Agricultural, Life and Environmental Sciences
Graduate Students' Association
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ALES Graduate Research Symposium

March 29 & 30, 2021

Solving Global Problems Together

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RESEARCH ABSTRACTS

Oral presentations

Session 1 (3:00 – 4:00 PM MT, March 29, 2021)

"Nothing about us without us": The context and realities of social movement organizing against poverty in Edmonton.

Razak Oduro *(HECOL), Deanna Williamson*

This presentation examines the dynamics, contexts, and realities of social movement organizing against poverty in Edmonton. This is part of my ongoing doctoral dissertation that examines the anti-poverty efforts of EndPovertyEdmonton (EPE) movement. EPE is a recent city-based movement in Edmonton aimed at "advancing a vision of shared prosperity for all, where every Edmontonian has an equal opportunity to live, work, participate, and thrive". At the core of EPE's vision is the spirit of activism using a social movement approach to mobilize inclusive support to eliminate poverty in Edmonton, heralding the belief "nothing about us without us". However, the extent to which a social movement approach to poverty provide an impetus for transformative change and lead to ending poverty in Edmonton is largely unknown (unexplored). Based on in-depth interviews, publicly available EPE documents, and relevant literature, a critical ethnographic approach is used to examine how EPE leverages social movement thinking into anti-poverty work. The presentation offers insights and critiques into how EPE movement is unfolding, contextual factors influencing how the movement organizes, and the realities and challenges of organizing on the basis of poverty in Edmonton. The implications of a social movement perspective to help revive and/or redefine anti-poverty efforts in Edmonton, and Canada as a whole are discussed.

The efficiency of large fire suppression in Alberta: A stochastic frontier analysis

Kalli Herlein *(REES), Vic Adamowicz, Scott Jeffrey*

The area burned by wildfires in Alberta is expected to increase 200-800% by 2100. This is attributed to more lightning-caused fire starts and fire seasons extending by 20 days on average. An increase in the number and size of wildfires will create more demand for personnel, equipment, and aircraft to contain wildfires and protect Alberta's communities. With these expectations of increasing resource demand, it is important to understand how efficiently firefighting resources are being used in Alberta. Our research question asks; what factors affect the technical efficiency of large wildfire containment in Alberta's boreal zone? We seek to quantify the length of held perimeter wildfire suppression resources can generate per day and identify which variables affect the efficiency of wildfire containment. Stochastic frontier analysis is used to quantify technical efficiency. This method uses length of held perimeter as the dependent variable assuming fire containment is the goal of suppression. We also calculate a weighted perimeter using inhabited structures within 30 km of the perimeter to account for communities at risk. Ground and aerial equipment are the production function's input variables while fire weather indices, fuels, and large waterbodies are the explanatory variables for inefficiency. The stochastic frontier model parameters are estimated using maximum likelihood procedures to simultaneously estimate the production frontier and the

two-sided error term composed of stochastic noise and technical inefficiency. From our sample dataset, preliminary results indicate ground equipment significantly increases held perimeter and is an effective wildfire containment resource. However, aerial firefighting resources did not significantly contribute to held perimeter on large fires in Alberta's boreal zone. Coniferous fuels and extreme fire weather significantly decrease technical efficiency of containment. These results can inform Alberta's fire managers which resources will be most effective given each day's fuel and weather conditions.

Are jet fuel and diesel prices vulnerable to crude oil markets? Implications for emerging energy sources

Wenbei Zhang *(REES), Marty Luckert, Feng Qiu*

New biojet and biodiesel technologies are trying to substitute biomass for crude oil as refining inputs. Potentials for emerging biojet and biodiesel industries will be influenced by current price relationships between crude oil and jet fuel/diesel. To investigate these price relationships, we estimate long-run relationships and short-run adjustments. We find that jet fuel and diesel prices are vulnerable to oil markets in both the long and short runs, but in substantially different ways, depending on whether oil prices are relatively increasing or decreasing. Jet fuel prices respond to oil price decreases, while diesel prices respond to oil price increases. Emerging biojet and biodiesel with biomass inputs could improve risk management within jet fuel and diesel industries by diversifying input supply. Biojet may be especially attractive to jet fuel producers because they are unable to pass increased oil costs through to consumers.

Session 2 (3:00 – 4:00 PM MT, March 30, 2021)

Effect of labelling and information on consumer sensory acceptance, attitude, and quality ratings of foods labelled as 3D printed

Xiaoqin Feng *(AFNS), Khemiga Khemacheevakul, Susana De León Siller, John Wolodko, Wendy Wismer*

3D food printing (3DFP) enables customization of intricate food design, personalized nutrition, and attractive presentation of pureéd food. Consumer current experience with 3DFP is low, and little is known about consumer sensory acceptance of foods made with 3DFP. The primary aim of this study was to investigate the effect of labelling and product-specific positive information about 3DFP on consumer sensory acceptance of foods labelled as 3D printed. Three commercially available conventionally produced food products were each evaluated in a sensory panel; milk chocolate swirls (n = 68), gummy candy carrots (n = 59), and baked potato Smiles® (n = 59). For each panel, participants evaluated sensory attribute acceptance on 9-point hedonic scales and perceived quality on 5-point Likert scales after each of 3 product presentations; the product labelled "conventional", the product labelled "3D printed", and the product again labelled "3D printed" after the presentation of benefits about 3DFP. Food Technology Neophobia (FTN), previous knowledge about 3D printing, consumer orientations, preference, and attitude before and after labelling and information were also analyzed. Labelling and information had limited effect on participant sensory attribute acceptance of the foods; but resulted in a more positive attitude towards 3D printing. Participants (75–79%) preferred the "3D printed" to the "conventional" chocolate swirls and gummy candy carrots and increased agreement of high product quality. Participant attitude decreased with higher FTN and was not affected by previous knowledge about 3D printing. Overall, the mostly young and educated population had little knowledge about 3DFP but positive attitude towards 3D printing.

