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ABSTRACTS

Jointly organized by:

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Select soil quality and plant uptake parameters under different water and fertilizer management systems and their relationship with greenhouse gas emissions

Friday, September 11, 2020, 10:20 am PDT

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Abstract #1:

Agricultural fertilizer and water management practices have short- and long-term effects on soil chemical and physical properties and, in turn, greenhouse gas (GHG) emissions. A 4-year study (2012-15) was conducted to assess the effects of different fertilizer and water table management practices on soil carbon (C), nitrogen (N), plant N uptake parameters and their relationship to GHGs emissions [carbon dioxide (CO2) and nitrous oxide (N2O)], in a corn-soybean rotation. Inorganic fertilizer (IF) and a mix of solid cattle manure and inorganic fertilizer (SCM) were two fertilizer treatments combined with tile drainage (DR) and controlled drainage with sub-irrigation (CDS). Soil C and N parameters were assessed in the spring season each year. N in biomass (BMN) and N in grain (GRN) were measured and used to calculate other plant N parameters at harvest. The N2O and CO2 fluxes were collected weekly, and their respective cumulative emissions were calculated during the four growing seasons (2012-15). The results showed that soil C, total N and soil organic matter (OM) were 35%, 33% and 32%, respectively, greater in SCM than IF in the top 15 cm soil depth. Furthermore, CO2 emissions were 30% greater, and N2O emissions were 25% lower from SCM compared to IF. Soil total N and total C were positively correlated with CO2 emissions, indicating the importance of N availability on soil respiration. Plant N uptake parameters were negatively correlated with N2O and CO2 emissions, suggesting that agricultural practices with higher plant N uptake can reduce N2O and CO2 emissions.

Economic and Environmental Analyses of Bioenergy Production from Wood Pellets

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Abstract #2:

This study investigated two pretreatment methods: steam explosion and torrefaction, which can decompose woody biomass and make it accessible for further processing. It explores the economic aspects of applying these methods on forest residues as well as the application of treated pellets in combined heat and power (CHP) plants. Total capital investment, operating cost, profitability, and other economical indices were estimated through SuperPro Designer®. In terms of environmental performance, a comprehensive life cycle assessment (LCA) including global warming potential (GWP), acidification, human toxicity, and all other environmental impacts was conducted using SimaPro®. According to LCA methodology, in order to reduce all environmental impacts simultaneously, we should optimize the following three steps in our process: Grinding, pellet production in the pellet mill, and transportation of pellets to customers. The combined analysis will facilitate decision-making processes related to the sustainable use of biomass for CHP. It will also generate science-based information that can facilitate commercial acceptance and adoption of bioenergy pathways, including the development of government clean energy policy.

Keywords: woody biomass, heat, electricity, LCA, Techno-economic analysis (TEA)

Effect of Moisture Content, Temperature, and Grinding Method during Microbial Incubation of Camelina sativa L. straw by Trametes versicolor on Properties of Solid Biofuel Pellets

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Abstract #3:

Pretreatment process plays an important role in renewable energy production regardless of the form of the biofuel (liquid, solid or gaseous). Conventional pretreatment technologies often require high energy and chemical input, high corrosive resistant reactors, high cost of downstream processing regarding wastes and additional cost for detoxification. In this study, biological pretreatment approach was investigated in which camelina straw (CS) was pretreated by Trametes versicolor m4D (TVm4D) in different conditions of moisture content, temperature and grinding method to enhance the mechanical strength of the solid biofuel pellets. Results show that tensile strength of pellets was significantly enhanced from 1.982 MPa in untreated CS pellets to 3.736, 4.017 and 4.793 MPa in pellets produced via tub grinder, knife mill and chopper, respectively. Response surface methodology suggested that pellet produced via chopper at its optimal condition (87.87% MC, 24.76_C, 40.04d) was expected to yield highest tensile strength (7.33 MPa) followed by knife mill case (73.66% MC, 28.65_C, 30.67d, 5.452 MPa) and tub grinder case (77.15% MC, 27.86_C, 25.18d, 4.98 MPa).

Keywords: solid biofuel pellets, fungal pretreatment, microbial pretreatment, bioenergy, white-rot, camelina, response surface methodology.

