightly basic pH, a low C/N ratio, a decrease in ammonia and an increase in nitrates and CEC as the material matures. With irrigation, salts are leached from the system, bringing high initial electric conductivity (EC) values down to acceptable levels for containerized forest seedling production. Pure *Acacia* compost has good physio-chemical properties and can be used to modernize forest nursery production in developing countries. Finding additional local sources of readily available organic materials with stable physio-chemical properties would not only improve the quality of the resulting compost but could also improve seedling growth and survival, important factors in the efficient use of plantation establishment to reduce desertification.

Soil greenhouse gas, nutrient, and microbial biomass dynamics in recently fertilized western Canadian plantation forests

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Keywords: Carbon dioxide, methane, nitrogen, nitrous oxide

Fertilization of plantation forests in British Columbia with nitrogen (N, as urea) or a mixture of N and other nutrients 10 to 40 years following planting is becoming increasingly common. Beyond the intended effect of enhancing rates of primary production, fertilization also has the potential to alter soil carbon, nutrient, and in particular, greenhouse gas dynamics, however these effects are largely unknown. We fertilized soil plots with N or a mix of N, phosphorus (P), and micronutrients at an operationally realistic rate of 200kg N per ha in 25yo lodgepole pine, western hemlock, and Douglas fir plantations in three biogeoclimatic zones of BC. For up to 7 months following fertilization we measured soil fluxes of carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) and soil N, P, and microbial biomass dynamics. Fertilization resulted in an initial increase in CO₂ efflux as urea was mineralized, but rates returned to control levels within 14 days in all forest types. Consistent with this pattern, soil ammonium (NH₄) concentrations increased concomitantly. Beyond rapid mineralization to NH₄, there was surprisingly little transformation of N over the measurement period. Ammonium was largely retained in the soil organic horizons with moderate uptake by microbial biomass and little oxidation to nitrite and nitrate. In the lodgepole pine site, fertilization with urea led to a short-lived suppression of soil CH₄ uptake, presumably due to NH₄ inhibition of CH₄-monooxygenases. Nitrous oxide efflux was significantly greater than 0 in fertilized plots at only 1 measurement date in 1 forest type (Douglas fir) following fertilization. We conclude that in western Canadian conifer plantations with acidic soils, initial impacts of fertilization on soil greenhouse gas dynamics are short-lived and relatively minor.

Using the SWAT Model for BMP implementation and diffuse source phosphorus reductions: Results from Pike River Watershed

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Keywords: Best Management Practices, phosphorus, SWAT, Model, Water Quality

An agreement between the governments of the province of Québec (Canada) and the state of Vermont (USA) calls for a 41% decrease in phosphorus (P) loads reaching Missisquoi Bay, the northern portion of Lake Champlain. The agreement particularly targets the agricultural sector, since 80 % of non-point source P inputs to the bay are associated with cultivated lands. In order to identify sustainable cropping practices likely to help meet the target P loads, the SWAT (Soil and Water Assessment Tool; Arnold et al. 1998) model was employed to assess hydrological processes, erosion and P mobility on the bay's principal Québec P contributing area, the 630 km² Pike River watershed. Strong in-watershed spatial clustering of vulnerability to non-point source exports highlights the need for targeted implementation of sustainable agricultural practices and soil conservation works, to derive the greatest environmental benefits.

Planting cover crops over the 10 % most vulnerable lands would result in a 21 % drop in overall P exports at the watershed outlet, whereas the same 10 % randomly distributed over the watershed would only contribute to a 6 % drop in P exports. The study of different field-scale management scenarios indicated that achieving the targeted 41 % reduction in P exports, would require the widespread (half the land devoted to annual crops) implementation of sustainable cropping practices, and the conversion of a specific 10 % of the territory to either cover crops or permanent prairie-land. Meeting the P target-loads would require additional investments in the protection of flood-plains and riparian strips, the targeted construction of runoff-control structures, and the rapid soil incorporation of manures on lands dedicated to annual crops

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ODEP; Un Outil d'aide à la Décision face au risque d'Exportation de Phosphore en provenance des champs agricoles. Vers in « P-index » pour le Québec.

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Keywords: phosphore, indice de risqué, IRP, P-index, Québec.

L'objectif général du projet ODEP est d'intégrer les connaissances actuelles disponibles issues des travaux de R&D sur la mobilité du phosphore réalisés au cours des dix dernières années et de les rendre disponible grâce à la réalisation d'une revue de littérature ainsi qu'au développement d'un **O**util d'aide à la **D**écision face aux **E**xportations de **P**hosphore. Cet outil de gestion agroenvironnementale du parcellaire, à l'intention des services-conseils et des entreprises agricoles, supportera le diagnostic de la vulnérabilité des champs au ruissellement de surface, à l'érosion et à l'exportation de phosphore. L'ODEP, d'utilisation conviviale supportera:

- Une évaluation qualitative et quantitative et à l'échelle du champ des lames de ruissellement de surface, des taux d'érosion, de même que des charges et de la biodiponibilité du phosphore exporté;
- Une interprétation des facteurs déterminants dans la vulnérabilité de la parcelle, à l'égard des facteurs de régie des sols et des cultures, de l'aménagement hydro-agricole et des propriétés des sols;
- Des prédictions de retombées environnementales associées à des scénarios alternatifs de régie des sols, des cultures et d'aménagement hydro-agricole.

Conceptuellement, l'utilitaire informatique développé permettra d'apprécier les risques associés aux facteurs "Sources" et "Transport" de mobilité des sédiments et du phosphore à l'échelle d'une parcelle ou d'un ensemble de parcelles données, et d'aiguiller le conseiller et le producteur vers des solutions bien adaptées aux spécificités du site à l'étude. La conception et les fonctionnalités proposées pour l'utilitaire ODEP en feront un outil complémentaire et bien intégré aux autres outils couramment utilisés par les services-conseils au Québec ou en voie de le devenir.

Critical P concentration in spring wheat

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Keywords: phosphorus, nitrogen, diagnosis, nutrition, deficiency

Efficient management of P in crop production requires tools to quantify its status in plants. A diagnosis of P nutrition, based on the relationship between P and N concentrations during growth, was first proposed for perennial grasses in France (Duru and Ducrocq 1997) and later extended to timothy (*Phleum pratense* L.; Bélanger and Richards 1999) and corn (*Zea mays* L.; Ziadi et al. 2007) in eastern Canada. Our objectives were to establish the relationship between P and N concentrations in spring milling wheat (*Triticum aestivum* L.) during the growing season and, in particular, to determine the critical P concentration required to diagnose P deficiencies.

Shoot biomass and P and N concentrations were determined weekly and grain yield was measured at harvest in an experiment conducted in Québec at three sites in each of two years (2004 and 2005) on soils with adequate P for growth. Treatments consisted of six N rates (0, 40, 80, 120, 160, and 200 kg ha⁻¹) except at one site where five N rates were used in 2004 (0, 30, 70, 110, and 150 kg ha⁻¹) and four in 2005 (30, 60, 90, and 120 kg ha⁻¹). A randomized complete block design with four replicates was used at each experimental site. At seeding, all plots received 30 kg N ha⁻¹ as ammonium nitrate (34-0-0), except those with no N fertilization (0 kg N ha⁻¹). At either the end of the jointing stage or the beginning of the heading stage of development, a second N application (27-0-0) was broadcast by hand to obtain the desired N rate for each plot.

Both shoot P and N concentrations decreased with time or increasing shoot biomass during the growing season and they increased with N fertilization, suggesting that they are closely related. The relationship between shoot P and N concentrations under non-limiting N conditions is described by a linear function ($P = 0.94 + 0.107N$, $R^2 = 0.59$, $P < 0.001$) in which concentrations are expressed in g kg⁻¹ DM. Under severe limiting N conditions (relative grain yield < 0.70), the relationship was different ($P = 1.70 + 0.092N$, $R^2 = 0.48$, $P < 0.001$) with greater P concentrations for a given N concentration.

These relationships approximate the critical P concentration under both non-limiting and severely limiting N conditions. This critical P concentration can then be used to quantify the degree of P deficiency during the current growing season.

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Effets des apports de différents types d'engrais ammoniacaux sur la structure et la diversité des communautés des bactéries oxydant l'ammoniac (Ammonia-Oxidizing Bacteria)

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Les bactéries oxydant l'ammoniac (Ammonia-Oxidizing Bacteria, AOB) jouent un rôle clé dans le processus de nitrification et, par conséquent, dans la productivité des sols. Grâce à leur enzyme spécifique, l'ammoniac monoxygénase (*amoA*), ces bactéries chimioautotrophes et aérobiques convertissent l'ammonium en nitrites qui sont immédiatement oxydés en nitrates, la forme d'azote la plus facilement assimilable par les plantes. L'objectif de notre étude était de comparer les effets des apports de différents types d'engrais ammoniacaux (NH_4OH , NH_4NO_3 et Solution 32) sur la structure et la diversité des AOB dans un sol sous culture de maïs.

L'ADN total extrait directement du sol a servi de matrice pour l'amplification par réaction de polymérisation en chaîne (PCR) des fragments d'ADNr 16S à l'aide d'amorces spécifiques aux AOB. Les amplicons, de même taille mais de composition différente, ont été séparés par électrophorèse sur un gel en gradient de dénaturation (Denaturant Gradient Gel Electrophoresis, DGGE). La comparaison des profils DGGE suggère que ces engrais ammoniacaux ont inhibé la croissance de certaines populations AOB dominantes dans le sol, et qu'ils ont favorisé la croissance d'autres AOB non détectables ou peu abondantes dans le sol témoin. Ces changements se sont manifestés dans cet ordre : $\text{NH}_4\text{OH} > \text{Solution 32} > \text{NH}_4\text{NO}_3$. L'analyse des profils DGGE indique également l'influence du type d'engrais azoté sur les populations des AOB dominantes du sol.

Remontée des sels et de l'eau en substrat tourbeux sur matelas capillaire

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Mots clés: Matelas capillaire, substrat.

La production en serre est une activité qui entraîne une consommation importante d'eau et de fertilisants. La mise au point d'un système de production sur matelas capillaire a constitué une avancée importante dans ce domaine puisqu'elle permettrait d'obtenir une diminution importante de ces éléments. La maximisation de la production sur matelas capillaire, et donc de la diminution des coûts de production, passe par une meilleure compréhension du milieu de culture et de son évolution. Plusieurs travaux ont aussi mis en évidence l'influence du substrat utilisé sur la remontée capillaire. Les propriétés physiques d'un substrat tourbeux lors d'une production en serre de chrysanthème sur matelas capillaire ont été comparées à une production sans matelas. Nous avons observé qu'il y avait une meilleure répartition de l'eau sur l'ensemble du pot avec l'utilisation d'un matelas capillaire pour ce type de substrat. Ce système de production a permis de réaliser des économies de solution nutritive d'environ 60 % tout en nécessitant moins de main d'oeuvre. Par contre, nous avons constaté qu'il y avait une concentration en sel accrue dans la partie supérieure du pot dans la culture sur matelas. La conductivité électrique mesurée en fin de culture a pu nuire à la croissance des plants puisqu'elle se situait en moyenne à 5,58 mS/cm comparativement 1,35 mS/cm dans la culture hors matelas. Une gestion mieux adaptée à ce système de production, permettant de réduire l'accumulation de sels par une diminution des fertilisants, serait envisageable et pourrait être économiquement avantageuse.

Net primary productivity and annual plant P cycling in some common agroecosystems in Quebec

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Keywords: Phosphorus, roots, nutrient cycling, risk assessment, phosphorus indices

Net primary productivity (NPP) is the major determinant for nutrient cycling in ecosystems and is therefore closely related to environmental issues. In this study, we adapted a methodology developed to estimate NPP from Canadian agroecosystems (Bolinder et al. 2007) to include P partitioning. This approach can be used in 'annual soil surface P budget' and 'crop residue P' calculations which are important components of phosphorus indices (PI) that evaluate the risk of surface water contamination by P from agroecosystems (Beaudet et al. 1998; Bolinder et al. 2000). Using this approach, we calculated the annual accumulated P uptake (P_{TOT}) and the proportion of this P that is exported from the field (P_{EXP}) for some average yielding commonly grown crops in Central Quebec. P_{TOT} was highest for silage-corn (49.5 kg P ha⁻¹) followed by grain-corn (36.6 kg P ha⁻¹), soybeans, potatoes and perennial forages (25.3 to 30.8 kg P ha⁻¹), whereas the lowest P_{TOT} was that of small-grain cereals (14 to 16.8 kg P ha⁻¹). As much as 56% of P_{TOT} was present in the root fraction for forages, while this proportion for cereals, potatoes and soybeans represented between 20 to 30%. The agroecosystem that presented the highest amount of P exported (P_{EXP}) was that of a silage-corn crop (≈ 33 kg P ha⁻¹). Generally, it can be considered that: (1) silage-corn is the crop with the highest P removal capacity, (2) grain-corn has moderate P removal capacity, (3) small-grain cereals (with all straw removed), soybeans, perennial forages and potatoes has low P removal capacity, and (3) small-grain cereals - without straw removal has a very low P removal capacity. If the component related to crop residues in an PI approach should also account for the amount of P accumulated from below-ground NPP, the boundaries of the respective P transfer rating categories should be redefined. The methodology is more complete compared to classical approaches since it takes into account all plant parts (including the root system), and it offers a better opportunity to compare the estimates of nutrient accumulation and distribution in agroecosystems to those of natural ecosystems such as mixed grasslands and forests. At present we are expanding our approach to include tuber crops with a more complete data set (C, N, P) for different potato cultivars determined under field conditions in eastern Canada.

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Évapotranspiration quotidienne d'une culture de canneberge déterminée à l'aide du bilan hydrique estimé par des tensiomètres et des sondes TDR en sols organique et en sol sableux

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Mots clés: évapotranspiration, bilan hydrique, tensiomètre

L'irrigation des cultures est un domaine qui demande de plus en plus de précision de la part des opérateurs. Les impacts d'une mauvaise gestion sont nombreux, tant sur le plan économique qu'environnemental (USDA, 1997). Il importe donc d'appliquer l'eau au bon moment tout au long de la saison de croissance. Pour savoir quelle quantité d'eau appliquer et à quelle fréquence, il faut entre autre connaître l'évapotranspiration quotidienne de la culture.

Il existe une façon directe de mesurer cette évapotranspiration où l'on dresse le bilan hydrique du sol où la culture est implantée. En connaissant les flux d'eau entrant (précipitations et remontée capillaire) et/ou sortant (drainage) de la profondeur d'enracinement, il est possible de déduire quelle quantité d'eau a été perdue par évapotranspiration par la loi de la continuité et la loi de Darcy. Un minimum de caractérisation du sol est essentiel pour connaître la conductivité hydraulique en condition non saturée, ce qui est fait par la méthode du profil instantané (Watson, 1966). Des essais faits dans un sol organique et dans un sol sableux cultivés en canneberges ont permis de découvrir que les quantités d'eau appliquées par les producteurs étaient beaucoup plus grandes que ce qui était consommé par la transpiration des plantes et l'évaporation au sol.

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Cartographie et interprétation des sols à l'échelle du microbassin versant agricole, rivière Bras d'Henri (Québec)

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Mots clefs : cartographie très détaillée des sols, transect aléatoire, bassin versant agricole.

Bien que la majeure partie du territoire agricole du Québec soit dotée d'une information pédologique de base, une mise-à-jour de cette information est nécessaire dû à l'âge parfois élevé et la précision de cette information. C'est pourquoi, une cartographie des sols à l'échelle de 1 :15 000, selon la méthode de prospection conventionnelle (transect aléatoire selon une grille systématique de 150 m x 150 m), a été réalisée dans deux microbassins expérimentaux de 3 km² du bassin versant du Bras d'Henri (Beauce Nord, Québec). De 2004 à 2006, 235 et 180 profils de sol ont été décrits et analysés respectivement dans le microbassin d'intervention (MBI) et le microbassin témoin (MBT). Cette cartographie a permis de mettre à jour l'information pédologique disponible et d'améliorer la précision de la cartographie. Les cartes pédologiques de Lotbinière (1957; échelle de 1 :63 360) et de Dorchester (1975; échelle de 1 :50 000), couvrant ce territoire indiquaient la présence des sols des séries de Beurivage (matériau sablo-graveleux), de Neubois et de Le Bras (matériau loameux-fin d'origine fluvio-lacustre). Le relevé très détaillé a également montré la présence d'autres séries de sols dans les microbassins, soit les sols des séries de Valère (matériau sableux fin); St-Jude (matériau sableux grossier); Des Saults (alluvions anciennes loameuses), de la caténa de Dosquet Des Pins et Mawcook (till remanié) dans le MBI et des sols de la série de Lévrard (matériau limoneux-fin sur argileux d'origine lacustre) dans le MBT. Des sols organiques minces y ont également été cartographiés.

L'interprétation des cartes détaillées des sols indique une dominance des ordres podzoliques (56%) et gleysoliques (34%) pour le MBI. Ces ordres reflètent la nature de l'environnement et les effets des processus dominant la formation et le comportement des sols du MBI. Les dépôts rencontrés étaient principalement fluviaux (46%) et fluvio-lacustres (31%). Les principales familles granulométriques répertoriées sont sableuses (37%), loameuse (31%) et loameuse grossière (21%). La texture de surface présente sur le territoire d'étude est majoritairement du loam sableux (82%). Le drainage des sols du MBI variait d'imparfait à mal drainé. Le paysage y est relativement plat. En effet, les pentes varient de 0 à 3% pour 44% de la superficie totale du microbassin alors qu'elles varient de 3 à 8% pour 53%. De ces caractéristiques et de bien d'autres non énoncées précédemment, une quinzaine de séries de sols ont été définies pour cette zone. Toutefois, deux séries dominent principalement le MBI: Beurivage (33%) et Le Bras (28%). L'abondance dans le MBI de sols grossiers très perméables rend ces sols plus vulnérables au processus de lessivage des nutriments, plus particulièrement des nitrates.

D'autre part, la carte détaillée des sols du MBT, nous révèle un territoire beaucoup plus homogène que pour le MBI, contrairement à ce qu'on avait anticipé à partir des cartes de 1957 et 1975. En effet, l'ordre gleysolique domine sur 86% de la superficie du territoire du microbassin. Les dépôts fluvio-lacustres (63%) occupent la majeure partie du territoire dans cette zone. Le type de dépôt dominant est le même que celui révélé par les études pédologiques disponibles au départ. La famille granulométrique dominante est loameuse (65%) alors que la texture de surface dominante est un loam limoneux (87%). Les sols de ce microbassin sont caractérisés par un mauvais drainage. Les pentes sont comparables celles du MBI, soit de 0 à 3 % pour 54% de la superficie du microbassin alors qu'elle varie de 3 à 8% pour 46% de la superficie. Une douzaine de séries de sols caractérisent le territoire du MBT. Toutefois la série de Le Bras domine largement (64%). De granulométrie plus fine, ces sols sont par nature moins vulnérables au lessivage des nutriments que ceux du MBI. Par contre, présentant une perméabilité plus lente que les sols du MBI et des pentes comparables, les sols du MBT sont plus vulnérables au ruissellement et transport de surface.

Nouveau carottier manuel pour l'échantillonnage de sol non remanié – Efficacité et fiabilité de la mesure de la masse volumique apparente

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Mots clés : variabilité spatiale et temporelle, indicateur, qualité des sols

La masse volumique apparente (MVA) est fréquemment utilisée comme indicateur de la qualité structurale des sols et diagnostic de compaction. Cette mesure est en effet très reliée à la vitesse d'infiltration de l'eau, au mouvement des nutriments à travers le profil de sol, aux échanges gazeux entre le sol et l'atmosphère ainsi qu'au développement des racines. La MVA est traditionnellement mesurée à partir d'un échantillon prélevé avec un carottier à double cylindre (méthode standard). Cet appareil, composé d'un porte cylindre de type fermé, est volumineux, lourd (9 kg) et exige un temps considérable pour le prélèvement des cylindres de sol non remanié dû au raccordement par vissage du porte-cylindre fileté à la poignée, munie d'une tête de frappe. Ces caractéristiques ont pour effet de limiter le nombre d'échantillons prélevés pour la mesure de la MVA. Or, la précision et la fiabilité de cette mesure sont directement reliées au nombre d'échantillons prélevés. Une nouvelle méthode d'échantillonnage est donc requise pour mieux documenter la variabilité spatiale et temporelle de cet indicateur.

Un carottier moins lourd (1.8 kg), plus petit et semi-fermé, avec tête à marteler avec une masse en nylon (1.7 kg), a donc été conçu aux laboratoires de pédologie et d'agriculture de précision d'Agriculture et Agroalimentaire Canada pour réduire le temps de prélèvement de cylindres de sol non remanié. L'objectif de cette communication est de comparer l'efficacité et la fiabilité des deux méthodes de prélèvement (standard (S) et modifiée (M)). Cette étude a été menée durant deux saisons (en 2005 sous culture de maïs et en 2006 sous culture de céréale), trois types de sols (sableux, loameux et argileux), trois périodes d'échantillonnage (pré-semis, mi-saison (6 à 8 feuilles pour le maïs et à la montaison pour le blé) et récolte) et selon deux profondeurs (5-11 et 20-26 cm). Les échantillons ont été prélevés en triplicata à 15 cm du rang dans le maïs grain et au milieu de l'entrerang dans la culture du blé. Un dispositif en bloc complet avec quatre répétitions a été utilisé pour l'expérimentation.

L'analyse de variance a été effectuée sur la différence de la MVA entre S et M en considérant l'humidité du sol comme covariable. Les deux méthodes de prélèvement montrent des précisions d'estimation comparables (CV=5-10 %). Les résultats indiquent qu'il n'y a pas de différences significatives entre les deux méthodes de prélèvement pour la MVA des échantillons de surface (5-11 cm). Cependant, les échantillons prélevés entre 20-26 cm avec la méthode M présentent des valeurs moyennes de MVA supérieures à la méthode S et cela, peu importe la culture, le type de sols et la période d'échantillonnage. La différence entre la MVA mesurée avec la méthode M et la méthode S est de 20 kg m⁻³ sous culture de blé et de 23 kg m⁻³ sous culture de maïs. Le nouveau carottier semble donc surestimer la MVA pour les échantillons prélevés en profondeur. Cependant la célérité du prélèvement des échantillons (méthode deux fois plus rapide) avec le nouveau carottier par rapport à la méthode standard offre une alternative intéressante à la mesure de la MVA lorsque l'étude requiert un très grand nombre d'échantillons. L'ajout d'un anneau de sécurité à la base du cylindre pour réduire l'effet de compaction observée lors du prélèvement des échantillons en profondeur sera évalué lors de la saison prochaine.

Soil Organic Matter in Riparian Areas of Prairie Pothole Wetlands

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The Prairie Pothole Region (PPR) in Canada is estimated to contain more than 4.5 million hectares of wetlands along with eighty-percent of the agricultural land in the country. This overlap has resulted in the drainage of a significant portion of these wetlands for agricultural uses. Ducks Unlimited Canada (DUC) has restored over 1000 prairie wetlands since 1989. However, there is a paucity of information on the effects of restoration, defined as the initial cessation of artificial drainage through the installation of an earth plug, on soil carbon processes in these restored wetlands. The primary objective of this study was to identify and compare key control variables and indicators of soil carbon structure and function in riparian areas of natural and restored wetlands. A total of 63 natural and restored wetlands were sampled (0-6 cm depth) in August/September 2005 and analyzed for soil microbial community structure using phospholipid fatty acid (PLFA) analysis. A combination of density, particle-size, and acid hydrolysis separation techniques were employed to quantify the distribution of carbon among labile (low-density) and recalcitrant (acid-insoluble) organic matter pools. Chemical composition of the low-density fractions was further characterized using CPMAS ¹³C Nuclear Magnetic Resonance (NMR) spectroscopy. Preliminary results indicate differences in chemical composition among natural wetlands that may be related to climatic conditions at the sites, but no differences between natural and restored soils. On the other hand,

PLFA results indicate significant differences linked to wetland restoration.

Regional variation of 17-beta-estradiol sorption in Alberta soils

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Keywords: sorption, 17-beta-estradiol, regional variability

Sorption coefficient is one of the most important parameters in the determination of pesticide fate. It gives a quantitative measure of the amount of compound that will be sorbed to the soil compared with the amount of compound that will stay in solution and therefore stay available to mobilization by hydrologic processes such as runoff. This mobilization can then lead to surface water contamination. This study aims at a better understanding of the importance of soil properties and regional variability as explaining factors in the sorption coefficient (K_d) of 17-beta-estradiol in Alberta soils. Samples were collected from three slope positions (upper, mid and lower) in 42 sites in Alberta in 41 ecodistricts. Three slope positions (upper, mid and lower) were sampled for each ecodistrict. Soil properties were determined including % sand, %clay, Soil Organic Carbon (SOC), Calcium Carbonate content (CaCO_3), pH, Electrical Conductivity (EC) and Cation Exchange Capacity (CEC) were determined (Gauthier *et al.*, 2006). The sorption of 17-beta-estradiol by soil was determined using batch equilibrium experiments with tritium labelled $[6,7\text{-}^3\text{H(N)}]17\text{-beta-estradiol}$ and a two hour equilibrium time (Casey *et al.*, 2003). Concentrations of 17-beta-estradiol in solution was 50 ppb (Casey, 2003). Preliminary experiments on sorption confirmed that 17-beta-estradiol sorbed to Teflon tubes and was also sensitive to photodegradation and biodegradation. Experiments were therefore conducted with autoclaved soils in glass tubes and at 5°C in the dark. K_d was determined using the formula $K_d = C_s/C_e$ where C_s is the quantity of compound sorbed on soils and C_e is the quantity of compound left in solution. Radioactivity in solution was measured using liquid scintillation counting with automated quench correction (LS 7500 Beckman, Fullerton, CA). Statistical analyse consisted of redundancy analysis which is a form of constrained principle component analysis that maximizes predictions of a set a response variables by a set of factor variables. Slope position was thus coded as 1=upper, 2=mid and 3=lower slope position. The relative geographical position of the sampling sites was expressed as numbers representing the order in which the different sampling sites were encountered following A) an East-West transect and B) a North-South transect. One of the important factors explaining the extent of 17-beta-estradiol sorption was soil organic carbon content. The distribution of soil organic carbon content across slope position or regions has therefore a large influence on 17-beta-estradiol mobility in soils.

Réduction des pertes d'herbicides par ruissellement à l'aide de bandes végétalisées : importance des premiers événements pluviaux suivant le traitement phytosanitaire

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Mots clés: bandes végétalisées, herbicides, ruissellement, événements pluviaux.

Les bandes riveraines végétalisées sont reconnues comme étant des dispositifs efficaces pour réduire les exportations des certains pesticides par ruissellement et avoir un impact positif sur la qualité des eaux. Leur efficacité est cependant susceptible d'être fonction de conditions météorologiques (hauteur des précipitations et intervalle de temps écoulé entre l'application des pesticides et les premiers événements pluviaux) qui agissent sur le transfert des pesticides vers les cours d'eau. Ce travail examine l'efficacité de deux types de bandes végétalisées à réduire les pertes d'herbicides dissous, ceci pour deux saisons de croissance présentant des conditions météorologiques différentes suite au traitement phytosanitaire.

Le système expérimental au champ est constitué de 12 parcelles (30 m x 5 m) cultivées en maïs-grain et réparties en quatre blocs aléatoires complets. Les traitements sont : un témoin sans bande, une bande enherbée (5 m) et une bande enherbée+arborée de 5 m (E+A). Les herbicides étudiés sont l'atrazine, le métolachlore et le dééthylatrazine (DEA). L'eau ruisselée a été récoltée lors des saisons de croissance en 2004 et 2005. En 2004, les événements pluviaux ont eut lieu dans une courte période suivant l'application soit aux jours 1, 2 et 8 après l'application. Ces événements étaient respectivement de 15 mm, 15 mm et 45 mm. En 2005, les événements ont eu lieu assez tardivement après l'application soit aux jours 20, 24 et 27. Ces événements étaient respectivement de 40 mm, 19 mm et 29 mm. Le tableau 1 indique les masses moyennes en herbicides lors des trois premiers événements pluviaux survenus après l'application.

Tableau 1. Masses exportées en herbicides (μg) dans l'eau ruisselée lors des deux années d'étude

| | | 2004 | | | 2005 | | |
|-------------|---------|----------|--------------|------|----------|--------------|-----|
| | | Atrazine | Métolachlore | DEA | Atrazine | Métolachlore | DEA |
| Événement 1 | Témoin | 3591277 | 829975 | 925 | 440 | 977 | 38 |
| | Enherbé | 97924 | 277135 | 316 | - | - | - |
| | E+A | 82216 | 228618 | 262 | - | - | - |
| Événement 2 | Témoin | 83708 | 298802 | 1364 | 2259 | 5180 | 262 |
| | Enherbé | 16369 | 53891 | 354 | - | - | - |
| | E+A | 7632 | 26777 | 164 | 0,8 | - | 0,5 |
| Événement 3 | Témoin | 79644 | 113018 | 2298 | 3809 | 9631 | 701 |
| | Enherbé | 19432 | 29155 | 741 | 1,0 | - | 0,3 |
| | E+A | 13710 | 27971 | 520 | 1,0 | - | 0,6 |

Les deux types de bandes végétales étudiées présentent des efficacités similaires. Un intervalle de temps plus long entre les premiers événements pluviaux et l'application réduit les exportations d'herbicides.

Improvement of water use efficiency and yield of greenhouse tomato using matrix potential sensors

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Mots clés : substrats, irrigation, tomate de serre, greenhouse tomato, substrates, irrigation

Depuis nombre d'années, les contraintes environnementales et économiques ont forcé les producteurs de tomates de serres à rechercher de nouveaux substrats pour remplacer la laine de roche. On a proposé des mélanges de sciure de bois et de tourbe en remplacement à la laine de roche, avec toutefois des rendements généralement inférieurs, liés sans doute aux problèmes d'irrigation et d'aération. Le développement récent de tensiomètres de haute précision fournit une occasion de raffiner cette stratégie d'irrigation. L'objectif de cette étude était d'étudier la zone du confort hydrique de la tomate de serre en croissance active pour définir des consignes appropriées d'irrigation et d'employer celles-ci pour conduire des essais comparatifs sciure tourbe et laine de roche. Avec des consignes appropriées, un mélange sciure/tourbe à 2 : 1 sciure (v/v) a permis des augmentations totales de rendement par substrat de 10.5 % et de 10.3 % respectivement en comparaison avec la laine de roche, sans diminution de qualité de tomate. Par conséquent, une stratégie adaptée d'irrigation a pu permettre aux producteurs d'employer un milieu de culture durable, meilleur marché que la laine de roche tout en augmentant leur rendements et performances économiques.

Environmental and economical constraints have forced growers to look for new substrates for replacing rockwool in greenhouse tomato production. A new type of peat sawdust mix has recently been proposed as an alternative to rockwool, with a need though to develop an appropriate irrigation strategy. The objective of this study was to investigate the zone of hydric comfort of actively growing tomato plant to define appropriate irrigation setups and then to use these setups to grow tomato in comparison with rockwool. Defining new setups appropriate to 2 : 1 (v/v) sawdust:peat substrate and maintaining them using wireless accurate tensiometers allowed total and marketable yield increases of 10.5 % and 10.3 % respectively in comparison with rockwool, without tomato quality decrease. Hence, an adapted irrigation strategy could allow growers to use a sustainable growing media, cheaper than rockwool while increasing their yield and economical performances.

Estimation de l'eau mobile immobile dans les milieux artificiels : efficacité du lessivage

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Mots clés: substrats, irrigation, tomate de serre, transport des solutés

Keywords: greenhouse tomato, substrates, mobile immobile water, solute transport

La production de tomate de serre est importante dans l'économie canadienne et les volumes consommés augmentent régulièrement d'année en année. Cette production se fait de plus en plus en milieu organique (fibre de coco, sciure, tourbe, compost). Des travaux de recherche sont en cours pour développer de nouveaux substrats à base de mélange sciure/tourbe et une régie de culture qui lui soit approprié. Ces milieux ont cependant la tendance à accumuler des sels et la mise au point d'une stratégie d'irrigation compatible avec ces nouveaux milieux requiert qu'on comprenne bien la dynamique de lessivage des sels lors de l'irrigation. A priori, ces substrats contiennent une phase d'eau mobile et une immobile, résultats de la présence de structures végétales mortes (hydrocystes et structures de vaisseaux ligneux). Une série d'expériences a été conduite en conditions non saturées et en régime permanent pour évaluer le transport du NaCl durant le lessivage et quantifier la proportion d'eau immobile, de même que le transfert entre les zones mobiles et immobiles. Les résultats démontrent que la proportion d'eau immobile est très importante dans ces sols et que les échanges entre les zones mobile et immobile sont extrêmement lents, en accord avec des conclusions obtenues dans les transferts gazeux.

Relation entre le pH et le rapport $(P/Al)_{M3}$ de quelques sols sablonneux amendés avec de la chaux

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L'indice de saturation en phosphore, représenté par le rapport $(P/Al)_{M3}$, est généralement considéré comme un outil efficace dans la gestion agro-environnementale de la fertilisation phosphatée des sols agricoles. Toutefois, l'effet du chaulage sur le rapport $(P/Al)_{M3}$ des sols sablonneux est peu documenté. Un essai en laboratoire a été mené pour déterminer l'effet de la chaux sur les niveaux de P_{M3} , Al_{M3} et Ca_{M3} , ainsi que sur le rapport $(P/Al)_{M3}$ dans le cas de 34 sols sablonneux. Cent grammes (100g) de sols ont été placés en duplicata dans des pots en plastique puis chaulés avec du carbonate de calcium ($CaCO_3$), à des taux oscillant entre 0 à 7,5 tonnes ha^{-1} . Après trois (3) mois d'incubation à la température de la pièce, les échantillons de sol ont été séchés à l'air et analysés pour le pH et les éléments P_{M3} , Al_{M3} et Ca_{M3} . Les résultats obtenus montrent que les extraits Ca_{M3} et Al_{M3} ont été les plus significativement influencés par les doses de chaux. Les quantités de Al_{M3} ont diminué avec les doses croissantes de chaux. Les valeurs de Al_{M3} ont été négativement corrélées avec celles du pH. En général, la variation de P_{M3} en fonction du pH (4 à 7) était peu évidente, et par conséquent, la variation du rapport $(P/Al)_{M3}$ n'était pas uniforme pour l'ensemble des sols sélectionnés. En conclusion, la relation entre le pH et le rapport $(P/Al)_{M3}$ semble être une caractéristique propre à chaque sol ou à un certain groupe de sols.

Évaluation de la CEC des sols minéraux acides par la somme des bases extraites par Mehlich III et par la baisse du pH tampon SMP : une approche nouvelle

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La CEC (capacité d'échange cationique) est un bon indice de la fertilité des sols. Il existe plusieurs méthodes, directes et indirectes, pour la déterminer, au pH du sol ou à un pH de 7, qui sont plus ou moins longues à faire. Il serait donc avantageux de pouvoir estimer, assez précisément, la CEC des sols minéraux à l'aide de résultats analytiques obtenus nécessairement par ailleurs. Au Québec on a la possibilité de faire cela avec les bases extraites par Mehlich III et avec la mesure de l'acidité échangeable obtenue par la baisse de pH du tampon SMP, nécessaire à l'établissement du besoin en chaux des sols acides. La relation de la CEC en fonction des bases échangeables et de l'acidité d'échange s'écrit: $CEC = \text{acidité titrable} + \Sigma \text{ bases échangeables (Ca, K, Mg)}$, les unités étant toutes en méq/100g ou cmole kg^{-1} .

Le guide de référence en fertilisation du CRAAQ, et les publications antérieures des Engrais chimiques du Québec et du CPVQ, donnent une relation erronée par rapport à l'acidité échangeable. C'est cette correction à laquelle on s'est intéressé. La baisse du pH de la solution SMP, c'est-à-dire $\Delta \text{pH} = \text{pH initial du tampon} - \text{pH de la solution d'équilibre}$, $\Delta \text{pH} = 7,5 - \text{pH de la solution d'équilibre SMP}$. Van Lierop et Tran (1983) ont précisément titré la solution SMP avec un acide (HCl 0,01 N) pour trouver l'acidité titrable. La courbe d'équivalence est une polynomiale de degré trois avec un coefficient de corrélation de 0,9995. Si on appelle x le ΔpH , la relation pour la CEC est : $CEC = (-0,8844x^3 + 5,6329x^2 - 1,1149x) + \Sigma \text{ bases échangeables-MehlichIII}$ en méq/100g ou cmole/kg.