Transcriptome analysis of rutabaga (Brassica napus) cultivars indicates glucosinolate-derived nitriles may play a role in inducing plant defense against clubroot disease

Hui (David) Liu *(AFNS), Qinqin Zhou, Stephen E. Strelkov, Sheau-Fang Hwang, Jocelyn A. Ozga*

Clubroot, caused by the obligate biotrophic protist Plasmodiophora brassicae, is one of the most damaging diseases of the Brassicaceae. Glucosinolates (GSL) are a group of defense-related secondary metabolites found in species of this family, and their hydrolysis products (isothiocyanates, thiocyanate, nitriles) are implicated in plant defense processes against many pathogens and herbivores. We analyzed the GSL pathway in a database from a recently published study (Zhou et al., 2020 Int J Mol Sci 21, 8381) where the authors compared transcriptomic profiles of two rutabaga (Brassicae napus subsp. rapifera) cultivars which showed resistant ('Wilhelmsburger') and susceptible ('Laurentian') responses to P. brassicae inoculation. The results indicated that several genes that lead to production of nitriles along the indolic GSL degradation pathway are more highly upregulated 7 days after pathogen inoculation in 'Wilhelmsburger' than in 'Laurentian'. Nitriles serve as defensive compounds against plant pathogens because of their toxic nature and are also proven to elicit defense response pathways in plants. These data suggest that GSL-derived nitriles may play a role in inducing enhanced plant defense against the clubroot pathogen in the rutabaga cultivar 'Wilhelmsburger'. Further research to understand the role of GSLs in defense against P. brassicae in cruciferous plants is warranted.

Fractionation strategies to obtain renewable fuels, solvents, and fatty acids from lipid pyrolytic liquid.

Uche E. Sea-Nduka *(AFNS), Justice Asomaning, David C. Bressler*

Sustainability issues have driven the exploration of renewable sources for fuels and chemicals. Lipid pyrolysis, which is the thermal decomposition of lipids into gas, liquid, and solid products, is a successful approach to addressing these issues. The liquid product from traditional lipid pyrolysis is a complex mixture that cannot be directly used to produce fuel and chemicals. A biorefinery can be established by separating the pyrolytic liquid into fractions to be processed into high-grade products. This would improve the end-products' properties and the process viability. This research aimed to prove a biorefinery concept by developing fractionation strategies for the pyrolytic liquid to obtain multiple products. The pyrolytic liquid was caustic washed to obtain an acid-free hydrocarbon fraction, and the extractant was treated with HCl to recover the fatty acid fraction. The hydrocarbon fraction was distilled using a 90cm spinning band distillation unit with about 100 theoretical plates at reflux ratios between 90:1 to 240:1 to obtain n-pentane and n-hexane solvents. The bottom product of the hydrocarbon distillation (renewable diesel) was analyzed for conformity to Canadian Diesel Fuel Standards: CAN/CGSB – 3.517-2020. The fatty acids fraction was distilled under a vacuum of 133.3 Pa using the same distillation unit at a reflux ratio of 60:1 to obtain individual C5:0 – C:10 fatty acid compounds. Upon analysis, the average purity of the n-pentane fraction from all experiments was between 70 - 80%, and the purity of the n-hexane fractions was 80%. The renewable diesel met the CAN/CGSB – 3.517-2020 specification for acid number, viscosity, cetane number, and flashpoint. The purity of individual fatty acids obtained ranged from 60 – 80%. These results demonstrate that a fractionation strategy could establish a biorefinery from lipid pyrolytic liquid, produce renewable fuels for cleaner transportation and chemicals for industrial applications.

Evaluation of physiological parameters and symbiotic nitrogen fixation in early-maturity soybeans cultivars under drought stress

Dilrukshi Kombala Liyanage *(AFNS), Davoud Torkamaneh,Francois Belzile ,Linda Gorim, Gavin Chen, Malinda Thilakarathna*

Soybean is economically the most important legume crop globally and the third-largest field crop in Canada in terms of farm cash receipts. It fixes atmospheric nitrogen through symbiotic rhizobia bacteria that inhabit root nodules, a key feature of sustainable agriculture. Western Canada has been experiencing frequent and severe droughts over the last few decades. Therefore, evaluation of symbiotic nitrogen fixation (SNF) in soybeans under drought stress is important to identify resistant varieties to use in future breeding programs. We believe that there is a genetic variation for SNF under drought stress in short-season Canadian soybean varieties. The main objective of this study is to identify allelic variation associated with SNF under drought stress in short-season soybean varieties. A diversity panel of 100 early-maturity Canadian soybean varieties for which genome-wide genotypic data are available was used in this study. A greenhouse pot experiment was conducted to determine plant phenotypic traits and SNF under drought stress. Seedlings were inoculated with Bradyrhizobium japonicum USDA 110, and the initial soil moisture content was maintained at 80% field capacity. The drought treatment was imposed after 3-weeks of plant growth, where half of the plants were maintained at 30% field capacity and the rest at 80% field capacity until maturity. Results show a reduction in stomatal conductance, number of pods per plant, number of seeds per plant, and increase in leaf chlorophyll under drought stress. Genotypic variability was found for leaf chlorophyll content, stomatal conductance, photosynthesis (at flowering stage), the number of pods per plant, and the number of seeds per plant (at maturity). The % nitrogen derived from atmosphere (%NDFA) will be measured using the 15N-dilution method. A genome-wide association study will be performed to identify allelic variation associated with SNF under drought stress and provide molecular markers useful in future soybean breeding programs.