Labile organic phosphorus in temperate arable Histosols revealed by enzymatic hydrolysis of sequential phosphorus fractions

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Abstract #4:

Once hydrolyzed, labile organic phosphorus (P_o) can be a potential source of nutrition for crops. While knowledge on these forms of phosphorus (P) could result in the reduced application rates of P fertilizers, studies rarely assess their availability, especially in organic soils that have a large total P_o stock, nor the effect of different management practices on their quantities, such as mineral P fertilizer application and drainage management. We conducted a field experiment on two arable organic soils with tile drainage, one of which was equipped with a controlled drainage structure, during the pre-fertilization, growing and post-harvest periods of 2016. To quantify labile P_o forms, we performed phosphatase addition assays on sequential extracts that represented their abiotic stabilization in soil. Phosphodiesters were present in the largest quantities (0–109 kg P ha^{-1}), but their stocks fluctuated during the study period. In addition, 89% of the phosphodiester compounds were associated with aluminum and iron complexes, suggesting that these labile P_o forms were largely unavailable. Greater labile P_o was observed after mineral P fertilizer application (115% increase), indicating the inhibition of soil phosphatase enzymes with inorganic P. Overall, there was no significant difference in total labile P_o between the fields with and without controlled drainage, which may be due to the dry growing season. While gross labile P_o stocks were large for these arable organic soils, their stabilization in the soil matrix suggests these forms are unlikely to be hydrolyzed into available inorganic P, and thus cannot abate P fertilizer application.

Mini review: Worldwide food allergy prevalence and the characterizations of "big eight" allergenic foods

Friday, September 25, 2020, 10:20 am PDT

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Abstract #5:

Nowadays, food allergy is common disease of public health significance well known worldwide. Food allergy prevalence was variable due to many factors, such as geographic variations, diet exposure effects, age differences, and races. It has been reported that 90% of food allergic reactions are triggered by the "big eight" allergenic foods, including tree nuts, peanuts, cow's milk, hen's egg, wheat, soy, fish, and crustaceans. This review has focused on the biochemical characterizations of the main allergens in above foods, and the global epidemiology of food allergy with comparisons in various regions and countries. Meanwhile, the economic and social impacts caused by food allergy are also discussed. Hopefully, this mini review can provide an in-depth understanding on the mechanism and influence of food allergy.

Keywords: food allergy, worldwide prevalence, "big eight", biomedical characterizations

Assessment of physicochemical properties of growth media based on wood ash and sludge in combination with biochar.

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Presenter: Muhammad Farhain

Abstract #6:

Organic amendments influence soil physicochemical properties, and consequently plant growth and development. Wood ash (WA), and Paper sludge (PS) waste products produced by Corner Brook Pulp & Paper Mills Ltd., Newfoundland and Labrador (NL), have lower bulk density, porous structure and high pH that may improve the physicochemical properties of Podzolic (acidic) soil-based plant growth media. We evaluated the physicochemical properties of growth media developed from a sandy loam soil combined with WA, PS and biochar (BC). Soil was collected from 0-15 cm depth from the Wooddale research station, NL. Two composite samples of WA and PS were prepared from 30 grab-samples collected twice daily over a 15-d period. Treatments carried out in triplicate included: T1–Soil (control); T2–Promix (Positive control); T3–50%Soil+ 50%WA; T4–75%Soil+25%WA; T5–50%Soil+50%PS; T6–75%Soil+25%PS; T7–75%Soil+25 %BC; T8–25%Soil+50%WA+25%BC; T9–50%Soil+25%WA+25%BC; T10–25%Soil+50%PS +25%BC; T11–50%Soil+25%PS+25%BC and T12–25%Soil+25%WA+25%PS+25%BC.Results showed significant (p=0.000) treatments effects on pH, electrical conductivity (EC), soil organic matter (SOM), bulk density and plant available water (PAW). Treatments amended with WA showed very high pH (8-12); while those with PS exhibited pH in the desired range for plant growth (6.5 to 8). Both WA and PS significantly (p=0.000) reduced the bulk density and improved the water holding capacity of growth media. T6, T10 and T11 produced high amount of PAW with desired pH compared to T1 and T2. These results showed potential of PS in developing growth media but assessing its effects on plant growth and elemental uptake needs to be investigated.

Keywords: Physicochemical properties, Corner Brook Pulp and Paper Mill, Growth media, Wood ash and Paper sludge.