Désorption du cuivre de résidus miniers amendés par deux matériaux organiques.

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Mots clés: Résidus de citron, Mycorhize, *Glomus intraradices*, Amendement organique.

Les effets bénéfiques d'amendements biologiques ou organiques sur l'amélioration de la fertilité de résidus miniers sont bien connus. Par contre, peu d'études se sont attardées à évaluer l'effet de ces amendements sur la disponibilité du cuivre (Cu) dans les résidus miniers riches en cuivre et en calcium. L'objectif principal de cette étude est d'évaluer l'effet de deux matériaux organiques sur la libération du cuivre (Cu) d'un résidu minier de cuivre (RM). Le protocole expérimental comprenait un essai d'incubation en conditions contrôlées de température et d'humidité avec aération périodique. Deux matériaux organiques ont été choisis, soit un substrat potager commercial contenant sept propagules actives de *Glomus intraradices*/g (SP) et un substrat acide composé d'épluchures de citron séchées et broyées (RC). Des échantillons de 500 g de RM ont été amendés avec quatre doses de SP (0, 1,25%, 5% et 10%) et deux doses de RC (0 et 10%). Les traitements ont été répartis aléatoirement à l'intérieur de trois blocs. Le cuivre dans les substrats a été fractionné (Asami et al., 1990) en 4 fractions : soluble + échangeable (Cu_{ECH}), liée au carbonate (ou spécifiquement adsorbé) (Cu_{CAR}), liée à la matière organique (Cu_{ORG}), et forme résiduelle (Cu_{RES}). Les résultats obtenus montrent qu'en général, les quantités de Cu_{ECH} , de Cu_{CAR} et de Cu_{ORG} sont plus élevées dans le cas du RM amendé avec le SP par rapport à celles extraites du RM amendé avec le RC. Après 8 semaines d'incubation, les quantités de Cu extraites ont augmenté dans l'ordre suivant : $Cu_{RES} > Cu_{CAR} > Cu_{ORG} > Cu_{ECH}$. L'effet des doses de RC sur les quantités de Cu extractibles était très hautement significatif ($P < 0,001$) par rapport au RM témoin. L'apport de RC a tendance à augmenter les quantités de Cu_{RES} des substrats. De plus, les doses croissantes de SP ont influencé le contenu en Cu_{CAR} , Cu_{ORG} et Cu_{RES} des substrats. Toutefois, cet effet était beaucoup moins marqué que celui du RC. Finalement, l'interaction entre les deux amendements était très hautement significative sur les quantités de Cu_{ORG} . Les résultats de cette étude ont permis de démontrer que l'indice de disponibilité du Cu des substrats miniers est significativement affecté par la dose d'amendements organiques.

Nitrification and immobilization of ammonium in cold soils after application of ¹⁵N-enriched pig slurry

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Keywords: nitrogen cycle, cold soils, nitrogen-15, immobilization, nitrification.

The spreading of pig slurry in the fall is a common practice in Canada. It is often believed that decomposition and N transformations are negligible in soils at temperatures below 5 °C, and that slurry nitrogen therefore remains in the soil and is available for plants the following spring. However, some studies have shown that communities of nitrifying bacteria in the soil may be able to acclimatize to cold conditions (Anderson et al. 1971; Cookson et al. 2002) and that microbial activities, such as respiration and denitrification, continue in soils under snow cover (Chantigny et al. 2002).

The objective of the present study was to examine transformations of slurry ammonium applied to soil at low temperatures. A St-André loam and a Kamouraska clay were amended with ¹⁵N enriched pig slurry (55 kg NH₄⁺-N ha⁻¹), alone or with wheat straw (10 Mg ha⁻¹ dry matter). Soils were incubated at one of five constant temperatures (-6, -2, 2, 6 and 10 °C). Concentrations of NO₃⁻, NH₄⁺, and microbial biomass N (MBN), and the ¹⁵N in each of these fractions, were measured in order to determine whether nitrification and immobilization of slurry nitrogen occurred in soil as a function of incubation temperature.

A decrease in NH₄⁺ and ¹⁵NH₄⁺ occurred in slurry-amended soils incubated at temperatures of -2 °C or higher. At the same time, concentrations of NO₃⁻ and ¹⁵NO₃⁻ increased in amended soils, indicating that nitrification occurred in both soil and slurry N at temperatures as low as -2 °C. Straw incorporation caused an immobilization of N in clay and loam soils at 2 °C and above, as seen by a significant decrease in the soil mineral N concentration. This effect was not observed at -2 or -6 °C, suggesting that N immobilization was limited below the freezing point. The size of the soil MBN pool was not significantly affected by temperature. However, the presence of ¹⁵N (up to 30% of total MBN) in the microbial biomass indicated that an assimilation of slurry N occurred across soils and temperatures.

This study confirms that pig slurry NH₄⁺ can be nitrified at low temperatures, indicating a risk of nitrate loss by leaching or denitrification during the winter for fall-applied slurry N. Conversely, the presence of crop residues may lessen this risk by immobilizing nitrogen when soil temperature remains above the freezing point. Further studies under field conditions are required to evaluate both the risk of N loss to the environment and the mitigation potential of immobilization using crop residues.

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Leaching of Litterfall Collecting in Litterfall traps and its Impact on Forest Ecosystem Nutrient Cycling

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Keywords: Litterfall, litter trap, leaching, biogeochemical cycle.

Litterfall is collected to determine forest nutrient and carbon cycling, including the quantification of nutrient and carbon input. Litterfall in forest ecosystems is collected in trapping devices (litter traps), though it has been suggested that between sampling periods, usually a weekly or biweekly schedule during autumn, the litter is exposed to early stages of leaching and decay. Opportunity exists for litterfall to undergo leaching while in litter traps as a result of being exposed to changing environmental conditions including wetting and drying, and freezing and thawing, in addition to microbial activity (Barlocher, 1992). Leaching by precipitation is a substantial part of the mass lost from leaf litter in early stages of decomposition (Taylor and Parkinson, 1988). As well, microbial activity can contribute to large losses in litter weight (Tietema and Wessel, 1994). Thus, litterfall studies may inaccurately determine the nutrient content of abscised leaves, and thus nutrient input to the soil. The objective of this study is to quantify the change in weight and nutrient content of *Tsuga Canadensis*, *Tilia Americana*, *Acer saccharum*, *Thuja occidentalis*, and *Carpinus caroliniana* leaves as a result of leaching by exposing leaves to different levels of precipitation in a laboratory setting. In the field, a litterfall trap experiment will be set up to quantify and compare litter weight and nutrient changes, in addition to evaluating changes in microbial activity. Preliminary results have shown that the nutrient content and dry weight of the leaves are significantly lower ($p < 0.05$) in the naturally abscised leaves after the leaching experiment as compared to the leaves before the experiment. As well, fresh leaves exposed to 21mm of deionized water exhibited a significant ($p < 0.05$) weight loss where as treatments exposed to 49 mm and 62 mm exhibited an increase in weight and nutrient content. These latter treatments may be influenced by microbial action, a hypothesis corroborated by the measured decrease in carbon content of the leaves post treatment. The microbes may be utilizing the carbon as an energy source resulting in an increase in weight and a decrease in the carbon content.

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National Indicators of Risk of Water Contamination by Agriculture: Preferential Flow Component

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Keywords: Macropore flow, finger flow, lateral flow, agri-chemicals, contamination.

The indicators of risk of water contamination by nutrients, pathogens and agri-chemicals are important tools for assessing environmental sustainability, water contamination by agricultural activities, land management and conservation practices. Agriculture and Agri-Food Canada (AAFC) has initiated the National Agri-Environmental Health Analysis and Reporting Program (NAHARP) to address various environmental policy needs by developing agri-environmental indicators (AEIs). Among these AEIs, four of them are indicators of risk of water contamination (IROWCs) by nitrogen (IROWC-N), phosphorus (IROWC-P), pathogens (IROWC-Path) and pesticides (IROWC-Pest). These indicators are designed to classify different area entities such as watersheds and Soil Landscape of Canada (SLC) polygons (scale 1:1,000,000) within five risk classes (very low, low, medium, high and very high) for residual N, P, pathogens and pesticides transport to surface water bodies. The indicators must respond to soil and climate characteristics and changes in agricultural management practices.

The IROWCs Common component is the *transport-hydrology*, which connects the main contaminant transport processes such as soil water erosion, surface runoff, and infiltration to the hydrologic network. Water and solutes may bypass a significant portion of the soil matrix by flowing through macropores such as earthworm burrows, desiccation cracks and root channels. Flow instability, manifested most often at soil layer boundaries (finer layer over coarser layer), may concentrate water and solute flow in fingers within the soil matrix. If infiltrating water and solutes encounter sloping low permeability layers, lateral flow may occur eventually leading to vertical finger development. Bypassing the soil matrix prevents the contaminants to mingle with matrix solution and minimizes retention time, which is necessary for surface exchange, catalysis reaction and biodegradation. The objectives of this study are to develop the macropore flow (MF), finger flow (FF), and lateral flow (LF) sub-components of the IROWCs *transport-hydrology* component, and to predict the potential risk of preferential (MF, FF, and LF) contaminant transport for all SLC polygons of Canada. Major input parameters needed to build the sub-components are soil texture and layering, presence of restricting layer, slope, tile drainage, precipitation, crop type and surface area, tillage, water infiltration, surface runoff, and contaminant sorption coefficient. Most of these input parameters are available through Census of Agriculture, CanSIS, Environment Canada, pedological surveys and reports, and pesticide registration data. The theoretical considerations, outcomes and limitations of the MF, FF, and LF sub-components will be discussed.

Effect of freeze-drying on soil aggregate stability

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Keywords: freeze-drying, freeze-thaw, aggregate stability.

The freeze-drying process is generally reported as having a destructive effect in terms of the structural stability of soil aggregates (e.g., Lincoln and Tettenhorst, 1971; de Jong and Kachanoski, 1988; Staricka and Benoit, 1995).

Hand sieved aggregates of between 1 - 2 mm in diameter from three soils of varying clay content (a sandy loam, a clay loam, and a clay) and water content (0.10 kg kg⁻¹, 0.20 kg kg⁻¹ or 0.30 kg kg⁻¹) were subjected to three treatments, including not frozen (control), freeze-thaw and freeze-dry.

The freeze-thaw treatment involved freezing at -15°C for 12 hr and thawing at +15°C for 12 hr. The freeze-dry treatment involved overnight freezing at -15°C followed by further freezing at -60°C and slow thawing to room temperature under vacuum to facilitate sublimation.

Aggregate stability was measured at two levels via the wet aggregate stability (WAS) and the amount of dispersible clay (DC) liberated from the sample following treatment by the methods outlined by Pojasok and Kay (1990).

The freeze-thaw treatment was typically destructive in nature as measured by a reduction in WAS and an increase in DC over control samples. Contrary to both experimental results and anecdotal field evidence reported in the literature, suggesting that freeze-drying is a more destructive process in terms of aggregate stability, the freeze-dry treatment resulted in greater aggregate stability as shown by greater WAS, but also greater DC, after freeze-drying than for control samples.

The desiccation of the aggregates by ice crystal growth within inter-aggregate pore spaces, in conjunction with the extremely dry state of the aggregates following freeze-drying, resulted in a hydrophobic state that resisted overall aggregate breakdown during stability testing as reflected in increased WAS. Aggregate deterioration as recorded by DC values were higher than expected (given the elevated values of WAS) as a result of surface wetting during stability measurement promoting the sloughing off of surficial clay particles while the aggregates as a whole maintained their overall integrity as a result of their dryness and hydrophobic state.

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Nitrogen-fixing community profiles determined by PCR-DGGE: differences and similarities between southern Vancouver Island old-growth, mature, and variable retention Douglas-fir stands.

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Keywords: forest soil, *nifH*, PCR-DGGE, genotype profile

Soil microorganisms are key participants in nutrient generation and recycling processes and consequently, forest productivity. Identification and characterization of soil microbes is difficult as most are unculturable using current technology. However, microbial genotypes present within a soil sample can be profiled using denaturing gradient gel electrophoresis (DGGE), which separates polymorphic fragments generated by polymerase chain reaction (PCR) amplification of a particular gene of interest from soil-extracted DNA. Specific gene-fragments amplified from soil-extracted DNA and separated by DGGE represent potentially functional genotypes. We have used nested PCR amplification, DGGE, with subsequent band sequencing, to assess nitrogenase (*nif H*) genotypes. We have compared *nifH* genotype profiles of forest soils under different-aged stands of Douglas-fir (old growth, mature, and variable retention LOGs plots) present on southern Vancouver Island. Preliminary results suggest that *nifH* sequences retrieved by a nested PCR method are more closely related (yet different) to uncultured *nifH* forest clones described in other forest soils. We are currently assessing how different the *nifH* sequences are from each of the various-aged stands.

(RETIRÉ / WITHDRAWN)

Determination of sorption thermodynamic parameters of zinc and copper in some calcareous soils of western Iran

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Keywords: Sorption; Thermodynamic; Free energy; Enthalpy; Entropy

The bioavailability and ultimate fate of heavy metals in the environment are controlled by chemical sorption (Serrano et al., 2005). To gain further insight into sorption process and its mechanism, thermodynamic approach can predict the final state of metal in the soil system from an initial nonequilibrium state (Jurinak and Bauer, 1956; Sposito, 1984).

The thermodynamic parameters: thermodynamic equilibrium constant (K°), standard free energy (ΔG°), standard enthalpy (ΔH°) and standard entropy (ΔS°) were determined by using sorption data at two different temperatures 25 ± 1 and 45 ± 1 °C of soil suspension (Adhikari and Singh, 2003). The results indicate that value of K° increased with increase in temperature from 25 to 45 °C in all the soils. The ΔG° values both for Zn and Cu were negative. The ΔG° at 25°C for Zn and Cu ranged from -16.64 to -7.00 and -22.42 to -18.39 kJ mol⁻¹ respectively. The ΔG° at 45°C for Zn and Cu ranged from -41.93 to -14.59 and -26.91 to -20.80 kJ mol⁻¹ respectively. The negative values of ΔG° both for Zn and Cu indicated that both the reactions are spontaneous. The values of ΔH° for Zn and Cu sorption were positive and ranged from 357.47 to 74.02 and 68.65 to 10.33 kJ mol⁻¹ respectively. This provides an indication that sorption reaction was endothermic for both Zn and Cu. The values of ΔS° for Zn and Cu were positive and ranged from 1255.97 to 281.79 and 346.66 to 109.91 J mol⁻¹ K⁻¹ respectively. Thus, higher ΔS° values for Zn was found to be indicative of more disorder in the Zn sorption process than Cu.

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Sorption characteristics of zinc and copper in some calcareous soils of western Iran

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Keywords: Sorption; Calcareous soils; Heavy metal; Isotherm

Adsorption is one of the most important chemical processes in soils. It determines the quantity of plant nutrients and affects transport of nutrients and contaminants in soils (stumm, 1992; sparks, 1995). For proper evaluation of the environmental threat posed by Cu and Zinc, or of their availability, it is necessary to supplement the individual sorption characteristics (Arias et al., 2006).

To study the sorption of heavy metals, 0.5 g soil samples were equilibrated at 25±1 °C with 25 ml of 0.01 M CaCl₂ containing 0 to 60 mgL⁻¹ Zn or Cu as ZnSO₄ or CuSO₄. After equilibration time, suspension was centrifuged, filtered and concentration of Zn and Cu in clear extract solution was determined and then heavy metals sorbed were calculated. The results showed that the data of Zn sorption could be described satisfactorily by Freundlich and Langmuir isotherms, that the Freundlich equation gave better fit ($R^2 = 0.92-0.99$) than Langmuir equation ($R^2 = 0.81-0.92$). Data of Cu sorption could be described satisfactorily by Freundlich isotherm ($R^2 = 0.74-0.99$), however did not described by Langmuir equation. Langmuir adsorption maxima (b) for Zn ranged from 625 to 1250 mg kg⁻¹, and the bonding energy (k) for Zn ranged from 0.941 to 11.482 L mg⁻¹. The values for k_f (Freundlich constant) were 225.53 to 1121.50 for Zn and 798.18 to 27567.67 for Cu, which indicate that the sorption capacity for Cu was higher than Zn. In Freundlich equation 1/n which indicate the adsorption intensity of the soils, for Zn and Cu ranged from 0.2551 to 0.5106 and 0.8555 to 1.5091, respectively. The high values of 1/n for Cu indicate that adsorption intensity for Cu is higher than Zn in all the soils.

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Spatial and temporal variation in N₂O emissions, denitrification and denitrifier population dynamics under potato production

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Keywords: nitrous oxide emissions, denitrification, denitrifier population dynamics, potato

Nitrous oxide (N₂O) is the most important greenhouse gas from agricultural crop production and, in humid environments, is associated primarily with the process of denitrification. In recent years there has been considerable effort invested in understanding the magnitude of, and controlling factors for, N₂O emissions. However, there is limited information on denitrifier population dynamics within agricultural soils. This study quantified spatial and temporal variation in denitrifier population dynamics in a podzolic soil cropped to potato. Soil samples were collected on ten sampling dates from early spring to late fall, and for different row locations (rhizosphere, bulk soil in potato hill and furrow) during the crop growth period. Quantification of bacterial populations was done using real time-PCR using primers designed to target narrow (using the *cnorB* gene, which encodes nitric oxide reductase, of *Pseudomonas mandelii*, a dominant culturable denitrifier isolated from the field site) and broad (using the *nosZ* gene which encodes nitrous oxide reductase) segments of the soil denitrifier population and total bacterial populations (using the 16S gene). Denitrification rate (acetylene-blockage method) and N₂O emissions (static chamber method) were measured in the potato hill and furrow on each sampling date. Unusually high rainfall early in the crop growth period resulted in high rates of N₂O emissions and denitrification in the potato hills after planting when soil NO₃ availability was high. In the furrow, wetter soil conditions resulted in greater total denitrification, whereas lower soil NO₃ availability resulted in lower N₂O emissions because denitrification was going to completion, compared with the potato hill. Total bacterial populations were relatively stable over the sampling period under these moist soil conditions. The number of gene copies of the *Pseudomonas mandelii* *cnorB* gene was generally higher in the potato hill than in the furrow, and higher in the rhizosphere soil than in the bulk soil in the potato hill.

Validation of the Indicator of Risk of Water Contamination by Phosphorus for Quebec Agricultural Watersheds

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An indicator of risk of water contamination by phosphorus (IROWC_P) was developed and calculated for Quebec Province Soil Landscape of Canada (SLC) polygons having more than 5% of agricultural land using Census of Agriculture (CoA) data of 1981, 1986, 1991, 1996 and 2001. Since its application, major changes have been made to improve the IROWC_P. P source and transport factors are now multiplicative rather than additive. Moreover, additional hydrological processes that are significant in various Canadian agro-ecosystems have been integrated in a transport-hydrology component. The new transport-hydrology component includes both particulate and dissolved P transport processes (erosion, surface runoff and infiltration) as well as other factors accounting for hydrological connectivity between P sources and water bodies (topographic index, tile drainage, surface drainage and preferential flow).

The updated IROWC_P represents the first estimation of the improved indicator and requires more modification, testing and evaluation at different scales both for source and transport components. In this study, methodology and first results of the IROWC_P testing and evaluation, considering the Quebec province case study, were presented. The main objective of this work was to calibrate and validate the IROWC_P transport-hydrology component (PT_H). This was performed by adjusting the weighting and rating values for each sub-component to obtain a final PT_H algorithm by which the predicted risk of P loss better fits to water P concentrations measured at the watershed outlet in humid region of Canada. Total P values measured at outlets of 16 agricultural watersheds in the province of Quebec (Canada) were used for the Census years 1981, 1986, 1991, 1996 and 2001. The PT_H adaptation to different Canadian regional conditions will be discussed.

Croissance du maïs dans un résidu minier légèrement alcalin amendé par de la tourbe de sphaigne

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Mots clés: amendement organique, cuivre, métal lourd.

Dans une perspective de développement durable, la valorisation de la tourbe acide peut constituer une pratique intéressante pour amender les résidus miniers neutres à légèrement alcalins. L'objectif principal de cette étude est d'évaluer l'effet à court terme de la combinaison d'une tourbe de sphaigne acide et d'un engrais minéral (NPK) sur la croissance du maïs (*Zea mays* L.) cultivé en serre dans un résidu minier de cuivre. Un dispositif en bloc complet aléatoire avec deux répétitions a été utilisé. Le maïs a poussé durant 35 jours après l'émergence. Après la récolte, les valeurs moyennes de pH variaient entre 6,30 et 7,88. Les résultats statistiques ont révélé un effet simple linéaire très hautement significatif ($P < 0,001$) des doses de tourbe (0, 5, 10 et 15%) sur le rendement en matière sèche du maïs ainsi que sur l'accumulation du Cu dans la biomasse aérienne. De façon générale, l'addition de la fumure minérale à la tourbe diminue significativement ($P < 0,05$) le rendement tout en augmentant légèrement la teneur en Cu de la biomasse aérienne de la plante. Les doses de tourbe ont tendance à abaisser le pH des substrats. Les données statistiques concernant les régressions simples ont révélé des corrélations significatives entre le contenu en matière organique (MO) des substrats et les teneurs en Cu des racines et des tiges. De plus, le rendement des parties aériennes du maïs était significativement corrélé avec le pH et la MO des substrats. Les résultats de cette étude suggèrent que la tourbe peut être utilisée comme amendement organique lors de la mise en végétation de résidus miniers riche en Cu.

Mesures de teneur en eau par TDR: Calibrations adaptées aux substrats organiques

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Mots clés: time domain reflectometry, water content, growing media.

La réflectométrie métallique (TDR) est devenue une méthode standard pour la détermination de la teneur en eau dans les sols minéraux et les substrats organiques. La validité de cette méthode est principalement dépendante de l'équation utilisée afin de convertir la constante diélectrique (K_a) mesurée en teneur en eau volumique (θ_v). Dans les sols minéraux, l'équation de Topp et al. (1980) est reconnue, mais s'avère inapplicable pour les substrats organiques en raison des quantités importantes d'eau liée qui influencent la relation K_a - θ_v . Au cours des quinze dernières années, plusieurs auteurs ont proposé des équations spécifiques aux substrats organiques (Paquet et al., 1993; Anisko et al., 1994; da Silva et al., 1998; Caron et al., 2002; Nemati et al., 2005). Malgré les efforts pour développer un modèle unique adapté aux substrats organiques, un tel modèle n'existe toujours pas. Ces auteurs ont démontré l'impact majeur de la composition du substrat sur la relation K_a - θ_v . Ainsi, pour obtenir des valeurs absolues de teneurs en eau fiables, des équations spécifiques aux différentes formulations devraient être développées. Afin de réduire le nombre d'équations, des équations intégrant la proportion des composantes des substrats ont été proposées (Morel et Michel, 2004). Outre la composition du substrat, la relation K_a - θ_v semble dépendante du système TDR utilisé lors de la calibration. L'objectif de cette étude est donc de démontrer l'importance d'utiliser une équation de calibration adaptée à la composition du substrat de culture. L'impact du système TDR utilisé, sur la relation K_a - θ_v , sera également discuté. En effet, pour un même type de substrat, des différences de teneur en eau pouvant dépasser $0,20 \text{ m}^3 \cdot \text{m}^{-3}$ ont été obtenues pour une même valeur de constante diélectrique selon la procédure de calibration et le système TDR utilisés.

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L'utilisation de données LIDAR et d'images multispectrales pour appuyer le diagnostic et l'aménagement hydro-agricole: le cas du bassin versant du ruisseau Ewing, localisé en Montérégie Est, Québec

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La cartographie haute précision du relief et la modélisation des parcours du ruissellement demeure l'outil idéal pour diagnostiquer les zones problématiques et planifier sur mesure les aménagements hydro-agricoles les plus appropriés. Le recours systématique à des capteurs au sol, ou *embarqués*, demeure cependant difficilement envisageable à grande échelle en raison des coûts et des courtes fenêtres de temps propices à la circulation au champ en VTT. Le capteur aéroporté LIDAR (*Light Detection And Ranging*) constitue cependant une alternative intéressante aux capteurs embarqués dans l'acquisition de données topographiques de haute précision. L'acquisition de tels relevés permet notamment de (1) systématiser le diagnostic d'égouttement du parcellaire ; (2) identifier les zones de concentration du ruissellement responsables de la majeure partie des exportations de sédiments et d'éléments nutritifs ; (3) subdiviser les parcelles agricoles en unités de sols homogènes requérant les mêmes besoins en termes de nutriments et d'aménagement ainsi que de (4) supporter la conception de travaux d'aménagement des terres, des zones riveraines et des cours d'eau. C'est précisément dans cette optique que le projet *Gestion Raisonnée et Intégrée des Sols et de l'Eau (GRISE)* a été élaboré. Conséquemment en mai 2006, le LIDAR *ALTM 2050* de la compagnie québécoise *Lasermap Image Plus* a survolé, à une altitude de 1200 mètres, un territoire de 60 km² dans le bassin versant de la Rivière aux Brochets. D'une durée de 3 heures, ce survol a permis d'acquérir plus de 175 millions de points altimétriques (soit 2 points/m²) d'une précision variant entre 5 et 15 centimètres en élévation. Un second survol à une altitude de 2000 mètres a permis d'acquérir plus de 420 images numériques multispectrales d'une résolution spatiale de 66 cm à l'aide de la caméra Duncan appartenant à l'ITA de La Pocatière. Celles-ci ont été orthorectifiées et corrigées au niveau radiométrique à l'aide de 5 panneaux dont les réflectances (4, 8, 16, 32 et 64%) étaient connues lors du survol aéroporté.

Suite à l'interpolation spatiale des données altimétriques LIDAR, l'analyse du modèle numérique d'altitude a permis de dériver les patrons d'écoulement de l'eau, les dépressions, les sous-bassins, les pentes et divers indices topographiques. Ces indicateurs permettent notamment d'identifier les secteurs de concentration des eaux de ruissellement pouvant favoriser l'exportation d'importantes quantités de sol et de contaminants. Une cartographie des risques relatifs d'érosion et de pollution diffuse, basée sur les attributs biophysiques des sous-bassins de l'ensemble de parcellaire, permet également d'établir des priorités d'interventions sur le territoire étudié. Enfin, la classification non-supervisée de la mosaïque d'images multispectrales orthorectifiées complète le diagnostic en dressant une représentation des conditions d'égouttement des sols prévalant à la fin du mois de mai 2006, période qui fut particulièrement pluvieuse.

Développement d'une méthode de détermination de la présence de pesticides dans l'eau souterraine basée sur des indicateurs physico-chimiques

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Mots clés: Contamination, eau souterraine, pesticides, indicateurs chimiques, apprentissage automatique

En milieu rural, la majorité de la population est alimentée par des puits privés. Dans un souci de santé publique il est nécessaire de prévoir les risques de contamination de l'eau souterraine par les pesticides agricoles. Cependant les mécanismes de transfert des pesticides à travers les sols sont complexes et résultent de l'interaction d'un grand nombre de processus et de facteurs. La prévision de la contamination potentielle des aquifères requiert donc une connaissance détaillée des sols, du milieu physique, des travaux culturaux, du régime pluviométrique ainsi que des propriétés des composés utilisés, ce qui devient très difficile à appréhender à une échelle régionale. Une telle prévision est souvent réalisée à l'aide de la modélisation prédictive du transport des composés à travers la zone non saturée du sol.

Dans cette étude, nous avons décidé de procéder par une méthode inverse et de chercher directement dans l'eau souterraine des indicateurs nous permettant de prédire la présence potentielle de pesticides. Plusieurs études ont en effet montré des corrélations entre la détection de pesticides et certains paramètres, mais l'utilisation d'une combinaison de paramètres chimiques, afin de prédire la présence de pesticides, n'a pas été testée. Dans cette optique, des campagnes d'échantillonnage à l'échelle régionale ont été effectuées sur trois sites présentant des caractéristiques agro-pédologiques et climatiques différentes (au Québec et en France). Nous avons mesuré, dans près de 250 échantillons d'eau, les pesticides les plus fréquemment détectés ainsi que les paramètres chimiques communs à toute analyse routinière d'eau.

Dans un premier temps, les statistiques descriptives nous ont permis de mettre en évidence des caractéristiques chimiques similaires pour les échantillons ayant de fortes concentrations en pesticides, et ainsi de sélectionner cinq indicateurs (nitrates, chlorures, sulfates, carbone organique dissous et conductivité électrique). En effet, pour chacun des trois sites, ces cinq paramètres chimiques présentaient des concentrations significativement différentes entre les échantillons avec et sans détection de pesticides.

Dans un second temps, les cinq indicateurs ont été utilisés comme entrée de modèles statistiques à apprentissage automatique. Pendant la phase d'apprentissage, ces modèles utilisent les données connues pour approximer une fonction entre des entrées et une classification de sortie (détection vs non détection des pesticides). Une fois cette fonction établie, le modèle la teste sur des données nouvelles afin d'évaluer sa performance. Le réseau utilisé dans notre cas nous permet de déterminer correctement la détection de pesticides agricoles dans environ 80% des échantillons d'eau aussi bien sur les données d'apprentissage que sur les données de validation.

Cette méthode, qui n'utilise que les données classiques des analyses chimiques courantes, pourrait permettre d'améliorer sensiblement les campagnes d'échantillonnage en ne ciblant non plus de grandes zones à contrôler mais en déterminant directement les puits qui ont dans ce cas-ci 80% de risque de présenter des pesticides en concentration détectable. La méthode pourrait contribuer à l'exploitation durable de ces ressources en milieu agricole, ceci sous divers contextes pédologiques et météorologiques.

Validating the Canadian residual soil nitrogen (RSN) indicator with on-farm data

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Keywords: residual soil nitrogen, nitrate, nitrate leaching

Residual soil nitrogen (RSN) is the amount of inorganic nitrogen (N) that remains in the soil at the end of the growing season after crops have been harvested. RSN_E is an estimate of this quantity, calculated as the difference between all N inputs (fertilizer, manure-N, biological fixation, and atmospheric deposition) and all N outputs (N removed in crop harvest, N lost from ammonia volatilization and N lost from denitrification). The Canadian average RSN_E values from 1981 to 1996, estimated using the CANB model, were fairly constant with a range of 12.9 to 13.9 kg N ha⁻¹. However, RSN_E increased by 51% from 13.9 kg N ha⁻¹ in 1996 to 21.0 kg N ha⁻¹ in 2001 (Drury et al. 2007). These RSN_E values are estimates based on census data, statistics Canada data as well as published coefficients (Yang et al., 2007). However, this budget approach has to be validated to ensure that our model estimates are realistic. Hence the objective of this study was to compare estimated RSN_E values with measured RSN_M values.

Soil samples were collected from 138 farm fields in Ontario in the fall of 2005. Composite soil samples were obtained from three locations in each field at three depths (0-15 cm, 15-30 cm and 30-60 cm). The soils were sampled in fields following corn (58 fields), soybean (42 fields), winter wheat (27 fields), as well as other crops including alfalfa and hay. These 1,242 soil samples were extracted and analyzed for ammonium and nitrate content. The highest concentration of inorganic N in the soil profiles occurred in the 0-15 cm soil depth. There was good agreement between the overall predicted RSN_E value for Ontario agricultural soils (40.6 kg N ha⁻¹) versus the average measured RSN_M values (38.0 kg N ha⁻¹). The predicted RSN_E and measured RSN_M values for the soybean fields were also similar (38.0 kg N ha⁻¹ predicted vs 34.3 kg N ha⁻¹ measured), however RSN_E in the corn fields were overestimated (66.3 kg N ha⁻¹, RSN_E vs 43.6 kg N ha⁻¹, RSN_M) and the RSN_E in the winter wheat fields were underestimated (6.6 kg N ha⁻¹, RSN_E vs 36.8 kg N ha⁻¹, RSN_M) by the model. Hence additional fine tuning of the CANB model is required.

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Nitrous oxide and carbon dioxide emissions from continuous and rotational cropping of corn, soybean and winter wheat

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Keywords: crop rotation, crop residues, carbon, nitrous oxide, carbon dioxide

National estimates of nitrous oxide (N₂O) and carbon dioxide (CO₂) emissions from agricultural land are based on the type of crop grown, the form and amount of nitrogen (N) fertilizer applied, and the soil and climatic conditions under which the crop is grown. Crop rotation adds another dimension that is often overlooked, however, as the crop residue being decomposed and supplying soluble carbon and nitrogen is often from a different crop type than the crop which is currently being grown. For example corn may be planted into soil that was cropped to soybean or winter wheat (WW) in the previous year. The amount and type of residue from these previous crops can differ substantially. The type and rate of applied fertilizer and/or manure N is based on residual soil fertility (soil test) and the crop under production, but the carbon substrate supply is based on the previous crop and the root exudates from the current crop. Hence, the objective of this study was to compare N₂O and CO₂ emissions from two crop rotations (corn-soybean-WW, or corn-soybean) to the emissions from continuous cropping of corn, soybean or WW.

Averaged over 3 growing seasons, N₂O emissions were found to be 3.3 to 5 times greater from continuous corn (1.2 kg N ha⁻¹ yr⁻¹) compared to continuous WW (0.36 kg N ha⁻¹) or continuous soybean (0.24 kg N ha⁻¹). This was due in part to higher N levels in the soil resulting from the greater fertilizer N application for corn (170 kg N ha⁻¹) than for WW (83 kg N ha⁻¹) or soybean (no fertilizer N applied). When corn followed corn, the N₂O emissions were about twice as high (1.2 kg N ha⁻¹) than when corn followed soybean (0.61 kg N ha⁻¹), and about 60% greater than when corn followed WW (0.75 kg N ha⁻¹). The impact of the previous crop residue on N₂O emissions was not as evident when either soybean or WW were grown.

Continuous WW had an average of 45% greater CO₂ emissions than continuous corn, and 51% greater emissions than continuous soybean, over the 3-growing season study. In the corn phase, CO₂ emissions were greater when the previous crop was WW (5.03 t C ha⁻¹) than when the previous crop was soybean (4.20 t C ha⁻¹) or corn (3.91 t C ha⁻¹). In addition, continuous WW had greater CO₂ emissions compared to WW following soybean. Hence, WW stimulated CO₂ production both as a standing crop and as the previous crop in a rotation.

It was concluded that residues from a previous crop can have a substantial influence on soil-borne N₂O and CO₂ emissions.

Chronique d'une fonte printanière: érosion hydrique et qualité des eaux de ruissellement.

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Mots clés: parcelle agricole, fonte printanière, ruissellement, érosion hydrique, qualité des eaux

L'érosion hydrique implique des processus d'arrachement, de transport et de sédimentation des particules de sol par les forces agressives des pluies et du ruissellement. L'érosion en milieu agricole constitue une source de dégradation des sols et contribue à restreindre leur productivité. De plus, les sédiments et les nutriments transportés par le ruissellement représentent une importante source de pollution qui affectent la qualité des eaux de surface. Dans les régions nordiques, les conditions favorisant le ruissellement et l'érosion sont souvent critiques lors de la fonte des neiges. Le printemps conduit généralement aux écoulements de surface les plus importants de l'année. Des conditions climatiques particulières impliquant une combinaison de fonte et de pluies intenses sur un sol partiellement gelé conduisent à une érosion hydrique sévère. Certains hivers, les sols peuvent subir plusieurs cycles de gel-dégel. Puisque le dégel des premiers centimètres de la surface du sol a une influence directe sur l'érodabilité des sols, les processus régissant les pertes de sol et de nutriments deviennent alors très complexes. Ce projet avait comme objectif d'étudier la dynamique du ruissellement et de l'érosion hydrique pendant un épisode de fonte printanière. Un dispositif expérimental a été mis en place afin de mesurer le ruissellement journalier et les pertes de sols en provenance d'une parcelle agricole de 450 m² maintenue en sol nu. Une série d'événements de ruissellement enregistrés sur une période de 5 jours au printemps 2003 témoigne de l'influence du cycle gel-dégel journalier. L'analyse temporelle du ruissellement et de la qualité de l'eau mesurés lors d'une fonte journalière montre que le transport des matières en suspension (MES) et du phosphore (P total, P dissous) répond aux conditions météorologique, hydrologique et édaphique locales. Une mesure de la variation micro-topographique du sol situé à l'aval de la parcelle révèle la création de rigoles par les eaux de ruissellement. La comparaison granulométrique du sol de la parcelle et des sédiments transportés en suspension indique un enrichissement en particules fines érodées. Ces particules fines transportées en suspension étant essentielles à la fertilité du sol, la fonte printanière constitue donc une période critique pour le maintien d'une agriculture durable.