Session 3 (4:00 – 5:00 PM, March 30, 2021)

Americium-241 in peat bogs as a marker of the beginning of the Anthropocene: examples from Europe and North America.

Andrii Oleksandrenko *(RENR), Peter Appleby, Tommy Noernberg, William Shotyk*

Americium-241 (241Am) is present in terrestrial and aquatic environment around the globe as a result of the atmospheric testing of high yield thermonuclear weapons carried out mainly in the 1950s and 1960s. Radioactive debris (including mainly 137Cs, 90Sr, and various Pu isotopes) from the tests was injected high into the stratosphere where it was rapidly dispersed around the world. Over a period of months this material slowly returned to the troposphere, from where was quickly removed by wet and dry fallout onto the earth's surface. As the matrix to detect 241Am was proposed to use peat bogs - ombrotrophic peatlands in that the plants growing there receive nutrients and contaminants exclusively from the atmosphere. The purpose of this study is to determine the fidelity of 241Am records in peat bog cores. Specifically, we compare the position of the 241Am concentration peak with the 1963 depth determined by 210Pb dating. We use 39 peat cores from Europe and North America, collected by our team during the past 30 years for studies of atmospheric deposition of trace metals, all of which had been independently dated using 210Pb. We find that 18 of the cores provide an excellent agreement between the 241Am and 210Pb dates, 12 were in good agreement, and 9 agreed poorly. Possible reasons for the discrepancy in the 9 cores with poor agreement are 1) the sensitivity of the gamma spectrometer for detecting 241Am, and 2) disruptions to the fallout records caused e.g. by disturbances to the peat bog or changes in the peat topography or hydrology.

Small scale horizontal and vertical variations in bogs help explain why in a triplicate of peat cores collected from Wildseemoor (Black Forest of Germany), excellent agreement was found in one core, good agreement in a second, and poor agreement in the third.

Trace elements in surface water of ombrotrophic bogs: evidence dissolution of atmospheric dust from mining operations in Athabasca Bituminous Sand Region (ABSR)

Sundas A. Butt *(RENR), William Shotyk, Fiorella Barraza, Na Chen, Chad W. Cuss, Lukas Frost, Iain Grant-Weaver, Muhammad Babar Javed, Andrii Oleksandrenko, Lei Pei*

Considerable volumes of dust are generated by open-pit mining for bitumen extraction in the ABSR, northern Alberta, Canada. The most reactive mineral phases of dust can potentially dissolve in acidic bog water. The goal of this study is to determine whether elevated rates of dust deposition to peat bogs near bitumen mines have led to greater concentrations of trace elements (TEs) in their surface waters. To achieve this goal, it is essential to ensure that the TEs being measured in surface waters only represent dust dissolution and are not influenced by groundwaters or surface runoff. The concentrations of TEs were measured in the dissolved fraction (<0.45 µm) of surface waters collected from four peatlands near industry (JPH4, McK, McM, ANZ) and a control site (UTK) using ICP-MS. Surface waters near industry have elevated concentrations of Li, Fe, Mn, Ni, Y, Tm, Dy, Yb, Sm, and Pb at 3 out of 4 sites, relative to UTK. Most concentrations were enriched 2x compared to UTK, but Li, Mn, and Rb were enriched >10x. A vegetation survey at the site closest to industry (JPH4, 12 km from the mid-point between the two central bitumen upgraders) indicated that this peatland includes both ombrotrophic and minerotrophic zones. These zones were identified based on the pH and concentrations of major ions in bog surface waters. At McK (25 km away), electrical conductivity and concentrations of chloride, Na, and K, all increased towards the highway, which suggests contributions from road salt runoff. Thus, at these two sites, the TEs concentrations in surface waters are supplied not only from airborne dusts but also from groundwater and road. In contrast, the surface waters from McM (49 km) and ANZ (69 km) sites are ombrotrophic, so the elevated concentration of TEs in these waters can be attributed exclusively to dust dissolution.

Size distribution of trace elements in Sphagnum mosses within the Athabasca Bituminous Sands Region

Na Chen *(RENR), William Shotyk, Fiorella Barraza, René Belland, Muhammad Babar Javed, Chad W. Cuss, Iain Grant-Weaver*

