






Joint Annual Conference for the Canadian Society of Agronomy and the Canadian Society for Horticultural Science

Sustaining and improving agricultural production under the increasing complexities

July 24-26, 2016
Montreal, QC

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La Plaza, Montreal, QC, Canada

Organizing Committee

Jaswinder Singh, Co-Chair (McGill University)

Valérie Gravel, Co-Chair (McGill University)

Philippe Seguin (McGill University)

Marie Thérèse Charles (Agriculture and Agri-Food Canada)

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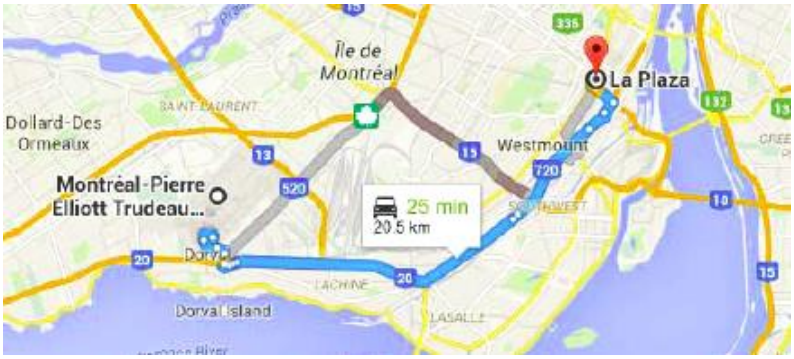

Program

Sunday July 24th, 2016

7:00-8:00	**Registration, breakfast and poster set-up Session #1 (P1 to P36)**
8:00-9:00	**Plenary lecture**
8:00	**Welcoming address** Conference Chairs, Jaswinder Singh and Valérie Gravel, McGill University, Ste Anne de Bellevue, QC, Canada
8:05	**Opening remarks (Introduction by Valérie Gravel)** Dean Anja Geitmann, McGill University, Ste Anne de Bellevue, QC, Canada
8:20	**Plenary lecture (Chair: Tarlok Sahota)** **Whither agronomy research** Dr. Gilles Saindon, Associate Assistant Deputy Minister, AAFC, Ottawa, Canada
9:00-12:30	**Conference Sessions**
	1-Food security and sustainability (Chair: Jayasankar Subramanian)
9:00	**Keynote Lecture** **Title: Food security: Role of technology** Dr. Maurice Moloney Global Food Security Institute, University of Saskatchewan, SK, Canada
9:45	**1.1- Food and Nutritional Security: Tackling Post-Harvest Loss with Nano-solutions** Dr. Jayasankar Subramanian
10:00	**1.2- Food Security in Northern Canada (Food SINC) project: Development of northern greenhouse and working prototype** Patricia Gaudet
10:15	**1.3- Low cost Sustainable Agriculture Kits (SAKs) as an agronomic strategy to improve farmer's livelihoods in Nepal.** Tejendra Chapagain
10:30-11:00	**Coffee break**
	2-Agronomy and cropping systems #1 (Chair: Tarlok Sahota)
11:00	**Keynote Lecture** **Making waves. Einstein's lessons for agricultural science** Dr. Paul Fixen International Plant Nutrition Institute (IPNI), Brookings, SD, USA
11:30	**2.1- Corn residue management for soybean production in Manitoba: On-farm trial** Patrick A. Walther
11:45	**2.2- Optimal plant spatial arrangement for dry bean (*Phaseolus vulgaris* L.) production in Manitoba** Laura Schmidt
12:00	**2.3-Survey of herbicide resistance common ragweed and wild oat in Quebec** Félix Marsan-Pelletier
12:15	**2.4- Optimal seeding methods of winter wheat to increase the winter survival and productivity in contrasted climates in Quebec** Francis Allard
12:30-13:30	**Lunch – CSA AGM**
13:30-18:00	**Conference Sessions**