Utilisation du traceur isotopique ^7Be pour évaluer l'impact du travail du sol sur l'érosion hydrique

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Mots clés: érosion, travail du sol, radioéléments, modélisation

Depuis plusieurs années, l'érosion hydrique attire l'attention des scientifiques et des gestionnaires préoccupés par les problèmes de conservation des sols et de l'eau. Le besoin d'assembler des renseignements fiables sur les pertes de sol s'avère essentiel afin d'évaluer l'ampleur du problème d'érosion hydrique et d'optimiser les mesures de conservation à adopter pour assurer un développement agricole durable. L'utilisation de la technique de traçage des sédiments par le radio-isotope ^7Be (Béryllium 7 : demi-vie de 53,4 jours ; émission gamma à 477 keV) permet la quantification des taux d'érosion relatifs aux courtes périodes (saison agricole). Le but de ce projet visait à mesurer et comparer l'érosion hydrique des sols agricoles soumis à différents types de travail du sol au Canada et au Maroc. Ainsi, un suivi de l'érosion hydrique en parcelles agricoles a été effectué en 2005 et 2006 sur deux sites expérimentaux localisés au Maroc (domaine Marchouch) et au Québec (Ferme de St-Lambert-de-Lauzon). Le site marocain se composait de 18 parcelles situées sur une pente de 17% alors que le site québécois comprenait 6 parcelles aménagées sur une pente de 5%. Les parcelles du Québec avaient 31 m de longueur par 3 m de largeur alors que celles du Maroc avaient 22 m de longueur par 4 m de largeur. Le sol du site québécois est constitué d'un loam (51% sable; 39% limon; 10% argile) alors que celui du site marocain est constitué principalement d'argile (28% sable ; 24% limon et 48% argile). La précipitation moyenne annuelle est de 405 mm pour le site du Maroc alors qu'elle atteint 1000 mm pour le site du Québec. Les parcelles des deux sites ont été soumises aux labours conventionnels et aux semis-directs. Les taux d'érosion ($\text{t}\cdot\text{ha}^{-1}$) ont été calculés à partir d'un modèle de conversion qui tient compte des activités en ^7Be ($\text{Bq}\cdot\text{m}^{-2}$) mesurées dans les champs agricoles étudiés et dans les sols de référence non perturbés par le processus d'érosion. Pour le site du Maroc, les résultats obtenus sur une période de six mois (octobre-mars) démontrent que le travail en semis-direct conduisait à des taux d'érosion de 6,6 à 10,3 $\text{t}\cdot\text{ha}^{-1}$ alors que le labour conventionnel atteignait entre 8,3 et 19 $\text{t}\cdot\text{ha}^{-1}$. Pour le site du Québec, les taux d'érosion à court terme (juin-août) s'élevaient à 0,123 $\text{t}\cdot\text{ha}^{-1}$ pour le labour conventionnel, à 0,076 $\text{t}\cdot\text{ha}^{-1}$ pour le chisel et à 0,057 $\text{t}\cdot\text{ha}^{-1}$ pour le semis-direct. Ces résultats témoignent de l'efficacité du travail minimum du sol à réduire l'érosion hydrique, diminuant ainsi l'apport de sédiments contaminés vers les cours d'eau. La technique du ^7Be s'avère alors intéressante pour obtenir un diagnostic rapide de l'érosion à court terme.

Solute transport in sub-irrigated growing media

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Keywords: solute transport, substrates, irrigation, peat

New legislation to reduce the amount of fertilizer leached into the environment by horticultural growers and the need to implement water-saving irrigation systems requires an understanding of salt build-up and of nutrient cycles in order to develop efficient water-use strategies for growers. Solute transport in growing media is central to this process and it has received very little attention thus far. The objectives of this study were to determine how solutes behave in sub-irrigated growing media and to validate solute transport models for these media. A steady-state solute transport experiment was carried out with three different growing media. Bromide, K and Cu transport were monitored using solution samplers to determine the concentrations in packed columns. At the end of the experiment the columns were sliced and analyzed for the solute concentrations. Solutions of the convective dispersion equation (CDE) were found to give reliable predictions of the measured concentrations. Hydrus-1D was used to fit the solution sampler data assuming non-linear adsorption and the sliced column data were analyzed using linear adsorption. Independent adsorption isotherm results from batch experiments were mixed and the results indicate that the preferred approach is an in-situ evaluation of the transport parameters.

The estimation of the risk of water contamination by pesticides in Manitoba using the pesticide fate model PRZM.

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An Indicator of the Risk of Water Contamination by Pesticides (IROWC-Pest) is currently under development under the National Agri-Environmental Health Analysis and Reporting Program, Agriculture and Agri-Food Canada. The purpose of IROWC-Pest is to provide a measure of the risk of water contamination resulting from the application of agricultural pesticides. Although IROWC-Pest will be applied to the national scale, initial development is taking place at the provincial scale for the province of Manitoba.

The amount of pesticide expected to move from agricultural fields will depend on the amount and types of pesticides applied and their environmental fate. The pesticide fate model PRZM (Pesticide Root Zone Model), and transfer functions that relate pesticide use to crops grown are being used to estimate the mass of pesticides being transported by leaching, in surface runoff and with water-eroded soil. The soil parameters required for running PRZM are obtained from the National Soils Database. Weather data are obtained from Environment Canada. Although the PRZM analyses are conducted at the soil series level, the results are scaled up to the Soil Landscapes of Canada (SLC) polygon level for reporting pesticide movement. The risk of pesticide movement can then be mapped. For the province of Manitoba, patterns of risk of pesticide surface runoff and water erosion were closely related to the pattern of pesticide use. In contrast the risk of leaching was not closely related to the pattern of pesticide use.

Soil carbon sequestration: the potential of abandoned agricultural land in Eastern Canada

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Keywords: soil carbon, carbon storage, secondary succession

Globally, soils contain approximately twice as much carbon as the atmosphere. Therefore, any change in carbon dynamics within soils could substantially alter atmospheric CO₂ concentrations. Recovery of soil carbon following the widespread abandonment of farmland in Eastern Canada could be a significant CO₂ sink. The long-term patterns of soil carbon change and of carbon sequestered in different physical soil fractions are largely unknown. We tested the hypothesis that soil carbon increases at a steady rate for about 100 years following agricultural abandonment with similar patterns for total and labile carbon pools. We compared carbon dynamics across three common but distinct soil types in southeastern Ontario, Canada: a sandy-loam; a loam; and a clay soil. We identified chronosequence sites spanning 15 to 95 years since agricultural abandonment, as well as current agricultural fields and mature forests. Soil carbon content increased significantly and at a steady rate in all soil types between 0 and 5 cm, with a similar trend between 5 and 10 cm. There was no change over time in carbon storage in deeper soil horizons. Light fraction carbon content, determined by density fractionation, did not recover following abandonment. Our results suggest that most carbon is sequestered in association with mineral particles, rather than in a labile pool, making it relatively resistant to decomposition in the future. The average rate of carbon sequestration in the marginal agricultural soils we studied was about 10 g C m⁻² yr⁻¹ in the top 10 cm and that rate is similar for all land abandoned in the past 100 years.

Bio-disponibilité des métaux lourds suite à l'application répétée de biosolides papetiers et résidus forestiers alcalins en grandes cultures

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Mots clés: biosolides papetiers, produits chaulants, cendres de bois, métaux lourds

L'industrie forestière dispose de grandes quantités de résidus (biosolides papetiers, résidus alcalins, cendres, écorces) qui peuvent être utilisés efficacement en agriculture pour améliorer, de façon tangible et durable, la fertilité et la qualité des sols. En 2004, près de 30% de ces résidus étaient compostés ou valorisés à des fins agricoles (Environnement Québec 2004). Même si ces résidus sont soumis à des réglementations strictes sur la présence de métaux lourds (Environnement Québec 2004) et que la majorité des produits appliqués en champ respectent largement ces normes (Charbonneau et al. 2001), aucune étude n'a évalué l'impact que peut avoir l'application répétée de biosolides papetiers et résidus alcalins sur l'accumulation de métaux lourds dans le sol et les cultures. Ainsi, l'objectif de cette étude était d'évaluer l'effet de l'application répétée en post-levée de biosolides mixtes papetiers seuls ou en mélange avec des résidus alcalins sur le pH et la teneur en métaux lourds (Cu, Zn, Ni et Cd) du sol, et sur la composition minérale des cultures. L'expérience se déroule depuis 2000 sur un site loameux à Yamachiche dans la région de Trois-Rivières. De 2000 à 2002, les biosolides ont été apportés en post-levée à des taux de 0, 30 et 60 t hum. ha⁻¹. Les résidus alcalins (chaux calcique commerciale, boues de chaux, cendre de bois et deux sous-produits magnésiens) ont été appliqués séparément à un taux de 3 t hum. ha⁻¹ dans les parcelles recevant 30 t ha⁻¹ de résidus papetiers. De 2003 à 2005, les parcelles recevant les résidus de magnésium ont été remplacés par d'une part des biosolides papetiers appliqués à une dose de 90 t hum. ha⁻¹ et d'autre part par un traitement d'engrais N minéral. Du maïs-grain a été cultivé de 2000 à 2002 et une rotation haricot sec-maïs grain-soya a été appliquée de 2003 à 2005. Des analyses de sol ont été effectuées au printemps 2003 et à l'automne 2005 alors que les plantes ont été seulement analysées à l'automne 2005. Les résultats démontrent que l'application répétée de boues de chaux a produit les augmentations de pH les plus importantes, suivies par la chaux agricole. Cette augmentation de pH a eu un effet marqué, particulièrement après 6 ans d'applications, en diminuant les concentrations en aluminium Mehlich-3, et en métaux extraits au DTPA, à l'eau et par les résines d'échanges cationiques. Par contre, les teneurs des métaux extraits au Mehlich-3 et au HNO₃ ont été augmentées. Les effets sur la composition des plants de soya ont été plutôt mixtes. Ces essais se poursuivront jusqu'en 2008 avec les mêmes traitements appliqués annuellement en post-levée.

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Disponibilité à la plante et solubilité à l'eau du phosphore provenant des fractions solides de lisiers traités.

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Mots clés: phosphore, lisier traité, disponibilité, fixation de P, solubilité à l'eau.

La séparation des solides permet de réduire la charge en P de la phase liquide des lisiers. Or les procédés physiques, biologiques ou chimiques utilisés peuvent influencer la disponibilité du P dans les fractions solides. Quatre sols à capacités de fixation contrastantes ont été amendés avec huit fractions solides de lisiers puis incubés et semés en chambres de croissance afin d'évaluer la solubilité du P dans l'eau et sa disponibilité à la plante par rapport à des engrais minéraux. Cinq de ces fractions solides provenaient de lisiers de porc traités par digestion anaérobie, floculation, décantation naturelle ou séparation mécanique; un solide provenait de fumier de porc composté; deux solides provenaient de lisiers de vache décantés naturellement ou séparés mécaniquement. Un loam Tilly, un loam limoneux Tilly, un sable Ivry, et un sable Morin avaient respectivement 26, 26, 15 et 115 mg P M3/kg sol et 715, 1171, 2012 et 1781 mg Al M3/kg de sol, leur conférant des capacités de fixation de P contrastantes et corrélées à l'indice de sorption du P (PSI) de Bache et Williams (1971). Les indices de saturation en P/Al M3 de 3,7, 2,2, 0,7 et 6,6% sont aussi corrélés aux rapports P/Al+Fe extrait à l'oxalate d'ammonium. Les sols ont été fertilisés avec les fractions solides de lisiers à raison de 50 mg P/kg sol. Un traitement d'engrais minéral à 25, 50 et 100 mg P/kg sol ainsi qu'un témoin non fertilisé ont été inclus dans le dispositif. Les sols ont ensuite été incubés dans des pots durant 2 semaines à températures et humidités contrôlées dans un dispositif complètement aléatoire à 3 répétitions avant d'être échantillonnés pour fin d'analyse. Les sols ont ensuite été semés avec de l'avoine (*Avena sativa* L.) pour évaluer la disponibilité du P des engrais organiques.

Après 2 semaines d'incubation, le P extrait au Mehlich-3 (PM3) a augmenté linéairement dans le loam, le loam limoneux, le sable Ivry et le sable Morin, respectivement de 0,57, 0,30, 0,16 et 0,16 par unité de P apportée en engrais minéral, en lien inverse avec la capacité de fixation initiale des sols. Par rapport à la dose de 50 mg P /kg en engrais minéral, ces mêmes sols se sont enrichis en PM3 de 83, 89, 93 et 103% avec la même dose de P provenant des solides de lisiers. La solubilité du P dans l'eau des sols est quand à elle fortement influencée par le rapport de dilution sol:eau utilisé (1:2, 1:20 et 1:200). Sans apport de P dans les sols, le sable Morin, fortement fixateur mais riche en PM3, contenait davantage de P solubilisé dans l'eau que les autres sols et ces quantités de P se sont accrues avec une augmentation du rapport de dilution, passant de 0,45 mg P/kg sol (1:2) à 25 mg P/kg sol (1:200). Par contre, avec un apport de 100 mg/kg sol de P minéral, le loam Tilly, faiblement fixateur, a produit davantage de P soluble avec des concentrations variant de 1,1 (1:2) à 63 mg P/kg sol (1:200). Comme pour le PM3, l'apport de P en provenance des fractions solides de lisiers a produit moins de P soluble à l'eau dans le loam faiblement fixateur (59% (1:2) à 69% (1:200)) que dans le sable Ivry très fixateur et pauvre en P (101% (1:2) à 76% (1:200)) par rapport à l'engrais minéral (50 mg P/kg sol). Par ailleurs, les concentrations de P soluble et de PM3 ont en général été plus élevées dans les sols amendés avec les solides issus des lisiers de vaches que ceux des lisiers de porc.

L'avoine a répondu positivement aux doses croissantes de P minéral dans tous les sols et un maximum de biomasse a été atteint avec 90 à 105 mg P/kg (courbes quadratiques), les réponses étant plus prononcées dans le loam et le loam limoneux moins fixateurs. Avec 50 kg P minéral/kg de sol, la production de biomasse a varié de 8 g MS/pot dans le sable Ivry, pauvre en PM3 et très fixateur, à 31 g MS/pot sur le loam Tilly, pauvre en PM3 mais très peu fixateur. La production de biomasse obtenue avec les différents solides dans les différents sols a atteint 98% de celle produite avec l'engrais minéral apporté à la même dose (50 mg P/kg sol). De plus, les prélèvements en P dans les traitements avec solides ont été en moyenne de 96% des prélèvements réalisés avec l'engrais minéral à la même dose, conférant à ces solides une efficacité fertilisante en P très proche de celle de l'engrais minéral. Ces résultats démontrent une valeur fertilisante en P de ces fractions solides de lisiers comparable à celle des engrais minéraux, mais indiquent une légère diminution de la solubilité du P dans l'eau des sols fertilisés avec les fractions solides.

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Harrowing for weed control: impact on soil structure, mineral nitrogen and wheat production

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Keywords: Mechanical weed control, Spring tine harrow; Bread wheat; N immobilization

Harrowing has become a significant technique for mechanical weed control in cereal crops. The spring tine harrow is recognized to be effective for weed suppression and for its low use cost. However, the impact of its use on soil properties still needs to be investigated. (Coulombe, 2003). The aim of this project was to assess the impact of harrowing and different forms of N fertilizer on wheat crop yield and quality, soil mineral N content and soil structural stability.

The experiment was performed during two successive years on a clay loam at St-Hyacinthe and in a silty loam at St-Augustin. The previous crop was no-till soybeans in all cases. Spring tine harrowing strategies which included harrowing before emergence, at three-leaf and five-leaf stages were compared to untreated plots. Three N fertilizer treatments were included within these main treatments: a non-fertilized control, a mineral fertilizer and dry granular poultry manure. Soil mineral N content was measured every four days during wheat growth in the 0 to 5 and 5 to 20 cm soil layers. Soil NO_3^- and NH_4^+ contents were determined colorimetrically after 1M KCl extraction. Water stable aggregates were analyzed before and after each harrowing treatments.

At each year and site, mineral fertilizer resulted in better crop yields compared to the dry granular manure. This effect was largely explained by variations in soil mineral N contents which were greater in plots receiving mineral fertilizer than poultry manure. On average, at St-Hyacinthe, wheat yields were 310 kg ha^{-1} lower with intensive harrowing while no statistical differences appeared at the St-Augustin site. Spring tine harrowing had a significant effect on mineral N contents at both sites in the 0 to 5 layer. Slightly higher mineral N contents (average of 2.6 kg N ha^{-1}) were measured in the harrowed treatments than the control at St-Hyacinthe in 2006 and at St-Augustin in 2005. However for the other two sites and cropping seasons, significantly lower mineral N contents were observed in the harrowed treatments than in the undisturbed plots. This apparent N immobilization amounted to up to 23 kg N ha^{-1} at St-Hyacinthe in 2005 (for both mineral fertilizer and dry poultry manure) and 31 kg N ha^{-1} at St-Augustin in 2006 (only in mineral fertilizer plots) after the successive harrowing treatments. In all cases, the last sampling dates indicated that residual N content was not affected by the treatments. The effects of the treatments on soil aggregation were variable. The mean weight diameter of water stable aggregates showed an average reduction of 15 % with harrowing at both sites in 2006, whereas in the same year, it was greater in the plots receiving organic fertilizer. In conclusion, harrowing for weed control had variable effects on wheat yields and mineral N contents. Of note, significant mineral N immobilization was observed at a few sampling dates following the harrowing treatments. Overall, the impact of harrowing and dry poultry manure on soil aggregation was measurable but relatively small.

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N and C K-edge XANES and pyrolysis field-ionization mass spectrometry of rhizosphere and non-rhizosphere soils.

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The rhizosphere is loosely defined as the volume of soil that is affected by the presence of plant roots. In this region, plant root exudates, dead tissue and enhanced microbial activity combine to create an environment that differs greatly from that of bulk soil. The complexity of the rhizosphere presents formidable challenges to the analyst. Indeed, formation of the rhizosphere is a result of the combined contributions of the plant, the soil, and the associated microorganisms. In this study, we use the techniques of pyrolysis field ionization mass spectrometry (Py-FIMS) along with synchrotron-based N and C K-edge XANES to explore differences between pea rhizosphere and bulk soils. Py-FIMS data shows differences in nitrogen-containing compounds, lignin monomers and carbohydrate classes between rhizosphere and bulk soils. N and C K-edge XANES patterns showed also showed differences in nitrogen and carbon functionality. The information provided by these novel techniques will help to further broaden our knowledge of rhizosphere processes.

The biogeochemical cycling of manganese in a forested ecosystem of the Canadian Shield

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Keywords: Manganese, biogeochemical cycling, forested ecosystem, topography, season

Recently, a decline reaching 50% of the exchangeable manganese (Mn) pools in the FH and B horizons was measured in the Hermine watershed (45°49' N, 74°01' W) for the period 1993 to 2002 (Courchesne *et al.*, 2005). Considering the fact that Mn is an essential nutrient for the photosynthesis of the plants, this severe change in the stock of available Mn could have major consequences on the health status of this forested ecosystem. In order to increase our understanding of Mn distribution and movement within the ecosystem, the objective of this project is to quantify the cycle of Mn, for the years 2003 to 2005, by 1) measuring the concentrations and fluxes of dissolved Mn in the five biogeochemical compartments of the Hermine and 2) establishing the impact of topographic position on the cycling of Mn.

The 5-ha Hermine watershed is located 80 km north of Montreal (Canada). The vegetation is composed of Sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*) and Yellow birch (*Betula alleghaniensis*). Soils are classified as sandy orthic or gleyed humo-ferric and ferro-humic Podzols. The watershed is divided into six 300m² sampling sites: three on an upslope position and three others located downslope close to the stream channel. The sampling of solutions in the five biogeochemical compartments (precipitation, throughfall, soil at 0 and 50 cm, and stream) is performed at the six sites every two weeks. Before the filtration, the pH and the electrical conductivity (EC) are analyzed with appropriate electrodes. Within 24 hours, the solutions are filtered at 0,45 µm and acidified with 2mM EDTA. The concentrations of dissolved Mn, Ca, Mg, SO₄ and Cl are measured using ICP-AES or ICP-MS and IC. Solutions are analyzed for dissolved organic carbon (DOC) using a carbon analyzer. Hydrological fluxes in each biogeochemical compartment are either measured in the field (precipitation, throughfall, stream) or modelled (flow in soil horizons). Discriminant, redundancy and temporal analyses are performed on the chemical and the physical variables in order to explain the spatial and temporal variations in dissolved Mn concentrations in each compartment.

The Mn concentrations are generally highest in the throughfall and in the organic soil horizons. The discriminant analyses performed on Mn concentrations for the five compartments show significant statistical differences between throughfall, solutions from organic soil horizons and streamwater. Significant seasonal differences between the growing and the senescence periods, are observed for four of the five compartments with the exception of the mineral soil solutions. These intra-annual changes are mostly associated to processes like the decomposition of organic matter by microorganisms, bioaccumulation in plant materials and dilution of streamflow during snowmelt. As for the influence of topography, only the solutions collected in the organic horizons are significantly affected. This effect is caused by the combined lower pH and more reductive conditions recorded at the downslope position and is also associated to the contrast in tree species. Redundancy analyses performed for each component of the hydrograph (rising limb, peak and recession limb) showed that the significant explanatory variables are not the same for the three components of the hydrograph. This study will contribute to our understanding of the response of forested ecosystem to environmental changes such as variations in climate conditions and trends in the chemistry of atmospheric deposition.

Relation entre les teneurs en P total et assimilable d'un sol limoneux et celles en P dans les sédiments et dans les eaux de ruissellement selon différentes cultures

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Mots clés: Érosion des sols, sédiment, phosphore total, phosphore dissous, facteur d'enrichissement du P.

Les teneurs en P dans les sédiments et en P dissous dans les eaux de ruissellement de surface sont nécessaires pour déterminer les charges de P perdues lors des processus d'érosion des sols. Des chercheurs de l'Iowa ont démontré que la teneur en P des sédiments peut être évaluée à partir de la teneur en P total du sol d'origine en appliquant toutefois un facteur pour tenir compte de l'enrichissement en P des particules pendant le processus d'érosion (Mallarino et al. 2005) ; NRCS-IOWA, 2004). Selon ces mêmes auteurs, la concentration en P total dissous dans les eaux de ruissellement peut être estimée à partir d'une relation avec la teneur en P assimilable des sols. Le but de cette étude est de valider cette approche dans un loam limoneux de la série Le Bras situé sur la station de recherche de l'IRDA de Saint-Lambert-de-Lauzon (Qc). Les eaux de ruissellement provenant d'une parcelle d'érosion de 30 m x 15 m, cultivée pendant 4 ans successivement en maïs-grain, en soya, en orge grainée et sur sol nu, ont été prélevées lors de chaque événement pendant la période de mai à novembre et analysées pour connaître les teneurs en P de différentes fractions : particulaire, total dissous, réactif dissous et biodisponible. Une autre parcelle de 26 m x 80 m a permis de recueillir les eaux de ruissellement sur une prairie de luzerne-mil pour une année pendant la même période. Le facteur d'enrichissement moyen, correspondant au rapport entre la teneur en P particulaire des sédiments et la teneur en P total du sol, a été de 1,83 pour le sol nu, de 1,89 pour le maïs-grain, de 2,39 pour le soya, de 2,47 pour l'orge grainée et de 4,01 pour la prairie de luzerne-mil. À mesure que la couverture végétale s'accroît, il y a moins de sédiments transportés mais ces derniers sont plus fins et plus riches en P. Les teneurs moyennes en P mesurées dans les sédiments ont été de 1212 mg/kg sur sol nu, de 1288 mg/kg pour le maïs-grain, de 1664 mg/kg pour le soya, de 1461 mg/kg pour orge grainée et de 2334 mg/kg pour la prairie. Les teneurs prédites correspondantes ont été de 1134 mg/kg, de 1171 mg/kg, de 1482 mg/kg, de 1532 mg/kg et de 2486 mg/kg respectivement pour les mêmes cultures. Pour la fraction dissoute, nous avons mesurée la concentration moyenne de P total dissous dans les eaux de ruissellement de chacune des cultures et comparées avec celles prédites par l'équation utilisée en l'Iowa. Les concentrations prédites étaient plus élevées que celles mesurées. Des équations plus adaptées à nos conditions expérimentales ont été établies pour relier la concentration en P total dissous des eaux de ruissellement avec la teneur en P Mehlich-3 ($R^2=0,81$) et avec la saturation en P des sols ($R^2=0,86$). Une équation a également été établie pour déterminer la concentration en P réactif dissous à partir de la saturation en P du sol ($R^2 = 0,86$).

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Effect of three polycyclic aromatic hydrocarbons on nodulation of *Phaseolus vulgaris* by *Rhizobium tropici*

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Keywords: nodulation, naphthalene, phenanthrene, benzo[*a*]pyrene

Polycyclic aromatic hydrocarbons (PAH) are ubiquitous organic pollutants that are considered toxic and carcinogenic compounds to living organisms (Kanaly and Harayama, 2000). There is scarce information about the effect of PAH on symbiotic systems such as *Azolla-Anabaena* (Castro *et al.*, 2007), arbuscular mycorrhizal fungi-plants (Alarcón *et al.*, 2006), or legume-rhizobia. Thus, the objective of this study was to evaluate the effect of three PAH on the symbiosis between *Phaseolus vulgaris*-*Rhizobium tropici*. Common bean seeds were surface disinfected and germinated on water-agar 1%. Seven-days old seedlings were transplanted to a 3-split growth pouch system containing an artificially-contaminated Jensen's nutrient solution with PAH: naphthalene (NAPH), phenanthrene (PHE), or benzo[*a*]pyrene (BAP). Each PAH was dissolved in acetone and applied to the respective nutrient solution at the following concentrations: 20, 40, 60, 80, and 100 $\mu\text{g mL}^{-1}$. Uncontaminated plants with or without acetone were included as controls (T). Seven days after treatments were established, plants were inoculated with 1.0 mL of a *Rhizobium tropici* strain CIAT88 ($87.2 \text{ UFC} \times 10^{10} \text{ mL}^{-1}$). Plants were grown under growth chamber conditions: 70% HR, 23°C, 12 h, during 21 days. Root nodules were counted and recorded from day 5 to day 21. Plants were harvested to evaluate the nodule dry mass at the end of the experiment. The three PAH significantly reduced the number of nodules (Figure 1). All NAPH and BAP treatments had significantly lower number of nodules than the controls (Figure 1A, C). Also concentrations of PHE higher than 40 $\mu\text{g mL}^{-1}$ resulted in significantly lower number of nodules; however, at 20 $\mu\text{g mL}^{-1}$ this PAH stimulated the nodulation (Figure 1B). Similar response was observed for nodule dry weight where the highest concentration of any PAH resulted in the lowest dry mass of nodules (data not shown). This study shows the negative effects of PAH on nodule either formation or dry mass, in the *Phaseolus vulgaris*-*Rhizobium tropici* symbiosis.

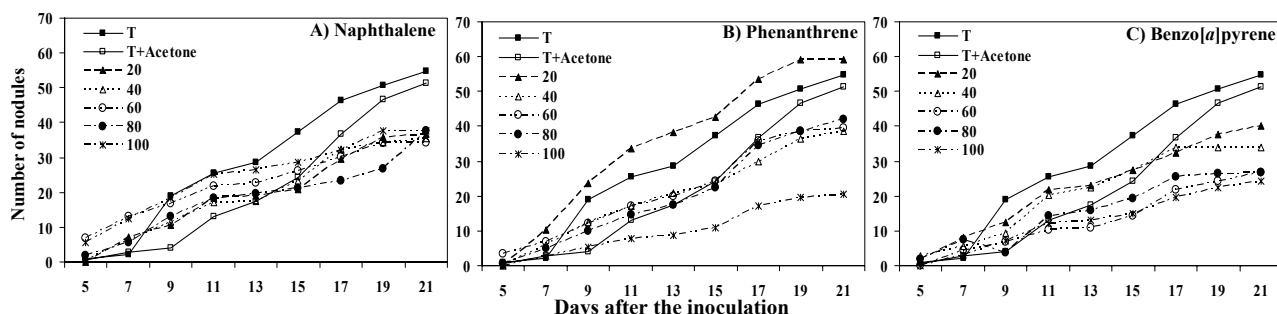


Figure 1. Number of root nodules in the *Phaseolus vulgaris*-*Rhizobium tropici* symbiosis treated with three polycyclic aromatic hydrocarbons. T = Inoculated controls. n=3.

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Integration of a new model of soil-water retention to obtain the hydraulic conductivity function

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Keywords: water retention, hydraulic conductivity.

Using old (Van Genuchten) and new (Groenevelt & Grant) models for the soil-water retention curve we explore the qualities of both, the Burdine and the Mualem equation, to produce the hydraulic conductivity function. Based on the Van Genuchten model one lands, upon integration of the B. and M. equations, in the ballpark of the beta functions. With a specific assumption, one finds a complete beta function for the Burdine equation and, with another assumption, one finds another complete beta function for the Mualem equation. Both functions are widely used and are standard inputs in geo-hydrological and soil- physical models. Based on the Groenevelt-Grant model one lands, upon integration of the B. and M. equations, in the ballpark of the gamma functions. The gamma ballpark is user-friendlier than the beta ballpark. For both, the Burdine and the Mualem equation, a wide range of complete gamma functions is available. Up to date, the most widely used combination, viz. the Van Genuchten- Mualem combination, has produced acceptable results for lighter soils, particularly under wet conditions. Now, there is a need to produce better results for heavier soils (e.g. used as clay-liners under landfills) and for dry soils (e.g. desert soils used for storage of nuclear waste). We explore the opportunities in the gamma ballpark.

Organic and Mineral Fertilization of Crops and Dynamics of Soil Nutrients

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Keywords: Ion exchange membranes, integrated nutrient management

An adequate nutrient supply is necessary to optimise crop yield and quality but excess nutrients moving to the air or water pose a serious environmental risk. A key to improvement in nutrient use efficiency is the accurate quantification of nutrient availability to crops so that nutrient supply can be matched to crop demand. This requires an ability to predict the amount and pattern of nutrient availability from the soil and organic amendments. Nutrient availability depends on many factors such as agricultural practices and climatic conditions. Traditionally, soil analysis based on chemical extraction was used to evaluate nutrient availability to crops. Some of these methods, however, are not effective mainly because of the complex and dynamic nature of soil nutrient release. Use of Ionic Exchange Membranes (IEM) to measure nutrient ion supply rates can potentially provide a more realistic representation of soil nutrient availability than chemical extractions. The IEMs have been successfully used to determine a majority of soil nutrients (N, P, K, micro-nutrients) under different soil and climatic conditions. The Electro-Ultrafiltration (EUF) technique has also been used to predict the short and long term soil P and K availability and has been compared to chemical and IEM techniques.

If the supply of nutrient from the soil is inadequate for optimum crop production, nutrients can be provided to the crop in a wide range of organic amendments. Nutrient release through mineralization of organic amendments will vary with the source materials and management practices. Manures, composts and biosolids are widely used to provide nutrients for crop production. However, it is critical that these sources are managed effectively as nutrient sources rather than viewed as waste materials, since there is a serious risk of environmental damage if excess nutrients move to the air or into water.

Agricultural use of paper mill sludge (PMS) and liming by-products (K, Ca, Mg) is increasing due to the recognition of the nutrient value of these by-products and the environmental concerns of other traditional disposal methods. Results in the province of Quebec demonstrated that the addition of PMS to soils improves crop yields and soil properties. The apparent N efficiency is around 40% and P availability from this by-product is comparable to mineral P fertilizer. The PMS applied at appropriate rates increases yields without any increase in soil and plant heavy metal content.

Inorganic fertilizers are also widely used to increase nutrient supply and enhance crop yield and quality. Improved management of inorganic N, including use of enhanced efficiency products, and optimised timing and placement practices can improve N use efficiency and reduce potential losses to the air and water. Integrated management of inorganic and organic nutrient sources can improve the overall efficiency of nutrient use within a farming system and make the best use of the nutrient resources available.

Response of soil organisms to varying sizes of aggregated green-tree retention

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Keywords: soil microorganisms; soil fauna; green-tree retention; DGGE; enzymes

Variable retention of living trees is increasingly being favoured as an alternative to clear-cutting in forest management. Soil organisms have a vital role in nutrient cycling, so preservation of a functioning soil community is essential for ecosystem function. Currently, only retention of woody debris and limitation of soil scalping are recommended to protect soil organisms after harvest. However, a more suitable management treatment may be preservation of living trees on harvested sites, providing soil organisms with sources of energy from tree roots and litter. The aim of this project is to assess the potential of green tree retention (GTR) as a management tool to maintain soil function after harvesting. This project brings together multi-disciplinary researchers, applying a range of novel techniques to quantify changes in soil microbial and faunal diversity and function in response to harvesting. The project is using STEMS installation near Elk Bay, Vancouver Island. STEMS is a multi-disciplinary field experiment that compares the ecological and socio-economic effects of 7 silvicultural systems (clear-cut, uncut, group selection, patch cuts, dispersed retention, aggregated retention). This experiment has allowed us to examine the same soils pre- and post-harvest. Our investigations are determining how soil communities change, whether key species are lost, and if GTR of different aggregate sizes and density ameliorate modifications of these communities. Changes in rates of soil processes are being measured concurrently to determine if the observed alterations in soil communities have serious consequences for soil functioning. Analyses of our pre-harvest samples have shown that 95% of the soil faunal populations were found in the forest floor. The forest floor harboured a distinct microbial community from the mineral soil in both composition, measured using PCR-DGGE, and function as measured using enzymatic and catabolic profiles. These results indicate that the forest floor is a critical reservoir for soil organisms in this forest. One of the benefits, therefore, of GTR may be retention of undisturbed forest floors in the retention patches, which could serve as refugia for colonization of disturbed areas following harvest. This is confirmed by the analyses of post-harvest samples which have shown that populations of most of the soil macrofauna and Collembola are influenced more by the amount of disturbance of the forest floor, than by the influence of living trees.

Soils and ecosystem functioning in Antarctic dry valleys

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The Antarctic dry valleys are the most extreme terrestrial habitats on the Earth. Dry valley ecosystems have considerable environmental significance because of their sensitivity to environmental change and because the relatively simplicity (low biomass and diversity) of the biological communities provide an opportunity to explore relationships between resource inputs and ecosystem function. The land surface lacks a conspicuous community of autotrophs, yet the soils contain enduring populations of heterotrophic micro-organisms and invertebrates. Understanding the provenance of resources for soil heterotrophs in nutrient- and energy-poor polar deserts requires consideration of a wider range of possible sources than in most other ecosystems. When the indigenous stocks of soil organic C and N are as low as occurs in the dry valleys, even very modest C and N inputs from other sources represent significant subsidies of resource inputs to the soil. These sources include (1) modern *in situ* autotrophs, such as the cryptoendolithic communities, mosses, and cyanobacteria, (2) ancient *in situ*, or “legacy”, organic material deposited as sediments in paleolakes with levels much larger than those present, (3) spatial subsidies of aeolian deposited marine and ornithogenic material from coastal regions, and (4) spatial subsidies from the margins of modern lakes, where the organic matter from microbial mats which accumulate under favourable conditions is subsequently dispersed onto the surrounding soils. This presentation will evaluate various possible sources of subsidies in dry valley soils, how the contributions from different sources and their redistribution within the valleys vary with changing environmental conditions, and how these may ultimately affect ecosystem function in the dry valleys.

Indice de saturation en phosphore des sols organiques

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Mots clés: phosphore, sols organiques, saturation, fertilisation, Mehlich-III.