The Athabasca Bituminous Sands (ABS) industry drives the economy of Alberta, Canada. However, with its increasing industrial extent, environmental concerns have grown regarding trace element (TE) contamination of air and water. Industrial mechanical processing of ABS generates considerable volumes of dust particles from open-pit mining, quarrying, road construction, etc. These dusts are dominated by coarse aerosols with short atmospheric residence time, consisting primarily of recalcitrant silicate minerals enriched in lithophile elements such as Al, Fe, and Mn. In contrast, high-temperature industrial processes such as the smelting and refining of metallic ores and coal combustion yield fine aerosols (< 2 µm) that can be transported for thousands of kilometers. These fine aerosols are respirable and mostly in the forms of oxides and hydroxides rich in TEs such as As, Cd, and Pb, posing a risk to living organisms. Hence, it is important to differentiate between TEs in the two aerosol fractions.
Here, Sphagnum mosses collected from rain-fed bogs within the ABS region are used as biomonitors of atmospheric deposition, and compared with mosses from a reference site 264 km to the southwest. The aim

is to determine the percentage of TEs in the fine versus coarse aerosol fraction in Sphagnum, by determining the abundance of TEs in the acid soluble ash (ASA) and acid insoluble ash (AIA). Trace element concentrations (total, in ASA and in AIA) were obtained using ICP-MS. Concentrations of AIA and total concentrations of TEs increased towards industry, reflecting increasing dust deposition. Lithophile elements were more abundant in moss samples collected near industry, and in their AIA and ASA fractions. However, chalcophile elements exhibited either insignificant differences, or were more abundant at the control site. Clearly, measuring only the total concentrations of TEs in moss from a dusty industrial region provides limited information about their associated health risks.

The impacts of channel artefacts on trace element fractionation using asymmetrical flow field-flow fractionation

Yu Wang *(RENR), Chad. W. Cuss, William Shotyk*

Insufficient recovery rates, as well as retention time shifts, have been observed and explained by unspecific membrane-particle interactions. The porous ceramic frit underlying the membrane can also be problematic, which is likely to cause losses of trace elements (TEs) as a result of the interaction with the crossflow ionic species due to its high surface charge. These membrane and channel artefacts have been studied for silver, gold, and titanium dioxide nanoparticles. However, few studies have reported the impacts of these artefacts on TE speciation during the fractionation of natural colloids. In this work, the recovery rates of TEs were tested on a new polyethersulfone membrane to study the impact of the membrane condition changes using the AR772 sample. A pre-condition process using at least five high-dissolved organic matter (DOM) samples was necessary for Mn, Co, Ni, Cu, Y, and Pb to clean the potential contamination in the channel. Insufficient recoveries were also observed for almost all the elements. More than 80% of Mg, Mn, Sr, and Ba were lost in the channel due to the interactions with the membrane and ceramic frit. The membrane foulant was mainly composed of tryptophan-like components obtained by the fluorescence excitation-emission matrix spectra. The DOM concentration was significantly higher around the focus position than other membrane areas, which indicated the progressive deposition of tryptophan-like DOM components on the membrane focusing line during the focus step. The different trends of the distribution of TEs (i.e., Ni and Pb) and DOM on the membrane were observed, which indicated the membrane foulants were not the main reason for TEs losses in the channel due to the weak affinity with TEs.

Poster presentations

Creating a genetic screening platform for increased seed protein content from metabolically-engineered *Arabidopsis*

Kallum McDonald *(AFNS), Gavin Chen*

Canola is a major oilseed crop cultivated in Canada that contributes billions of dollars in economic output. The oil that accumulates in the seeds (about 40% of weed weight) is highly valuable and is used for cooking, biodiesel, and chemical synthesis. After oil extraction, the leftover protein (about 25% of seed weight) and carbohydrate meal is mostly used as animal feed. There is much potential for creating value-added canola with increased seed protein content, which would yield benefits for the agriculture industry. The cell wall carbohydrates in the meal (about 8%) can inhibit animal digestion and represent a low-value use of carbon resources by the cell. One potential avenue of improving the value of canola meal is by redirecting carbon from seed coat carbohydrate biosynthesis to protein biosynthesis. In this study, we propose creating a genetic screening platform from a close relative of canola, the model plant Arabidopsis thaliana, that have been metabolically-engineered for increased seed oil and protein content. This platform can be used to rapidly screen for genes involved in increased protein content without penalizing oil. The scheme of this project is to develop a transgenic Arabidopsis population wherein carbon flow is partially shifted away from seed coat carbohydrates and towards increased oil and protein biosynthesis. To achieve this, we are using AtCESA1 RNAi downregulation to reduce carbon allocation to seed carbohydrates, BnDGAT1 overexpression to increase seed oil, and protein overexpression (DOF1, AspAT, or AlaAT) to increase seed protein. Thus far, a population of T2 Arabidopsis with AtCESA1 downregulation and BnDGAT1 overexpression has been created and a few lines with increased oil content have been advanced to the T3 generation. Further screenings are ongoing to build up the population; once an increased-oil population has been achieved, they will be further transformed to obtain increased seed protein.

Effects of steam explosion and enzymatically-mediated acid hydrolysis on the production of cellulose nanocrystals and sugars