	3-Abiotic stresses (Chair: Marie Thérèse Charles)
13:30	**Keynote Lecture** **Endosymbionts protect crops and vegetables against abiotic stresses.** **Dr. Vladimir Vujanovic** University of Saskatchewan, Saskatoon, SK, Canada
14:00	**3.1-Induced tolerance to abiotic stress in tomato plants** Ines Ben Rejeb
14:15	**3.2- Preharvest UV-C radiation triggers accumulation of volatile organic compounds in strawberry leaves** Yanqun Xu
14:30	**3.3- Genetic transformation of Canadian pea (*Pisum sativum* L.) for drought tolerance using DREB2a and PR10a genes** Jagroop Gill Kahlon
14:45	**3.4- Micropropagation of american chestnut (*Castanea dentata* (Marsh.) Borkh.)** Christie Lovat
15:00-15:30	**Coffee break**
	4-Biotic stresses (Chair: Valérie Gravel)
15:30	**Keynote Lecture** **Biovigilance: a framework to address the increasing complexity of plant protection.** Dr. Odile Carisse Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, QC, Canada
16:00	**4.1- The role of fungicide spray coverage and population heterogeneity on the selection for resistance in *Botrytis squamosa* in Onion Plants** Zhe Steven Jia
16:15	**4.2- Low UV-C dose exposition elicits disease resistance against bacterial leaf spot caused by *Xanthomonas hortorum* pv. *vitians* in lettuce** Olbert Nicolas
16:30	**4.3- Identification of QTL conferring resistance to common bacterial blight and days to maturity in common bean *Phaseolus vulgaris*** Raja Khanal
16:45	**4.4- A neural network model to predict wheat stem sawfly cutting in solid-stemmed wheat cultivars** Brian L Beres
17:00	**4.5- Influence of atmospheric carbon dioxide and nitrate fertilization on Arabidopsis metabolism** Jacqueline C. Bede
17:15	**4.6- Race characterization of *Puccinia striiformis* f. sp. *tritici,* the cause of wheat stripe rust, in Saskatchewan and Southern Alberta, Canada and virulence comparison with races from the USA (Pest management award presentation)** Gurcharan. S. Brar
17:30-18:00	**CSP presentation**
18:00-19:30	**Poster Session #1 (P1 to P36) & Cocktail**
19:30	**Removal of posters from session #1**

Monday July 25th, 2016

7:15-8:15	**Registration, breakfast and poster set-up Session #2 (P37 to P69)**
8:15-9:00	**Plenary lecture**
8:15	**Opening remarks** Conference Chairs, Jaswinder Singh and Valérie Gravel, McGill University
8:20	**Plenary lecture (Chair: Samir C. Debnath)** **Incorporating synchrotron techniques as tools to improve agricultural production under the increasing complexities** Karen Tanino, University of Saskatchewan, SK, Canada
9:00-12:30	**Conference Sessions**
	5-Nutrient and water management (Chair: Rigas Karamanos)
9:00	**Keynote Lecture** **Managing nitrogen fertility in horticultural systems with an aim to balance crop productivity and N losses** Dr. Laura Van Eerd University of Guelph, Guelph, ON, Canada
9:30	**5.1- Canola N Nutrition and productivity as affected by a combination of cover crop and organic or mineral fertilization** Mathieu Vaillancourt
9:45	**5.2- Techniques for management of variable rate irrigation in potatoes** Alison Nelson
10:00	**5.3- Effect of urea and urea + ESN blend on MasterGraze corn and sorghum sudangrass for silage production in Northwestern Ontario** Tarlok. S Sahota
10:15	**5.4- Concentration and uptake of mineral nutrients in soybean, pea, lentil, and in following rotational crops in Saskatchewan, Canada** Jing Xie
10:30-11:00	**Coffee break**
	6-Plant breeding and genetic resources (Chair: Ali Navabi)
11:00	**Keynote Speaker** **Breeding faba bean for climate change** Dr. Fred Stoddard University of Helsinki, Helsinki, Finland
11:30	**6.1- Innovative technologies to accelerate industry transition from "wild" to cultivated cool climate small fruit crop production systems** Samir C. Debnath
11:45	**6.2- Study of genetic diversity among various blueberries (*Vaccinium* spp.) using molecular markers** Dhrumit Bhatt
12:00	**6.3- Predictive biomarkers for cold-induced sweetening resistance and improved long term storability.** Sanjay Gupta
12:15	**6.4- Genomics of drought tolerance in flax (*Linum usitatissimum* L)** Demissew S. Desta
12:30-13:30	**Lunch – CSHS AGM**
13:30-18:00	**Conference Sessions**
	7-Genomics and biotechnology (Chair: Jaswinder Singh)
13:30	**Keynote Lecture**

	Genomics and biotechnology in horticultural crops: Recent advances in stone Fruits Dr. Jayasankar Subramanian University of Guelph (Vineland Station), ON, Canada
14:00	**7.1-Cellulose synthase (CesA) gene family and its relation to cell wall traits in wheat** Simerjeet Kaur
14:15	**7.2- Characterization of vernalization and photoperiod response in fall-planted wheat in South Western Ontario** A. Whittal
14:30	**7.3- A whole cell biosensor (*GlnLux*) to measure and visualize symbiotic nitrogen fixation in legumes** Malinda S. Thilakarathna
14:45	**7.4- The involvement of protein-carbohydrate module in barley malting quality** Rajiv K. Tripathi
15:00	**7.5- Differential regulation of developmental genes expression and methylation status of phytoplasma and insect infested *Brassica napus* L.** Samina Jam Nazeer Ahmad
15:15-15:30	**Coffee break**
15:30-17:00	**Poster Session #2 (P36 to P69)**
17:00	**Removal of posters from session #2**
18:00	**Banquet**