Comparing the performance of automated and manual chambers for measuring greenhouse gas emissions from agricultural soil

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Abstract #7:

Greenhouse gas emissions from agricultural soil are highly variable across space and time. Spatial/temporal "hotspots" can account for a significant fraction of cumulative emissions, an important consideration when using non-steady state chambers to measure treatment effects on agricultural emissions. Manual chambers, being cheaper and easier to deploy in large numbers, can be better at capturing spatial variability. Automated chambers sample continually and so are better at capturing temporal variability. To compare their ability to measure treatment effects on soil emissions, we used both manual and automated chambers to measure CO_2 and N_2O emissions from maize fields amended with several biosolid treatments over 2 years of a field experiment. Manual chambers were used to measure emissions from all plots on a weekly/biweekly basis. Automated chambers were used in the first year to measure continually from one replicate of all treatments, and in the second year to measure continually from 3 replicates of a selected subset of the treatments. Preliminary results indicate that daily flux rates and cumulative emissions of CO_2 and N_2O measured by the automated chambers were higher than or similar to those measured by the manual chambers. Apparent differences were especially large in the first year and for flux rates of N_2O but varied between treatments. These results suggest that weekly/biweekly manual chamber measurements supplemented with automated measurements may provide superior information about treatment effects on greenhouse gas emissions from agricultural soils. This information can be used to develop agricultural management practices that more effectively reduce greenhouse gas emissions.

Comparing the sustainability performance of smallholder farming systems: a case study in rural Panama

Friday, October 9, 2020, 10:40 am PDT

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Abstract #8:

The agricultural sector experienced unparalleled transformations in the 50s, from the manual cultivation of grains to the mechanization sector (60s to 70s). With industrialized agriculture, the land area manages per worker as well as the average grain yield increased exponentially. However, the industrialization of agriculture has also contributed to environmental and human health degradation. At least 1.3 billion people, mostly located in developing countries, are trapped in degrading lands and thus excluded from the right to economic development (UN, 2017). A transition to agroecological systems has been proposed as one of the solutions to the current agricultural crisis. Such systems include practices such as permaculture, bio-intensive farming, and organic farming. Compared to commercial monocultures, the literature suggests that agroecological systems can improve soil fertility, crop resistance, yields, and sequestered carbon emissions. Hence our research aims to respond to the question, Can small Panamanian farms be more ecologically sustainable than commercial monoculture when managed according to different systems of production, as compared using energy-based indicators? To test this hypothesis, we will implement a combination of qualitative (Stakeholder Theory and Energy System Diagrams) and quantitative (System Dynamic Modeling and Emergy Analysis) tools to quantify the sustainable performance of different agroecological systems against a baseline (commercial monocultures). This research aims to streamline the decision-making process of smallholders' farmers in rural Panama to facilitate their transition to agroecological systems. Moreover, the scientific community will benefit by either implementing/adapting this methodology, and so, fostering research, and field trials to evaluate the impact of the adoption of more progressive and sustainable farming systems around the world.

Comparison of nitrogen and phosphorus from two drainage water management systems on agricultural organic soils

Friday, September 11, 2020, 10:00 am PDT

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Abstract #9:

Nutrient released into the environment from agricultural tile drainage is a major contributor to increased eutrophication in waterbodies. Mitigation practices to reduce nitrogen and phosphorus loss, include drainage water management (DWM). This study assessed two DWM systems: a control drainage structure (CD) located on the subsurface tile outlet before discharge, and a farmer's management system using a pump (PD) that discharged when the farmer deemed it necessary. These two DWM techniques were evaluated in 2015 and 2016 in terms of their efficacy to reduce nutrient outflows from subsurface tile drainage. The results identified PD as significantly correlated to the drain discharge, denoting that the water movement within the field occurs at similar time periods as discharge. The N loads were found to be lower under PD (2 – 21 kg ha^{-1}) allowing for increased N retention in the field when compared to CD (35 – 53 kg ha^{-1}). The N loads were significantly different ($p < 0.05$) between the two sites, while the P loads were not significantly different in 2015. In 2015, the discharge under PD was less than CD, although PD had an increase in P loads (PD 0.90 kg ha^{-1}; CD 0.60 kg ha^{-1}). In 2016, the P loads were less per volume under CD when compared to PD. Overall, PD was more effective in managing N loads, while the CD system was more efficient in reducing P loads.

Keywords: phosphorus, nitrogen, phosphate, nitrate, organic soil agriculture, nutrient loads, evapotranspiration, soil moisture.

Comparing the Fertilizer Value of Compost to that of Vermicompost

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Abstract #10:

Generation of organic residues is increasing around the globe and 1/3 of them are landfilled. This environmentally detrimental practice can cause groundwater pollution and contribute to greenhouse gas emissions. Furthermore, industrial and residential organic waste is rich in macro- and micro- nutrients and can be revalued as organic fertilizer. North American municipalities commonly use compost as a waste revaluation method. Another waste management system is vermicompost, which uses earthworms and their associated microbiome to decompose organic waste. Gardeners have used vermicompost for centuries, but only in recent decades has academia begun researching vermicompost.