Dagem Zekaryas Haddis *(AFNS), Michael Chae, David C. Bressler*

For producing bioethanol from lignocellulosic biomass, the feedstock must be broken down into sugars that could be further converted into ethanol. However, depolymerizing the cellulose to fermentable sugars can be challenging, and currently, the lignocellulosic ethanol industry is using advanced cellulase cocktails to breakdown the recalcitrant crystalline region contained in cellulose into fermentable sugars. These enzymatic approaches are often associated with high costs associated with the advanced cellulase cocktails and longer reaction time. Thus, further biorefinery strategies need to be designed that provide high fermentable sugars recovery with additional high value-added products from lignocellulosic biomass. Since cellulosic material comprised amorphous chains, which can easily hydrolyze to fermentable sugars and subsequently fermented to ethanol and crystalline regions, which are a precursor to produce cellulose nanocrystals (CNCs), it is possible to minimize the use of high enzyme loading and long reaction time by co-producing multiple products. CNCs are nanomaterials that have excellent mechanical properties (Young's modulus of 150 GPa and tensile strength of 7.5GPa), high surface reactivity, and biodegradability. Due to their excellent properties and broad range of envisaged uses, CNCs have attracted great interest as a novel nanomaterial in recent years. In this study, a steam explosion pretreatment combined with enzymatically-mediated acid hydrolysis was exploited to co-generate an increased yield of CNCs and

fermentable sugars from poplar wood chips. Characterization was performed using X-ray diffraction, thermogravimetric analysis, and high-performance liquid chromatography. The preliminary results indicated that steam explosion increases the glucose yield from 12% to 35%, the crystallinity index from 58% to 65% and that the yield of CNCs obtained through acid hydrolysis was improved by 2.5-fold as compared to the original material.

Influence of agricultural lime and pH on the clubroot pathogen: Identifying pH-insensitive strains

Marla Roth *(AFNS), Sheau-Fang Hwang, Victor Manolii, Stephen Strelkov*

Clubroot, caused by Plasmodiophora brassicae, is a serious disease of canola and is becoming increasingly prevalent in Alberta. Because clubroot thrives in acidic soil, agricultural lime can be applied to alkalize soil and suppress disease outbreaks; however, it is unknown whether lime acts as a selection pressure for the pathogen to evolve in alkalinity. For example, clubroot-resistant canola cultivars offer genetic resistance against clubroot, but the pathogen's repeated exposure forces it to evolve and overcome the plant's genetic resistance, causing disease on clubroot-resistant canola. Similarly, P. brassicae's continued exposure to alkalinity might cause it to adapt and become more difficult to control. In this thesis, clubroot-susceptible canola was sown in 132 planting bins. Three soil pH treatments were: 7.2, 8.0, and a control (no lime). Each pH treatment was inoculated with five pathotypes: 3A, 3H, 3D, 5G and 5X, plus controls (no clubroot). Once inoculated, plants grew for 8 weeks then were uprooted. Disease development was rated on a 0 to 3 disease severity scale (zero = no disease; 3 = heavily diseased). This experiment was repeated three times. Significant results did not occur in trial #1. In trial #2, no statistical difference occurred when transgressing from no lime to the 7.2 pH in pathotypes 3A, 3H and 3D; however, there was a significant difference in 5X and 5G. Disease severity with 5X was drastically reduced when liming to 7.2. Pathotype 5G caused greater disease severity in the 7.2 pH compared to no lime. The 8.0 treatment had only 6 diseased plants. The results suggest that 5G is potentially resistant to alkaline soil. Continued spread of 5G, or other alkaline-tolerant pathotypes, presents a serious concern for managing clubroot as lime may no longer offer protection from outbreaks. Future experiments will explore whether other alkaline-insensitive pathotypes exist or if tolerance develops.

Characterization of the arthropod community and predator-prey interactions in canola agroecosystems in central Alberta

Aldo F. Ríos Martínez *(AFNS), Boyd A. Mori*

Canada is the number one producer and exporter of canola in the world, and this industry has an estimated $26 billion (CAD) yearly contribution to the Canadian economy. Canola production in Canada is affected by a variety of introduced and native insect pests. Mortality by predation is a major factor determining the population dynamics of invertebrate pests and has the potential to be an effective alternative to insecticide use. Even though several families of insect and arachnid generalist predators are known to be associated with canola agroecosystems in the Canadian Prairies, the composition of these arthropod communities have not yet been characterised. Similarly, predator-prey interactions in canola remain widely unexplored. Recent advances in molecular techniques are being used to determine the diet composition of generalist predators through gut-content analysis, allowing the identification of the entirety of a predator's diet. This project aims to identify the key predators of insect pests in canola and investigate their trophic interactions. To achieve this, 1) a series of field surveys will be conducted to characterize the arthropod community in canola fields in central Alberta, using a variety of collecting techniques; 2) molecular techniques including

next-generation sequencing and multiplex PCR will be used to determine the diet composition of key predators through molecular gut-content analysis. This project will fill a knowledge gap on information that is necessary to develop predation-based biological control strategies in canola.

Rapid depolymerization of lignin by microwave irradiation

Karen Lopez Camas *(AFNS), Aman Ullah*

Lignin is the most abundant natural resource of aromatic compounds on the earth; it constitutes three basic lignin-phenol units: p-coumaryl alcohol, coniferyl alcohol, and sinapyl alcohol. Around 70 million tons of lignin, generally used as boiler fuel, is produced worldwide annually. About 1.06 million tons of surplus kraft lignin is produced in Canada after fulfilling the recovery boiler demand. If a solution for effective and controlled depolymerization of lignin is found, then using the kraft lignin supply in Canada can generate a multibillion-dollar lignin-based bioproducts industry. Therefore, within the academia and bioenergy fields across the world, lignin depolymerization has become a gold-rush. Nevertheless, breaking down its structure has not been an easy path to achieve. Lignin tends to re-condensate during depolymerization processes; hence finding the best technique to obtain lower molecular weight compounds is the primary goal. This research focused on Kraft lignin's depolymerization using mild conditions under microwave heating. This study developed a method to produce low molecular compounds (>60% yield) in less than 60 min. These results are essential steps to future approaches to obtain more specific chemicals from lignin.