Tuesday July 26th, 2016

7:15-8:15	**Registration, breakfast and poster set-up Session #2**
8:15-8:30	**Opening remarks** Conference Chairs, Jaswinder Singh and Valérie Gravel, McGill University
8:30-11:30	**Conference Sessions**
	8-Agronomy and cropping systems #2 (Chair: Philippe Seguin)
8:30	**Keynote Lecture** **Biomass: Understanding the risks and opportunities for agriculture?** Dr. Bill Deen, University of Guelph, Guelph, ON, Canada
9.00	**Distinguished Agronomist Lecture** **Crop Physiology: the plant science mediator** Dr. Malcolm Morrison
9:30	**8.1-Forage species and cultivars in grass-legume mixtures that perform well under cattle grazing** Yousef A. Papadopoulos
9:45	**8.2-Nitrogen requirements of winter cereals for forage production in northwestern Ontario** Tarlok S. Sahota
10:00-10:30	**Coffee break**
10.30	**8.3- Meta-analysis of cover cropping systems: the effects of cover crops on subsequent cash crop yields** Anaïs Charles
10:45	**8.4- The effect of weeds on soil arbuscular mycorrhizal fungi and agronomic traits**

	in spring wheat (Triticum aestivum L.) under organic management in Canada (CJPS best paper presentation) Hiroshi Kubota
11:00	**8.5- Effect of cultivar and environment on end-use quality of winter wheat in Canada** Yan Zi
11:15	**Closing remarks**
13:00	**Tour of the Macdonald Campus**
17:00	**Return to La Plaza**

INVITED SPEAKERS

Professor Anja Geitmann

Dean, Faculty of Agricultural and Environmental Sciences of McGill University, Montreal, Canada

Welcome Address

Dr. Anja Geitmann is Professor and Dean at the Faculty of Agricultural and Environmental Sciences of McGill University. From 2001 to 2015 she was Professor at the Department of Biological Sciences of the *Université de Montréal* and Scientist at the *Institut de recherche en biologie végétale*. She obtained her PhD in 1997 from the University of Siena (Italy), following undergraduate and graduate studies at the University of Constance (Germany), Oregon State University (USA), and Stockholm University (Sweden). Between 1997 and 2001 she performed postdoctoral research at the *Université Laval*, Québec, and at the University of Wageningen, The Netherlands. She currently serves as President of the Canadian Society of Plant Biologists and as Past-President of the Microscopical Society of Canada. She is the Vice-President of the International Association of Plant Sexual Reproduction Research. She serves on the editorial boards of multiple scientific journals including *Plant Physiology*. Dr. Geitmann leads an interdisciplinary team of cell biologists and mechanical engineers and her research program focuses on the biomechanical principles governing plant development and reproduction.

Dr Gilles Saindon

Associate Assistant Deputy Minister, Agriculture and Agri-Food Canada (*Science and Technology Branch),* Ottawa, Canada

Plenary lecture

Dr. Gilles Saindon has been the Associate Assistant Deputy Minister at Agriculture and Agri-Food Canada (AAFC), Science and Technology Branch, since 2012. The Science and Technology Branch provides industry producers and processors a single point of access to AAFC's science and technology expertise and to sustainable solutions. Dr. Saindon began his agricultural career when he joined AAFC in 1989 as a research scientist in Lethbridge, AB, developing new dry beans adapted to western Canada. His first appointment as a Government of Canada executive was in 1996 as Director of the AAFC Potato Research Centre in Fredericton, NB, where he was responsible for operations and the scientific program. In 2000, he was appointed Director of the Southern Crop Protection and Food Research Centre in London, Ontario with responsibilities for associated research sites in Delhi and Vineland, Ontario. From 2004 to 2012, Dr. Saindon held several Director General responsibilities including the scientific and managerial leadership of a network of 19 research centres across the country. As Director General-Science Bureau, he was also involved in developing the AAFC Science and Innovation Strategy, released in 2006. Dr. Saindon holds a Bachelor degree in Agronomy Science (1983) and a Masters in Plant Breeding (1986) from Laval University, as well as a Ph.D. in Plant Genetics (1988) from the University of Guelph.