The aim of my research is to compare the fertilizer value of compost to that of vermicompost. To conduct this comparison, I will first perform a structured literature search and summarize my findings in a synthetic literature review. I will generate a list of criteria and formulate them into Boolean operators, which I will then search in databases such as Web of Science, Agricola and Scopus. Some of the criteria evaluating fertilizer value are process conditions: temperature, porosity of material. Other criteria examine flow rate - i.e. NO_3-, CO2, CH_4- and final product quality. Secondly, I will conduct a physical experiment comparing the nutrient-use efficiency of compost to that of vermicompost, in order to support or dispute the findings from my literature search. One prediction to be tested is that the fertilizer value of vermicompost or compost will depend on the type of feedstock and its carbon-to-nitrogen ratio. Preliminary results of this work will be shared.

Keywords: Organic Waste, Vermicompost, Compost, Circular Economy.

Modelling Poultry Barn Ventilation using Geothermal Energy

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Abstract #11:

Given the current growing interest in the poultry production in Canada, a focus was developed towards providing the best heating and air quality environment for the poultry production facilities. A geothermal heat pump (GHP) system was proposed to allow for a consistent source of heating (wintertime) and cooling (summertime), regardless of the ventilation requirement of the facility. A MATLAB model that utilizes energy balance equations to solve for the energy requirement of the poultry barn was developed. The model incorporates the ventilation standards set by the Ontario Ministry of Agriculture and Food and Rural Affairs, to normalize the varying ventilation standards set by different farmers within Ontario. The model takes into consideration barn specific parameters as an input to compute the cost of running the compressor of the GHP, and the required heat load of the barn for a typical meteorological year based on the data collected from the London, Ontario weather station. The MATLAB model can be used as a reference/general tool for any broiler poultry barn that is considering implementing a GHP system within the Ontario region. The model was validated by comparing the energy load calculated using the MATLAB model to the experimental energy requirement calculated using fuel consumption at a broiler breeder facility located near Woodstock, Ontario

Effect of pre-treatment on the physical and nutraceutical properties of the puree processed from the carrot rejects and waste.

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Abstract #12:

Carrot (*Daucus carota* L.) is amongst the top ten vegetables in the world. Carrot rejects and waste (CRW) separated during the primary processing comprise of out graded carrots (OGC) and processed discards (PD). The usage of processed discards (PD) is limited towards animal feed with the remaining ending in the landfills. The study was conducted to explore the potential for bioconversion of PD's into the puree and analyze the effect of thermal treatment on its properties. The PD's procured from the processing unit were cleaned and stored at 2 ± 1˚C. These were (i) steam blanched at 100°C for 10 minutes at atmospheric pressure and (ii) pressure cooked at 115°C for 10 minutes at 0.19 MPa. The PD's (treated and untreated) were pureed with an equal amount of double-distilled water in a commercial blender for 2 minutes and analyzed for physical properties (moisture content, color, pH, total soluble solids, particle size) and nutraceutical properties (α-carotene and β-carotene) using standard methods. A significant difference was observed in the particle size distribution, β-carotene, and α-carotene content between the carrot purees. Purees prepared from steam blanched PD's reported higher β-carotene, α-carotene, color and TSS values in comparison to the ones processed from untreated and pressure cooked PD's. The values of the former were comparable to the market samples. The experimental findings confirmed the need for pre-treatment for the bioconversion of PD's into carrot puree.This information would be useful in the future for the development of the novel processing technique.

Predicting Crop Water Requirements and Yield for Tomato under a Humid climate using AquaCrop model

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Abstract #13:

Methodologies to predict crop water requirements in arid and semi-arid areas are well documented. Humid regions pose a challenge, because irrigation is normally required during the growing season, to supplement rainfall. This study assessed the use of AquaCrop model to estimate irrigation requirements for tomatoes grown in humid region of Eastern Canada. The model inputs were obtained from two years (2017 and 2019) of field experiments conducted at the Horticultural Research station of McGill University, Quebec, Canada. The model was calibrated and validated with 2017 and 2019 data, respectively. Calibrated and validated parameters were evapotranspiration, dry yield, total biomass, harvest index, and water productivity. The validated model was used to predict irrigation water requirements and fruit yield for the driest and average growing season rainfall year in a 35-year period, for three different soil types. AquaCrop estimated dry yield and total biomass with $R_2 = 0.94$ ($p < 0.5$) and 0.86 ($p < 0.5$), respectively, in the calibration phase, and $R_2 = 0.84$ ($p < 0.5$) and 0.96 ($p < 0.5$) for dry yield and total biomass, respectively, in the validation phase. Results indicated that the model overestimated biomass under water limiting conditions but underestimated the dry yield of tomato. Overall, the model is suitable for predicting irrigation water requirement, crop yield, total biomass, and water productivity for tomato under humid climate. This approach provides valuable tools for quantifying the response of crop yield to water and is essential for developing strategies that can improve agricultural water management.