Identifying carabid (Coleoptera: Carabidae) predator-prey interactions in prairie wheat management systems

Max Lortie *(AFNS), Boyd A. Mori*

Chemical insect control methods can have significant drawback in the form of unintended environmental and health effects, as well as the development of insecticide resistance. Integrated pest management (IPM) plans which incorporate alternative control methods are needed to keep insect management in agricultural systems economically and environmentally sustainable. Biological control methods are a powerful alternative management strategy, and it is suggested that efficacy may be enhanced under the conditions present in organic systems. The proper utilization of biological control agents, however, requires knowledge of the insect communities present in a system as well as their interactions. To fill this knowledge gap on the prairies and test the hypothesis of increased pest control by carabid beetles under organic conditions, we plan to survey insects in conventional and organic wheat systems throughout Alberta. The three most abundant carabid beetles in each system will have their gut contents examined for pest species via a twofold approach of multiplex PCR assays and next generation sequencing. Suggestions for potential biocontrol agents will be made based on the results of these analyses.

Are ground beetles overlooked as weed seed predators in Canadian wheat?

Natalie B. LaForest *(AFNS), Boyd A. Mori*

Every year between 30% to 40% of crop yield is lost due to pests and disease, with weeds accounting for the highest percentage of this potential loss; this results in Canadian producers spending millions on herbicides annually. Herbicide use has led to an increased number of herbicide resistant weed species and an increased awareness of potential environmental effects. Previous research has shown some ground

beetles (Coleoptera: Carabidae) will consume weed seeds in laboratory trials, and an increased presence of carabids near weed patches. However, there has been a lack of research demonstrating if weed seed predation occurs in the field. Here, we will investigate the carabids' feeding behaviour in conventional and organic wheat using molecular gut content analysis to identify plant DNA within field captured carabids. Plant material within carabids will be identified with PCR using the plant-specific primer for rubisco (ribulose-1,5-biphosphate carboxylase-oxygenase, rbcL) and be compared to a reference database created from publicly available data and to sequenced species found within the seedbank. The results of this study will contribute to understanding the role of carabids in agroecosystems as weed seed predators.

Development of a multiplex real-time immuno-PCR assay for the simultaneous detection of three wheat fungal pathogens

Ilakkiya Thirugnanasambandam *(AFNS), Tara Vucurevich, Tara Shelton, Caitlin Watt, Nat Kav, André Laroche*

Plant diseases result in major economic consequences worldwide, including crop losses leading to reduced global food production. Wheat is a staple food crop across the world as 760 million tonnes are consumed annually. Canadian wheat production rose to 35 million tonnes in 2020, with the Prairie Provinces of Alberta, Manitoba and Saskatchewan being the major producers of the country. Airborne fungal pathogens pose a severe threat to wheat growers all over the world including Canada. Although fungicide application and resistant cultivars are developed against the diseases, new isolates of pathogens evolve through mutations which may become resistant to control measures taken and can cause significant yield losses. This research aims to develop a highly specific and sensitive multiplex immuno-PCR assay for the simultaneous detection of three different pathogenic fungi infecting wheat: Pyrenophora tritici-repentis, Fusarium graminearum and Puccinia striiformis f.sp.tritici causing tan spot, Fusarium head blight and stripe rust of wheat, respectively. The main aim of the research is to develop a highly sensitive immunoassay to detect the spores from these three different fungal pathogens of cereals based on antibody-based reagents coupled with PCR technologies. The availability of a test using antibodies to detect multiple fungal plant pathogens simultaneously would be very helpful to cereal producers by providing timely information on presence of few spores of fungi before disease symptoms are apparent and would provide near real-time information to prevent further crop infection and yield loss. An early detection and prevention system may result in better wheat crops protection, fewer pesticide applications and reduce the risks associated with environmental impacts to pesticide use.

FIA/LC – MS/MS identifies urinary biomarkers specific of subclinical mastitis in transitory dairy cows

Klevis Haxhiaj *(AFNS), Zhili Li, Mathew Johnson, Suzanna M. Dunn, David S. Wishart, Burim N. Ametaj*

Subclinical mastitis (SCM) remains one of the most important infectious diseases of dairy cows. Early identification of susceptible cows will enable better prevention, management, and reduction of associated financial losses. However, most SCM research focuses on diagnosing and treating this intramammary infection (IMI). Therefore, this study aimed to identify metabolic alterations in the urine of pre-SCM cows during the dry period, along with developing a panel of screening biomarkers. We classified cows into healthy (CON; n=15) and SCM (n=10) based on their postpartum somatic cell count (SCC) tests. Metabolomics analyses were performed by flow injection liquid chromatography coupled with tandem mass spectrometry (FIA/LC-MS/MS). Top altered metabolites belonged to the group of amino acids,

phosphatidylcholines, acylcarnitines, and organic acids. Urine metabolic profiling revealed that a total of 27 metabolites were different for each sample period, at –8 and –4 weeks before the expected calving date. Further regression analysis showed alterations in ADMA, proline, leucine, and homovanillic acid (AUC=0.88; p=0.02) at –8 weeks. Whereas at –4 weeks, ADMA, spermidine, methylmalonic acid and citric acid (AUC=0.88, p=0.03) were significant in the urine of cows that developed SCM postpartum. These altered metabolites represent use as potential biomarkers to identify SCM susceptible cows. Our results support that IMI is present during the dry period and provide specific knowledge to understand better the altered urinary metabolites associated with SCM pathobiology. However, these metabolites' accuracy in predicting SCM needs confirmation in other cohorts during the dry period. Upon validation, these pre-SCM biomarkers will help the dairy industry develop prevention and treatment strategies for SCM that will improve animal welfare and minimize the associated economic burden.