La concentration en phosphore dans les cours d'eau drainant les sols organiques dépasse jusqu'à 14 fois le critère de 0.03 mg PT L⁻¹ retenu par le ministère de l'environnement pour prévenir l'eutrophisation. Le but de cette étude était de développer des indices environnementaux et agronomiques de saturation des sols organiques selon la méthode de Mehlich-III (IPS_{M-III}). L'approche a été testée sur 82 sols organiques et 66 sites d'essais de fertilisation à travers le Québec. La méthode a été étalonnée par rapport au degré de saturation en P extrait à l'oxalate acide d'ammonium (DPS_{OX}) avec un facteur $\alpha_m=0.4$ et à la méthode d'extraction à l'eau du P (P_W). Les essais au champ sur la réponse de la culture à l'ajout de P ont été réalisés sur 8 sites de carottes, 11 sites de pommes de terre, 10 sites d'oignons, 7 sites de chou-chinois, 10 sites de céleris et 20 sites de laitues. L'extraction du phosphore au Mehlich-III était mieux reliée au DPS_{OX} ($r^2=0.73$) que la méthode Bray 1 ($r^2=0.62$) et la méthode de la Floride ($r^2=0.53$). Le rapport molaire $[P/(Al+\gamma Fe)]_{M-III}$ ($\gamma=5$) était le mieux corrélé au DPS_{OX} ($r^2=0.88$). Un seuil critique de 0,05 de $[P/(Al+5Fe)]_{M-III}$ a été calculée pour DPS_{OX}=0.25 et P_W=9.7 mg P L⁻¹. Cette valeur fut validée avec une étude indépendante menée en Caroline du Nord. La teneur en P des sols organiques influençait significativement le rendement des cultures maraîchères. Les valeurs agronomiques IPS_{M-III} se situaient entre 0.10 et 0.15. Le critère environnemental (0.05) et les critères agronomiques (0.10 et 0.15) sont de nouveaux outils pour la gestion du P dans les cultures maraîchères en sols organiques.

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The effect of glucose on glycine-catechol polycondensation as catalyzed by birnessite

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Keywords: abiotic humification, oxidative polymerization, birnessite, polyphenol, Maillard reaction

Soil humic substances are made up of complex and heterogeneous mixtures of organic molecules. The composition of humic substances varies widely with origin (e.g. soil or groundwater), age and location. The formation of humic substances (humification) proceeds by biotic (enzymatic catalysis) and abiotic (mineral catalysis) pathways. Our research focuses on abiotic humification catalyzed by birnessite (δ -MnO₂), a metal oxide commonly found in soil environments. The Maillard reaction, i.e., condensation reactions between sugars and amino acids, and integrated polyphenol-Maillard reaction pathway, involving polymerization reactions of polyphenols with amino acids and sugars, are perceived as important processes in the genesis of humic substances in nature (Jokic et al., 2001, 2004). The kinds and relative abundance of biomolecules (polyphenols, sugars and amino acids) substantially vary with natural vegetation, microbial populations and activity, and the environment. Sugars and amino acids are abundant in soils. Glucose is one of the primary decomposition products of cellulose during natural degradation (Koivula and Hanninen, 2001). The source of polyphenols includes tannin, root exudates, degradation of lignin and microbial metabolites. The objective of our study was to investigate the effect of the molar ratio of glucose to catechol (polyphenol) and glycine in the integrated polyphenol-Maillard reaction system on the humification processes as catalyzed by birnessite.

A number of treatments, with an increasing concentration of glucose to a fixed molar ratio of catechol and glycine in the presence and absence of birnessite, were conducted at environmentally relevant conditions, i.e., pH 7.0 and 45° C, for a period of 15 days. The systems were maintained under sterile conditions to establish the role of abiotic catalysis. The degree of humification and the nature of the products formed were examined using XRD, visible, FTIR and C, N and O K-edge NEXAFS spectroscopy. Our results show that increasing the molar ratio of glucose to glycine and catechol results in a significant increase in the degree of humification (browning), and the humic acid (HA) produced contains increasingly more Maillard reaction type products. The C K-edge NEXAFS spectra show that the IHSS river, soil and peat HA standards are basically similar to the HA produced in the glucose-glycine (Maillard reaction) system and the equimolar glucose-glycine-catechol (polyphenol-Maillard reaction) system. The findings obtained in this study are of fundamental significance in understanding the importance of the nature and abundance of biomolecules in influencing abiotic humification pathways and products in natural environments.

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Impact of harvesting and forest floor removal on N mineralization in jack pine forest soils: a combined sequential sampling and chronosequence approach.

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Keywords: Net N mineralization, forest harvesting, organic matter removal

Since jack pine growth is commonly N limited and young plantations acquire most of their N from the soil, different forest management practices may influence soil fertility and forest productivity. We examined the impacts of both harvesting and forest floor removal on net N mineralization at the Tunnel Lake Research Site (46° 21' N, 83° 23' W) in northeastern Ontario. The soil is a Humo-Ferric Podzol that has developed in a glaciofluvial deposit and consists of a well developed mor humus, acidic B horizons (pH 5.0) and low clay content (<7%). Mineralization was determined in situ using closed top PVC tubes and 90-day growing season incubations. Accumulation of NH₄⁺-N and NO₃⁻-N was determined for organic soil horizons and the upper mineral soil 1, 5 and 10 years after stem-only harvest (OM₀), full-tree harvest (OM₁) and full-tree harvest with forest floor removal (OM₂) and within uncut forest (UF). We also assessed the impact of the OM₂ treatment 17 and 24 years post-harvest using an older adjacent plantation. Though the climate is cool and humid, surface soil daily maximum temperatures on some of the harvested treatments reached > 25° C during the incubation periods. N production within the surface soil horizons was higher where forest floor layers were maintained on site. Nitrification rates were greater in soils from stem-only harvest plots compared to full-tree harvest plots 10 years after harvest. Variations in substrate quality and quantity, soil temperature and soil moisture between treatments were important factors regulating inorganic-N production in the forest soil.

Suivi de la contamination par *Escherichia coli* des eaux de ruissellement et de drainage dans des parcelles de maïs-grain fertilisées au lisier de porc.

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L'agriculture intensive et l'emploi des déjections animales comme fertilisants organiques sont souvent cités comme étant une source importante de contamination chimique et microbiologique des eaux de surface et souterraine. L'aménagement de bandes végétales filtrantes entre les terres agricoles et les cours d'eau réduit la pollution diffuse d'origine agricole, dont les coliformes fécaux potentiellement pathogènes aux humains. Afin de mesurer l'efficacité de ce type d'aménagement, un site expérimental a été instrumenté pour documenter les qualités physico-chimique et microbiologique des eaux de ruissellement et de drainage provenant de parcelles de maïs-grain fertilisées au lisier de porcs.

L'étude s'est effectuée, de 2004 à 2006, à la Ferme expérimentale de l'IRDA située à Saint-Lambert-de-Lauzon, à environ 30 km au sud de la ville de Québec. Le site expérimental se compose de 4 blocs aléatoires comprenant chacun 3 parcelles (30 m x 5 m) d'une culture de maïs-grain (*Zea mays L.*). Ces parcelles sont aménagées sur un loam limono-argileux dont la pente est de 3%. Pour 8 des 12 parcelles, une bande enherbée (5 m x 5 m) a été aménagée au bas de la pente. Dans 4 de ces bandes enherbées, 8 peupliers hybrides par bande ont été plantés. Les doses de lisier de porc ont été appliquées à la fin du mois de mai (40 t/ha) et à la fin du mois d'octobre (30 t/ha) de chaque année. Les parcelles sont munies de systèmes collecteurs d'eau de ruissellement et de drainage reliés à des cabanons où se retrouvent les équipements de mesure (augets basculeurs) et d'échantillonnage. Les décomptes de l'indicateur microbien *Escherichia coli* dans les volumes d'eau de ruissellement et de drainage indiquent : (1) *E. coli* est détecté durant toute la période d'échantillonnage, mais les décomptes sont réduits à l'automne, (2) à la suite d'un événement de pluie, il n'y a pas de relation entre la pluviométrie et la charge de *E. coli*, (3) l'aménagement d'une bande filtrante réduit significativement la charge de *E. coli* dans les eaux de ruissellement, particulièrement à la suite de l'application de lisier à l'automne, (4) l'aménagement d'une bande filtrante ne réduit pas la charge de *E. coli* dans les eaux de drainage, et (5) les bandes filtrantes réduisent les charges de *E. coli* lorsque l'on considère le volume total d'eau évacué des parcelles. Les relations observées entre la charge de *E. coli* et la quantité de matières en suspension (MES) dans les eaux de ruissellement et de drainage seront discutées.

Long-term trends (1959-2006) in soil temperature, evidence for sub-soil warming and microbial responses

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Keywords: microbial respiration, soil warming

There are relatively few long-term temperature records that include sub-soil measurements. By analysing one of the few such dataset, recorded at the Scottish Crop Research Institute in eastern Scotland, trends of increasing average temperatures for soil at 10, 20, 30, 50 and 100 cm depth have been detected. The increases in soil temperature over the 47 years for which data are accessible is between 1.3 and 1.5°C which is close to the rise in mean air temperatures over the same period of 1.3°C (increase in mean minimum air temperature = 0.9 °C and increase in maximum air temperature = 1.7 °C). There was no noticeable difference in the warming trend at or below 20 cm depth in the soil, but at 10 cm the soil had warmed slightly less over the period. The most important observation, however, was the warming in the sub-soil at 100 cm, which followed the rising trend of the overlying soil closely. There were significant increases in the t-sum (cumulative soil temperatures; degree.days) for soil at all depths and for the soil temperatures on both the coldest and hottest days (according to air temperatures) over the 47 year period. However, there was no evidence of heat imbalances in the soil which would lead, for example, to the sub-soil staying warmer for a longer period in the year with increasing time. The effect of increased soil temperatures for biological processes in the soil were assessed by measuring the temperature response functions of carbon mineralization by soil micro-organisms from different depths. The responses of carbon mineralization are used to explore the implications of soil carbon storage at different depths.

Changes in soil carbon contents in long-term experimental grassland plots in northern England between the 1980s and 2006

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Keywords: carbon losses, fertilizers, bulk density.

Recent reports of widespread C losses from soils in the UK over 10-25 years have focussed attention on the importance of re-sampling previously characterized sites to assess long-term trends in soil properties. This has in turn highlighted the difficulties of dealing with incomplete historic data, confounding effects of changing land-use, and precisely re-locating previously sampled sites. We believe that six of the Palace Leas meadow hay plots established at Cockle Park, Northumberland, northern England, represent the only experimental grassland site in England that has been under constant management for over a century and for which replicated data on soil C concentration and bulk density by depth were collected by depth in the 1980s at known locations. In 2006, we re-sampled the six plots, which have received different fertilizer and manure treatments since 2006, and measured the same parameters. Four of the plots showed no net changes in the soil C content to a depth of 27 cm (the maximum depth which data were available from the 1980s), but two plots did show net losses of soil C of 14 and 17% with proportionately greater losses of C from deeper layers. However, comparable losses were not reproduced by two adjacent plots that have received closely analogous fertilizer additions. The differences observed were mainly driven by differences in the bulk density measurements between the 1980s and 2006, and not soil C concentration.

Long-term tillage treatments affect soil nitrogen mineralization and denitrification potentials in a corn agroecosystem

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Keywords: tillage, crop residue management, soil microbial activity, nitrogen dynamics.

Agricultural practices like tillage and crop residue management are expected to modify the size of soil organic matter pools and soil physical attributes like aggregation. These changes will likely affect the functioning of soil microbial communities under aerobic and anaerobic conditions. The study was conducted in long-term (14 years) experimental plots under corn production at the Research Farm of McGill University, Ste-Anne-de-Bellevue, QC. The factorial experiment was designed with three tillage treatments (conventional-, reduced- and no-tillage) and two levels of residue input (corn roots, corn stover + roots). Soil was collected from the 0-5 cm and 5-20 cm depths of the experimental plots in fall, after corn harvest. Corn grain yield was 9.7 to 11.4 tonnes (dry matter, d.m.) ha⁻¹ in 2006, so the residue input was about 3.5 to 4.0 t d.m. ha⁻¹ from corn roots and 10.4 to 11.9 t d.m. ha⁻¹ from corn stover + roots. There was more microbial activity (respiration, N mineralization and denitrification) in the 0-5 cm depth than the 5-20 cm depth. Soils from plots under reduced- and no-tillage that received the higher residue input exhibited a higher microbial activity (respiration, N mineralization and denitrification), perhaps because more soil organic C and N was preserved when soils were not disturbed by tillage. The potential denitrification was examined after adding NO₃-N and glucose, alone or in combination, which revealed that denitrifiers were limited more by the amount of readily-available C than N. We conclude that the physical protection of soil C in reduced- and no-tillage systems may be the major limitation to aerobic and anaerobic microbial activities *in situ*, although this should be confirmed under field conditions.

Intermittent tillage effect on soil biochemical properties of continuous no-till cropping systems in Saskatchewan

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Keywords: soil enzymes, microbial biomass, nutrient pools, soil zone

There has been a large scale shift in agricultural management on the prairies in farming converting over 50% of Saskatchewan's agriculturally productive land area to no-till farming methods. This has occurred largely over the last 20 years, since farmers have come to learn of the advantages of no-till cropping systems, in conserving soil moisture, preventing erosion, improving soil structure and quality. However, the withdrawal of tillage from this management system means alternative methods of weed control are needed, and without summer fallow additional fertilizers are needed to compensate for crop removal. These added inputs are expensive and for farmers already operating on a small profit margin, any decrease in these inputs would be significant. Intermittent tillage in a no-till system would provide an alternative method of weed control and allow for net mineralization of nutrients from the residue or soil organic matter (SOM). The purpose of this study is to assess the effect of intermittent tillage on soil biochemical properties of a no-till cropping system. Three sites were selected across the province, one each in the dark brown, black and grey soil zones, and three tillage treatments, varying in intensity applied at each site. The tillage treatments were done in fall 2004 and spring 2005, and soil samples taken throughout the growing season and fall of 2005 and continued in spring 2006. The soils were analyzed for effect on microbial biomass, soil enzymatic activity and nutrient pools of plant available nitrogen and phosphorus to assess the effect of tillage on the soil quality and health.

Updating soil data information to facilitate the National Land and Water Information Service (NLWIS)

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Keywords: soil survey, pedon database, interpretation model.

From 2005 to 2009, the federal government invested \$100 million to create a new service (NLWIS). It is an agri-environmental web portal providing information and analysis of land, water and climate data to enhance land-use decisions for agricultural productivity and environmental sustainability. There are several teams working together to implement NLWIS and the Soils Data team, which holds the highest budget, plays a fundamental role on delivering the land information service. National-wide soil related projects include updating the National Pedon Database, compiling detailed and semi-detailed maps, developing soil data interpretations for analytical applications and upgrading the Soil Landscapes of Canada. In New Brunswick, the on-going activities are: a) editing and standardizing 515 pedons derived from the 20 historical soil surveys, and collecting 40 new pedons to enrich the database; b) upgrading the existing soil survey of the Fredericton-Gagetown area (the original survey was initiated in 1938 and resurvey is required to obtain a better understanding as well as managing the soil); c) Re-packaging the CanSOIL-InterpNB to a universal and user friendly soil interpretation model. On the conference, preliminary results from New Brunswick will be presented. Also, the NLWIS's frame and function will be introduced. The relevance of the Soils Data team's activities and how they address the Department's priority of environmental health will be discussed.

Séquestration de l'azote par des complexes protéines-tanins dans l'humus de la forêt boréale

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Mots clés: Tanins condensés, *Kalmia angustifolia*, épinette noire, ammonium, respiration microbienne

L'azote (N) est un élément souvent limitant pour la croissance des arbres dans la forêt boréale. La disponibilité du N dans le sol est régulée par plusieurs facteurs, dont la décomposition des litières qui dépend entre autre de leurs qualités chimiques. Cependant, la litière des plantes de la forêt boréale contient de fortes concentrations en tanins condensés, spécialement chez les éricacées retrouvées dans le sous-bois et les parterres de coupes, tel que *Kalmia angustifolia* L. (*Kalmia*). Les tanins ont la propriété à ce lier aux protéines et de former des complexes protéines-tanins qui semblent résistant à la décomposition. Compte tenu qu'une diminution de la disponibilité du N est souvent observée suivant l'envahissement par le *Kalmia* sur les parterres de coupe, il a été proposé que la séquestration du N par leurs tanins pourrait être un mécanisme important.

L'objectif de cette étude était de déterminer et de comparer la séquestration de l'azote par des complexes protéines-tanins formés avec des tanins de *Kalmia* et de *Picea mariana* (Mill.) BSP (Épinette noire). Pour ce faire, nous avons réalisé une incubation en microcosmes dans laquelle des protéines (BSA), des complexes protéines-tanins et des tanins d'épinette noire et de *Kalmia* ont été ajoutés à de l'humus forestier provenant d'un parterre de coupe. Nous avons mesuré la minéralisation du N (N-NH₄) et du carbone (C-CO₂) ainsi que le N microbien pendant 28 jours.

Les résultats indiquent une forte minéralisation (N-NH₄) du BSA après 28 jours, alors qu'il n'y avait pas de différence significative entre les complexes, les tanins et le sol témoin. Également, le C-CO₂ cumulatif respiré et le N microbien n'ont pas augmenté suivant l'ajout des tanins et des complexes protéines-tanins, ce qui indique que la faible minéralisation net n'est pas due à une immobilisation du N par les microorganismes du sol suivant l'acquisition du carbone des complexes protéines-tanins. Les tanins de *Kalmia* et d'épinette semblent autant efficaces pour séquestrer le N sous forme de complexes protéines-tanins. Cependant, la litière de *Kalmia* contient environ cinq fois plus de tanins que la litière d'épinette, ce qui devrait augmenter la formation de complexes protéines-tanins dans les sols recouverts par le *Kalmia*. Ceci pourrait procurer un avantage compétitif au *Kalmia*, car il a été démontré que celui-ci peut acquérir du N des complexes par l'entremise de ses mycorhizes éricoïdes.

Predicting a ceiling in soil organic carbon stocks for carbon sequestration under no-till

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Keywords: erosion, C capacity, saturation ratio, spatial variability, C sequestration.

Studies on level landscapes in Eastern Canada indicate that implementation of no-till (NT) in maize (*zea mays* L) - cereal - bean rotations do not result in significant C sequestration. In contrast, studies on sites with variable topography have shown that sequestration of C does occur on sites where the initial organic carbon (OC) stocks are small. Carbon sequestration decreases as the initial OC stocks (OC_{init}) increases and becomes negative at large OC_{init} (VandenBygaart et al. 2002). We introduce the concept of a ceiling in OC stocks for C sequestration. The potential to sequester C by reducing tillage is greatest in those parts of landscapes where the OC stocks are well below a ceiling (OC_c) and sequestration diminishes as OC stocks approach the ceiling. The concept of a ceiling would also imply that OC stocks on a site on which $OC_{init} < OC_c$ would increase following implementation of NT until $OC = OC_c$. One would intuitively expect values of OC_c to vary with several factors including climate, texture, drainage and cropping system.

The physical basis for OC_c is not understood and therefore it is difficult to predict where C sequestration will occur in variable landscapes. Two hypotheses were proposed: (1) OC_c coincides with the steady state OC (OC_{ss}) stocks on non-eroded sites and (2) OC_c coincides with a critical proportion of the capacity of the clay and silt fraction to absorb OC (i.e., a critical saturation ratio). The objectives of this study were (1) to determine if values of OC_{ss} determined on non-eroded sites approximated OC_c , and (2) to identify the saturation ratio at which there are neither gains nor losses of OC in variable landscapes following implementation of NT and compare it with the saturation ratio for soils on non-eroded sites and the limiting saturation ratio proposed by Carter et al. (2003).

Characteristics of OC stocks (approx. 0-30 cm) were determined on ten sites across Ontario that had similar management history and represented a range in soil texture. These characteristics were compared to those on the sites studied by VandenBygaart et al. (2002).

Comparison of data from sites with level and variable topography disproved the first hypothesis; OC stocks on level sites were as much as 30 Mg ha⁻¹ larger than the OC stock on variable landscapes that distinguished locations that had gained OC from those that had lost OC after 15 year of NT. Further analyses indicated the saturation ratio at 0-10 cm must be less than 0.45 before C is sequestered in the profile. Although the analyses support the second hypothesis, the critical saturation ratio is surprisingly small and comparison with values obtained from level sites indicate that none of these sites would sequester C under NT. Additional tests of the second hypothesis is warranted in environments in which C sequestration has been documented on level landscapes.

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Variabilité spatiotemporelle des indicateurs de fertilité d'un sol organique

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Mots clés : Géostatistique, Structure spatiale, Échantillonnage de précision

Le mode traditionnel de prélèvement d'échantillons de sol, dans le but d'estimer les besoins en eau et en éléments fertilisants des cultures, suppose l'absence de structure spatiale dans les données, c'est à dire que celles-ci sont aléatoires ou indépendantes les unes des autres. Le but principal de la présente étude est d'analyser les indicateurs de fertilité physiques, chimiques et biologiques (teneur en eau volumique, conductivité électrique, pH, teneur en matière organique, nitrates, P_{CaCl_2} , P de la biomasse microbienne) dans un sol organique drainé de la région de Sherrington. Ces indicateurs ont été déterminés pour chaque tranche de 10 cm jusqu'à une profondeur de 60 cm et à chaque 5 ou 30 m sur un transect de 1000 m traversant perpendiculairement 7 fossés de drainage et 3 cultures maraîchères (carotte, laitue et oignon). Les analyses des indicateurs de fertilité ont été effectuées à 9 reprises allant du 1^{er} juin au 16 octobre 1999. L'application des statistiques descriptives et des géostatistiques spatiales a révélé une grande variation spatiale (latérale et verticale) et temporelle (du printemps à l'automne) des propriétés du sol. L'étude de la nature et de l'amplitude des variations a permis de différencier les variations insolites (effet de pépité) des variations spatiales. Les résultats de cette étude militent en faveur d'une stratégie d'échantillonnage par morcellement longitudinal des espaces entre deux fossés de drainage successifs en trois unités d'échantillonnage.

Controls on the adsorption and desorption of dissolved organic carbon to Canadian mineral soils.

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Keywords: sorption isotherms, mineral soils, carbon cycling, soil-solution interactions.

One of the primary processes controlling the accumulation of soil organic carbon within mineral horizons is the adsorption of dissolved organic carbon (DOC) (Kalbitz et al. 2000). Studies designed to relate soil properties to the adsorption capacity of forested mineral soils within Canada are limited (Moore et al. 1992). Thus, adsorption isotherms have been developed for 61 mineral soils collected from sites in British Columbia, Saskatchewan, Ontario and Quebec. In doing so, a large diversity of soil properties, representing five soil orders, have been included in the study. A non-linear isotherm approach was used to derive sorption characteristics such as the desorption term (*b*), the point where adsorption and desorption processes are at steady state, known as the null point (*np*), the slope of the non-linear regression when the starting concentration is 10 mg C/L (*m10*), and the adsorption capacity at a starting concentration of 60 mg C/L (*RE60*). Soils with the strongest ability to retain DOC (*RE60* > 20 mg C/L) include highly weathered soils from Vancouver Island, and B horizons of Podzols. The strongest control on DOC adsorption (*RE60*) was citrate extractable Fe ($R^2=0.61$, $p<0.01$) and oxalate extractable Al ($R^2=0.59$, $p<0.01$). While the strongest predictor for the *np* of B horizon soils was effective cation exchange capacity (ECEC), and soil pH. Soil properties other than extractable Fe and Al showed weaker correlations. For instance, the combined influence of clay content and soil organic carbon explained only 22 % of the variability in the slope of sorption isotherms using stepwise multiple regression ($p<0.05$). Soils with high levels of soil organic matter (> 4%), and low soil pH showed the greatest desorption potential (*b*). Clay content was correlated to ECEC ($R^2=0.20$, $p=0.0002$), however numerous clay soils with low levels of extractable Fe and Al displayed weak sorption characteristics. These findings support previous findings that the most important source of charge for DOC adsorption is Fe and Al oxides and hydroxides. However, this study did not find clay content to be a strong predictor of adsorption. In addition, this study did not find soil organic matter as a hindrance to adsorption processes, however soil organic content did increase the desorption potential.

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Spatial and temporal variability of soil moisture regimes under different soil management practices.

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Keywords: preferential flow, temporal stability, tillage, no-tillage.

Preferential flow is considered one of the main contributory factors of the phenomenon of rapid transport of contaminants from vadose zone to groundwater. The existing literature indicates that soil heterogeneity and soil management practices influence preferential flow. The behaviour of soil moisture regimes in the vadose zone can provide sufficient evidence as to the existence of preferential flow. Therefore, it can be hypothesised that the spatial and temporal stability of the soil moisture regime in the vadose zone could provide sufficient evidence capable of determining the existence of preferential flow.

Sixteen soil moisture sensors were installed in two transects located on two plots with different soil management practices, no-till and conventionally tilled. Each plot had four vertical columns of moisture sensors. Hourly measurements of soil moisture content were obtained over a period of two years, which included two growing seasons. The crop was rotated from corn to soybeans during the two growing seasons.

The graphical visualizations of the soil moisture changes along the vertical columns in both plots did not show any strong evidence of preferential flow and the semivariograms showed that the moisture content at 16 locations in each plot were uncorrelated. However, the analysis of the mean relative difference of daily average moisture content of the columns indicated that the soil moisture content along some columns show a considerable variability when compared to the rest of the columns. The time stability of the soil moisture regime along the columns varied between the first half of the growing season and the remainder, and appears to be influenced by the crop row positions, type of the soil management practice adopted, and the row crop (corn or soybeans). Further analysis of soil moisture stability; especially in relation to rainfall events, is required to confirm differences in preferential flow in the two transects.

Validation par les analyses foliaires du statut nutritif du bleuet nain sauvage

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Mots clés : bleuet, analyse foliaire

Afin d'optimiser la productivité et la rentabilité de la culture du bleuet (*Vaccinium angustifolium* Ait), de grandes quantités de fertilisants minéraux sont utilisés. Pour évaluer le statut nutritif du plant de bleuet, les éléments nutritifs des feuilles sont mesurés et comparés à des valeurs établies selon les conditions climatiques du Maine (Trevett 1962). Ainsi, l'objectif de cette étude était de valider ces valeurs sous les conditions climatiques du Lac-Saint-Jean. Des échantillons de feuilles provenant de quatre bleuetières ont été pris durant quatre années lors de l'année de végétation. Les teneurs en N, P, K, Ca et Mg des feuilles ont été déterminées. Pour le N foliaire, 16 % des échantillons ont eu des valeurs inférieures aux normes. Pour le P foliaire, 39 % des échantillons ont eu des valeurs inférieures aux normes. Pour le K, tous les échantillons ont rencontré la norme. Pour le Ca et Mg, 5 et 15 % des échantillons ont eu des valeurs inférieures aux normes. L'analyse des données a indiqué que plus de 83 % des valeurs sont décrites par leur moyenne respective avec \pm un écart-type. En comparant ces nouvelles valeurs aux normes établies du Maine, il est apparu que les niveaux optima en N, K et Ca des feuilles étaient semblables tandis que ceux en P et Mg étaient plus faibles. Ces ajustements des niveaux optima des éléments nutritifs dans les feuilles permettront de mieux gérer les fertilisants minéraux et de déterminer, sous les conditions climatiques du Lac-Saint-Jean, les seuils de carences ou d'excès.

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Residual soil nitrate after canola harvest

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Key words: residual soil nitrate, canola, nitrogen fertilizer, economically optimum N fertilizer application

Spring canola has high N requirements to reach maximum grain yields but excessive applications can result in an environmental degradation. The objectives of this study were to determine the effect of N fertilization on spring canola grain yields, to quantify the effect of N fertilization on residual soil nitrate content and to determine if residual soil nitrate content after harvest can be maintained at a reasonable level when N fertilization is based on the economically optimum N fertilizer application. Canola plots were established on two sites during two years. The treatments were five rates of mineral nitrogen (0, 40, 80, 120 and 160 kg N ha⁻¹) applied before sowing. Canola grain yields significantly increased with increasing N fertilizer rates. Increases of 554 to 1096 kg ha⁻¹ were measured. The economically optimum nitrogen fertilizer application derived from regression equations was 88 kg ha⁻¹ except for one site where the value was 58 kg ha⁻¹. Residual soil nitrate content measured at the harvest significantly increased with N fertilizer rates. The amount of residual soil nitrate estimated at the economically optimum nitrogen fertilizer application ranged from 10 to 46 kg ha⁻¹. The results have shown that residual soil nitrate after harvest can be maintained at a reasonable level (< 88 kg N-NO₃ ha⁻¹) when N fertilization is based on the economically optimum nitrogen fertilizer application.

Spatial variability of gas diffusion in agricultural soils

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Keywords: geostatistics, gas flux, agricultural fields, variograms, relative gas diffusivity

Gas diffusion affects plant and microbial growth (e.g. O₂, CO₂), the release of gases such as N₂O (when fertilized), CH₄ (in spring), NH₃ (after soil amendment), greenhouse gases, and the movement of volatile pesticides and their degradation (e.g. oxidation, microbial degradation) in agricultural soils. Water content (θ_v), soil temperature (T), and bulk density (ρ_a) of two similar sandy loam soils under corn-potato-soy rotation were monitored throughout a summer during the potato phase of rotation. Each site covered 1 ha and consisted of 108 measurement positions. An empirical model of soil gas diffusion (D_s) was used to predict gas diffusion at every position and every measurement times. Spatial variability of θ_v , T, ρ_a , and D_s were studied using geostatistical approaches. Spatial and temporal tendencies will be discussed along with their implications.

Spatial variability of CO₂ emission from sandy loam soils under potato production

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Keywords: geostatistics, greenhouse gas, agricultural fields, variograms

The variability of greenhouse gas fluxes affects the accuracy of the global greenhouse gas budget. It also influences the approaches used for measuring these emissions (spatial frequency and position). The CO₂ emissions from two similar sandy loam soils under corn-potato-soy rotation were measured four times during the growing season of the potato phase of rotation. Each site covered 1 ha and had 108 measurement positions. Closed chambers, with gastight syringes and vials were used for sampling gas emissions during 20 minutes. Gas concentration was measured on GC with a molsieve column and a TCD detector. Physico-chemical soil properties such as density, water content, and temperature were also measured at the same positions. Spatial variability of CO₂ emission was studied using geostatistical approaches. Spatial and temporal tendencies of gas emissions will be discussed along with their implications.

Soil changes in the first six years of an irrigated rotation study in Southern Alberta

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Keywords: soil quality, soil carbon, irrigated cropping, microbial biomass

Irrigated cropping offers a dual challenge of producing high value crops while maintaining soil quality. Common irrigated crops (e.g. potatoes, beans, sugar beets) produce little crop residue for return to the soil and tight rotations may have long-term detrimental effects on our soil resource in terms of diminished soil quality and increased erosion risk. An irrigated rotation study was initiated in 2000 at Vauxhall, Alberta to examine the impact of conventional and sustainable rotations for potatoes, sugar beets, beans and soft wheat. The sustainable rotations were built around four specific management practices: direct seeding/reduced tillage, cover crops, feedlot manure compost application and where beans occurred in the rotation, solid-seeded narrow-row beans vs. conventional wide row beans. There was a total of six rotations: 3-yr conventional and sustainable; 4-yr conventional and sustainable; 5-yr sustainable; 6-yr sustainable (which included 2 yr of timothy); as well as continuous wheat. In the 3-yr rotations, in fall 2005, (i.e. after 6 yr of the study), sustainable management had increased soil organic carbon (SOC) concentration by 42% over conventional management at the 0-7.5 cm depth (15.8 vs. 11.1 g kg⁻¹). For the 4-yr rotations, the increase was 25% (15.3 vs. 12.2 g kg⁻¹). The overall effect of sustainable management was to increase SOC mass by 22% (29.2 vs. 24.0 Mg ha⁻¹) in the top 15 cm depth by fall 2005. On the sustainable rotations, compost application, greatly increased SOC mass while inclusion of 2 yr of timothy was less effective. The 3- and 4-yr sustainable rotations averaged 26-27% higher than their conventional counterparts for microbial biomass C in bulk soil. Also, the cumulative effect, as evidenced by the overall average value (2002-2005), showed that the 3-yr sustainable rotation had significantly higher microbial diversity than its conventional counterpart (Shannon index of 2.59 vs. 2.25). The 5-yr sustainable rotation had a significantly higher Shannon index (2.50) than the 4 yr conventional rotation (2.22). At the 0-100 cm depth, 31% of 294 sampling dates [across all years (2001-05) and crops] showed a significantly higher percent available water under sustainable management while only 4% showed significantly higher available water under conventional management. Most soil parameters point to the beneficial effects of sustainable soil management for irrigated cropping.

Nitrates du sol et besoin en azote du blé panifiable

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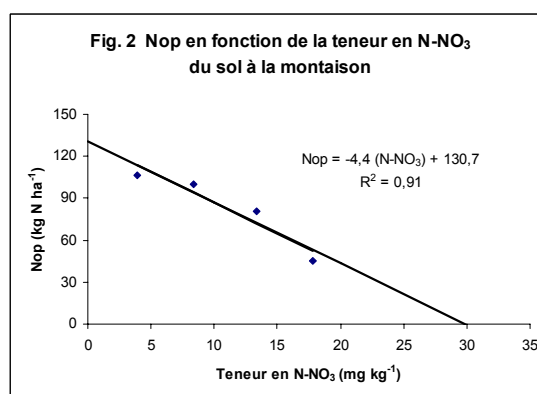
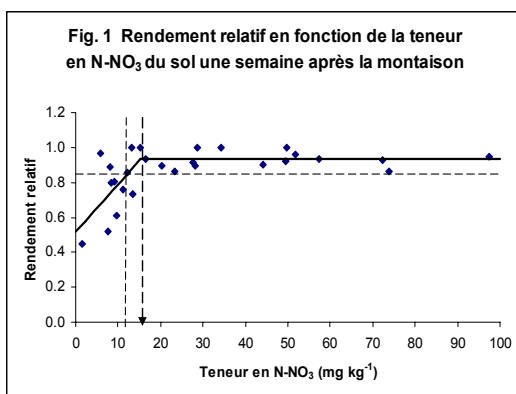
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Mots clés : azote, nitrates du sol, blé.

La volonté de limiter les conséquences environnementales de la surfertilisation azotée tout en maintenant un rendement économique élevé incite les producteurs agricoles à se doter d'outils de diagnostic afin de maîtriser la gestion de l'azote. Les tests de nitrates du sol pourraient offrir une avenue intéressante pour les producteurs de blé panifiable du Québec. Bien que la teneur en nitrates du sol mesurée en pré-levée était reliée au rendement relatif (Isfan 1993) et à la dose d'azote optimale (Nop) (Bélangier et al. 1998) pour cette culture, peu d'études ont été faites sur des tests en post-levée.

Des essais au champ ont été réalisés sur trois sites au Québec (Montréal Ouest, Montréal Est et Lanaudière) en 2004 et 2005. Le cultivar était AC Barrie. Un dispositif expérimental composé de quatre blocs complets aléatoires et de doses croissantes de N (0-200 kg N ha⁻¹) fractionnées entre le semis et la montaison fût établi à chacun des sites. Au cours de la saison de croissance, la teneur en nitrates des sols (0-15 cm) a été déterminée à huit dates en 2004 et cinq dates en 2005 à un intervalle d'une semaine à partir du stade zadoks 15 et 22 respectivement. Le rendement en grain a été mesuré à la récolte. Le rendement relatif et le Nop ont par la suite été calculés.

La méthode Cate-Nelson sur la relation linéaire plateau entre la teneur en nitrates du sol une semaine après la montaison et le rendement relatif (Fig. 1) a permis d'identifier une valeur critique en nitrates de 17 mg N-NO₃ kg⁻¹ au-dessus de laquelle l'ajout de N n'était pas justifié. Le Nop, calculé à quatre sites, était relié à la teneur en nitrates du sol à la montaison (Fig. 2), permettant ainsi de prédire la dose d'azote à appliquer pour des teneurs en nitrates inférieures à 30 mg kg⁻¹ afin d'atteindre le rendement économiquement optimal. Lorsque la teneur en nitrates est supérieure à 30 mg kg⁻¹, aucun apport d'azote n'était requis pour d'atteindre le rendement optimal. La teneur en nitrates des sols en post-levée semble donc un outil intéressant pour gérer l'azote dans la production de blé panifiable.



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Évaluation des effets d'un revêtement de mousse et de différents couverts forestiers, sur les propriétés hydriques d'un Podzol tourbeux

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Mots clés: infiltration, conductivité hydraulique, mousse, humus, forêt, Podzol.

Les propriétés physiques et hydrodynamiques des sols forestiers, avec ou sans couverture de mousse, sont méconnues. Or, les caractéristiques hydriques des mousses et des horizons organiques sont très différentes de celles des horizons minéraux. De plus, des études récentes montrent que les essences forestières peuvent avoir des impacts variables sur la physique des sols [Levrel et Ranger, 2006].