Optimizing an organic hydroponic solution brewed from a combination of chicken manure extracts and vermicompost leachate

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Abstract #14:

The goal of this study was to produce an organic nutrient solution with similar nutrient ratio of a conventional hydroponic nutrient solution. The use of a bioreactor, vermicompost leachate and fresh chicken manure extracts were studied to brew an organic nutrient solution referred as Biojuice. The impact of the Biojuice on Romain Lettuce (Lactuca sativa) in hydroponic conditions were studied during three consecutive growing tests. The preliminary experiment of this study occurred during the four-season testing of the CING, an experimental northern greenhouse, where a nutrient solution prepared with vermicompost leachate was compared to an inorganic solution. The N-P-K ratio of the Biojuice and the inorganic nutrient solution were comparable, respectively 4,6-1-7,9 and 7-1-7.5 . The Biojuice yielded lettuce with fresh mass 15% higher than the inorganic nutrient solution at an electrical conductivity of 1,1 mS/cm. At higher electrical conductivity of 1,5 and 1,6 mS/cm, the Biojuice lettuce yields were respectively 44% and 69% lower than the inorganic nutrient solution. This result is explained by a calcium deficiency in the plants caused by a Ca:Mg nutrient ratio in-balanced mixed with a high sodium content.

Keywords : Organic farming, hydroponics, manure, vermicompost, biomass production

Dynamiques des systèmes couplés avec modèles des cultures : modélisation participative pour l'évaluation des systèmes agricoles à petite échelle au Guatemala

Friday, October 9, 2020, 10:20 am PDT

Julien J Malard*, Jan Adamowski, Héctor Tuy, Hugo Melgar-Quiñonez

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Abstract #15:

L'agriculture à petite échelle est centrale au développement et à la sécurité alimentaire des communautés, surtout de celles Indigènes, à travers le monde. Ces systèmes agroalimentaires locaux se voient cependant de plus en plus menacés par les changements climatiques, et les relations complexes entre les composantes environnementales et humaines de ces systems compliquent la tâche de prédire comment ils répondront à des choques futures. Le développement de méthodes participatives pour l'évaluation de la résilience et des opportunités pour la mitigation des impacts des changements climatiques sur les systèmes agricoles à petite échelle est donc d'une grande importance dans le contexte présent. Lors de cette étude, nous utilisons un modèle participatif des dynamiques des systèmes représentant le système agroalimentaire des régions du Tz'olöj Ya' et du K'iche' (Guatemala) pour analyser l'impact de différents scénarios climatiques autant que leur interaction avec de diverses politiques de mitigation. Les résultats démontrent que le couplage du modèle des dynamiques des systèmes avec un modèle externe des cultures augmente de manière significative son habilité de modéliser les impacts des changements climatiques. En outre, les résultats suggèrent que des politiques d'ordre socioéconomique, tel que l'implémentation d'un salaire minimum ou d'un meilleur accès à l'éducation, pourraient être parmi les plus efficacies non seulement envers les enjeux socioéconomiques (malnutrition, pauvreté) mais aussi envers les problèmes environnementaux, tel le déboisement, et cela, même dans un contexte de changement climatique. Cette analyse est la première à utiliser un modèle socioéconomique des dynamiques des systèmes, couplé avec un modèle externe des cultures, pour analyser un système alimentaire socioenvironnemental et la sécurité alimentaire qui en dépend.