Characterizing midge emergence: An investigation of patterns within *Contarinia brassicola* populations through sex pheromone trapping.

Kyle Van Camp *(AFNS), Boyd Mori*

Population monitoring is an essential aspect of integrated pest management that allows for effective risk and economic threshold assessment. During routine monitoring for swede midge in the Canadian prairies a new species of gall-forming insect was discovered. The canola flower midge (Contarinia brassicola) infests flower buds of canola (Brassica napus Linnaeus and Brassica rapa Linnaeus), preventing anthesis and seed development. The larvae manipulate the buds to produce a gall, a casing of nutrient-rich plant tissue on which they feed. The pest potential of canola flower midge is yet unclear as monitoring midge populations can be challenging; larvae are difficult to detect as they are small and feed within developing buds and often drop to the soil to pupate before their damage becomes easily noticeable. This project will deploy sex pheromone traps optimized for canola flower midge adults in commercial canola fields to evaluate their effectiveness at indicating midge population density levels and subsequent crop damage. The influence of abiotic factors on population density will be evaluated alongside laboratory tests on emergence and oviposition patterns to characterize the insect's life cycle. This data will be used to estimate the pest status of the canola flower midge and provide tools that can be used to monitor and predict infestations.

Gibberellin regulation of protein accumulation in developing seeds

J. Duncan Giebelhaus *(AFNS), Jocelyn A. Ozga, Dennis M. Reinecke*

Many field pea varieties have a mutation in the PsGA3ox1 gene which causes a decrease in bioactive gibberellins (GAs), a plant hormone that regulates growth and development. This mutation in field pea leads to lower GA levels, producing shorter stemmed plants useful for cultivation; however, its effects on seed composition are not well understood. This study tests the hypothesis that part of GAs effect on seed development is through modulation of protein accumulation in the developing seeds. Using GA overproducing and isogenic null control lines, changes in seed tissue free amino acid and total nitrogen content were determined to identify potential GA-induced effects on processes that affect protein accumulation during seed development. Cotyledon nitrogen content per seed and estimated protein content were elevated in the GA overproducing line during development and at maturity compared to the null line, suggesting that seed storage protein accumulation is influenced by GA. Developmental variation in the profiles of key free amino acids involved in seed nitrogen transport and storage in seed coat, endosperm, and cotyledon seed tissues indicate that GA could potentially regulate amino acid transport and metabolism within developing seeds. These modifications, in turn, could influence the rate of storage protein synthesis

in the cotyledons with possible implications on final seed protein content. The knowledge gained on GA regulation of storage protein production during seed development can be used to improve protein content in conventional field pea varieties, which could address issues faced by global agriculture and the plant-protein industry.

Transcriptomic analysis of skeletal muscle in a preclinical model of colorectal cancer: Insights into prevention of lipid accumulation by fish oil

Peter Isesele *(AFNS), Alaa Almasud, Bhumi Bhatt, Sambasivarao Damaraju, Vickie Baracos, Vera C Mazurak*

Myosteatosis is independently prognostic for survival in cancer patients. Prior work has revealed that dietary EPA and DHA (fish oil) reverse chemotherapy-induced myosteatosis in an experimental model of colorectal cancer, but the mechanisms by which EPA and DHA mitigate this effect are not known. This study aimed to identify the differentially regulated transcripts associated with fatty acid uptake and storage in the skeletal muscle in response to tumor, chemotherapy, and the effects of dietary EPA and DHA. Female Fischer 344 rats fed control diet were compared with experimental groups provided EPA and DHA (2.0 g /100 g of diet) initiated on the first day of chemotherapy. Rats received chemotherapy (irinotecan + 5-fluorouracil) 2 weeks after tumor implantation (1-cycle). Total RNA was extracted from gastrocnemius muscle and subjected to transcriptomic analysis using RNA-Seq. Differentially expressed genes were subjected to Ingenuity Pathway Analysis (IPA). Genes enriched in a pathway were identified and annotated for their putative functional role. Transcripts of adipogenesis (Pparg[p=1.39E-02, fc=1.6], Fabp4 [p=0.069, fc =1.6], Lep [0.005, fc =13.8], Scd1 [0.0017, fc = 6.8], Plin1 [0.0033, fc = 4.2], Klf5 [0.0046, fc = 1.6), fatty acid activation (Slc27a1 [p =2.3E-02, fc = 1.54], Slc27a6 [p = 0.012, fc = 4.1), and acetyl-CoA biosynthesis (Dld [p=0.033, fc = 1.5], Phda1 [p=0.014, fc =1.5]) were activated in tumor bearing and chemotherapy treated animals compared to reference animals (no tumor/chemotherapy). Dietary EPA and DHA restored these transcripts to levels not different from reference animals. Lipid synthesis and storage appear to be driven by tumor and chemotherapy, contributing to myosteatosis. Provision of dietary EPA and DHA restored transcripts in these pathways to levels similar to reference animals. Collectively, these findings offer a potential mechanistic insight on the role of EPA and DHA in mitigating myosteatosis.