Le mandat de ce travail fut donc de caractériser l'influence à la fois des interfaces entre horizons organiques et horizons minéraux mais aussi l'influence des couvertures de mousses et d'horizons humifères, sur l'infiltration. Pour cela, une technique innovante a été employée, combinant un infiltromètre à disque et des mini-colonnes de sol sur lesquelles le potentiel hydraulique appliqué est évolutif [Caron et al., 2005 ; Caron et Elrick, 2005].

Une forêt ouverte plantée il y a 35 ans et localisée à proximité de la ville de Pont-rouge (près de Québec), a servi de site d'étude. Des essences forestières telles que le bouleau à papier, l'Épinette de Norvège, l'Épinette blanche, ainsi qu'un revêtement épars de mousse (dominance de *polytrichum* commune), représentent la couverture végétale de la parcelle. Les effets de ces couverts sur les conductivités hydrauliques et sur la macroporosité du sol, ont été comparés à celui d'un couvert de prairie.

Les résultats ont montré qu'au bout de 35 années, les essences forestières et fongiques semblent déjà avoir apposé leur empreinte sur le sol. Elles ont modifié sa structure et son fonctionnement hydrologique. La mesure de conductivité hydraulique avec la méthode de l'infiltromètre à disque, s'avère assez sensible pour distinguer l'effet des différents couverts à la fois pour les conductivités hydrauliques à saturation et pour les conductivités hydrauliques en milieu non saturé.

Ce travail met en évidence que dans une optique de modélisation hydrologique sur des bassins versants Québécois, il peut être judicieux de prendre en compte l'effet des humus forestiers et des mousses pour estimer le rôle des sols dans le bilan hydrologique [Verseghy, 1991 ; Fortin et al., 1995].

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Evaluation des infiltrations dans les sols boréaux du moyen-nord québécois, région de la Baie de James

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Mots clés: infiltration, modélisation, CLASS, mousse, sols boréaux.

On connaît peu les propriétés physiques et hydrodynamiques des milieux humides et des sols boréaux du moyen-nord Québécois. Or, cette région génère 40% de la production hydroélectrique de la province, et la connaissance de ces propriétés est primordiale lorsque des modèles hydrologiques tel qu'HYDROTEL [Fortin et al., 2001] ou climatiques tel que le MRCC [Music et Caya, 2007] sont utilisés pour évaluer les apports aux réservoirs hydroélectriques de cette région. Même si le modèle de surface du MRCC, CLASS « Canadian Land Surface Scheme », a été quelque peu modifié pour mieux tenir compte de ces propriétés [Admiral et Lafleur 1999; Comer et al. 2000; Lafleur et al. 2000; Lafleur et al. 1996; Letts et al., 2000], il n'en demeure pas moins que les influences des interfaces entre horizons organiques et horizons minéraux ainsi que l'influence des couvertures de mousses et de lichens, sur l'infiltration, restent encore mal connues. Nous disposons pour cette étude d'un site qui se localise à l'Est de la Baie de James (Centre-Ouest du Québec), à proximité de la Rivière La Grande, le bassin versant de la Nécopastic (54°N, 78°O). Les sols sont développés principalement sur des substrats drainants sableux. Le couvert est constitué de forêts boréales ouvertes sur des tourbières majoritairement ombrotrophes. Les sols peuvent également être surmontés de pessières à lichens ou à mousses. Dans le cadre de cette étude, nous souhaitons affiner la cartographie pédologique du bassin versant. Les sols des principales unités pédologiques seront ensuite reconstitués en colonnes au laboratoire. Nous allons étudier les effets des horizons pédologiques isolés, puis le rôle de leurs interfaces, et pour finir nous étudierons l'incidence des couverts de mousse et de lichens, sur les écoulements et l'infiltration [Price et al.; Caron et Elrick 2005]. Une des retombées majeures de ce travail sera la production d'une base de données géographiques des propriétés physiques et hydrodynamiques des sols organiques du bassin versant de la Nécopastic.

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Characterizing scale- and location- dependent correlation of water retention parameters with soil physical properties using wavelet techniques

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Keywords: water retention parameters; wavelet spectrum; wavelet coherence

Understanding the correlation between soil hydraulic parameters and soil physical properties is a prerequisite for prediction of soil hydraulic properties from soil physical properties. The objective of this study is to examine the scale- and location-dependent correlation between two water retention parameters (α and n) in van Genuchten (1980) function and soil physical properties (sand content, bulk density and organic carbon content) using wavelet techniques. Soil samples were collected from a transect from Fuxing, China. Soil water retention curves were measured and the van Genuchten parameters were obtained through curve fitting. Wavelet coherency analysis is used to elucidate the location and scale dependent relationships between these parameters and soil physical properties. Results showed that the wavelet coherence between α and sand content is significantly different from red noise at small scales (8-20 m) and from distance 30 to 470 m. Their wavelet phase spectrum is predominantly out of phase indicating negative correlation between these two variables. The strong negative correlation between α and bulk density exists mainly at middle scales (30 to 80 m). However, parameter n has strong positive correlation only with bulk density at scales between 20 and 80 m. Neither of two retention parameters has significant wavelet coherency with organic carbon content. It suggested that location-dependent scale analyses are necessary to better the performance for soil water retention characteristics predictions.

Tillage erosivity of potato production systems in Canada

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Keywords: soil erosion, tillage erosion, erosivity, potato production

Tillage is an erosive force, just as wind and water are, causing soil movement and soil erosion within cultivated landscapes. Tillage erosion is a significant form of soil erosion that has caused considerable degradation of cropland across Canada. Using the Tillage Erosion Risk Indicator (TILLERI) model, it was estimated that about 50% of cropland exceeds sustainable levels of tillage erosion.

Tillage erosion is a function of the erodibility of the landscape and the erosivity of the tillage system used. Crops that are frequently tilled with implements that move large amounts of soil over great distances are highly erosive. Changes in tillage erosion are achieved by changing the erosivity of cropping and tillage practices. Accurate assessments of tillage erosion and of the effectiveness of control measures require values of tillage erosivity for a range of tillage practices for a variety of crops.

Potato production is an important form of crop production in Canada, significant for its predominance in specific regions of the country and for its dependence on intensive tillage. To date, there is only one study of tillage erosion specific to potato production in Canada, and only a couple worldwide. To generate estimates of tillage erosivity for cropping and tillage practices associated with potato production systems, a thorough examination of farm management practices and of data from relevant tillage erosion studies was carried out. Estimates of tillage erosivity are presented for a suite of crop rotations associated with potato production and for conventional and conservation tillage systems.

Reverting to conventional or zero tillage: changes in soil microbiological properties

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Keywords: Conservation tillage, microbial biomass, microbial diversity, crop rotation

We investigated the response of soil microbial biomass and diversity in the first two years of reverting to conventional tillage (CT) from zero tillage (ZT), and vice-versa, after 21 years of CT and ZT at Swift Current, Saskatchewan. Zero tillage and conventional tillage treatments were established in 1982 under fallow-wheat (F-W) rotation or continuous cropping with wheat (W-W). In 2003, some plots were split to accommodate reversal of the tillage systems, i.e., zero tillage was converted to conventional tillage, and vice versa. In 2004 and 2005, soil microbial biomass C (MBC) and the diversity of bacteria were measured in wheat rhizosphere and bulk soil (0-7.5 cm depth) in the original treatments (CT and ZT) and converted treatments (CT-to-ZT and ZT-to-CT). In 2004 in wheat rhizosphere, tillage effects on MBC varied with rotation. In F-W rotation, CT had lower MBC than ZT, and reverting to ZT (CT-to-ZT) increased MBC whereas changing from ZT to CT decreased MBC. In W-W cropping, ZT had lower MBC than CT, and reverting to CT (ZT-to-CT) increased MBC whereas converting from CT to ZT decreased MBC. A similar interaction was observed in bulk soil in 2005. Differences in soil bacterial diversity were not significant, but a similar pattern was observed in bulk soil in 2005. Therefore, the effects of tillage and tillage conversion on MBC and, to a less extent, bacterial diversity, in the F-W system were the opposite of those in the W-W system, i.e., ZT increased MBC in the fallow-based system, but decreased MBC in the continuous wheat system. This difference suggests that there may be a similar interaction between tillage and rotation in amounts of organic materials that are returned to the soil, and the observed differences in MBC may be an early indicator of potential differences in soil organic C.

Greenhouse gas emissions from organically managed potato rotations in Atlantic Canada

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Keywords: Organic agriculture, greenhouse gases, forage legumes, potatoes, compost

Organic potato production systems are characterized by extended rotations (4yr+) involving leguminous crop green manures, often combined with organic amendments. In these soils, the absence of inorganic N fertilizer, reliance on legume N₂ fixed from biological nitrogen fixation (BNF), and relatively high quantities of stable organic matter may regulate the availability of nitrogen and carbon needed for release of greenhouse gases (GHG) (CO₂, N₂O and CH₄). Other potential benefits of organically managed soils, such as improved physical structure, may also reduce trace gas emissions.

Trace gas emissions from legumes reliant on BNF have recently been shown to be much lower than previously estimated. However, very little Canadian data on *in situ* N₂O emissions as a function of red clover management appears to be available (Rochette and Janzen 2005). Composts turn over slowly in soil, and as much as 80% or more of compost N is often plant available in the years after application (Lynch et al. 2006). Only a limited number of studies, however, have measured GHG emissions from compost-amended soil, and examined the impact of compost use on key related soil physical, biological and chemical properties. Ginting et al. (2003) found that while the benefits of compost to soil C and N indicators were still evident four years after compost application, residual effects on CO₂, N₂O and CH₄ emissions from soil were minimal.

Research trials commenced in 2006 at the Nova Scotia Agricultural College (NSAC) and AAFC Bouctouche, NB are examining trace gas emissions under potato crop rotation sequences fertilized organically (green manures, compost) or through application of standard rates of inorganic N fertilizer. At NSAC, the effect of crop (red clover, timothy or potato), timing of forage tillage (spring/fall), and potato fertility regime (preceding crop with or without fertilizer N addition) on N₂O emissions is being determined. At the AAFC Bouctouche site, variable rates of compost application are compared with inorganic N fertilization in potato rotation sequences to determine effects on N₂O emissions, potato yield and N uptake. At both sites, N₂O flux measurements were made weekly to bi-weekly from early spring to late fall using a non-flow-through, non-steady-state chamber with a total volume of 1.6 L covering a soil area of 315 cm². Soil samples (0-15cm) were taken at each gas sampling, and analyzed for available N and C. Interim results from year 1 (2006) will be presented.

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Nutrient Availability and Microbial Community Structure in Reclaimed Oil Sand Boreal Forest Soils

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Keywords: Land reclamation, phospholipids, resin membrane, ordination, season

The Athabasca oil sands region in northeastern Alberta is the largest single oil reserve in the world with an estimated one trillion barrels of bitumen. The current footprint of the companies operating in this area is approximately 150 km² and it is expected to increase by as much as 1000% by the year 2025. Much of the oil is extracted by large scale surface mining which represents a disturbance that is parallel in magnitude to glaciation, where not only is above ground vegetation removed, but the geologic substrate is also removed. Decommissioned mines are reclaimed with a combination of stock-piled substrates leading to Anthrosols with artificial horizons. The land reclamation treatments examined here consisted of a salvaged peat-mineral mix horizon overlying horizons of mineral materials such as tailing sand, lean oil sand and overburden. The objective of this project is to examine ecosystem function as it is related to microbial community structure and nutrient availability. Our hypotheses are that nutrient availability will vary more greatly than microbial community structure, and that site, slope position and season will cause more variability in these factors than will time since reclamation or peat type. To examine nutrient availability we installed plant root simulator (PRS) probes, which consist of a resin membrane that adsorbs ions from soil solution, much in the same way as plants. We used phospholipid fatty acid (PLFA) analysis to examine microbial community dynamics, as this method has been extremely useful in monitoring shifts in community structure. Replicate samples were taken from three slope positions at three sites on three dates (June and August 2005, and August 2006) and non-metric multi-dimensional scaling (NMS) was used to examine trends in the data set. Preliminary results indicate that site and season affect variability in both soil nutrient availability and microbial community dynamics more so than slope position, peat type and age. A lack of vegetation at one of the sites is also an extremely important factor in driving nutrient fluxes. Finally, nutrient availability seems to vary more than microbial community structure, supporting one of our hypotheses.

Greenhouse gas production and emissions in Saskatchewan boreal forest soils

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Keywords: methane, nitrous oxide, boreal forest

Despite the spatial significance of Canada's boreal forest, there is very little known about greenhouse gas emissions within it. The primary objective of this project was to study the atmosphere-soil exchange of CH₄ and N₂O in the boreal forest of northern Saskatchewan. In the summer of 2006, greenhouse gas emissions were measured along transects in three different mature forest stands (Aspen, Black Spruce and Jack Pine) using a sealed chamber method. In addition, the relative contribution of nitrification to N₂O emissions was measured using a stable isotope technique in which ¹⁵N-enriched nitrate was injected into intact soil cores. The amount of ¹⁵N found in the emitted N₂O was used to determine the relative contribution of denitrification to total N₂O emissions. Results indicated that the Jack Pine and Black Spruce sites were slight sinks of CH₄ (-1.23 kg CH₄-C ha⁻¹ yr⁻¹ and -0.17 kg CH₄-C ha⁻¹ yr⁻¹ respectively), whereas the Aspen site was a net source (44.0 kg CH₄-C ha⁻¹ yr⁻¹). All three sites had very low cumulative N₂O emissions, ranging from 0.08-0.12 kg N₂O-N ha⁻¹ yr⁻¹. Of the environmental controls examined, water-filled pore space had the strongest correlation with emissions. At the Aspen site, the drier uplands were the primary source of cumulative N₂O emissions, and the ¹⁵N results indicated that these were due to a nitrification related process. The moist depressions were the primary source of CH₄, and also emitted some N₂O, which ¹⁵N measurements indicated were denitrification related.

Contributions of organic and mineral soil fractions to soil carbon and nitrogen dynamics in tilled and minimum-tilled arable land

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Keywords: SOM fractionation; N mineralization; Nitrification; Conventional tillage; Minimum tillage

Developing sustainable strategies to maintain soil organic matter levels is important to improve the carbon sequestration capacity of agricultural soils and to maintain nutrient availability. In this study, we assessed the effects of tillage practices and the relative contributions of different soil organic matter fractions on soil organic carbon storage and nitrogen dynamics. Soil samples were collected from conventional and minimum tilled fields in Maulde (Belgium). A size and density fractionation procedure (Huygens et al., 2005; Meijboom et al., 1995) was used to separate SOM into five fractions: a light (LF, $< 1.37\text{g cm}^{-3}$) and a heavy (HF, $> 1.37\text{g cm}^{-3}$) 150-2000 μm -sized macro-organic matter fraction, and three mineral fractions (150-2000 μm , 50-150 μm and < 50 μm). All fractions were analyzed for total C, total N, and natural ^{13}C and ^{15}N abundance. Nitrogen dynamics was assessed by measuring net N mineralization and nitrification during a 4 week incubation experiment using whole soil and isolated SOM fractions (LF and HF). Minimum tilled soil showed a higher total C and total N content compared to CT soil. The HF and < 50 μm fraction accounted for most of the difference in total C between MT and CT. Because of the higher weight of HF in the MT, the organic carbon stabilization capacity of the MT was attributed to the < 50 μm fraction. In the MT, cropped with C_3 plants, the different SOM fractions showed the following trend in $\delta^{13}\text{C}$ signature: LF and HF $< 50\text{-}150$ μm $< (< 50$ $\mu\text{m}) < 150\text{-}2000$ μm mineral fraction, indicating an increasing degree of humification across these macro organic matter and mineral size fractions. The introduction of maize in the CT crop rotation caused intermediate $\delta^{13}\text{C}$ values of the LF, HF and 150-2000 μm mineral fraction between common $\delta^{13}\text{C}$ signatures of C_3 and C_4 plants. However, the 50-150 μm and < 50 μm fractions showed more depleted $\delta^{13}\text{C}$ values suggesting that the input of maize did not yet influence their isotopic signature due to their slow turnover rate. The potential N mineralization rate and rate constant of the LF and HF of CT soils were significantly greater than those of MT soils, in contrast to the whole soil potential N mineralization rate which showed the opposite trend (i.e. greater for MT soil though not significantly). The latter, which is most likely a result of the higher total N levels under MT than CT, suggests that although MT managed soils have less degradable organic materials than CT soils; MT soils are more prone to processes causing the release of N components in the soil system.

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Phosphorus export response to best management practices in paired-watershed design experiments

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Keywords: phosphorus, water quality, runoff, erosion, watershed.

Reduction of non point source sediment and nutrient loads related to agricultural land use has been identified as a priority for Etchemin, Pike and LaGuerre basins, where paired-watershed design experiments (control and treatment watersheds, 3-8 km² in size) were established in 2001. The objectives of the cooperative “Action-Research” network were 1) to describe the non-point source sediment and nutrient transfer processes to the aquatic ecosystem through outlet monitoring and description of landscape and agricultural production systems and 2) to evaluate the water quality response to best management practices (BMP's) implementation at watershed scale. Planning and implementation of BMP's were based on spatially-referenced geophysical and management data including a precision-scale digital elevation model (DEM) and derived surface runoff flow paths, hydrologically active areas revealed by multispectral airborne photography and erosion marks photographed in early spring and located by GPS. Watershed treatments, based on voluntary landowner participation and 70% cost-sharing, included systematic riparian buffers establishment along stream reaches, implementation of structural runoff controls on critical erosion and runoff-sensitive areas (catch inlets, filter trench, grassed waterways and streambank bioengineering) as well as introduction of no-till and cover cropping on significant land acreages. Stream monitoring included continuous discharge recording, continuous geochemical signal monitoring (conductivity, turbidity and pH) and intensive grab sampling for nutrients and suspended solids. Monitored sediment and phosphorus loadings were temporally episodic in nature and occurred dominantly during peak stream flow events and under late-winter/early-spring conditions when overland runoff was generated through snowmelt or precipitation on thawing or saturated soils. Comparisons of watersheds geochemical signals and covariance analysis (ANCOVA) of discrete sampling water quality data, using stream flow as a covariate, highlighted seasonal and landscape-driven hydrologic controls on surface runoff, erosion and P transfer amongst watersheds. ANCOVA analysis of suspended solids and P concentrations and loadings of treatment watersheds comparing calibration (2001-2003) and evaluation (2004-2006) periods, using respective control watershed data as covariate, also highlighted significant water quality response to BMP's treatment. The project clearly demonstrated the potential for concerted land owners action on riparian zone restoration, structural runoff control and soil conservation practices to reduce non point source contamination of surface water in rural watersheds of Quebec.

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Le chaulage : un traitement efficace pour revigorer les érablières dépérissantes

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Mots clés: Chaulage, érable à sucre, dépérissement, érablière.

Au cours des années 1980, le dépérissement de l'érable à sucre a été observé à la grandeur de son aire de distribution au Québec, de même qu'ailleurs dans le nord-est de l'Amérique du Nord. Malgré l'amélioration de la santé de la plupart de ces érablières au cours des dernières années, certaines ont continué à montrer des signes de progression du dépérissement. C'est le cas à la station expérimentale du bassin du lac Clair (Duchesnay) dans les Basses-Laurentides, située à environ 50 km au nord-ouest de la ville de Québec. Des études réalisées dans ce secteur ont montré que les précipitations acides jouent un rôle majeur dans l'occurrence du dépérissement, en accélérant la perte de calcium et en magnésium dans ces sols naturellement très acides et pauvres en ces éléments. Dans ce contexte, une étude de chaulage a été entreprise en 1994 afin de démontrer le lien qui existe entre les carences en calcium et en magnésium du sol et la vigueur de l'érable à sucre (croissance, dépérissement) et de documenter la réaction à long terme de cette essence au chaulage.

Un chaulage expérimental de l'érablière de Duchesnay a permis de démontrer que ce type de traitement a un effet bénéfique à long terme sur la santé de l'érable à sucre (Moore et Ouimet 2006). De plus, l'ampleur de la réaction des érables après dix ans laisse présager que l'effet se poursuivra encore plusieurs années. Ultimement, en revigorisant ainsi les érables dépérissants, le chaulage pourrait permettre de conserver la représentativité de l'érable à sucre dans les érablières situées sur des stations de faible fertilité.

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Litter decomposition in temperate peatland ecosystems: the effect of substrate and site

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Keywords: Bog, fen, tissue quality

The large accumulation of organic matter in peatlands is primarily caused by slow rates of litter decomposition. We determined rates of decomposition of major peat-forming litters of vascular plants and mosses at five sites: a poor fen in New Hampshire and a bog hummock, a poor fen, a beaver pond margin and a beaver pond in Ontario. We used the litterbag technique, retrieving triplicate litterbags 6 or 7 times over 3 to 5 years, and used that simple exponential decay and continuous-quality non-linear regression models could adequately characterize the decomposition in most cases. Within each site, the rate of decomposition at the surface was generally *Typha latifolia* leaves = *Chamaedaphne calyculata* leaves = *Carex* leaves > *Chamaedaphne calyculata* stems > hummock *Sphagnum* = lawn/hollow *Sphagnum*, with exponential decay constant (k) values generally ranging from 0.05 to 0.37 and continuous-quality model initial quality (q_0) values ranging from 1.0 (*Typha* leaves) to 0.7 (*Sphagnum*). In general, surface decay rates were slowest at the bog hummock site, which had the lowest water table, and in the beaver pond, which was inundated, and fastest at the fens. The continuous-quality model site decomposition parameter (u_0) ranged from 0.80 to 0.17. Analysis of original litter samples for C, N and proximate fractions revealed a relatively poor explanation of decomposition rates, as defined by k and q_0 , compared to most well-drained ecosystems. Three litters, roots of a sedge and a shrub and *Typha* leaves, were placed at depths of 10, 30 and 60 cm at the sites. Decomposition rates decreased with depth at each site, with k means of 0.15, 0.08 and 0.05 yr⁻¹ at 10, 30 and 60 cm, respectively, and u_0 of 0.25, 0.13 and 0.07. These differences are primarily related to the position of the water table at each site and to a lesser extent the cooler temperatures in the lower layers of the peat. The distinction between bog and fen was less important than the position of the water table. These results show that we can characterize decomposition rates of surface litter in northern peatlands, but given the large primary productivity below-ground in these ecosystems, and the differential rates of decomposition with depth, subsurface input and decomposition of organic matter is an important and relatively uncertain attribute.

Soil physical and chemical properties along a boreal wetland-upland catena, coupled with LiDAR-based soil wetness modeling: a case study for central Alberta

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Keywords: soil moisture, soil nutrients, spatial modelling, soil catena, LiDAR.

Soil moisture or drainage conditions tend to vary along soil catena toposquences and are closely associated with other soil chemical and physical properties. Such properties were investigated for a wetland to upland catena in the boreal forests of the Swan Hills, Alberta. Soils were characterised for points along several transects. One transect was sampled by horizon from soil pits, while bulk auger samples were taken from the others. Results from a newly developed GIS approach to topographic modelling of soil moisture conditions were related to these soil characteristics. The utility of both a high resolution (1 m) LiDAR DEM and a lower resolution (10 m) photogrammetric DEM for spatial modelling was assessed. Soil characterisation included soil classification, organic depth, drainage, moisture regime, texture, pH, exchangeable cations, Fe, Al and Zn, total C, N and S (Leco combustion), available P and ammonium and total P, K, Ca, Mg, Mn, Fe, Zn and Al. The potential for DEM modelling of such soil characteristics across the landscape was examined. Such approaches may be able to add significantly to the resolution and reliability of soils data available to forest operations planners and other natural resource managers, moving operations towards sustainable management. They may also be able to provide insight into the processes of nutrient cycling and transport at the landscape scale.

Apparent phytotoxicity of boreal bark substrates on two horticultural species: terpenes, metals or aeration.

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Keywords: boreal barks, phytotoxicity, aeration.

In Québec (Canada), approximately 3.5 million tons of barks are produced annually, 10 % of which are buried or burned without use or recycling. The horticultural industry could certainly use such by-products as growing media. Previous work has already shown the possible use of composted bark as an additive or as a main component of substrate mixes. However, growing media made of fresh bark often show plant growth reduction. Risk of phytotoxicity could come from high concentration of organic molecules often found in fresh barks, such as phenolic, terpenes or organic acids, or from too high heavy metals concentrations. Some studies have reported, for bark based substrates, that large particles size increased air-filled porosity by increasing the proportion of drainable macropores, but their geometry (shape, size) created barriers to gaseous exchange and bioavailability in the porous medium, with corresponding yield decreases. Thus, these gas exchange physical barriers could also cause the observed plant growth reduction. Therefore, the objectives of this study were: to evaluate the phytotoxicity of barks of seven different tree species on the germination of lettuce and on tomato growth and to identify the possible factors of physical (aeration, water availability), chemical or biochemical (heavy metals, phenol, terpenes, sugars concentrations) origin causing those reductions. With respect to germination of lettuce and dry matter production of tomato, bark origin affected both plant performance indicators. For both, best results were obtained with raw paper birch bark, and this treatment was superior to performances obtained with the control (rockwool), a commonly used product by growers. Chemical, biochemical and physical properties were correlated to plant growth parameters. Among these properties, air-filled porosity was significantly correlated to shoot dry weight and germination index. Plant growth parameters were also related to biochemical fractionation of organic matter properties: Li + Cu and the soluble fraction, probably reflecting reduced microbial competitive effect with slowly decomposable organic matter. All these results seemed to indicate that the apparent phytotoxicity of some barks could be explained by a lack of aeration in the substrate. This implies that active growing media, with strong micro-organisms activity, the Air-filled porosity should be higher than in inert substrates.

Estimation of nitrogen availability by means of carbon stability in organic amendments and fertilizers

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Key words: Organic amendment and fertilizer, carbon stability, nitrogen efficiency coefficient

Routine analytical methods to predict the N efficiency coefficient (NEC) of organic amendments and fertilizers (OAFs) must be developed to improve their N management. Our objective was to relate humification and biological stability indices to potentially mineralizable N (N_o) in OAFs incorporated into soils and to compare NEC of OAFs with the values currently used in Quebec.

We incubated 12 manure, compost and biosolid OAFs of contrasting C/N ratios and C stability with a L'Acadian silt loam and a Morin sand for 26 wk. The C stability of OAFs was estimated using a biological stability index, BSI (AFNOR 2005) and the ratio of absorbance at 600 nm to organic C content, A6C (Ikeya and Watanabe 2003) and the spectrofluorimetric humification degree, HD (Zsolnay et al. 1999).

The N_o was more highly correlated to A6C, HD, and BSI ($r = -0.86$ to -0.90) than to the C/N ratio ($r = -0.63$ to -0.68). The N_o was more closely related to BSI ($R^2 = 0.86$) and HD ($R^2 = 0.87$) than to A6C ($R^2 = 0.70$). The HD and BSI appeared to be more reliable estimators of N_o than A6C for OAFs with low C stability. The NECs computed by dividing mineral N plus N_o by total added N was found to be close ($r^2 = 0.84-0.86$) to NECs currently used in Quebec (CRAAQ 2003). The proposed model based on analytical data therefore appeared to be valuable across manures, composts, and biosolids by accounting for specific mineral and organic N contents. The assessment of N_o from BSI and HD could be a useful tool for OAFs N management in Canadian agroecosystems.

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Timing and rate of N fertigation affect nutrition, yield and quality of apples in high density orchards

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Keywords: colour, firmness, fruit, leaf, nitrogen.

Fertigation offers the potential to develop a more efficient N fertilization regime in horticultural production systems by reducing unit area N application rates and synchronizing N application with plant demand. Furthermore, applying N dissolved in irrigation water results in considerable flexibility in timing of application. In order to assess the effects of rate and timing of fertigated N on apple (*Malus domestica Borkh*), a randomized, replicated experiment was established and maintained for the first five growing seasons in a high density apple orchard (3300 trees per ha.) on M.9 rootstock. Six N fertilizer treatments (main plot units) were applied annually through drip irrigation lines to three-tree subplots, containing five cultivars (Gala, Fuji, Cameo, Ambrosia and Silken). Treatments included daily applications at high N (target soil solution concentration of 168 mg N/L) and low N (28 mg N/L) each treatment applied at time A (0-4 weeks postbloom (pb)), time B (4-8 weeks pb) and time C (8-12 weeks pb). Irrigation was applied daily according to evaporative demand measured by an atmometer. Maintaining a high N fertilizer regime for the first five growing seasons increased cumulative yield (7%), leaf N concentrations (less than 10%) and fruit N concentrations (10-20%) but consistently decreased fruit firmness and to a lesser extent per cent red colour. Changing the timing of application of N-fertilizer altered leaf and fruit N concentrations but had few consistent effects on fruit quality and yield. Differences among cultivars in yield and fruit quality were larger in magnitude than differences among fertigation treatments.

Changes in Soil Health throughout an Organic Potato Rotation

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Key words: soil health indicators, organic farming, potato, rotation, *Folsomia candida*

Soil health is a central concept of sustainable agriculture and can be defined as the “capacity for a specific soil to function within natural or managed ecosystem boundaries, to sustain biological productivity, maintain environmental quality, and promote plant, animal and human health” (Doran 1996). Organic field crop production in Eastern Canada utilizes extended rotations to sustain soil fertility and maintain soil health. The aim of this study is to evaluate changes in soil health indicators throughout a 5 year rotation period following the potato crop. These changes are being assessed by using (i) a set of biological, physical and chemical soil indicators of the overall system function, and (ii) the soil organism, *Folsomia candida*, an ISO indicator of soil pollution, as a potential standard biological indicator of changes in soil health. In 2006, the total and available soil C and N, microbial biomass C, light fraction (LF), bulk density, as well as earthworm abundance and biomass for each year of a 5 year grain/forage/potato rotation were examined at four organic potato production sites in New Brunswick and Prince Edward Island. Long term permanent pasture sites (10+ years) located adjacent to the fields were also sampled as reference fields to determine the influence of the rotation on soil health. Preliminary results suggest that the number of years in rotation after a potato crop has no significant effect on soil bulk density ($P=0.707$), pH ($P=0.238$), total soil carbon and nitrogen concentration or ratio ($P=0.930, 0.937, 0.660$ respectively) and the amount of LF ($\text{g LF kg}^{-1}\text{soil}$) ($P=0.498$). However, mean overall earthworm abundance and biomass were significantly ($P=0.0001, 0.012$ respectively) affected by the duration of the rotation period. Earthworm abundance and biomass was lowest following the potato crop ($\bar{X}=73.5/\text{m}^2$ and 32.2 g/m^2 respectively) and did not recover to the level of that in the pasture fields until after 4 or 5 years in the rotation ($\bar{X}=493.5/\text{m}^2$ and 215.4 g/m^2 ; $450.3/\text{m}^2$ and 168.4 g/m^2 respectively). Our preliminary results suggest that biological indicators may be more responsive to early changes in the soil health than soil physical and chemical properties. Initial testing of *Folsomia candida* growth response to artificial soils with different soil characteristics is underway. Eventually, they will be tested against soil collected from the phases of the rotation in 2007.

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Time Domain Reflectometry: Développement D'un Modèle Pour Déterminer Le Contenu En Eau Volumique Des Substrats Organiques.

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Depuis deux décennies, la technique de réflectométrie métallique est fréquemment utilisée pour mesurer la teneur en eau volumique (θ) des sols. Pour déterminer θ , le TDR utilise la constante diélectrique apparente (K_a). La relation entre K_a et θ est décrite à l'aide de modèles empiriques comme celui de Topp et coll (1980) pour les sols minéraux et celle de Paquet et coll (1993) pour les substrats tourbeux. L'équation de Topp est peu efficace pour les milieux artificiels et l'équation de Paquet et coll (1993) est valide jusqu'à une constante diélectrique de 55. Cependant, lorsque les terreaux sont saturés d'eau ou tout près d'un état saturé, la constante diélectrique d'eau dépasse 55 pour la plupart des milieux artificiels organiques. L'objectif de ce projet de recherche est de développer un modèle empirique permettant de déterminer avec précision la teneur en eau volumique dans des milieux artificiels organiques à partir des mesures de la constante diélectrique d'eau. Trente substrats tourbeux ont été étudiés. Les substrats ont été empotés dans des cylindres (200-mm hauteur 200-mm i.d.) en PVC et ont été saturés. Après saturation, les cylindres ont été drainés par gravité et ensuite placés sur des tables de tension pour plus de drainage. Plusieurs mesures de K_a et de θ ont été effectuées sur chacun des cylindres durant la période de drainage. Un modèle cubique a été ajusté sur les données observées ($R=0.97$). En comparaison avec les modèles existants (Topp et Paquet), le modèle développé est plus efficace pour déterminer la teneur en eau volumique des substrats organiques. Puisque le modèle a été développé seulement à partir de substrats organiques, il est mieux adapté pour les substrats artificiels. En utilisant le modèle développé, il est possible de déterminer θ à une constante diélectrique apparente d'eau plus élevée que 55 (près de la zone de saturation des terreaux organiques), à des valeurs qui sont fréquemment observées avec les substrats artificiels.

Classification et cartographie du drainage des sols à partir d'images multi-temporelles RADARSAT-1.

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Mots clés : mise à jour des cartes de sol, télédétection, radar à synthèse d'ouverture, humidité des sols

L'utilisation des données pédologiques à la modélisation des processus environnementaux et à la planification de l'aménagement du territoire requiert une mise à jour des cartes de sol disponibles. En effet, celles-ci sont parfois obsolètes et ne sont pas assez précises et fiables pour l'échelle d'intervention visée. Le recours aux méthodes traditionnelles de prospection des sols est long et coûteux. Il est donc nécessaire de développer des méthodes de cartographie des sols plus efficaces. La classification du drainage des sols est une des propriétés pédologiques les plus utilisées dans les modèles d'interprétation ou de prise de décision environnementale. Les données de télédétection radar, notamment celles acquises à partir du satellite canadien RADARSAT-1, se sont avérées très utiles pour prédire la variabilité spatio-temporelle de l'humidité des sols. L'objectif de ce projet était donc d'évaluer le potentiel des images Radarsat-1 pour classifier et cartographier le drainage des sols à l'échelle du bassin versant agricole.

L'étude a été réalisée dans le bassin versant du Bras d'Henri (167 km²) où une étude pédologique semi-détaillée (échelle de 1 :40 000) a été menée selon les méthodes traditionnelles (1612 profils de sols) afin de mettre à jour l'information pédologique disponible dont l'année de publication variait de 1957 à 1995. Cinq des sept classes utilisées par les experts pour décrire le drainage des sols selon les normes du système canadien de classification des sols (bien à très mal drainés) étaient présentes dans le bassin versant. Afin de réduire l'impact du biais des experts dans l'application du système de classification du drainage, une méthode de groupement statistique multidimensionnel (méthode *Kmeans*) a été utilisée pour générer une classification normalisée des sols selon quatre classes en intégrant un ensemble de descripteurs morphologiques du sol : profondeur au gley, couleur de la matrice, texture et teneur en matière organique du sol, etc.). Six images RADARSAT-1 de la zone à l'étude (60 km²) ont été acquises au printemps 2005, soit les 3, 10, 24 et 27 mai et 10 et 17 juin, en mode standard (S) ascendant (a) ou descendant (d), soit respectivement S2a, S1a, S3d, S2a, S2d et S3d. Les images du 3 et du 27 mai permettaient également de comparer l'évolution temporelle de l'humidité de surface et du drainage des sols car elles ont été acquises selon les mêmes conditions d'acquisition d'image (mode S2a). Le contenu en humidité des sols a été mesuré parallèlement à l'acquisition des images dans six sites d'entraînement représentant la diversité pédologique de la zone à l'étude. Une analyse discriminante avec transformation *logit* a servi à dériver les modèles de classification du drainage des sols à partir des données radar.

Les données radar du 3 mai et du 27 mai sont celles qui différencient le mieux les classes de drainage des sols. Le 3 mai, ce sont les classes de sols mieux drainés que l'on distingue le plus facilement des sols plus mal drainés car elles présentent, en condition de sols nus, des différences de coefficients de rétrodiffusion de 2 db. Le pourcentage de bonne classification est alors de 88%. Les classes intermédiaires sont les moins bien classées. Sous couvert végétal (prairie, forêt et terres humides), la discrimination des classes est plus difficile avec un pourcentage de bonne classification de 57%. Des conditions de rugosité plus variables pourraient expliquer ces résultats. L'accès prochain à des données radar multipolarisées (HH, VV, HV, RR, LL et RL) et entièrement polarimétriques à haute résolution spatiale (3m) du satellite RADARSAT-2 devrait favoriser l'amélioration des modèles de classification du drainage des sols.

Prédiction du rendement de maïs (*Zea mays L.*) et de la nutrition azotée par l'analyse en composantes principales.