The development of multi-level storylines to ensure the inclusion of marginalized communities in participatory sociohydrological modelling: A case study in Tz'olöj Ya', Guatemala

Friday, October 9, 2020, 10:00 am PDT

Jessica Bou Nassar*, Julien Malard, Jan Adamowski, Marco Ramírez Ramírez, Héctor Tuy

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Abstract #16:

Sociohydrological modelling requires unconventional sources of data that improve our understanding of interactions between socio-economic and hydrological variables. Participatory modelling (PM) is a powerful tool for informing and conceptualizing sociohydrological models through stakeholder engagement. However, the implementation of most PM processes often fails to perceive communities as heterogeneous units with different needs and capabilities. This usually leads to the exclusion of key stakeholders, particularly those associated with marginalized communities. In this study, a participatory model building framework that ensures the inclusion of diverse stakeholders – illiterate, relatively powerless, and/or associated with marginalized languages – is suggested. The method (1) is based on the development of interdisciplinary storylines, (2) is underpinned by the Multi-level Perspective framework (Geels et al., 2002), (3) incorporates causal loop diagrams, and (4) aims to inform and conceptualize system dynamics models. A case study was conducted in Atitlán Basin, Guatemala, to understand the mechanisms underlying the lake's eutrophication problem. The PM activity incorporated stakeholders from the indigenous Mayan community, with different literacy ranges, from three linguistic backgrounds (Kaqchikel, Tz'utujil, and K'iche'). The storyline development process succeeded in effectively integrating marginalized stakeholders. Additionally, it helped (1) develop a proper understanding of governing mechanisms, (2) explore the system's leverage points, and (3) elicit potential policies. The activity generated three submodules – agriculture, tourism, and environmental awareness – each representing socioculturally-specific mechanisms that contribute to nutrient discharge into the lake. The identification of such mechanisms aids in designing well-targeted policies and allows stakeholders to investigate trends of variables under different policy and management scenarios.

Expanded Tree Pits as Part of a Low Impact Development Strategy for Urban Stormwater Management

Friday, February 5, 2021, 10:00 am PST

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Abstract #17:

Urbanization increases the impermeable surface area in cities, leading to changes in hydrological processes. Low impact development (LID) is an urban planning approach in which the natural hydrology is retained as much as possible, to preserve or enhance diverse ecological functions. The urban forest can be operationalized as part of LID, but a lack of information about the effectiveness of this approach impedes its adoption. The use of tree pits was researched by McGill University in collaboration with the City of Montreal to redirect urban runoff away from the sewer system and design the soil mixture within the tree pits to treat the runoff water quality. In this research, the mobility of four prevalent heavy metals (zinc, lead, copper and cadmium) and sodium from de-icing salt were studied. Data from hydrological field studies and soil column experiments allowed us to parameterize HYDRUS 1D to simulate water infiltration and solute transport through the vadose zone of the tree pits. We estimated the response of the system to different soil organic matter content and permeability of the surrounding surfaces. According to the preliminary 2-year simulation results, the heavy metals are effectively immobilized in the tree pit soil, but sodium is readily transported through the soil. Long term simulations of the movement of heavy metals and sodium through the tree pit soil are being conducted. Our results will assist city planners to improve the design of tree pits to efficiently divert stormwater runoff and moderate contaminant concentrations.

The effect of chemical retting parameters on the quality and quantity of the canola fibers

Friday, January 8, 2021, 10:00 am PST

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Abstract #18:

Chemical extraction is one of the popular extraction methods to extract plant fibers. The effect of chemical retting parameters on the quality and quantity of the canola fibers was studied. The treatments were time reaction (12-72 h), temperature reaction (24-90 ºC), and $NaHCO_3$ concentration (%w/w). Fibre yield was used to estimate the fiber quantity, and chemical compositions, crystallinity index and thermal stability were used to assess fiber quality. The maximum fiber yield was achieved when the retting time was longer than 50 h, temperature was between 50 to 60 ºC, and $NaHCO_3$ concentration was between 6 and 8%. Changing chemical composition of the fibres as a result of applying the chemical treatments caused some changes in the crystallinity index and thermal stability of the extracted fibers. The more desirable crystallinity index was obtained when the temperature was set at a higher level, and retting time was between 40 and 55 h, and $NaHCO_3$ concentration level was between 4 to 6%. The thermal stability of the extracted fibres was higher when the $NaHCO_3$ concentration was in the highest level, and the time and temperature levels were between 30 and 45 h, and 45 and 65 ºC, respectively.