Modeling variability in biomass feedstock supplies with limited data: An application of data clustering

Wanjing (Amy) Xu *(REES), Grant Hauer, Marty Lucker, Feng Qiu*

The feasibility of bioenergy production depends on economic conditions, which are subject to risk and uncertainty. Before setting up a biorefinery, policy makers and investors will need to consider the costs and risks of obtaining and managing variable sources of bio feedstock supply. These supplies may vary greatly across locations and time, so it is important to accurately characterize feedstock variability. However, traditional statistical techniques used to characterize variability may fail when observations are few. We apply clustering algorithms to improve feedstock supply variability estimation for agricultural residues. By accounting for variability among similar observations, variability across observations that are different can be more readily identified. Preliminary simulation results show that, after clustering, there is higher biomass total supply variability and higher variability in the distances firms may need to travel to obtain sufficient supply.

Comparison of bench-scale test methods for measuring heat transmission through wildland firefighters' personal protective clothing systems

Elena Kosareva *(HECOL), Jane Batcheller, Stephen Paskaluk*

Every year wildland firefighters put their lives at risk facing hostile fire conditions. Their clothing plays an important role in preventing burn injury. The performance of wildland firefighters' protective clothing can be evaluated by bench-scale tests and also full-scale manikin tests which more closely represent a life-like scenario. The aim of my research was to compare two bench-scale test methods used for evaluating heat transmission through two-layer protective clothing systems (exterior garment and base layer) under wet and dry conditions. The standard test methods were: a thermal protective performance (TTP) test with convective energy exposure, and a heat transfer performance (HTP) test with convective and radiant energy exposure. Each test method was performed using the standard flat specimen holder and sensor, as well as a novel cylindrical specimen holder and sensor. Recent studies showed good correlation between the shrinkage data obtained from the cylindrical specimen holder and the full-scale manikin test. In this study, the cylindrical holder was further investigated to see if differences in heat transmission also occur with changes in the specimen and sensor orientation under different energy exposures and wet/dry conditions.

The soil organic carbon in the hedgerow system and the shelterbelt system had similar thermal stability while differed in biological stability

Zhengfeng An *(RENR), Alain F. Plante, Edward W. Bork, Cameron N. Carlyle, Scott X. Chang*

Agroforestry systems could significantly increase carbon (C) sequestration and mitigate climate change in western Canada. Thus, more attention should be paid to soil organic carbon (SOC) stability to understand SOC dynamics in the agroforestry systems. The biological and thermal stability of SOC was determined by using biological and thermal analysis methods in two typical agroforestry systems (shelterbelt and hedgerow) and their constituent land-uses (forest and cropland) in central Alberta, Canada. The results showed that the shelterbelt system had lower biological stability, proven by higher cumulative soil respiration and basal soil respiration and 1.35 times greater C loss during the incubation than the hedgerow system ($p < 0.1$). Forest SOC had lower biological stability, which was 1.29 times greater C loss, 1.48 times basal soil respiration rate, and 1.35 times cumulative soil respiration rate than the adjacent cropland ($p < 0.01$). There was no difference between the SOC thermal stability between the hedgerow and shelterbelt system. Between land-uses, cropland SOC had greater thermal stability (higher TG-T50) than the forest SOC, while forest SOC had a higher energy density, DSC-T50, CO2-T50 than the cropland SOC ($p < 0.01$). Incorporating trees to form agroforestry systems influenced the biological and thermal stability of SOC, which have strong implications for SOC dynamics and C sequestration.

Acid-insoluble ash in Sphagnum moss, arboreal lichen and terrestrial lichens in Alberta ombrotrophic bogs, and the implications for biomonitoring

Lukas Frost *(RENR), Katharina Grobner, Rene Belland, Diane Haughland, Gillian Mullan-Boudreau, William Shotyk*

Mosses and lichens are considered excellent biomonitors due to their unique biology. They derive most of their mineral nutrition from the atmosphere and cannot redistribute inorganic constituents throughout the

plant. Both taxa are used as biomonitors, but they are seldom compared. Studies that undertake this endeavor occur more frequently in Europe, and are often concerned with different facets of biomonitoring, such as trace element concentrations, polycyclic aromatic hydrocarbons, or gaseous contaminants. Here we attempt to determine which organisms are better suited to binding and retaining dust particles, in the Athabasca Oil Sands Region and a rural-urban complex region west of Edmonton, Alberta. To minimize contamination from other sources, we have selected species that occur in bogs, where all mineral nutrition is derived from the atmosphere. Three types of mosses and lichens were analyzed; a composite sample of several arboreal (tree lichens), terrestrial lichens (ground lichens) composed of Cladonia mitis, and Sphagnum mosses. These samples were cleaned of foreign material, then ashed in a muffle furnace, and dissolved in an HNO3 acid solution. Once dissolved, the ash-acid solution was filtered through a 0.45 um filter to separate the acid-soluble ash (ASA) from the acid-insoluble ash (AIA). The AIA represents the mineral components of these samples. We then compared the AIA contents to determine the relative efficiency of trapping atmospheric dust. Their efficiency appeared to decrease in the following order Sphagnum moss > Arboreal lichens > Ground lichens. This difference suggests that Sphagnum mosses are likely to capture and/or retain a larger proportion of bulk deposition than the other species. We then suggest possible causes of this difference for further study. These include life-history strategies (like reproductive methods), morphology, and microhabitat. These differences may not only reflect these organism's ability to represent bulk deposition but may also represent different fractions of dust.

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