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Mots-clés: maïs, rendement, azote prélevé, analyse en composantes principales, indicateurs de disponibilité de l'azote.

Le rendement des cultures et le prélèvement de l'azote (N) dépendent de l'interaction de plusieurs facteurs du sol. Lors d'une analyse de régression avec des paramètres hautement corrélés, le phénomène de multicollinéarité est présent de sorte que deux ou plusieurs variables sont susceptibles de fournir une information redondante au modèle de prédiction (Bowerman et O'Connell 1990). L'analyse en composantes principales (A.C.P) permet de contourner cette difficulté, en groupant les paramètres hautement corrélés entre eux, les groupes créés pouvant ainsi être utilisés comme de nouvelles variables (Shukla et al. 2004). L'objectif de la présente étude vise à déterminer la variabilité en rendement et nutrition azotée du maïs expliquée en tenant compte des 16 paramètres du sol. L'A.C.P. combinée avec la régression « stepwise » a été utilisée afin de déterminer la relation entre les composantes principales (CP), le rendement et l'azote prélevé par le maïs. Les données de 2 ans provenaient d'un essai de longue durée impliquant différents systèmes de rotation et de fertilisation. Les paramètres retenus incluaient la masse volumique apparente (MVA), le diamètre moyen pondéré (DMP) des agrégats, l'azote total (NT), le carbone organique (CO), la porosité totale, la macro et micro-porosité, les nitrates (NO₃) extraits au KCl et avec 0,01M CaCl₂, l'ammonium mesuré après une courte incubation anaérobie (10 jrs), l'absorption d'un extrait au 0.01M NaHCO₃ aux longueurs d'onde de 205 et 220nm, les nitrates captés par les membranes échangeuses d'anion (M.E.A) et le contenu en N des trois fractions des substances humiques. À partir des 16 paramètres, l'A.C.P. a démontré que les valeurs propres (eigenvalues) des trois CP étaient >1, et comptaient pour 86.8% et 83.8% de la variance totale en 2005 et 2006, respectivement. En 2005, la CP₁ qui expliquait 59% de la variance regroupait les variables suivants : la MVA., le NT, le CO, le DMP., le contenu en N des trois fractions des substances humiques ainsi que le NH₄ libéré après l'incubation anaérobie. En 2006, la CP₁ regroupait les variables ci- haut mentionnés, plus les NO₃ extraits au KCl et au CaCl₂ ainsi que les NO₃ captés par les M.E.A. La variabilité en rendement expliquée en utilisant les CP retenues passaient de 90% en 2005 à 73% en 2006. La même tendance s'est observée aussi pour le N prélevé, étant de 88% en 2005 et de 70% en 2006. En 2005, la prédiction du rendement et de N prélevé considérant chaque indicateur de disponibilité d'azote séparément a montré que trois indicateurs soit, les NO₃ extraits au KCl et CaCl₂ ainsi que les NO₃ captés par les M.E.A, expliquaient chacun plus de 80% et 85% de variabilité en rendement et en N prélevé, respectivement (P <0.001). En 2006, la variabilité en rendement et en N prélevé expliquait par les mêmes indicateurs a baissé légèrement, se situant entre 66 et 71% pour le rendement et entre 66 et 73% pour l'N prélevé (P<0.001). Ces résultats démontrent que les indicateurs de disponibilité d'azote rapidement mesurables peuvent être de bons outils de prédiction des rendements et de la nutrition azotée des cultures, mais que la variabilité expliquée est influencée par les conditions annuelles.

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Greenhouse Gas Emissions and Soil Carbon Dynamics after Five Years of Boreal Forest Inundation

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Keywords: carbon dioxide, fractionation, flooding, soil carbon, stable isotopes,

The flooding of terrestrial landscapes for the generation of hydroelectric power leads to greenhouse gas (GHG) emissions, contributing to global warming. Currently Canada has flooded 73,000 ha and further flooding is planned on unproductive boreal forest sites, because southern sites have already been exploited. The current study was part of the Flooded Uplands Dynamics Experiment (FLUDEX), which took place at the Experimental Lakes Area (ELA) located 200 km east of Winnipeg, Canada. In FLUDEX, experimental reservoirs flooded substantial quantities of organic C stored in vegetation biomass and soil. Three areas, with different C stocks [high (22 Mg C m⁻²), medium (18 Mg C m⁻²), and low (11 Mg C m⁻²)] to a 30 cm depth, were flooded periodically from May to September over a 5-year period. In a parallel laboratory study, microcosm incubations were used i) to evaluate GHG emissions from soil periodically flooded for a period of five years (PF); ii) to evaluate GHG emissions from the same soil under continually flooded (CF) conditions; and iii) to evaluate GHG emissions from a non-disturbed control (CT) site. Changes in the C dynamics, including soil organic C and $\delta^{13}\text{C}$, within the soil profile were also evaluated as a result of 5-years of flooding. Quantifying the $\delta^{13}\text{C}$ of respired CO₂ from the soil was used to evaluate the mineralization of C from the large quantity of organic residues that entered the soil from aboveground vegetation. This technique was applied as a tool to help characterize short-term and long-term soil organic C dynamics. Results from this study have shown that after 5 years of flooding the level of soil organic carbon has increased in the mineral soil. This change in C distribution within the soil profile is likely the result of inundation, which has led to the translocation of organic matter to lower soil horizons. This was supported by stable isotope results, showing less enrichment with depth in the inundated soil compared to the control soil. The NF treatment had a CO₂ rate flux of 43, 21 and 6 $\mu\text{g CO}_2\text{-C g}^{-1}\text{ day}^{-1}$ for high, medium, and low C sites respectively, compared to 66, 26 and 24 $\mu\text{g CO}_2\text{-C g}^{-1}\text{ day}^{-1}$ for the F treatment and 20, 7 and 2 $\mu\text{g CO}_2\text{-C g}^{-1}\text{ day}^{-1}$ for the CT treatment. The greatest CO₂ rate flux was derived from the L horizon, followed by the FH and C horizons. Additionally, CO₂ emissions were 30 to 50% greater at 21°C compared to 14°C, representing summer high (21°C) and low (14°C) temperatures at ELA. Results for CH₄ emissions followed a similar trend to that of CO₂ with high, medium and low C sites emitting 752, 50, and 0.25 ng CH₄-C g⁻¹ day⁻¹ respectively in the NF treatment compared to 865, 697 and 150 ng CH₄-C g⁻¹ day⁻¹ respectively for the F, and 43, 13 and 0.19 ng CH₄-C g⁻¹ day⁻¹ and CT treatments. The quantification of the $\delta^{13}\text{C}$ of respired CO₂ showed that the evolved CO₂ was highly enriched and coincided with a faster rate of decomposition. Additionally, C in advanced stages of decomposition also showed a greater enrichment of the evolved CO₂. Results from this study have shown that periodic inundation over several years can lead to enhanced GHG emissions, especially from sites with a greater stock of C, and from labile organic material.

Phosphorus solubility and mobility due to the salination effect of long term cattle manure application in a calcareous clay loam soil.

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Keywords: Phosphorus leaching, P-soluble complexes, manure application.

Towards management of excessive manure from intensive livestock operations in southern Alberta Canada, a long term manure study was established in 1973 to examine the sustainability of applying high rates of manure to soils (Chang et al. 1993; Chang et al. 2005; Hao and Chang 2003; Miller et al. 2002; Whalen and Chang 2001). High rate of manure application increases phosphorus and salt accumulation in soil and groundwater above the normal soil salt content. The objective of this study is to examine the effect of salt deposition on the solubility and vertical mobility of reactive phosphorus in a field experiment. Leachate samplers were installed at depths of 30, 60 and 120cm in a Dark Brown Chenozermic Clay Loam soil with 33 years of manure application in 4 plots at rates of 0,60,120 Mg ha⁻¹ yr⁻¹ under irrigated and 60Mg ha⁻¹ yr⁻¹ under non-irrigated conditions. Leachate samples were analysed for reactive P, anions, cations and total dissolved salt. Positive correlation was observed between reactive P and salt contents in soil and groundwater samples. The rate of manure application significantly affects cumulative P concentration in plots (0-120 cm), although there is no significant change in reactive P concentration down the soil profile for each treatment. Salt concentration increases with increasing rate of manure application, and downward into subsurface profiles. Salt concentration in the control plot is significantly lower in comparison with other manure plots either irrigated or non -irrigated. Trend analysis of total P concentration suggests possible leaching of P while the detectable amount of inorganic P in both leachate and groundwater sample might be controlled by cations. It is possible that formation of soluble P complexes contributes to the P leaching in the calcareous soil.

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Soil Water Balance and Retention on a Long Term Cattle Manure Plot

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Keywords: water retention, water balance, manure application.

To examine the impact of long term manure application on the soil water retention and balance of subsurface profiles in a clay loam soil with 33 years of manure application at the rates of 0, 60, and 120Mg ha⁻¹yr⁻¹ with irrigation and a 60 Mg ha⁻¹yr⁻¹ without irrigation, as these parameters affect the amount of plant available water and leaching potential of a soil profile.

Climatic data (1971-2006) taken from a nearby weather station was used to estimate the monthly crop evapotranspiration ET_c using the Penman-monteith (FAO 56) with adjustment made for crop water demand, in this case barley(Kc) (John et al 2006).Monthly water balance was estimated as the difference between monthly precipitation and ET_c. Soil moisture retention characteristics of the clay loam soil was examined by determining gravimetric moisture content and the neutron probe was used to determine water content of the profiles during 2006 growing season. Neutron probe readings are compared using ANOVA.

Climatic data analysis indicate that snow is the most significant source of water for groundwater recharge on this plot and that crops require irrigation for optimum productivity as monthly water balance in the growing season indicate water deficit. Gravimetric moisture content data indicate that the subsurface profile of non-irrigated plot has greater water retention capacity. The subsurface soil moisture trend over the growing season indicate that there is greater variability in soil moisture content in the irrigated plots compared to non-irrigated plot, although there is no significant impact of manure application on the subsurface profile moisture retention capacity when compared with the control treatment. Irrigated plots seem to indicate greater tendency to lose water. Soils with long term manure application coupled with irrigation could significantly leach nutrients into groundwater.

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L'évolution des sols forestiers boréaux

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Mots clés : altération chimique, carbone, charges critiques, dépôts acides, podzols

À l'échelle planétaire, la forêt boréale a une influence majeure sur le cycle global de l'énergie, du carbone et de l'eau. La région que couvre la forêt boréale sur la Terre représente seulement 15 p. 100 de la surface terrestre et pourtant elle contient plus de 30 p. 100 de tout le carbone des biomes terrestres. Ceci est dû en à la plus grande proportion de carbone accumulé dans ses sols comparativement à d'autres biomes de forêt. En forêt boréale sur sol minéral, plus de la moitié du carbone se trouve dans les sols, en général des podzols.

De plus en plus, on intègre au Ministère des Ressources naturelles et de la Faune du Québec les connaissances sur les sols forestiers pour répondre aux enjeux sur le développement durable de la ressource forêt. Par exemple, le concept de « charge critique » a été employé pour évaluer l'impact à long terme des dépôts acides et de la récolte forestière sur la durabilité des sols (Ouimet 2005, Ouimet et al. 2006). La charge critique se définit ici comme étant une évaluation quantitative du seuil d'acidification des sols au-delà duquel des dommages significatifs peuvent survenir, à long terme, à des éléments de l'environnement selon les connaissances actuelles.

Il y a de plus en plus d'indications, basées sur les bilans entrées-sorties des bassins versants, que certains écosystèmes forestiers dans l'est de l'Amérique du Nord voient leur charge critique dépassée, ce qui a pour conséquence la perte nette de cations basiques (Watmough et al. 2005). L'un des éléments importants entrant dans le calcul de la charge critique est le taux d'altération chimique des sols. Le phénomène de l'altération des sols est celui par lequel certains éléments minéraux, libérés de la matrice principalement par voie chimique, deviennent assimilables pour les plantes et contribuent à la fertilité du sol. Ce processus est vital pour la fertilité des sols forestiers, particulièrement en ce qui concerne les cations basiques (Ca, Mg, K) dont les apports atmosphériques sont relativement faibles. Malgré l'importance de ce processus, il demeure difficile de le quantifier. Nos travaux de recherche ont permis de mettre au point une nouvelle méthodologie qui permet de modéliser le degré d'altération des podzols à partir de la composition élémentaire de leurs horizons. Les premiers résultats montrent que ces sols évoluent en grande partie de façon linéaire en termes de composition. C'est un premier pas vers la modélisation plus complète de la pédogénèse, modélisation qui sera grandement utile pour répondre aux nombreux enjeux environnementaux et forestiers qui impliquent les sols.

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Effect of nitrogen fertilization and preceding crop on deoxynivalenol content (DON) in barley

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Keywords: nitrogen, preceding crop, fusarium, deoxynivalenol

Fusarium head blight is a fungal disease caused by several *Fusarium* species. This disease can reduce grain yield, kernel weight and induce mycotoxins accumulation in the grain. Since 2001, in the Saguenay-Lac-Saint-Jean area (Quebec), FHB has become a major problem for many barley producers.

Crop rotation to a non-host crop should be considered to reduce the risk of infection by FHB. An important toxin produced by *Fusarium graminearum* is deoxynivalenol (DON). Schaafsma et al. (2001) indicated that between 14 % and 28 % of the variation in DON content in wheat grain can be explained by the previous crop. Some studies indicated that increasing N application can increased FHB (Martin et al. 1991; Lemmens et al. 2004). However, Fauzi and Paulitz (1994) and Schaafsma et al. (2001) concluded that N fertilization had little effect on FHB.

The effect of four preceding crops (barley, pea, red clover and soybean) and four nitrogen rates (0, 40, 80 and 120 kg ha⁻¹) on DON content in barley were evaluated from 2002 to 2005. In 2002, 2003 and 2005, DON content was significantly lower when barley followed soybean, red clover or pea compared to barley following barley. In 2004, the previous crop had no significant effect on DON content in barley. The effect of nitrogen fertilization on DON content was not significant during the four years.

The results indicate that seeding barley two years in a row increased DON content in grain. However, if the previous crop was pea, soybean or red clover, DON content in barley was lower compared with barley as the preceding crop. Also, nitrogen fertilization had no significant effect on DON content.

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Comparison of three methods estimating nitrogen mineralization rates along a climatic gradient encompassing three forest biomes

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Keywords: nutrient cycling, forest, soil, mycorrhizal fungi

Annual rates of nitrogen (N) mineralization was evaluated in three forest types representing an important climatic gradient using three independent methods: 1. *in situ* buried bags; 2. A model using *in situ* records of soil temperature and results from a long term laboratory incubation conducted at different temperatures and; 3. A mass balance approach using the sum of estimated fluxes of N in litterfall, in tree biomass increment and in fine root production. The three forest types were sugar maple, balsam fir and black spruce forests. The results indicated a close agreement between the three methods in sugar maple and balsam fir forests. However, in black spruce forest, *in situ* incubation greatly underestimated N mineralization rates as compared to the other methods. Estimates from the *in situ* incubation in black spruce forests were lower than the estimates of aboveground litterfall N fluxes alone, suggesting that this method, for this forest type, gives unrealistic estimates of N fluxes.

These results suggest that in black spruce forests, N mineralization is greatly reduced in the environmental conditions of the buried bags, where roots and associated mycorrhizal fungi are absent and where fluctuations in moisture content are minimal. They give support to the important role that ectomycorrhizal fungi may play in the scavenging of organic sources of N (Read *et al.* 2004). We can conclude that in cold black spruce forest soils, N mineralization is affected by different processes than in warmer forest ecosystems and that the estimation of this flux requires an appropriate methodology.

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RETIRÉ/WITHDRAWN

Physical properties of organo-mineral fertilizers made with stabilized pig slurry

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Keywords: sludge, amendments, mechanics of solids, organic fertilizers

Pig slurry is view as a trash causing important environmental problems. However, pig slurry contains nutrients and can be used to make fertilizers. To do so, we need to know how to make them into granular organic-based fertilizer so that their chemical and physical properties respect plant needs, the fertilizer industry needs for their handling, storing and transport. The goal of this study is to explore different pig slurry sources and mixtures to make organo-mineral fertilizers that could be competitive on the actual market. Among many properties, bulk and granule densities, diameter, tensile strength, friability, sorption of humidity from the air or from the soil were measured. Chemical properties such as pH, contents in C, N, P, K and micro-nutrients were also measured. This presentation will discuss physico-chemical properties of slurry used for these fertilizers in order to obtain fertilizer granules with good physical properties.

Corn response to preplant and sidedress N applications of Mg-treated liquid swine manure

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Keywords: preplant, sidedress, inorganic N fertilizer equivalent.

The marked increase in phosphorus (P) content of many soils and rivers, caused by excessive field applications of P-rich swine manure, constitutes an important environmental problem in regions with intensive swine production. One solution to this problem is to reduce the P content of the manure. A study conducted in Quebec reported that the addition of Mg to swine manure leads to the formation of Mg-P compounds that settles at the bottom of the manure pit (Parent et al. 2007). The remaining liquid fraction has a low P content and can then be applied as a N fertilizer while respecting environmental regulations for P applications. This low-P liquid fraction has never been assessed for crop production under diverse pedo-climatic conditions. Our objective was to compare preplant and sidedress applications of this low-P liquid fraction on corn (*Zea mays* L.) grain yield, N mineral fertilizer equivalent, and manure N availability.

A 2-yr field study (2005 and 2006) was conducted each year at three experimental sites located in distinct areas of Quebec. Sites were selected based on soil P level ($P/Al_{M3} > 10$) and were in corn the year prior to the experiment. Raw manure and the liquid fraction of Mg-treated manure were preplant (spring) or sidedress (6-8 leaf stage) applied at 50, 120, and 190 kg N ha⁻¹ using a plot manure spreader. Additional treatments consisted of a sidedress application of inorganic N fertilizer (urea ammonium nitrate solution, 32-0-0) at 0, 24, 48, 95 and 190 kg N ha⁻¹. Corn (HL 2222, 2450 UTM) was planted with an inorganic N starter (50 kg N ha⁻¹; 27-0-0). Phosphorus (0-46-0) and K (0-0-60) fertilizers were applied at seeding based on soil analysis and local recommendations (CRAAQ, 2003). Corn was harvested by hand at maturity.

Grain yield, averaged across the six site-years, was 10% higher with the sidedress than with the preplant N application. Grain yield was similar with raw manure and the low-P liquid fraction when the preplant application was used but it was higher with raw manure when the sidedress application was used. At the economically optimum inorganic N fertilizer rate of 161 kg N ha⁻¹ (grain yield of 9.5 t ha⁻¹), the N mineral fertilizer equivalent value was 78 kg N ha⁻¹ for a preplant application either as raw manure or the liquid fraction; for a sidedress application, the N mineral fertilizer equivalent values were 109 kg N ha⁻¹ (raw manure) and 83 kg N ha⁻¹ (low-P liquid fraction). The N availability therefore ranged from 48% for preplant application to 68% for sidedress application of raw manure. Even if grain yield was slightly lower, the low-P liquid fraction of the Mg-treated manure can be applied as a N source on high P soil in accordance to environmental regulations for P application.

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Environmental and agronomic phosphorus indices in soil-plant systems

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The agroecosystem paradigm severely modified the way agricultural research is now conducted by taking into account environmental issues. The phosphorus research resulted in a considerable amount of new knowledge and concepts assembled by J. T. Sims and A. N. Sharpley (2005) in the SSSA agronomy monograph no. 6 « Phosphorus: Agriculture and the Environment » dedicated to Drs. Les E. Layton and Regis R. Simard. Concepts of P fractions, budget, transfer, and balance were often developed or refined using classical approaches that generated little progress above simply increasing the amount of data to better fit the reality or producing repetitive or spurious correlations. In this paper, we revisit models and concepts currently used to evaluate soil P status and off-farm P transfer. Our objective is to explore new avenues for defining soil P saturation, P balance in crops and soils, P budget in agroecosystems, and P-related externalities. We present (1) a γ weighing factor in the Mehlich-III P saturation index to account for high Fe accumulation in mineral soils receiving Fe-rich biosolids or in organic soils; (2) compositional data analysis using scale invariance to assess the P balance in corn and to interpret soil P status as defined by the Hedley fractionation procedure; (3) a scaling approach to P index (PI) assessing P environmental risk and a P budget including above- and below-ground biomass calculated from estimates of net primary productivity; and (4) a sensitivity analysis of weighing factors in PI, especially for the P transport processes, using Monte Carlo simulations of a PI model proposed in Québec.

Measuring impacts of tillage on soil water and temperature dynamics

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Keywords: soil, temperature, water, tillage,

Previous studies have shown that there are differences in soil water content and temperature under no-tillage and tillage management systems. These differences may impact rates of greenhouse gas emission, seed germination and plant growth, yield, nutrient leaching losses, etc., under the two management systems. Therefore, it is important to quantify the rate and the extent to which differences in soil temperature and water content develop when converting from tillage to no-tillage practices. For example, this information is vital for modeling soil water budgets under the two tillage practices, which has not been adequately addressed to date (Ahuja et al., 2006). In this study hourly measurements of soil water content (by electromagnetic sensor) and temperature (by thermocouple) at 4 depths under no-tillage and tillage management practices are analyzed using time series methods with 6 years of data. As well, differences in soil thermal properties and heat fluxes are estimated as the no-tillage system matures after conversion from a tillage system. Preliminary results show that water storage is lower in the tilled system, especially in the late winter and early spring. Soil temperatures are lower in the no-tillage system in the early growing season.

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Cadmium concentration in two grass species fertilised with chloride

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Key words: chloride fertilisation, Cd, superphosphate, biosolids, grass forages.

Addition of Cl-fertilised forages to dry dairy cow rations helps prevent milk fever at the onset of lactation. However, high soil Cl content may potentially increase plant uptake of Cd, a toxic heavy metal. The effect of soil Cl content on plant Cd concentration varies with soil characteristics (texture, organic matter content, pH), Cd sources (geogenic, fertiliser sources), and plant species. Our objective was to determine the impact of Cl fertilisation on the Cd concentration of two forage grass species. A first trial was conducted in the field in Québec with timothy (*Phleum pratense* L.) fertilised in spring with Cl (0, 64, 96, and 144 kg Cl ha⁻¹ as CaCl₂) and grown at four locations with low soil Cd availability (0.02 to 1.37 µg kg⁻¹). The second, a glasshouse trial, was conducted in Australia with timothy and phalaris (*Phalaris aquatica* L.) fertilised with Cl (0, 80, 160, and 240 kg Cl ha⁻¹ as CaCl₂) and grown in paired soils from two locations with differing soil Cd availability (4 to 109 µg kg⁻¹). Soil from one location had received superphosphate for 47 years or had never been fertilized. At the other location, soil had been fertilised 12 years previously, with biosolids derived from the effluent treatment system of a large city, or had never received biosolids.

In the first trial, Cl fertilisation slightly increased the Cd concentration of timothy herbage at two of the locations by 0.002 and 0.027 mg kg⁻¹ DM. The increase at only two of the four locations was not related to levels of CaCl₂-extractable Cd in the soil. In the second trial, Cl fertilisation did not affect forage Cd concentrations. Grasses grown on soils previously treated with superphosphate or biosolids had higher Cd concentrations (0.100 to 2.490 mg kg⁻¹ DM) compared to grasses grown on untreated soils (0.040 to 0.220 mg kg⁻¹ DM). Cadmium concentrations were higher in grasses grown on the biosolid-treated soil (0.540 to 2.490 mg kg⁻¹ DM) compared to grasses grown on the superphosphate-treated soil (0.100 to 0.340 mg kg⁻¹ DM). Grass Cd concentration was also affected by grass species; it was higher for phalaris (0.060 to 2.490 mg kg⁻¹ DM) than for timothy (0.040 to 0.710 mg kg⁻¹ DM).

The highest forage Cd concentrations observed in these experiments (phalaris grown in biosolid-treated soil) were of concern because they exceeded guidelines for cattle feed (0.5 mg Cd kg⁻¹ DM) where there is a risk that Cd will enter the food chain but were below the threshold (5 mg Cd kg⁻¹ DM) where animals can experience health problems. However, Cl fertilisation did not increase the forage Cd concentration or, as at some field sites, only increased it marginally to levels well within acceptable guidelines. This indicates that it is unlikely that Cl fertilisation will exacerbate Cd contamination of the food chain.

The net greenhouse gas balance of a Prairie agricultural landscape

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The contribution of wetlands embedded in agricultural landscapes in western Canada to greenhouse gas emissions is largely unknown. In our study we assessed changes in soil organic carbon stores and emissions of nitrous oxide and methane from uplands and wetlands at the St. Denis National Wildlife Area (SDNWA) east of Saskatoon, SK from 2003 to 2006. Under current land use (i.e., with annual crop cultivation of the agricultural field and restored wetland vegetation in wetlands) the research site at the SDNWA acts as a net source of greenhouse gas on the order of $0.5 \text{ Mg CO}_{2\text{eq}} \text{ ha}^{-1} \text{ yr}^{-1}$ due primarily to high methane emissions from basin centers. Restoration of grass in the agricultural portions of this research site would lead the landscape becoming a sink for atmospheric carbon on the order of $1.5 \text{ Mg CO}_{2\text{eq}} \text{ ha}^{-1} \text{ yr}^{-1}$. Emissions of both methane and nitrous oxide for the centers of freshwater ponds embedded in the agricultural landscapes will continue to be high after grass seeding but these emissions would be more than offset by the potential for increases in SOC storage in the remainder of the landscape. Emissions of methane and nitrous oxide from the permanent wetland assessed in this study were very low and would be readily offset by even small carbon gains in this type of wetland.

Saisie des données pédologiques au champ à partir du carnet électronique GeoExplorer XT 2005 de Trimble – Développement et application.

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Mots clés : prospection pédologique, carnet électronique de terrain, GPS, SIG.

Toute campagne d'échantillonnage des sols a pour but d'acquérir une meilleure compréhension du comportement des sols et de leur évolution. Le processus qui s'ensuit, la cartographie des sols, permet de mieux représenter leur distribution spatiale dans un territoire selon l'échelle utilisée. En 1985, un système de codification simple et efficace (profil A–B–C) a été mis au point par les membres de l'équipe pédologique d'Agriculture et Agroalimentaire Canada (AAC) de Québec pour effectuer la saisie de données de sols au champ à l'aide d'un ordinateur portable de type RadioShack, TRS80, modèle 100. Cette technologie a permis de générer, au cours des vingt dernières années, une énorme banque de données numériques décrivant tous les profils de sols observés au cours de différentes missions menées par les pédologues d'AAC tant à l'échelle du comté, du bassin versant, de la ferme ou de la parcelle agricole. En plus d'informatiser le processus à sa base, elle permettait également de limiter les erreurs et le temps liés à la retranscription des fiches de données. De nos jours, ce système présente quelques limitations physiques et techniques qui nous ont mené à entrevoir de nouvelles avenues. En effet, dans un souci d'efficacité, de précision et de fiabilité, et dans un contexte de réduction des ressources financières et humaines allouées à la prospection pédologique, il est dorénavant indispensable de développer un outil facilitant l'acquisition des données pédologiques au champ ainsi que leur intégration rapide dans un système d'information géographique.

Le GeoExplorer 2005, série XT, un carnet de terrain de type *Pocket PC*, possédant un récepteur GPS intégré, ainsi que le logiciel de saisie Terrasync de Trimble sont à la base du nouveau système de capture de données pédologiques. Ces outils permettent l'intégration d'images (aériennes ou satellitaires) et de données (plan d'échantillonnage par navigation GPS) géoréférencées avant de procéder à la campagne de terrain, de même que l'acquisition des données directement sur le terrain tout en y associant une coordonnée géographique précise au mètre près. La numérisation et l'acquisition de ces données s'effectuent dans un ordre logique visant à minimiser le temps d'acquisition et le traitement des données par les pédologues avant et après la campagne d'échantillonnage sur le terrain. Pour la prise d'information concernant les sols, un formulaire de saisie de données a d'abord été créé, à l'aide du logiciel Pathfinder Office 3.10 de Trimble. Il comporte six composantes d'entrée : 1) l'identification du site (automatique ou manuelle); 2) la description du site, 3) du profil dans son ensemble, 4) de la couche de surface (horizon A), 5) du sous-sol (horizon B) et 6) du substratum (horizon C). Le formulaire a été conçu de façon à faciliter la saisie des données (entrée libre ou par menu déroulant) tout en assurant l'uniformisation des formats de données. Plusieurs erreurs d'entrée et de formatage peuvent ainsi être évitées, ce qui réduit considérablement le temps de validation suite à son intégration dans la base de données géographiques. Une fois développé, le formulaire est intégré au carnet électronique GeoExplorer 2005, série XT. Au retour de la campagne d'échantillonnage, les données accumulées dans le carnet électronique sont transférées vers l'ordinateur à l'aide du logiciel Pathfinder Office 3.10. Elles sont ensuite exportées sous forme de fichier de type shapefile (*.shp) ou dbase (*.dbf) et intégrées dans la base de données géographiques du projet de prospection (ArcGIS, V. 9). Le carnet et l'algorithme de saisie ont été testés sur le terrain à l'été 2006 par les pédologues d'AAC et de l'IRDA à deux niveaux d'intensité de prospection (NIP) : 1) la cartographie des sols à l'échelle de la parcelle agricole du bassin versant du bras d'Henri (NIP 1, échelle de 1 :10 000) et 2) la cartographie des sols du bassin versant Ewing (NIP 3, échelle de 1 :40 000). Le formulaire de saisie a également été adapté en format dbase Pocket PC pour carnet Palm.

Portrait statistique et évolution de la teneur en éléments traces métalliques (ÉTM) et en éléments fertilisants des biosolides municipaux du Québec

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Mots clés: biosolide, boue, métaux, sludge, azote.

L'épandage des boues municipales, aussi appelées biosolides municipaux, se pratique sur 0,2% des sols agricoles du Québec. Cette pratique demeure encore relativement marginale, mais elle fait l'objet de polémiques et de craintes chez certains intervenants en environnement et le public en général. Plusieurs préoccupations concernent le contenu en éléments traces métalliques (ÉTM), comme le cadmium, le mercure et le plomb. L'aspect du risque relatif aux ÉTM a fait l'objet de nombreuses études (MDDEP, 2006). Afin de documenter davantage le sujet, on a tracé un portrait des caractéristiques et des tendances statistiques quant au contenu en ÉTM des boues produites au Québec. Ce portrait a été réalisé à partir de banques de données gouvernementales datant de la fin des années 1980 jusqu'à nos jours.

Malgré les idées généralement reçues, les teneurs actuelles en ÉTM des biosolides municipaux du Québec s'avèrent très faibles. Les teneurs en «contaminants stricts», comme le cadmium et le plomb, ont baissé de plus de 65 %, au cours des 15 dernières années, en raison des efforts de réduction de la pollution à la source. Ces teneurs en Cd et Pb dans les boues sont maintenant inférieures à celles qu'on trouve naturellement dans les sols argileux du Québec. Le mercure affiche aussi de faibles niveaux et une tendance à la baisse dans certaines municipalités, comme Saguenay. Quant aux ÉTM qui sont considérés comme des oligo-éléments pour les plantes ou les animaux, tel que le cuivre, le zinc et l'arsenic, leurs teneurs dans les boues s'avèrent généralement inférieures à celles retrouvées dans le lisier de porc ou dans le fumier de poulet à griller.

Fait à noter, les teneurs en ÉTM sont généralement plus faibles dans les boues provenant de petites municipalités. Ceci est attribuable au fait que le type de traitement des eaux usées qu'on y trouve, par étangs aérés, implique un niveau accru d'oxydation biologique de la matière organique sur plusieurs années, ce qui a pour effet de concentrer les ÉTM dans la matrice résiduelle.

La valeur fertilisante des boues d'étangs est d'ailleurs plus faible que celles provenant des plus grandes villes. Elles contiennent en effet moins de matière organique, et moins d'azote, en raison des pertes dues à l'activité microbienne, par les phénomènes d'oxydation, de nitrification et de dénitrification. À l'inverse, les boues provenant de plus grandes municipalités ont un meilleur contenu en matière organique et en azote. Leur teneur en azote et en phosphore est même supérieure à celle des fumiers de bovins et des lisiers de porc, sur une base humide. Par contre, le potassium est en très faible teneur, en raison des pertes par solubilisation lors du traitement des eaux usées puis du rejet de l'eau épurée au cours d'eau récepteur.

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Variation spatiale de la qualité de la matière organique du sol dans deux champs agricoles du bassin versant du Bras d'Henri (Québec, Canada).

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Mots clés : matière organique, acide humique, acide fulvique, variabilité spatiale

Les résultats de l'inventaire des problèmes de dégradation des sols agricoles du Québec publiés en 1990 ont démontré à quel point les systèmes culturaux peuvent affecter la qualité ainsi que la quantité de la matière organique du sol et les propriétés physico-chimiques qui lui sont étroitement associées. De nombreuses études ont porté sur la qualité de la matière organique des sols, mais très peu de recherches ont abordé la question de la variation spatiale de celle-ci à l'échelle du champ agricole. C'est dans ce contexte qu'une étude a été effectuée à l'été 2006 sur deux champs expérimentaux du bassin versant du Bras d'Henri (St-Bernard de Beauce, Québec). L'objectif de cette étude était 1) de décrire la structure d'organisation spatiale de la qualité de la matière organique des sols et des propriétés pédologiques associées (critères de genèse des sols, texture, indicateurs de saturation et de capacité de fixation du phosphore) et 2) de classer ces descripteurs à partir de quatre paramètres géostatistiques, soit le coefficient de variation (CV), la portée, le ratio variabilité systématique sur variabilité totale et le coefficient de validation croisée (R^2_{vc}).

La couche de surface (0-20 cm) de 91 profils de sols a été échantillonnée à l'aide d'une grille non alignée de 30 m x 30 m appliquée à deux champs contigus totalisant une superficie de 8.7 ha, l'une semée en maïs grain et l'autre en foin. Les échantillons ont été séchés et broyés à 0.25 mm afin d'extraire les acides fulviques et humiques. Les analyses pédologiques de routine (granulométrie, pH, matière organique, éléments extraits au Mehlich-3, Fe et Al extraits à l'oxalate et au pyrophosphate) ont été réalisées. Les teneurs en C organique total et en N total des deux champs ont été déterminées par combustion sèche à 1250 °C avec un analyseur Leco.

Les résultats montrent que la distribution des acides humiques et fulviques dans les deux champs est principalement fonction de l'évolution génétique des sols (podzols vs gleysols) bien que la différence de gestion des deux champs étudiés contribuent également à expliquer le patron de distribution spatiale des fractions organiques. L'analyse géostatistique des différentes propriétés étudiées permet d'identifier trois groupes de propriétés qui diffèrent par leur structure d'organisation spatiale : les indicateurs de disponibilité et de taux de saturation en P caractérisés par une portée de 100 à 200 m et une fiabilité d'interpolation faible ($R^2_{vc} = 0.15-0.30$); les indicateurs de la qualité de la matière organique et de la texture avec une portée de 100 à 200 m et un R^2_{vc} variant de 0.30 à 0.60; et enfin les indicateurs de genèse et de capacité de fixation du P avec des portées > 300 m et une fiabilité d'interpolation modérée à élevée ($R^2_{vc} = 0.30-0.60$).

Reexamination of white spruce nutrient status in Canada: are N deficiencies still prevalent?

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Keywords: nutrition, *Picea*, base cations, CND.

In Canada, the coniferous forest has been generally found to be N deficient (Weetman et al. 1987). Some studies are however suggesting that base cation deficiencies may be becoming more prevalent. Nutritional standards based on the Critical Value Approach (CVA) and the Compositional Nutrient Diagnosis (CND) have been recently developed for white spruce (*Picea glauca* Moench Voss) (Quesnel et al. 2006). These standards were applied on selected published data of white spruce nutrition from sites across North America to determine the most common nutritional disorders of this species. Our study indicates that nutritional disorders in white spruce are not restricted to N deficiencies. Based on nutrient concentrations, deficiencies are common, particularly in P, K and Ca, but toxicities are rare. CND analysis revealed common deficiencies of P, K and Ca, common cases of excess N, P and Mg, and potential antagonistic effects of Mg on Ca and K.

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Decomposition-induced changes in soil organic matter composition

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Keywords: soil organic matter, decomposition, boreal forests, NMR.