Keywords: Canola; Fibre; Quantity; Quality; Retting; Optimization

Life Cycle Assessment of land-applied municipal wastewater biosolids in Canada

Friday, November 6, 2020, 10:00 am PDT

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Abstract #19:

As more Canadian jurisdictions ban the landfilling of organic matter, there is increasing pressure to recycle municipal wastewater biosolids to agricultural soils to replace commercial mineral fertilizers. However, information gaps remain about the environmental impacts of this practice. We conducted a Life Cycle Assessment (LCA) to estimate the impacts associated with the processing and land application of three different types of biosolids: anaerobically digested, composted, and lime stabilized. The biosolids were applied to agricultural land on McGill's Macdonald Campus Research Farm near Montreal, Canada. OpenLCA software and the ecoinvent 3.5 database was used to perform the comparative LCA of the three processing methods to determine global warming, eutrophication, and acidification potential impact scores. Monte Carlo simulation was used in the estimation of uncertainties of results. Preliminary analysis indicates that the land application of anaerobically-digested biosolids results in the lowest global warming potential owing to the production of biogas. Land-application of lime-stabilized biosolids has a higher global warming potential related to the energy-intensive production of quicklime used to stabilize the sludge. Based on this analysis, we will recommend best practices for biosolids management. The results will be useful to decision makers, wastewater plant operators, and farmers to ensure sustainable and responsible production and handling of biosolids. Final results will be presented at the CSBE/CIGR conference in Quebec, Canada.

Keywords: Life Cycle Assessment, biosolids, composting, anaerobic digestion, lime stabilization

Practical Utilization of Microbial fuel cells: A Review

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Friday, November 6, 2020, 10:00 am PST

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Abstract #20:

In the recent times, where the world is pushed to work towards sustainability and potential renewable resources of energy, the concept of Microbial fuel cells (MFCs) and their applicability is one of the active areas of research. A Microbial fuel cell is a bio-electro chemical device which utilizes the bio-chemical processes of micro organisms present in the substrate. A major application of MFC is in treatment of wastewater. However, the applicability of MFCs is not limited. For instance, MFCs also find use as a source of power to make various sensors like environment sensors, wireless sensors, biosensors work which are further utilized in remote sensing.

This paper focuses on the applications of MFCs starting with MFC in treatment of wastewater followed by utilization in desalination of water, MFC as a source of power and potential application in medicine. Finally, a brief note on other possible applications would be discussed followed by a conclusion on potential scaling up opportunities.

Microwave Torrefaction of Oat Hulls

Friday, January 22, 2021, 10:00 am PDT

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Abstract #21:

Microwave torrefaction (MWT) of oat hull was conducted to enhance biomass physicochemical properties. A bench-top borosilicate three-neck reactor was built with an internal stirrer for MWT of oat hulls at temperatures of 225°C, 255°C, and 285°C. The temperatures where measured via direct contact method with a fiber optic temperature probe to avoid any microwave interference. Results showed that high MW power levels for torrefaction have short processing time and low power consumption. The calorific values (CV) of torrefied oat hulls increased when increasing temperature level, but decreasing mass yield. The CV of raw oat hulls improved by 13-35% from its original value with the above temperature levels. Severe torrefaction decreased moisture adsorption, moisture content, and grinding energy consumption, but also decreased energy yield and bulk density. The liquid yield of MW torrefaction process accounts for 10, 20, and 30% of the total product for the corresponding temperatures of 225°C, 255°C, and 285°C. From these results, it can be concluded that increasing the MW power level will decrease energy consumption without significantly modifying mass yields or calorific values. In addition, MW torrefaction treatment enhances biomass in a similar way to conventional torrefaction, but at a faster processing time. Moreover, the liquid fraction from the torrefaction process could be utilized as a valuable product for another industry.

***Keywords*:** Microwave torrefaction, biomass, calorific value increase, mass yield, liquid yield.

An Experimental Study of the Aerodynamic Characteristics of Ryegrass Forage

Friday, September 11, 2020, 10:40 am PDT

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Abstract #22:

During harvest, a self-propelled forage harvester (SPFH) is used to collect, chop, and transport grasses and corn varieties by means of airflow to an external collection unit. The transportation system can sometimes become blocked and fail to provide an acceptable throughput, largely caused by poor crop and environmental conditions. For this reason, it is critical to understand the behavior of the airborne crop material for a variety crop conditions which aerodynamics play a key role in. This study focuses on developing a correlation between the drag and lift coefficients of the material and its physical characteristics to contribute to the design process of the transport system. More specifically, non-spherical particles are of considerable interest, and in agricultural engineering, the material's moisture content is a significant factor. Measurement techniques and methodology are also discussed. An experimental procedure was developed to measure the mass distribution of ryegrass samples when injected into a horizontal wind tunnel. From these tests, both aerodynamic coefficients were determined as functions of the average particle length and the sample's moisture content. Subsequently, a second set of experimental tests were performed in a vertical wind tunnel to calculate the drag coefficient from the material's terminal velocity. The results from the vertical wind tunnel are used to validate the corresponding tests in the horizontal wind tunnel.