On a global basis, 470 Gigatons of carbon are contained in boreal forest soils. Yet, despite their importance in the global carbon budget, very little is known about the exact nature and decomposition pathways of organic matter in these soils. The overall objective of this study was to examine the effects of vegetation, natural (fire) and anthropogenic disturbance (harvesting) on 1) soil organic matter composition, and 2) decomposition-induced changes in composition from a range of mature and disturbed boreal forest and peatland ecosystems typically found in Canada.

Forest floor and peat samples (0-10 cm) were obtained from the Fluxnet-Canada research network, including 17 sites along an east-west transect from New Brunswick to British Columbia. Carbon mineralization rates were measured during a 1-year laboratory incubation at 10 °C. Organic matter composition in pre- and post-incubation samples was characterized by solid-state ¹³C NMR using ramped-cross-polarization (RAMP-CP) on a Bruker Avance 400 spectrometer. Spectral divisions were assigned based on local minima of the spectra to differentiate among alkyl, O-alkyl, aromatic, phenolic, and carbonyl carbons. Integrated areas of spectral regions were ordered by non-metric multidimensional scaling (NMS). The multiple response permutations procedure (MRPP) was used to compare the distance among points.

NMR results revealed significant differences among vegetation types regardless of disturbance and sampling location. The percentage of carbon mineralized during incubation ranged from 1 to 24%. Decomposition-induced changes in carbon chemistry included an overall decrease in O-alkyl concentrations, but significantly differed among vegetation types. In particular, samples from the Jack pine and Douglas fir stands, which had the highest carbon mineralization rates, showed a significantly greater increase in aromatic, phenolic, and carbonyl carbons.

Carbonate removal for analysis of total and $\delta^{13}\text{C}$ soil organic carbon

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Keywords: soil organic carbon, $\delta^{13}\text{C}$, acid fumigation, carbonate removal.

Complete removal of carbonates from calcareous soil samples is critical for determination of total organic carbon (TOC) and $\delta^{13}\text{C}$ of soil organic matter. Carbonates confound TOC and $\delta^{13}\text{C}$ measurements because they have a $\delta^{13}\text{C}$ of $\sim 0\text{‰}$ whereas that of soil organic matter ranges from -27‰ to -13‰ , depending on the source of plant residues and climatic conditions. Commonly used methods for removing carbonates involve treatment with acid followed by repeated water washings; however these methods are time consuming, labour-intensive and may lead to losses of acid- and water-soluble organic carbon. Fumigation of soil samples with HCl was evaluated as an alternative method, and the time required for complete carbonate removal was determined in this study. Moist soil samples, taken from 0-10 cm and 30-50 cm depth, were exposed to HCl vapors for periods of 0, 6, 12, 24, 48, 72, and 96 h, followed by measurement of total C and $\delta^{13}\text{C}$ content using coupled elemental analyzer-isotope ratio mass spectrometry. The fumigation period required depended on soil inorganic carbonate content. The minimal time required to remove all carbonates was 24 h and 48 h for samples taken from the upper and lower depths, respectively.

Evaluation of heat pulse probe method for measuring soil thermal physical properties during freeze-thaw in agricultural soils

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Keywords: Heat pulse probes, Soil thermal properties, Soil freeze-thaw.

Agricultural soils are a major source of greenhouse gases, particularly nitrous oxide, in Canada. Spring freeze-thaw cycles can comprise as much as 50% of annual nitrous oxide emissions from agricultural soils. The events producing these large fluxes of nitrous oxide occur over a very short period when rapid soil thawing occurs. Characterization of the soil conditions during this period requires the quantification of the ratio of liquid to solid water. Conventional methods for measuring soil moisture, such as time-domain reflectometry, do not distinguish between liquid and solid water. Heat pulse probes measure soil heat capacity, thermal diffusivity, and thermal conductivity. These parameters are different for liquid water versus ice. Heat pulse probes (HPP) can utilize these values to obtain the ratio of liquid water to ice; allowing a better understanding of the role of water in the soil system during freeze-thaw. Laboratory and field testing of HPPs took place at the University of Guelph, in a temperature controlled environment, and at the Elora Research Station. Laboratory measurements were done on 20 cm hand packed cores of soil obtained from the field site. Cores were subject to multiple freeze-thaw cycles limited to the vertical direction. Field testing took place for two seasons continuously from fall through to spring in order to capture any and all freeze and thaw events. Through the use of HPP, together with data obtained using time-domain reflectometry, a better understanding of the role freeze-thaw processes play in the production of nitrous oxide can be obtained. Preliminary results from the above experiments will be presented.

Measurement of thermal physical properties of agricultural soils during freeze-thaw using heat pulse probe method

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Keywords: Heat pulse probes, Soil thermal properties, Soil freeze-thaw.

In Canada agricultural soils are a major source of greenhouse gases, particularly of nitrous oxide. This is a pertinent study as 50% of annual nitrous oxide can occur during spring thaw. These large nitrous oxide fluxes occur over a very short time period at spring thaw, when soil conditions are ideal for the production of nitrous oxide. Characterization of the soil thermal physical properties during this time is integral to understanding the interaction of water and temperature on the soil system dynamics and their effect on nitrous oxide fluxes. Conventional methods for measuring soil moisture, such as time-domain reflectometry, do not distinguish between liquid and solid water. Heat pulse probes measure the following thermal physical properties: soil heat capacity, thermal diffusivity, and thermal conductivity. There is a different standard value of these properties for liquid water versus soil water. Heat pulse probes (HPP) can be utilized to determine the ratio of liquid water to ice; allowing a better understanding of the role of water in the soil system during freeze-thaw. Laboratory and field testing of HPPs took place at the University of Guelph, in a temperature controlled environment, and at the Elora Research Station. Laboratory measurements were done on 20 cm hand packed cores of soil obtained from the field site. Cores were subject to multiple freeze-thaw cycles, in a system designed to simulate freeze-thaw in the vertical direction. Field testing took place for two seasons continuously from fall through to spring in order to capture freeze and thaw events. Through the use of HPP, together with data obtained using time-domain reflectometry, a better understanding of the role freeze-thaw processes play in the production of nitrous oxide can be obtained. Preliminary results from the above experiments will be presented.

Effects of consistent and changing land management on the physical quality of a clay loam soil

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Keywords: soil quality indicators, no-tillage, mouldboard plough tillage, sod, virgin soil

The impacts of agricultural land management on near-surface soil physical quality (SPQ) are poorly understood, and diagnostic SPQ indicators are not well developed. Hence, the objective of this study was to use a suite of potential SPQ indicators to characterize the physical quality of an agricultural clay loam soil under a range of common land managements.

Selected SPQ indicators were measured on intact soil cores collected from the 0-10 cm depth under the following long-term (14-17 years) and short-term (1-4 years) treatments: i) never cropped or cultivated virgin soil (VS); ii) long-term continuous bluegrass sod (BG); iii) long-term maize-soybean rotation under no-tillage (NT); iv) long-term maize-soybean rotation under mouldboard plough tillage (MP); v) short-term NT after long-term MP; vi) short-term MP after long-term BG; and vii) short-term MP after long-term NT. The soil texture averaged 28% sand, 35% silt and 37% clay in the Ap horizon (0-20 cm), and was located at the Hon. Eugene F. Whelan Research Farm, Woodslee, Ontario (42° 13' N, 82° 44' W).

Organic carbon content, dry bulk density, total soil air capacity, soil matrix air capacity, relative water-air capacity, and saturated hydraulic conductivity appeared to be potentially useful SPQ indicators because they were sensitive to land management, and optimal or critical values are proposed in the literature. Soil macroporosity and soil matrix porosity were also sensitive to land management and therefore potentially useful as SPQ indicators, but optimal or critical values for these parameters are not yet established. Plant-available water capacity has a recommended critical minimum value, but it did not respond substantially or systematically to changes in land management and was thus not particularly useful as an SPQ indicator in this study.

Converting long-term BG to MP caused overall SPQ to decline to a level similar to long-term MP within 3-4 years. On the other hand, converting long-term NT to MP or vice versa caused only minor changes in overall SPQ, and the indicator values changed primarily in the first year after conversion.

With respect to the measured SPQ indicators and their proposed optimal values or ranges, both VS and BG produced good overall SPQ in the near-surface soil, while long-term maize-soybean rotation under NT and MP produced equally sub-optimal SPQ. Studies are underway to improve and maintain the SPQ of this soil when under NT and MP crop production, and to quantify the yield and environmental consequences of sub-optimal SPQ.

Régis Simard : Vingt ans au service de la science du sol / Twenty years of service to soil science

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Déjà cinq ans qu'un des plus doués, des plus déterminés et des plus productifs d'entre nous nous a quittés. Dans sa trop courte carrière, Régis a d'abord prêté sa formidable énergie au progrès de la pédologie québécoise. Il a ainsi contribué à la cartographie des sols de la plaine de Montréal. La majeure partie de sa carrière a cependant été consacrée à l'étude des transformations des éléments nutritifs dans les sols agricoles. Sa curiosité et son imagination l'ont amené à étudier des sujets variés, allant du développement de méthodes d'analyse de sol au laboratoire à l'étude de l'impact environnemental de l'agriculture à l'échelle régionale. Cependant, ses travaux sur le rôle de l'infiltration préférentielle comme mode de transport du phosphore dans les eaux de drainage agricole ont particulièrement marqué sa carrière. Sa démonstration que la pollution diffuse n'était pas seulement reliée au phénomène d'érosion et de ruissellement mais aussi au drainage, a eu pour effet de modifier radicalement les normes régissant la gestion des fumiers au Québec.

Régis est parti trop tôt alors qu'il s'attaquait avec enthousiasme à de nouveaux défis. L'héritage scientifique qu'il a légué à la science du sol au Canada est cependant important. J'essaierai dans cet exposé non seulement d'en faire l'inventaire mais aussi d'exprimer l'influence que ses qualités de chercheur et d'homme ont eue sur ceux qui l'ont côtoyés.

It has already been five years since one of the most gifted, determined and productive Canadian soil scientists has passed away. In his too short career, Régis, initially lent his formidable energy to the progress of pedology in Québec, contributing to the mapping of the Montreal Lowlands soils. The major part of his career was, however, devoted to the study of nutrient transformations in agricultural soils. His curiosity and his creativity led him to study various subjects, from the development of soil analysis methods to the study of the environmental impacts of agriculture on a regional scale. Meanwhile, his work on the role of preferential flow as a means of phosphorus transport in agricultural drainage water particularly marked his career. His demonstration that non-point pollution was not only related to erosion and run-off but also to infiltration caused a radical change in the standards governing manure management in Quebec.

Régis left too soon as he was enthusiastically attacking new challenges. The scientific legacy that he has left to soil science in Canada is nevertheless important. In this talk, I will try, not only to make an inventory of his accomplishments, but also to express the influence that his qualities as a man and as a researcher had on those whom knew him or worked with him.

Chamber measurements of Soil N₂O emissions: Are they reliable?

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Agricultural soils are estimated to emit about 50 % of global anthropogenic N₂O. The vast majority of soil N₂O fluxes published in the scientific literature were obtained using non flow-through non steady-state (NFT-NSS) chambers. However, considerable variation in chamber methodology may influence N₂O flux measurements raising doubt about the reliability and accuracy of these measurements. The objectives of this study were to determine criteria for assessing the quality of soil N₂O flux measurements made using NFT-NSS chambers, to evaluate NFT-NSS chamber methodologies used in the scientific literature and identify changes to current chamber methodology that could improve the accuracy of soil N₂O flux measurements. We identified 15 characteristics of chamber methodology and developed 4 factors contributing to the quality of N₂O flux measurements from NFT-NSS chambers. We compiled a data set of 369 studies and in each study we evaluated the quality of the characteristics and factors to determine the confidence in the reported N₂O flux. The confidence in flux measurements improved with time; however as of 2007 there were still about 45 % of studies with poor or very poor methodologies. Some improvements, notably in handling and storage of samples, have been made yet only marginal improvements in most chamber characteristics have been achieved in the past 20 years. Furthermore, incomplete reporting of chamber characteristics also contributed to decreased confidence in many reported flux measurements. This study has shown that the quality of soil N₂O flux measurements reported in the literature is often poor. In the interest of improving the quality and confidence of future N₂O flux data, we strongly recommend adoption of a minimum set of criteria for reliable soil N₂O flux measurement using NFT-NSS chamber and the application of more rigorous methodological standards by scientists, reviewers and scientific editors.

From peat amendment to functioning forest soil: can we do it?

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Keywords: oil-sands reclamation, boreal forest, soil, litter decomposition, nutrients

This study addresses the question of whether oil-sands mine sites amended with different peat-mineral mixtures are on a predictable path towards a functional forest soil similar to those naturally occurring in the boreal forest of northern Alberta.

The study area comprises 18 natural forest plots representing six forest ecotypes and 29 reclaimed oil-sands plots varying in reclamation prescription, vegetation and age. Gravimetric moisture, pH and C: N ratios have been measured for the L, FH and soil layers while vegetation cover and *in situ* nutrient bioavailability (using Plant Root Simulator™probes) have been measured on each site.

The decay rates of leaf litter are measured using litter bags. In two amendments, decomposition rate of aspen litter does not appear to be related to soil moisture. There is an overall upwards shift in both pH and moisture for most amendments, which suggests that natural succession and ecotype development may be different from that of the boreal forest.

Preliminary results will be presented. The overall aim is to recommend the best reclamation prescription(s) based on their edaphic potential to restore natural forest ecosites.

Development of floodplain soils in humid and cold climate conditions

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Mots clés: alluvial soils, pedogenesis, floods, climatic conditions, fluvial dynamic.

This document presents an analysis concerning the fluvial dynamic responsible for the aggradation rates and pedogenesis processes observed in alluvial terraces with link of climatic factors (cold and humid conditions). The study area covers the basins and sub-basins of the south-central Québec affected by periodic floods. The analysis of soil profiles reveals a weak pedogenesis development (weak horizonation, absence of organo-mineral (Ah) and illuvial horizons (B), weak alteration). These weakly developed soils were classified among the regosolic and brunisolic orders (GTCS, 2002). For textural and sedimentological characteristics, the soil profiles present relatively homogeneous facies and weak textural variability. They are essentially fine matrix dominated with important proportion of silt or silty sand. The analysis of floodplains reveals important sedimentation rates connected to high frequency of floods that characterize this hydrographic basin. The sedimentation rates estimated from radiocarbon-14 dating and alluvial deposits range from 0.14 to 0.76 cm a⁻¹ depending on the study sites. The evaluation of the sedimentation rates obtained from other parameters (14-C, floods frequency) supply values from 3.29 to 4.55 cm by flood events. This important accumulation of sediments which causes substantial increases in terrace levels and also the weak development of alluvial soils suggest that the frequency of floods are increasing since the beginning of the century and more particularly during the last decades associated with an increase of precipitation rates.

Influence du chaulage des sols limoneux et argileux sur la saturation des sols en phosphore (extrait au Mehlich III).

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Mots clés: Chaulage, acidité, saturation en phosphore.

La saturation des sols en phosphore $(P/Al)_{M-III}$ (CRAAQ 2003) peut être modifiée par l'effet du chaulage sur le phosphore et l'aluminium Mehlich III dans le sol. L'objectif de ce projet est de définir la relation $(P/Al)_{M-III}$ et la dose d'application de chaux dans 30 sols montrant des teneurs en argile de 7 à 60 % et incubés pendant 3 mois au laboratoire. Les doses de chaux variaient de 0, 4 à 8 t ha⁻¹ de CaCO₃ pur et réactif à 100%. Il y avait une augmentation linéaire significative de la saturation en phosphore avec l'augmentation des doses de chaux dans 29 des 30 sols. En utilisant la valeur de la pente de la relation entre le rapport final $P_f/Al_f)_{M-III}$ et la dose de chaux appliquée, on peut calculer le taux d'augmentation du rapport $P_f/Al_f)_{M-III}$ avec l'ajout de chaux à partir d'un modèle logarithmique du type $\Delta(P_f/Al_f)_{M-III}/\Delta\text{chaux} = 0.152*\ln(P_i/Al_i)_{M-III}-0.0616$ ($r^2=0.80$). L'intervalle de confiance ($\alpha=0.05$) est ± 0.06 . Les sols ayant un rapport initial $P_i/Al_i)_{M-III}$ inférieur à 3,3 % n'ont pas montré de variation significative de saturation avec l'ajout de 1 T chaux/ha. Les sols ayant une saturation $> 3,4$ % montrent une augmentation significative de saturation avec l'ajout d'une tonne de chaux ou plus. Pour les saturations intermédiaires à élevées, le chaulage augmente significativement le rapport $P_i/Al_i)_{M-III}$. Le chaulage des sols peut donc modifier la classe de fertilité des sols en phosphore.

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Utilisation du chlorophyllemètre (SPAD 502) comme outil diagnostic à la fertilisation azotée de la pomme de terre.

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Mots clés: Azote, fertilisation, chlorophyllemètre, SPAD 502

La régie de la fertilisation azotée de la pomme de terre est déterminante pour l'atteinte du rendement optimal, en minimisant les risques environnementaux. Le SPAD 502 est un outil diagnostique d'évaluation de la suffisance en azote. Nous avons établi 23 sites de fertilisation azotés en sols sableux de 2003 à 2006 dans les régions de Portneuf et du Lac St-Jean avec 14 cultivars de pomme de terre à des doses variant de 0 à 300 kg N ha⁻¹. Le nombre de doses testées (entre 4 et 8) variaient selon le cultivar et la longueur de sa saison de croissance. Les parcelles avaient 4 rangs de large par 6 à 8 m de longueur répétées 3 fois. L'indice de chlorophylle était déterminé au stade début floraison. Les pommes de terre étaient récoltées sur les rangs centraux en fin de saison. Un indice 'delta SPAD' a été ajusté à la dose d'azote apportée au moment de la plantation. Le 'delta SPAD ajusté' a été relié au rendement relatif obtenu à chaque site. La méthode Cate-Nelson a permis de regrouper les cultivars et de leur attribuer une valeur critique de 'delta SPAD ajusté' vers 90% de rendement maximum. Les valeurs critiques ont été de 0,061 pour Bijou Rouge et Prospect, de 0,045 pour Yukon Gold, de 0,073 pour AC. Belmont et Péribonka, de 0,090 pour Pike, Andover, Chieftain, Superior et Shepody, de 0,108 pour Eramosa et Estima et de 0,125 pour Goldrush. Tous les sites montrant un pH CaCl₂ (0.01 M) inférieur à 5.0 ont produit des rendements inférieurs mais cette situation n'a pas affectée la valeur de 'delta SPAD ajusté'. L'utilisation combinée du SPAD 502, de caméras multispectrale et thermique aéroportés constitue une avenue intéressante pour dépister rapidement les carences ou excès de N. Toutefois, l'intensité de couleur de la feuille peut être influencée non seulement par la fertilisation azotée mais aussi par des facteurs externes tels les insectes et maladies. Des essais comparatifs débiteront en été 2007 afin de valider le modèle de suivi aéroporté.

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Minéralisation de l'azote de la biomasse microbienne dans quelques sols de prairie de la région de Québec

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Mots clés: Dynamique de N, Matière organique.

Il est connu que les pratiques agricoles sont susceptibles d'influencer la dynamique de l'azote dans les sols. Le but de cet essai est d'examiner la minéralisation de l'azote de la biomasse microbienne (N_{mic}) dans trente trois sols provenant de douze fermes laitières de la région de Lotbinière. À cet effet, une incubation prolongée sans lessivage a été menée dans des conditions contrôlées de température et d'humidité. Les teneurs en N_{mic} des sols au temps $t = 0$ ont varié de 41 à 148 mg N kg⁻¹, soit entre 1,94 à 10,7 % du N total. Après 56 semaines d'incubation, les quantités de N_{mic} variaient de 4 à 27 mg N kg⁻¹, soit entre 0,3 et 1,4 % du N total. Les courbes de la dynamique de N_{mic} montrent qu'aux premières semaines d'incubation (de 0 à 4 semaines), il y avait une réduction significative de la biomasse microbienne. Par la suite, la décroissance de la biomasse microbienne s'est atténuée de façon asymptotique. Après 16 semaines, la réduction variait de 7 à 38%, puis de 4 à 22% après 32 semaines et de 2 à 11% après 56 semaines. L'azote de la biomasse microbienne minéralisé après 56 semaines d'incubation a atteint en moyenne 84% du N_{mic} initial. L'étude de l'évolution du N_{mic} au cours de l'incubation a montré l'existence de deux compartiments et, par conséquent, l'existence de deux constantes de vitesse et de deux groupes de biomasse microbienne: un groupe labile et un autre résistant. Les valeurs de N_{mic} étaient positivement corrélées avec la fraction fine (argile + limon) et en N total des sols mais inversement corrélées avec la fraction grossière (sable). Les résultats de cette étude ont permis de démontrer que la dynamique de la biomasse microbienne est affectée essentiellement par la texture des sols sélectionnés.

Phosphate rock solubilization by *Aspergillus niger*: potential for an alternative P-fertilizer

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Keywords: phosphate rock, solubilization, *Aspergillus niger*, phosphorus, soil.

Phosphorus deficiencies are limiting crop production in agricultural soils worldwide. High costs of conventional phosphate fertilizers prevent smallholder farmers in developing countries from using these types of fertilizers. As an alternative, locally available sources of phosphate rock (PR) are being recognized for their potential role in soil fertility improvement. However, the P released from directly applied ground PR is often too low to provide sufficient P for crop uptake. The use of organic acid-producing microorganisms to mobilize P from PR has been proposed as a low-cost technology alternative to conventional P fertilizer production (Richardson 2001; Gyaneshwar et al. 2002). Citric acid has been shown to be superior to other organic acids in its PR solubilizing ability. In this study, four strains of *Aspergillus niger* were screened for phosphate solubilization and citric acid production. *A. niger* ATCC 9142 was selected for further use due to its superior ability to produce citric acid. PR solubilization from additions of PR to an *A. niger* ATCC 9142 culture medium at cultivation onset, was compared with additions of PR to the acid-containing culture supernatant. The two treatments were found to solubilize equivalent PR, with solution P values ranging from 219-382 mg/l. Future research is necessary to optimize this process and to investigate the effects of such phosphorus mobilization on plant growth.

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Long-term effects of tillage system on soil nitrogen mineralization potential in semi-arid and humid environments

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Keywords: conventional tillage, Indices of N availability, Mineralizable N, No-till.

Mineralizable N represents a major portion of labile soil organic-N pool. Improved understanding and prediction of N mineralization is important for improvement of crop fertilizer N recommendations and consequently for reducing adverse impacts of excess N fertilization on the environment. In this study, effects of no-till (NT) and conventional tillage (CT) systems on the soil mineralizable N pools and indices of N availability were examined. Pre-plant soil samples (0- to 15-cm) were collected from seven established long-term tillage comparison experiments located in semi-arid and humid environments across Canada. Potentially mineralizable N (N_0) was determined by aerobic incubation for 24 wk at 25°C. Three different pools of mineralizable N were recognized: [Pool-I]. The flush in mineral N which occurs in the first 2 wk period following rewetting. This pool represents the mineralization of a labile organic nitrogen pool. [Pool-II] Gross N mineralization which occurs between 2 and 22 wk and is representative of the release of an intermediate pool of organic N. [Pool-III] The amount of N which was predicted to be potentially mineralizable based on curve fitting but did not mineralize during the incubation period. The average value of N_0 for individual sites ranged from 65 to 156 mg N kg⁻¹ and represented an average of 7% of the total organic-N. Pool-II represented 56% of N_0 . The NT/CT ratio for N_0 ranged from 0.9 to 1.2 among sites, with five sites having ratios greater than 1. This ratio for pool-II ranged from 0.8 to 1.3 among sites, with six sites having ratios greater than 1. However, these tillage effects were not always statistically significant. Pool-II was significantly higher in NT compared to CT at Swift Current, L'Acadie and Agassiz. Climate (precipitation and temperature) was the primary factor controlling variation in N_0 among the experimental sites. The pattern of site ranking based on N_0 and pool-II was Brandon > Lacombe > Swift Current ≈ Agassiz ≈ L'Acadie > Woodslee. Indices of N availability such as microbial biomass C, KCl extractable NH₄-N, particulate organic-N and -C, and NaOH direct-distillation NH₄-N appeared to be useful predictors of variation in N_0 among experimental sites.

The diversity of nitrifiers and denitrifiers associated with spring thaw in an Ontario agricultural soil

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Keywords: spring thaw, nitrous oxide, microbial diversity, nitrifiers, denitrifiers.

Nitrous oxide (N₂O) emissions from agricultural soils in Ontario are known to fluctuate with soil and air temperature and moisture content, resulting in a flush of N₂O often occurring during the spring thaw period. Agricultural management practices, such as tillage can also affect N₂O emissions; however, findings in this area are inconsistent. This study attempts to assess the diversity of nitrifying and denitrifying bacteria associated with the spring thaw period from an Ontario agricultural soil under different tillage practices.

Large-scale, long-term field plots were established in Elora, Ontario in 2000, and managed using conventional tillage (CT) or no tillage (NT). Each field plot was instrumented with micrometeorological equipment to determine N₂O fluxes on a field scale. Six random soil samples for each plot were taken at six time points throughout one year: maximum growth (August 2005), physiological maturity (September 2005), post tillage (October 2005), pre spring thaw (February 2006), post spring thaw (March 2006) and post planting and N fertilizer application (May 2006). DNA was extracted from soil and the diversity of the nitrifier and denitrifier communities was assessed by PCR-denaturing gradient gel electrophoresis (DGGE) using primer pairs targeting the *amoA*, *nirS* and *nirK* genes. Cluster and principal component analysis of DGGE banding patterns revealed that seasonal variation had the largest influence on the diversity of both nitrifier and denitrifier populations, as seen by the clustering of DGGE banding patterns by sampling dates. Of particular interest, both cluster analysis and analysis of variance of Shannon's diversity index and Margalef's richness index point to a shift in microbial diversity during spring thaw, associated with an N₂O emission event in these fields. Our analysis also indicated that on some sampling dates management practice also impacted nitrifier and denitrifier diversity, where microbial communities associated with no-till soils clearly had different structure and composition compared to conventionally tilled soils.

As a follow-up to our field study, we commenced a laboratory incubation study to examine the active communities of denitrifying bacteria and their associated N₂O emissions during a thaw event. In February 2006, intact soil cores were taken from the long-term field plots in Elora. Five cores were taken from frozen soil in each treatment (CT and NT) to a depth of 5 cm and were maintained at -20°C until the beginning of the experiment. The cores were then thawed gradually at 10°C in the lab for 50 hours. Soil samples (7.5 mm cores) and gas samples were taken at 0, 2, 7, 12, 16, 18, 20, 26 and 50 hours. DNA and RNA were extracted from the soil samples and analysed using PCR-DGGE and RT-PCR-DGGE using primers targeting the *nirS*, *nirK* and *nosZ* genes. N₂O emission concentrations were analysed using gas chromatography. Preliminary results indicate a change in diversity over the 48-hour thaw period corresponding to changes in N₂O emissions as well as a difference in community structure of denitrifiers associated with the CT and NT cores.

Insight into the effects of spring thaw and management practices have on these microbial communities will improve our ability to model N₂O emissions in Ontario, and may aid in the development of best management strategies for minimizing emissions.

Prescribed burning: Effects upon microbial communities within boreal forest floors

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Keywords: burning, boreal, PLFA, microbial community.

Forest floor microbial communities may be affected differently by prescribed burning following timber harvesting than by harvesting alone. The aim of this project was to further test and develop the linkages between prescribed burning and harvesting by comparing the microbial biomass and microbial community structure of forest floors from stands dominated by white spruce (*Picea glauca*), trembling aspen (*Populus tremuloides*), and from mixed-species stands in northern Alberta, Canada. A prior study found that, when compared to uncut stands, harvesting had no effect upon forest floor microbial community structure, but revealed distinct differences among stand types, which seemed to be strongly affected by the presence of white spruce and the composition of the understory vegetation¹. In this study, the microbial community structure and functional diversity of prescribed-burn and harvest-only forest floors were determined using phospholipid fatty acid (PLFA) and substrate-induced respiration (SIR) analyses. Ordinations using non-metric multi-dimensional scaling (NMS) confirmed earlier findings that deciduous stands differed from both the mixed-wood and coniferous stands. Prescribed burning caused a significant decrease in forest floor microbial biomass that was related to a significant decrease in fungal PLFAs. Bacterial PLFAs were also lower in burned forest floors, but not significantly. In contrast, ordinations based on PLFA and SIR analyses did not show any differences between prescribed-burning and harvested forest floors. Taken together, these results suggest that differences in microbial communities among these boreal forest stand types are resilient to prescribed burning and harvesting disturbance.

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Using ^{137}Cs to identify the relative contribution of tillage and water erosion within cultivated potato fields in New Brunswick

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Keywords: soil erosion, tillage erosion, ^{137}Cs , potato production

Total soil erosion is the result of all soil erosion agents – wind, water and tillage. In Canada, the risk of soil erosion (in particular by tillage and water erosion) is expected to be greatest in regions where highly erosive cropping and tillage systems are used on highly erodible landscapes – such as the potato growing regions of northwestern New Brunswick. However, no previous studies have looked at the combined impacts of tillage and water erosion on soil and crop health in Atlantic Canada. The objectives of this project were to: 1) estimate the relative contributions of tillage and water erosion on gross soil redistribution across the landscape using measurements of spatial patterns of radioisotopes; and 2) assess the impact of tillage and water erosion on soil and crop productivity within intensive potato production in New Brunswick.

Estimates of the extent of past soil redistribution by both tillage and water erosion were made using caesium-137 (^{137}Cs : half-life 30.2 years), an environmental radionuclide that has been used with success in previous soil redistribution studies across Canada and worldwide. The ^{137}Cs present in the environment, in those areas unaffected by the 1986 Chernobyl nuclear accident, is the result of atmospheric testing of nuclear weapons that occurred during the second half of the twentieth century. This “bomb derived” ^{137}Cs came in contact with the soil through atmospheric deposition (usually in association with precipitation) and is strongly and rapidly adsorbed onto exchange sites within the fine earth fraction of mineral soils. Once adsorbed to the soil, the ^{137}Cs is essentially non-exchangeable, and biological and chemical processes move little of the adsorbed ^{137}Cs through the soil profile. Since ^{137}Cs remains concentrated in the surface soil, and its deposition at the local scale is assumed to be uniform, the subsequent redistribution of ^{137}Cs throughout the landscape allows for the estimation of the location, extent, redistribution and rate of total soil loss from all erosion processes for a time period of approximately 40 years. Depth incremental soil samples (0-15, 15-30, 30-45 and 45-60 cm) were collected at one of the two Agriculture and Agri-Food Canada benchmark sites (20NB) located near the town of Grand Falls, New Brunswick. Site 20NB is 3.5 ha in size and is under conventional up and down slope cultivation (slope gradients range from 2 to 17 %). Soil samples were collected across the landscape using two grid patterns – 25 x 25 m over the entire field and reduced to 12.5 x 12.5 m at the most concave part of the field. In total, 128 points were sampled and all soil samples were analyzed for ^{137}Cs , total C, total N, and Mehlich-available nutrients. Calculations of medium-term (ca. 40 years) soil redistribution at each sampling location was derived using a mass balance approach whereby the total concentration of ^{137}Cs at each sampling location was compared to the total atmospheric input obtained from a reference site. Preliminary analyses suggest that both tillage and water erosion are major erosive agents at this field site, but that tillage erosion is the dominant soil redistribution process occurring within potato production in New Brunswick. Additional analyses will be undertaken to determine if relationships exist between the measured soil properties, topography and overall soil redistribution. Current inventories of ^{137}Cs will also be compared to those previously taken at 20NB in 1990 and 1996 to compare soil redistribution over a shorter timescale (ca. 10 – 15 years). It is clear that both residue management for water erosion control and soil movement from tillage erosion must be considered when choosing implements and developing best management practices to improve soil conservation strategies for potato production systems in Atlantic Canada.

Spatial analysis of N-NO₃ levels in the soil profile as a function of N fertilization and terrain attributes

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Keywords: Mineral nitrogen, residues, soil electrical conductivity, slope, elevation

Optimal nitrogen (N) fertilization is complicated by many factors (Olf et al. 2005) but crop diagnosis offers an opportunity to adjust rates, provided that a significant portion of fertilizer N is saved for in-season application (Schroder et al. 2000; Tremblay, 2004). Field attributes such as topography and soil features must be taken into account in determining optimal N rate. Soil electrical conductivity (SEC) is considered by many as an indirect measurement of important soil characteristics such as soil type, texture, salinity and fertility. Topography influences the movement and content of water. Depending on seasonal conditions, these features can either promote or reduce crop growth and modify nitrification, denitrification and leaching. Assuming that growth and yield can be optimized with spatially adapted N rates, this must not come at the expense of leaving an excess of mineral N in the soil profile after harvest. The purpose of this study was to understand the respective influence of soil factors [elevation, slope and soil electrical conductivity (SEC)] and corn N fertilization on N-NO₃ content in the soil profile for different seasons. Experiments were carried out on corn fields in the Montérégie region of Quebec which were treated with different N fertilization levels at topdressing. The crops were grown mostly on silty clays of the Bearbrook and St-Laurent series. The results show that the risk of leaving excessive mineral N after harvest is little related to terrain attributes but rather to N rates, only if the latter are greatly in excess of crop requirements.

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Root organic acid exudates and properties of rhizospheres of *Picea glauca* and *Abies lasiocarpa*

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Keywords: rhizosphere, root exudates, organic acids

Rhizosphere processes, such as the production and release of organic acids, may contribute to changes in the rhizosphere and differences in properties between rhizosphere and nonrhizosphere soils. We compared the organic acid composition/concentrations in the root exudates of *Picea glauca* and *Abies lasiocarpa*, and in the rhizosphere and nonrhizosphere soils of *P. glauca* and *A. lasiocarpa*. We also compared the chemical properties and mineral composition of the soil samples. Higher concentrations of organic acids were observed in rhizosphere soils with aliphatic acids predominating in both soil samples and root exudates. Acetic, formic, and protocatechuic acids were the predominant aliphatic and aromatic organic acids in rhizosphere and nonrhizosphere soils. Organic acid composition varied in rhizosphere soils between the two plant species. Formic, gluconic, glutaric, malic, malonic, oxalic, propionic, pyruvic, succinic, phenylacetic, protocatechuic, salicylic, and gentisic acids were common in *P. glauca* and *A. lasiocarpa* rhizosphere soils. Lactic and ferulic acids were detected only in *P. glauca* rhizosphere soil while benzoic and gallic acids were restricted to *A. lasiocarpa* rhizosphere soil. Malonic and oxalic acids were predominant in the root exudates of both plant species. In root exudates, the total organic acid concentration was higher in *P. glauca* than in *A. lasiocarpa*, glutaric and isocitric acids were found only in *A. lasiocarpa* while gluconic and succinic acids were exclusive for *P. glauca*. pH was lower in the rhizosphere than in the nonrhizosphere soil of *P. glauca*. Cation exchange capacity, and exchangeable Ca²⁺ and K⁺ were higher in rhizosphere than in nonrhizosphere soils except for the *A. lasiocarpa* LFH horizon. Chlorite, mica, kaolinite, vermiculite, and smectite were detected in all soil samples. Rhizosphere soils may contain a higher concentration of 2:1 expanding clays.

Soil Organic Matter Quality in the Oil Sands Reclamation Area

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Keywords: soil organic matter, oil sands, reclamation, NMR.

Surface mining operations used to access the Athabasca Oil Sands deposits currently affect 150 km² around Fort McMurray, northeastern Alberta. Following mining, land reclamation entails the re-establishment of functioning ecosystems through the creation of soil-like profiles using salvaged soil materials and mining by-products. The organic component of reconstructed soils is composed predominantly of peat, due to its availability in large portions of the mining footprint.

The overall objective of this research is to assess how different reclamation practices influence organic matter quality in reconstructed soils as compared to undisturbed forested soils found in the Oil Sands region.

Soil samples (0-10 cm) were taken from replicated undisturbed and reclaimed sites chosen from the network of Long Term Soil and Vegetation Monitoring Plots established in the Fort McMurray area.

The distribution of carbon among labile (low-density) and recalcitrant (acid-insoluble) organic matter pools was quantified using a combination of density, particle-size, and acid hydrolysis separation techniques. Chemical composition of the low-density fractions was characterized using ramped-cross-polarization (RAMP-CP) ¹³C Nuclear Magnetic Resonance (NMR) on a Bruker Avance 400 spectrometer. Integrated areas of spectral regions were ordered by non-metric multidimensional scaling (NMS). In addition to macromolecular fingerprints obtained by NMR, phenols released by CuO oxidation are being considered as molecular biomarkers to separate between the contribution of peat and tree litter to organic matter in reclaimed soils.