Optimized production of a sugar-CO_2 complex for enhancing bioactive compound delivery via the oral mucosa

Friday, January 28, 2021, 10:40 am PST

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Abstract #23:

Drug delivery through the oral mucosa is an alternative to traditional oral and intramuscular injection routes. Absorption through the oral mucosa allows for direct entry into systemic circulation leading to an increase in the rate of drug delivery and a potential increase in bioavailability of the drug. A sugar-CO_2 complex, which can be formed in a specialized chemical reactor, may be combined with certain drugs and nutraceuticals to enhance permeation across the oral mucosa with an effervescent reaction. This study focuses on a preliminary analysis of the interactions between temperature, pressure and sugar concentration and how they influence the formation of this sugar-CO_2 complex.

Key Words: Pharmaceutical, Nutraceutical, Health, Food Engineering

Potentiometric Phosphate Sensing Using Pure Cobalt, Molybdenum and Their Alloy for Environmental Applications

Friday, October 23, 2020, 10:40 am PDT

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Abstract #24:

Phosphorous (P) is ubiquitous in the environment and a critical element for ecosystem functioning. While, it is one of the three macro-nutrients (nitrogen, potassium, and phosphorous) essential for plant growth and food production, it is considered as a major contributor for non-point source pollution including eutrophication in surface waters in agricultural watersheds and closed natural systems. Hence, accurate measurement of P in water bodies and agricultural systems are in great demand for managing these ecosystems. While traditional measurement in the laboratory is time consuming, costly, and requires environmentally unsafe chemicals, sensor-based P measurement shows promise. Cobalt (Co), and molybdenum (Mo) have shown potential in developing potentiometric sensors, but they are specific to certain pH ranges. The objective of this study was to examine the feasibility of Co, Mo, and for the first time their electrodeposited alloy, $Co_{63}Mo_{42}$ (wt%), as phosphate sensors. The three electrodes showed three sensing mechanisms towards phosphate ion: mixed potential (Co), Nernst potential (Mo), and surface reduction ($Co_{63}Mo_{42}$). Unlike Co and Mo, $Co_{63}Mo_{42}$ showed good selectivity towards phosphate over a wide pH range, (pH 6-8), while it exhibited the longest response time (8-10 minutes). The limit of detection of the $Co_{63}Mo_{42}$ was the highest. This made Co and Mo more reliable in soil and water phosphate sensing, where low phosphate concentration is witnessed. Nevertheless, alloy provides a new opportunity for improving phosphate sensors. Phosphate sensors based on Co and Mo hold strong promise in P measurement which is required for P management in the environmental sector.

Mineralization of Carbon in Composted, Alkaline Stabilized, and Anaerobically Digested Biosolids in Soil

Friday, September 25, 2020, 10:00 am PDT

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For Submission to: The Canadian Society for Bioengineering (CSBE) Conference 2020

Abstract #25

Biosolids are processed and stabilized municipal wastewater sludge which are applied to agricultural soils due to its high organic carbon and nutrient content. Their rates of degradation in soils differ. Therefore, the objective of this study was to characterize the decomposition of soil organic material following application of biosolids that have been composted (COM), mesophilic anaerobically digested (MAD), and alkaline stabilized (ATB) on soils under optimal and sub-optimal moisture conditions. Urea was added to treatments receiving COM, ATB, and no biosolid to minimize the effects of N limitation on soil C mineralization. The total C and N added to each experimental unit were equivalent to 276.2 kg C ha-1 and 58.8 kg N ha-1 for MAD, 692 kg C ha-1 and 127.8 kg N ha-1 for ATB, 1,982.2 kg C ha-1 and 214.5 kg N ha-1 for COM, and 120 kg N ha-1 for the urea treatments. Soil water-filled pore space was set at optimal (49%) and sub-optimal (29%) before incubation at 20ºC for 12 weeks. The CO2 evolution was collected twice weekly and analysed using a gas chromatograph. A two-way ANOVA was used to analyse the effects of soil moisture level and biosolids type on CO2 emissions. The results of this study show that there was an effect of soil moisture and biosolid type on rate of soil C mineralization. Biosolid degradation rate follows the order MAD > ATB > COM. These results provide insight into the carbon sequestration potential and eventual rate of nutrient release of land-applied biosolids.

Keywords: Biosolids decomposition, carbon mineralization, incubation experiment.