Preliminary NMR results indicate significant differences in organic matter composition between reclaimed and undisturbed soils. Reclaimed soils further exhibit a lower variability in composition than undisturbed soils.

DOC production, C mineralization and microbial biomass during decomposition of litter from 10 Canadian forests

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Keywords: Dissolved organic carbon, carbon dioxide, litter decomposition, microbial biomass, degree of decomposition, coniferous, deciduous.

Dissolved organic carbon (DOC) plays a major role as an energy source for microorganisms (Stevenson & Cole, 1999), pedogenetic processes and mineral weathering (Michalzik et al., 2001) and soil and water acidification (Likens et al., 1981) and soils are the central point of production and retention of soluble organic matter (Stevenson & Cole, 1999). We incubated litter samples from 10 Canadian forest sites (douglas fir, black spruce, jack pine, aspen, boreal mixed wood, white pine, black spruce/jack pine, balsam fir, sugar maple and sugar maple/american beech) representing varying degrees of decomposition, for 30 days. Measurements of DOC production and C mineralization were made. Microbial biomass C and N were measured on the initial and incubated samples using a fumigation-extraction method. The C content of the initial material varied from 22 to 75% (mean 49%) and C:N ratios varied between 17 and 86 (mean 40). Values for C mineralization over the 30-day incubation varied between 1.1 to 61.7 mg DOC/g C (overall mean of 10.6 ± 11.9 mg DOC/g C) and 1.6 to 88.2 mg CO₂-C/g C (overall mean of 17.4 ± 16.7 mg CO₂-C/g C), with significant differences only observed between degree of decomposition (ANOVA, $P < 0.05$). The CO₂-C:DOC ratio was also significantly different between degree of decomposition, but not between litter type (coniferous vs. deciduous). Despite the significant slope of the regression between the initial C content or C:N ratio and the amounts of DOC and CO₂-C produced, we were unable to find significant relationships ($R^2 < 0.08$, $P > 0.100$). We estimated gross DOC production by combining the production of DOC, CO₂-C evolved and microbial biomass C storage over the incubation period. Our results give some insight into the major source of DOC from forest litter. All other variables being constant, fresh litter produced more DOC than decomposed material (F and H horizons), and litter type was a smaller control on DOC production compared to the degree of decomposition.

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Influence of microbial activity and trace metal speciation in the rhizosphere on metal uptake by wheat.

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Keywords: rhizosphere, microbial activity, trace metal uptake

Few studies have demonstrated the intimate links existing between microbial activity in the rhizosphere, metal speciation and metal uptake by edible plants. Our approach was to conduct a growth experiment using metal-contaminated soil materials that had been previously manipulated to generate two distinct initial levels of microbial activity. The specific objectives of the study were: 1) to contrast the microbial and chemical properties of the rhizosphere and bulk components of manipulated soils at the end of growth experiments and 2) to establish the impact of the initial level of microbial activity on the speciation of soluble metals in the rhizosphere and on metal accumulation in plant parts.

The soil samples were collected close to a zinc plant in an abandoned agricultural field and under a forest stand in the Monteregian area (south shore of Montreal), Quebec, Canada (45°15'N, 74°08'W). A total of 50 kg of soil were sampled at each site, air-dried in the laboratory, sieved at 2 mm and homogenised. The experiment was performed in a growth chamber with a special dwarf cultivar of spring wheat (*Triticum aestivum* cv. USU-Perigee). The pots contained an inside (rhizobag around plants roots) and an outside compartment separated by a 25- μ m nylon mesh. Before the experiment, soil materials were sterilized using gamma rays (50 kGy) and a 90% sterile soil was produced by mixing 90% of sterilised soil with 10% of intact soil. Wheat was grown in sterilized (low microbial activity) or intact soil (high microbial activity), either agricultural or forested. Three wheat plants were grown per pot except for control pots. Treatment was replicated four times. The pots were watered every 48 hours and fertilised once a week with a Hoagland half-strength solution. The experiment ran for eight weeks until the plants reached maturity. At the end of the experiment, the rhizospheric material contained in the rhizobag was separated from the bulk material surrounding the rhizobag. In each sample, the characterization of the microbial properties will involve the measurement of the total microbial biomass C and N, the microbial C/N ratio and of the dehydrogenase, urease, arylsulfatase and acid phosphatase activity. For the rhizosphere and bulk soils, the speciation of the trace elements Cd, Co, Cr, Cu, Mn, Ni, Pb, Zn will be established using the following extractants: water, 0,01M CaCl₂, EDTA and a strong acid mixture. The roots, shoots and fruits of parts will be analysed for total trace metal content.

Preliminary results indicate that the dehydrogenase, acid phosphatase and arylsulfatase activities were higher in the rhizosphere than in the bulk component. These enzymes are also more active in the intact soil (soil with high microbial activity) and the difference between rhizosphere and bulk components is more pronounced in the soil that is well-colonised with roots, the forested soil. To the contrary, the urease activity did not differ between sterilized and intact soils. Nonetheless, the urease was more abundant in the rhizosphere of the forested soil while there was no difference between the rhizosphere and bulk compartments for the agricultural soil. In the forested soil, the microbial biomass C and N contents were also higher for the intact soil and the concentrations of major dissolved element (pH, Ca, Mg, Na and SO₄) were higher in the rhizosphere.

Greenhouse gas flux potentials of forests soils in Eastern Canada

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Keywords: N₂O and CH₄ emissions; forest soils; controllers of trace gas fluxes

Canada is home to 10% of the global forest cover, which can have significant bearing on the emissions and consumption of atmospheric N₂O and CH₄ gases; however our knowledge of environmental factors influencing trace gas fluxes from the Canadian forest soils is fragmentary. We conducted laboratory experiments to investigate the influence of forest types, topographic position and biogeochemical parameters on greenhouse gas emissions from forest soils in eastern Canada. Deciduous [well-drained and wetland], black spruce [mature and burned] and white pine [four chronosequence] forests soils were incubated in the laboratory at 70% water-filled pore space (WFPS) except the wetland soils, which were incubated at 100% WFPS for potential flux measurements. The incubations were conducted at room temperature under NH₄NO₃ and headspace CH₄ additions. Deciduous forest soils developed under saturated conditions showed significant increase in N₂O emissions compared to well-drained forest soils, when amended with mineral N. N₂O emissions were 5 and 12 times higher from black spruce and deciduous forest soils compared to those from the white pine forest soil. Denitrifier activity was higher in wetland than in well-drained soils, while nitrifier activity was higher in well-drained soils. This suggests that denitrification in wetland soils and nitrifications in well-drained soils are likely the major sources of N₂O emissions. CH₄ oxidation potentials were higher in deciduous and black spruce forests compared to white pine forests soils. Addition of mineral N to forest soils resulted in lowered CH₄ oxidation potentials, especially in the well-drained soils. Well-drained soils collected from an old-growth deciduous forest exhibited 2.5 times higher CH₄ oxidation than soils collected from similar locations in a semi-managed forest. Percent dissolved organic C (DOC) respired as CO₂ by soil microbes was highest in the wetland and boreal forests soils and lowest in the white pine forest soils. Percent DOC respired as CO₂ seem to be a more sensitive indicator of microbially available C than DOC alone in these soils. Mineral N additions enhanced CO₂ emissions in all of the forest soils. These results indicate that accurate quantification and modeling of greenhouse gas fluxes from forest soils in eastern Canada would be improved by integrating topographic, floristic and biogeochemical factors, which influence greenhouse gas emissions and consumption rates.

Factors impacting BMPs effectiveness on water quality in a Quebec agricultural intensive watershed

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Keywords: Best management practices, agriculture, water quality, diffuse pollution, watershed

With its intensive farming system, the Chaudiere River watershed south of Quebec City has long been considered as an important producer of manure, with a marked intensification of hog production in recent years. The increasingly high level of soil phosphorus (P) saturation of this region, and problems of soil erosion and surface runoff, have contributed significantly to the P nonpoint-source pollution of streams. This project takes place on a critical tributary to the Chaudiere River -- the Bras d'Henri River (150 km²) -- and is part of the Canadian WEBs (Watershed Evaluation of BMPs) project. This involves monitoring and diagnosing the impacts of a suite of BMPs on the water quality of two micro-watersheds (300 ha), by temporal comparisons of nutrients, herbicides, and pathogen loads at their outlets.

The four BMPs applied on one third of the total cropland of one of the two micro-watersheds are integrated plans of structural runoff and riparian buffer management, reduced use of herbicide in corn, post-emergence slurry application, and optimization of crop rotations. These BMPs have been previously tested to reduce sediments transfer and their associated contaminants to streams, reduce herbicides at the source minimizing risks for the crop yields, and optimize the uptake of nutrients by the crops.

Significant trends in stream water quality can be observed after three years of BMP application using the twin microwatershed approach. The differing water quality trends between the twin micro-watersheds show that detailed soil characterization is required to effectively assess impact of BMPs on contaminant transport from field to stream. As a result, subtle differences in initial soil conditions should clearly be taken into account when considering the long-term comparison of water quality between twin micro-watersheds. This study includes also a methodology designed to quantify the specific processes taking place at the field-stream interface allowing impact evaluation of selected BMPs and current management practices used by the farmers on stream water contamination. Water and solute transfers by surface runoff and drainage are measured during hydrologic events in spring, summer and fall at the edge of six corn and four forage instrumented fields (drain gauges, gutters, tile drains, cup lysimeters, piezometers). BMP impacts on water quality will be discussed in relation with nutrients, pathogens and herbicides water contamination.

A methodological approach for the development of a national indicator of risk of water contamination by pathogen

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Keywords: indicator, risk, water, contamination, pathogen

A Canadian indicator of risk of water contamination by pathogen (IROWC_Path) is being developed and will be calculated for all the agricultural Soil Landscape of Canada (SLC) polygons using the Census of Agriculture (CoA) data of 1981, 1986, 1991, 1996, 2001 and 2006. The IROWC_Path is part of the National Agri-Environmental Health Analysis and Reporting Program (NAHARP) which oversees a series of twenty-four agri-environmental indicators which aims reporting on the sustainability of the agriculture at the National scale. The objective of the IROWC_Path is to characterize the risk of having pathogens originating from livestock's fecal material reaching and contaminating surface water bodies and to evaluate how this risk is shifting over time.

The IROWC_Path consists of two main components related together in a multiplicative equation. A first component, "Pathogen-Source", will address the sources and an estimated magnitude of the pathogen population that could potentially reach surface water bodies. Fecal coliforms will be used as a surrogate for assessing potential contamination by livestock fecal material pathogens. A second component, "Transport-Hydrology", shared with other NAHARP indicators of water contamination, will address the different modes of transportation (soil erosion, surface runoff and water infiltration) and numerous hydrological connectivity parameters (*e.g.* surface drainage density, preferential flow, topographic index, etc.) of the landscape.

Compaction Effects on Soil Properties, Biogenic Gas Emissions and Crop Production

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Keywords: compaction, soil quality, biogenic gases, crop yields, soil structure

Soil compaction is a common problem in eastern Ontario and is detrimental to soil and environmental quality and crop productivity. A field experiment to assess the effects of compaction on various soil properties, biogenic gas emissions, and crop production was conducted at the Central Experimental Farm in Ottawa.

Compaction was achieved by repeated tractor traffic during very wet conditions after fertilization but prior to planting of maize (*Zea mays* L) in 2002 and 2003. Experimental plots were arranged in a factorial design with four N fertilizer (0, 75, 150 and 300 kg N ha⁻¹) and four levels of compaction randomized in four blocks. Regular measurements of CO₂, N₂O and CH₄ were made approximately once a week during the growing season of the crop. Soils were sampled before planting and after harvest each year for three years and were measured for residual mineral N (NO₃⁻ and NH₄⁺), bulk density and water content. Soil pore structure was characterized by collecting undisturbed core samples, impregnating them with epoxy resin, and measuring pore size and shape by image analysis.

Compaction resulted in significantly higher bulk densities, lower pore space, and grain yield reductions of between 20 and 40%. N₂O fluxes were strongly related to the rate of N fertilization. Compaction also enhanced the flux of N₂O but CH₄ uptake did not appear to be influenced by either N fertilization or compaction. Residual N in the soil profile was about two times higher in the compacted than the uncompacted soils. Rounded and irregular shaped pores between 100 and 1000 µm equivalent pore diameter were 30-70% lower in the compacted soils at both the 0-10 and 10-20 cm depths. Large elongated pores, between 500 and 3000 µm length, were reduced by greater than 70% at the 10-20 cm depth, indicating the significant impairment of water movement and storage in compacted soils. Further results of the experiments will be discussed to explore the effects of compaction on biogenic gas emissions, soil quality and productivity.

Soil Analysis Bordering Some Saline Ponds in the Surrounding Kamloops Area.

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Keywords: Soil Chemical Analysis, Saline Ponds

Kamloops is located in the Thompson Okanagan, where the climate is semi-arid and there are a number of saline ponds. This study was conducted to determine and compare the physical and chemical properties of selected soil samples taken from 3 saline ponds in the Kamloops region: Ice Pond, Pond 1 of 2 and Pond 2 of 2. Past and present chemical and biological studies evaluating the pond water indicate that they are unique environments.

The purpose of this study was to broaden the understanding of these sites via soil analysis. The data acquired was used to classify the soils. Chemically it was determined that both Ponds 1 and 2 of 2 are saline-sodic, and Ice Pond is saline. Physically, according to the Canadian System of Soil Classification Ice Pond and Pond 1 of 2 were classified as Alkaline Solonetz and Pond 2 of 2 was classified as Vertic Alkaline Solonetz.

Les données de relief de précision *LIDAR* au service de la prospection pédologique détaillée à l'échelle du parcellaire agricole

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Mots clés: *LIDAR*, *LandMapR*®, parcellaire agricole, pédo-paysages.

Afin de limiter les apports en phosphore au sol et dans les cours d'eau et, par le fait même, soutenir le rendement des cultures, il est recommandé d'effectuer une régie des sols et des cultures par zones de sols homogènes. Hors, peu d'entreprises disposent de données pédologiques suffisamment précises. À l'échelle du parcellaire agricole, la variabilité des sols dans leurs propriétés et comportements est amplifiée par le cadastre allongé et étroit des terres, généralement parallèles au gradient de la pente. En matière d'agriculture de précision, l'approche basée sur le captage de la conductivité électrique des sols reste limitée non seulement en raison de l'utilisation de capteurs embarqués mais aussi de la densité d'échantillonnage nettement insuffisante pour plusieurs régions. L'arrivée des systèmes d'information géographique (SIG) et des modèles numériques de terrain (MNA) a conduit au développement de techniques de classification automatique des paysages en entités spatiales fonctionnelles. Développé à des fins d'agriculture de précision et de prospection pédologique dans l'Ouest canadien, *LandMapR*® (MacMillan et al. 2000) effectue la classification automatique des paysages en entités de formes à partir de l'information quantitative dérivée des MNA. Associées au mouvement et à l'accumulation de l'eau et de la matière dans le paysage, les entités définies se veulent significativement différentes en termes de propriétés des sols et de rendement des cultures. Dans le cadre du projet GRISE (Gestion Raisonnée et Intégrée des Sols et de l'Eau) mené par l'IRDA, des données de relief de précision *LIDAR* (*Light Detection And Ranging*) ont été acquises à l'échelle des sous bassins des ruisseaux Ewing (40 km²) et Wallbridge (20 km²) (Montérégie). La technologie *LIDAR* utilise un système émetteur/récepteur embarqué sur une plate-forme aéroportée qui génère une pulsation laser et qui permet l'acquisition de données de relief de précision avec une densité d'échantillonnage élevée et ce, pour de grandes superficies. Les résultats préliminaires présentés permettent une évaluation partielle du potentiel des données *LIDAR* et de *LandMapR*® pour la classification des formes de terrain à l'échelle du parcellaire agricole en territoire québécois. Une validation empirique des entités de formes délimitées en termes de composition et d'association pédologiques sera réalisée à partir de couvertures pédologiques détaillées effectuées le long de transects ainsi que de mesures ponctuelles de conductivité électrique des sols. Les résultats obtenus permettront d'effectuer des recommandations quant à la pertinence de l'utilisation des données de relief de précision *LIDAR* et de *LandMapR*® pour la prospection pédologique détaillée et la gestion des sols et des cultures par zones de sols homogènes.

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Potentiel des MRF pour la fertilisation et le chaulage de plantation de peupliers hybrides : trois années de suivi en parcelles de démonstration

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Mots clés : peupliers hybrides, amendements, plantation, compost

L'utilisation de matières résiduelles fertilisantes (MRF) pour l'amendement de sols en milieu forestier demeure marginale au Québec mais présente un intérêt croissant particulièrement comme pratique au moment de la préparation des sites de plantation de peupliers hybrides alors plus accessibles pour les opérations d'épandage.

En mai 2004, GSI a procédé à la mise en place de 8 parcelles de démonstration d'une superficie totale de 0,8 ha comprenant 2 répétitions des 4 traitements suivants : 0, 46, 97 et 144 t/ha (base sèche) d'un mélange de MRF (compost, boues municipales chaulées et cendre de bois) correspondant respectivement à 0, 50%, 100% et 150% de l'apport maximal recommandé par le MDDEP pour l'épandage de MRF en sylviculture, soit la quantité de MRF correspondant à un apport calculé d'au plus 200 kg-N/ha d'azote disponible (MENV, 2004). Le mélange de MRF a été épandu à la surface puis incorporé au sol par labour (20 cm) et hersage conventionnel. Le site est un ancien banc d'emprunt qui a été nivelé et laissé en friche depuis une vingtaine d'années.

Chaque parcelle comprenait au départ de 20 à 21 plants. La mortalité à la fin de la 3^{ième} année (2006) a été négligeable (< 1 plant/parcelle). L'apport de MRF a eu un effet très positif sur la hauteur (H) et le diamètre hauteur poitrine (DHP) des plants. Par rapport au témoin, H a augmenté en moyenne de 128%, 151% et 145% respectivement pour les apports de 46, 97 et 144 t/ha de MRF (valeurs moyenne de H incluant le témoin de 191, 244, 290 et 277 cm). De façon similaire, le DHP a augmenté de 139%, 171% et 164% (valeurs moyennes de DHP incluant le témoin de 21, 30, 36 et 35 mm, respectivement pour un apport de 0, 46, 97 et 144 t/ha de MRF). L'effet des traitements sur le pH, la matière organique et les éléments disponibles (Mehlich 3) du sol (0-20 cm) et sur la composition du feuillage des plants seront discutés. Des corrélations seront également présentées pour tenter d'identifier les facteurs les plus reliés à H et au DHP compte tenu de la variabilité observée du site.

Les résultats obtenus semblent indiquer que l'apport de MRF basé sur un apport maximal de 200 kg-N disponible/ha préconisé en sylviculture par le MDDEP a permis d'obtenir un accroissement cumulatif à court terme optimal des plants. Un suivi à plus long terme est cependant nécessaire pour conclure sur la dose optimale puisque l'effet résiduel de l'apport de MRF est encore très marqué à la 3^{ième} saison et compte pour près de 50% de l'accroissement cumulatif mesuré (H et de DHP).

GSI remercie la Corporation de gestion CHARMES de Sherbrooke et le Groupement forestier coopératif St-François pour leur collaboration au projet.

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Use of micro-CT imagery to study biopore formation in clay, silt loam and sandy soils

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Keywords: X-ray scanning, micro computed tomography, 3D imaging.

Recent developments in microcomputerized X-ray tomography (CT scanning) allow study of the properties of the soil's intact three-dimensional structure. These systems have resolution capabilities down to 10 μm , which allow differentiation of soil solids from soil pore space. This study made weekly observations of soil biopores over a 2-month incubation period to evaluate the influence of texture on their formation. Soil cores (6.4 cm in diameter X 10 cm length) were kept at -60 kPa water potential and fresh, garden compost was added to the surface. Cores were scanned using a GE MS-8 micro-CT system to generate an axial sequence of X-ray attenuation imagery, from which a 3D image was reconstructed. A binary image of pore and non-pore components was obtained by level thresholding of the 16-bit image histogram. The pores were then quantitatively analyzed for selected morphological characteristics and connectivity.

Use of sodium for potassium in sugar beet growing on potassium-fixing soils

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Key words: potassium, sodium, K^+ -fixing soil, sugar beet

Alluvial soils with illite and vermiculite clay minerals are able to fix potassium. Such type of soils has been reported (Doll and Lucas, 1973) to require a huge amount of K^+ fertilizer to be applied. Subbarao *et al.* (2000) reported that 90% of applied K^+ is localized in of plant-cell vacuole, where it functions as an osmoticum and may be replaced by sodium. The question whether Na^+ can substitute K^+ in physiological processes in plants is not only of academic interest but also of practical importance in relation to fertilizer usage (Mengel and Kirkby, 2001). Sodium may substitute K^+ in a better way in some halophytes. Substitution in K^+ -fixing soils will replace the application of several hundred kilograms of K^+ fertilizer with a reasonable amount of Na^+ .

Three soils, differing in K^+ -fixing capacities, were selected and sugar beet was grown in Ahr pots with 15 kg soil/pot. Three treatments (no K^+ and Na^+ , K^+ equal to K^+ -fixing capacity of soil and Na^+ equivalent to regular K^+ fertilizer dose. In a second experiment containers were used for one of the K^+ -fixing soils, used in first experiment, with 170 kg soil/container and in each container one sugar beet plant was grown. In both experiments, plants were grown till maturity and beets were analyzed for sucrose concentration and quality parameters such as α -amino nitrogen to calculate white sugar yield (WSY) with new Brunswick formula.

The results show that growth and quality of sugar beet were not affected by Na^+ application and ultimately there was no significant decrease in WSY. Moreover, the soils with more K^+ -fixing capacity are more suitable for K^+ substitution by Na^+ . It is concluded that Na^+ can substitute K^+ in sugar beet nutrition to a high degree and this is more effective in soils with high K^+ -fixing capacity.

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Soil Chemical and Physical Classification of Three Saline Ponds near Kamloops, BC.

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Keywords: Solonetzic, Vertic, Saline Ponds, Classification

Kamloops, Cache Creek, the Okanogan and the Nicola Valley areas of British Columbia are all classified as semi-arid. The dry conditions are ideal for saline pond development. Precipitation is minimal and evaporation rates are high which results in reduced cation leaching capability of the soils. Several saline ponds in the Kamloops area have been studied over the last few years with regards to the chemical and biological properties of the pond water. Preliminary results of these studies show differences in water chemistry and biota among various ponds. This research investigates the soil chemistry bordering three of these ponds, Ice Pond, Pond 1 of 2 and Pond 2 of 2, for the purposes of soil description and classification. Thirty-five mm aerial photography has been used to map the aerial extent and vegetation zones around these ponds.

One soil pit was established within the *Salicornia rubra* vegetation zone for each of the three ponds. The three soil profiles were photographed, described and classified in the field. Replicate soil samples were obtained from each soil horizon from each pit. Standard methods were used to determine soil pH, electrical conductivity, soil salinity, exchangeable sodium percentage, sodium absorption ratio and extractable analysis of calcium, magnesium and sodium.

The soils were classified as Alkaline Solonetz, and saline for Ice Pond; Alkaline Solonetz, and saline-sodic for Pond 1 of 2; and (Vertic) Alkaline Solonetz, and saline-sodic for Pond 2 of 2. Of the three soils classified the Pond 2 of 2 (Vertic) Alkaline Solonetz Bvgk horizon displayed active signs of argillipedoturbation. Evidence of slickensides was not observed in any of the horizons.

Research continues in and around these pond environments. It is hoped that the soil results will lead to an improved understanding of the relationships among the soil, water chemistry and the biota in these areas.

Are earthworm populations in Quebec agroecosystems constrained by soil physical factors or food availability? Results from two long-term tillage experiments

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Keywords: tillage, earthworm, crop residues, soil organic matter, soil physical properties.

Earthworms are well known to contribute to soil fertility by accelerating decomposition and nutrient cycling processes, and change soil structure by creating macropores and forming aggregates. Earthworm populations are disturbed by tillage, which destroys their burrows and reduces the amount of surface residues that they may feed upon. Long-term intensive tillage is expected to reduce earthworm populations, relative to minimally-tilled or no-till agroecosystems. This study was conducted at two long-term (10+ years) experimental sites (La Pocatière and Ste-Anne-de-Bellevue) in Quebec. Each site had replicated plots with three tillage treatments: conventional tillage (mouldboard plow/disk harrow), reduced tillage (chisel plow/disk harrow) and no-tillage; and two levels of crop residue input (high and low). Earthworm populations were enumerated in fall 2006, and there were more earthworms in the no-tillage than reduced- or conventional-tillage treatments. There was no effect of crop residue input on earthworm populations. The dominant species were *Aporrectodea turgida* and *Lumbricus terrestris*, with a few individuals of *A. longa*, *A. rosea* and *Octolasion tyrtaeum* at La Pocatière; we also found *A. tuberculata* at the Ste-Anne-de-Bellevue site. We collected soil columns (20 cm depth, 10 cm diameter) from each experiment plot and stored them at <0°C for two months, then moistened the soil to -5 kPa and transferred the cores to an incubator at 20°C. Three earthworms (*A. turgida*) were added to each core and their growth was measured. Earthworms grew more in soil cores from reduced-tillage plots than the other tillage treatments, and earthworm growth was greater in soil cores from plots receiving the high crop residue input. However, earthworm growth in cores was not related to soil physical properties (bulk density, aggregation) or chemical properties (soil organic C, pH). The earthworm growth in soil cores leads us to propose that reduced tillage may improve the soil environment for earthworms, perhaps because earthworms can access crop residues and burrow more easily when the soil fabric is loosened by light tillage. No-tillage may be favourable to earthworm populations in the field because there is no mechanical damage to earthworms from tillage implements and because no-tillage soils tend to be moister and cooler than soils in other tillage systems. These possibilities remain to be examined.

Estimating manure N losses from storage systems and land application methods across Canada

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Keywords: Livestock manure, Manure storage and land applications, Manure nitrogen loss, Soil Landscapes of Canada, Census of Agriculture

Manure N and fertilizer N databases at the soil, crop and Soil Landscape of Canada (SLC) polygons were developed to support national modeling projects such as agri-environmental indicators, greenhouse gas emissions, carbon sequestration and agricultural policy (Huffman et al., 2007). Recent updates include the addition of a procedure to estimate manure N losses from storage and land application systems using data from Statistics Canada surveys. The Canadian Agricultural Nitrogen Budget model (Yang et al., 2007) was used to develop the manure and fertilizer N database. This presentation describes procedures developed to estimate manure N losses from storage and land application systems across Canada. The manure storage and management data were collected from Statistics Canada's Farm Inputs Management Survey of 1995 and Farm Environmental Management Survey of 2001. Manure N loss coefficients were derived from published literature (e.g. USEPA 2004). Manure production from all sources was estimated from Census of Agriculture livestock numbers using the N excretion coefficients. The distribution of manure storage systems was derived from the Statistics Canada classification that identifies 5 solid and 6 liquid systems (Statistics Canada, 2003). For land application systems, 3 incorporation periods (<1 day, 1-7 days and >7 days) and 4 seasons of application were considered (Statistics Canada, 2004). For each storage system, and application method, N losses, available N and organic N forms were estimated. In addition, the mineralization of organic N in years 2 to 4 was also estimated. The quantities of annual available manure N for each system were calculated for each SLC based on the recommended application rates for each crop. A manure N database was developed by SLC, by soil great group and by crop for each census year from 1981 to 2001.

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Carbon and nitrogen in particle size fractions separated by ultrasonic dispersion of a clay loam soil under mouldboard plough and no-tillage

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Keywords: Ultrasonic Separation, Sonication, Soil Size Fractions, Organic Carbon, Nitrogen.

Ultrasonic dispersion, or “sonication”, is commonly used to dissociate soil aggregates for soil textural analysis and determination of soil organic carbon (C) and nitrogen (N) content. The appropriate input energy is often varied with studies (Gregorich et al., 1988; Raine and So, 1994; Roscoe et al., 2000; Schmidt et al., 2005), however, despite the fact that input energy is critically important for accurate determination of particle size distribution and the amounts of C and nitrogen N associated with each particle size fraction. Hence, the objectives of this study were to determine for the near-surface (0-10 cm) of a Brookston clay loam soil under long-term no-tillage (NT) and mouldboard plough tillage (MP): 1) the appropriate ultrasonic energy input to fully disperse the soil for textural analysis; and 2) the impact of a range of ultrasonic energy inputs on particle size fractions (sand, silt, clay) and amounts of C and N associated with the size fractions.

A probe-type ultrasonic processor (Cole-Parmer 750-W) was used in conjunction with the standard pipette methods, along with a 1:5 weight ratio of soil to distilled water and a working temperature < 32 °C. The required energy input to fully disperse aggregates was determined by comparing texture obtained after sonication to texture obtained after removal of organic matter with hydrogen peroxide and chemical dispersion with sodium hexametaphosphate. The contents of C and N in the ultrasonically separated particle size fractions were determined using a LECO-CN Analyzer.

Soil dispersion increased with increasing input of ultrasonic energy, causing a decrease in the measured sand and silt fractions and a corresponding increase in the measured clay fraction. Increasing input energy also caused an increase in the amounts of C and N in the clay fraction and corresponding decreases in the silt and sand fractions. Plateaus for the measured particle size fractions and the measured C and N contents were reached at 750 J ml⁻¹, suggesting complete dispersion of the < 2 µm materials at that energy level. The absolute differences in measured particle size fractions between sonication at 750 J ml⁻¹ and standard chemical dispersion were negligible at < 1.5%. The distribution of C amongst the sand, silt and clay fractions at 750 J ml⁻¹ input energy was 9.4 %, 32.4 % and 58.2 %, respectively for NT, and 6.1 %, 39.6 % and 54.2 %, respectively for MP, indicating that a greater proportion of C was contained in the sand and clay fractions of the NT soils compared to the MP soils. In addition, the C/N ratios for silt were higher under NT (17:1) than under MP (13:1).

These preliminary results suggest that sonication may be a convenient and viable technique for both particle size analysis and determination of the C and N distributions amongst particle size fractions. The results also imply that long-term NT and MP may cause C and N to be distributed differently amongst the sand, silt and clay fractions of Brookston clay loam soil.

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Opportunities for Improved Fertilizer Nitrogen Management in Production of Arable Crops in Eastern Canada

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Keywords: soil tests, plant tests, precision farming, fertilizer products

There is increasing public pressure to reduce the environmental impacts of agricultural production. Therefore, one key challenge to producers is to manage their crop production systems in order to minimize environmental losses of nitrogen to air or water, while achieving commercial crop yield and quality targets. Many strategies have been developed in recent years to meet this challenge. These include: development of new tools to measure crop N status in order to refine in-season fertilizer N management, development of new soil N tests to improve prediction of soil N supply, development of new fertilizer N products with release patterns more closely matched to crop N uptake patterns, and development of site specific N management strategies. We review the opportunities and limitations to application of these new strategies within different arable crop production systems under the humid and sub-humid soil moisture regimes present in eastern Canada. Future research opportunities to improve the efficiency of fertilizer N utilization include development of practical methods to predict the magnitude of soil N mineralization, refinement of optically based measures of crop N status as a basis for variable rate fertilizer N application, development of affordable controlled release fertilizer N products with improved N release characteristics, development of gene expression profiling based techniques to identify crop N stress, and application of crop genomics and molecular breeding techniques to accelerate the development of new cultivars with increased N use efficiency.

Comparison of Colorimetry and ICP determination of Mehlich-3 Soil Phosphorus

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Numerous methods have been developed to estimate soil phosphorus availability. Among those, Mehlich 3 (M3) is considered the most appropriate and economical because of its suitability for a wide range of soils. The use of inductively coupled plasma (ICP) emission spectroscopy to determine soil P extracted by M3 (M3P) has expanded rapidly since the early 1990s and ICP has become one of the most popular methods used in routine soil testing laboratories. However, the use of ICP, rather than a colorimetric method, has been criticized, particularly when used for soil P. Our objective was to compare M3P as determined by ICP (M3P-ICP) and by a colorimetric (M3P-Col) method. Soil samples (440; 0-20 cm depth) were collected from five experimental sites in eastern Canada with different textures, organic matter contents (OM), pH, and previous use of organic or mineral P fertilizer. Values of soil P from all samples varied between 12 and 194 mg P kg⁻¹ when ICP was used and between 2 and 210 mg P kg⁻¹ with the colorimetric method. A significant and close relationship between the two methods was obtained ($R^2 = 0.93$; $P < 0.001$). However, for low soil P contents, values of M3P-ICP were greater than those of M3P-Col; the M3P-ICP/ M3P-Col ratio decreased exponentially with increasing soil P contents and reached a value of 1 at around 80 mg P kg⁻¹. Our results agree with those reported in other studies. The relationship between soils characteristics, especially pH and OM content, and soil P as determined by the two methods will also be discussed.

Engrais minéraux azotés : efficacité de leur utilisation et leur impact agro-environnemental dans la culture du maïs grain

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Mots clés : Azote, Nitrates résiduels, émissions de N₂O.

Bien que les engrais azotés soient essentiels pour assurer un meilleur rendement et une bonne qualité, l'azote peut causer des problèmes environnementaux majeurs s'il n'est pas géré convenablement ou s'il n'est pas prélevé par la plante au moment opportun. Ainsi, une utilisation optimale des engrais azotés peut permettre d'augmenter la rentabilité des cultures tout en préservant l'environnement. Une expérience a été conduite dans la région de Québec, de 2004 à 2006, afin d'évaluer l'impact de diverses sources d'engrais minéraux azotés sur l'efficacité d'utilisation de l'azote par le maïs-grain, le rendement, les émissions de protoxyde d'azote et les teneurs en nitrates résiduels d'un sol argileux Kamouraska. Les traitements consistaient en un témoin non fertilisé et trois engrais minéraux azotés (solution 32, nitrate d'ammonium calcique et hydroxyde d'ammonium) apportés à trois doses (100, 150 et 200 kg N ha⁻¹). Les engrais azotés ont été appliqués en bande entre les rangs de maïs au stade de 6-8 feuilles. De plus, toutes les parcelles ont reçu un engrais de démarrage appliqué à la volée avant le semis : 20 kg N ha⁻¹ en nitrate d'ammonium, 70 kg P₂O₅ ha⁻¹ et 30 kg K₂O ha⁻¹.

En moyenne, après trois années de recherche, on note une augmentation significative de 0.8 et 0.4 t ha⁻¹ maïs grain avec l'utilisation de la solution 32 par rapport à l'utilisation respective de l'hydroxyde d'ammonium ou celle du nitrate d'ammonium calcique. Les rendements totaux et en grains ainsi que les indices de récolte ont varié beaucoup avec les années et démontrent une fois de plus l'effet des conditions climatiques et de la zone de production sur les rendements des cultures (CRAAQ 2003). En moyenne, l'efficacité de l'utilisation des engrais azotés a été de l'ordre de 45%; ce qui corrobore les résultats d'autres études effectuées au Québec (Chantigny 2006, données non publiées). L'émission du N₂O a varié significativement avec le type d'engrais appliqué et la saison de croissance. Des émissions cumulatives de N₂O aussi élevées que 3,054 g N m⁻² ont été enregistrées en 2004. Cette variation d'émissions est principalement expliquée par la différence de quantité de pluie enregistrée sur le site expérimental juste après l'apport de fertilisant durant les trois années : 195, 98 et 88 mm en juillet 2004, 2005 et 2006, respectivement. Ceci souligne l'importance des études pluriannuelles pour évaluer l'effet des conditions météorologiques sur la dynamique du N₂O dans le sol (Rochette et al. 2004). Les nitrates résiduels ont varié avec la saison de croissance, le type d'engrais utilisé ainsi que la quantité de N appliquée. Les nitrates résiduels dans la couche 0-60 cm ont été environ deux fois plus élevés (70 mg kg⁻¹) lorsque l'azote a été apporté sous forme de nitrate d'ammonium ou de solution 32 que sous forme d'hydroxyde d'ammonium (35 mg kg⁻¹). Ces résultats peuvent être expliqués, en partie, par une fixation de l'ammonium dans les feuillets d'argile (Chantigny et al. 2004) ou par une perte d'azote par volatilisation d'ammoniac au moment de l'application (Rochette et al. 2004). Les résultats de cette étude démontrent clairement l'effet des conditions climatiques sur l'efficacité agronomique, économique et environnementale de l'utilisation des engrais minéraux azotés.

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