Dr. Karen K. Tanino

Professor, University of Saskatchewan, Saskatoon, SK

Plenary lecture

Dr. Karen Tanino received her B.Sc. and M.Sc. from the University of Guelph and her Ph.D. from Oregon State University. She is a tenured full professor in the Dept. Plant Sciences, College of Agriculture and Bioresources at the University of Saskatchewan. She held a 0.5 Extension appointment from 1989-2002 in which she was founding chair of the Prairie Horticulture Certificate Program, a consortium of four prairie universities and colleges (over 3500 students to date). She is currently Vice-President of the Circumpolar Agriculture Association and has taught a total of 14 undergraduate and graduate courses including the biannually offered graduate course on Plant Abiotic Stress. She has been studying/working in the field of plant abiotic stress for over 30 years and co-chaired the 8th International Plant Cold Hardiness Seminar (2007). She specializes in plant abiotic stress physiology and the interactions of plants with the environment. She has recently published on plant imaging of stress responses using synchrotron technology (Vijayan, P., Willick, I., Lahlali, R., Karunakaran, C., Tanino, K. 2015. Synchrotron Radiation Sheds Fresh Light on Plant Research: the Use of Powerful Techniques to Probe Structure and Composition of Plants. Plant & Cell Physiol. 56 (7): 1252-1263. She has published over 186 research contributions including 6 books.

Dr. Maurice Moloney

Executive Director and CEO, Global Institute for Food Security (GIFS), University of Saskatchewan, Saskatoon, Canada

Keynote lecture: Food security and sustainability

Dr. Moloney was appointed as Executive Director and CEO of GIFS in October 2014.Previously, he was the Group Executive for Food, Health and Life Sciences at CSIRO in Australia, that country's national science agency covering a range of disciplines. There, Dr. Moloney was responsible for all life sciences R&D and for industrial and company relationships. He led a staff of 1,400 staff and managed $AU400 million annually. From 2010 to 2013, Dr. Moloney was the Director and Chief Executive of Rothamsted Research in the UK. Rothamsted, a BBSRC Institute, is the oldest and largest agricultural research centre in Europe. He founded SemBioSys and served as the company's President from 1994-1998 and CSO from 1998-2010. Dr. Moloney's career in plant biotechnology spans more than 30 years. He was a Professor in Biological Sciences at the University of Calgary, pursuing research on seed-specific gene expression, herbicide resistance, and the plant cell cycle. From 1995-2003, he held the NSERC Industrial Research Chair in plant biotechnology. Previously, he headed the Cell Biology Group at Calgene Inc., where he developed the first transgenic oilseed plants using canola as the model. He has published more than 90 original research papers and is an inventor on 43 issued US patents and over 300 patents worldwide. He has served on the many scientific advisory boards and government committees, as well as consulted for several biotechnology and agri-business companies. He has received a number of prestigious awards, including two Alberta Science and Technology (ASTECH) Awards for leadership in Alberta Technology. Dr. Moloney holds a Bachelor of Science degree in chemistry from Imperial College, London,and was awarded his doctorate in plant biochemistry from De Montfort University/Leicester Polytechnic in the UK. He was honoured by the University of Lethbridge with a DSc *honoris causa* in 2004 and by De Montfort University in 2011.

Dr. Paul E. Fixen

Senior Vice President, International Plant Nutrition Institute, Brookings, SD, USA

Keynote lecture: Agronomy and Cropping Systems #1

Dr. Paul Fixen is Senior Vice President of the International Plant Nutrition Institute (IPNI) where his responsibilities include coordination of the Institute's programs in the Americas and Australia and serving as director of the Institute's global research efforts. Dr. Fixen is also currently serving as President of the American Society of Agronomy (ASA), the largest agronomic professional and scientific society in the world. He grew up in southwestern Minnesota on a crop and livestock farm and served in faculty positions at the University of Wisconsin and South Dakota State University prior to joining the Institute. His career has emphasized the science of nutrient stewardship and how soil fertility and fertilizer use fit into the overall scheme of crop production systems and the environment. Throughout his career he has authored over 300 articles related to nutrient management including several book chapters and developed and taught popular courses at both undergraduate and graduate levels. Dr. Fixen is a Fellow of the American Society of Agronomy, the Soil Science Society of America (SSSA), the American Association for the Advancement of Science, and the Fluid Fertilizer Foundation. He has served on numerous boards, academic and agency review panels, and industry committees. Examples include the Planning Committee for the 18th World Congress of Soil Science and, for several years, the Science Advisory Committee of the International Nitrogen Initiative. Dr. Fixen has also served on Minnesota and South Dakota Certified Crop Adviser Boards and was the founding President of the South Dakota Board. He is currently a member of the Agronomic Science Foundation Board of Directors.

Dr. Vladimir Vujanovic

Associate Professor, University of Saskatchewan, Saskatoon, SK

Keynote lecture: Abiotic stresses

Dr. Vladimir Vujanovic graduated in Forestry and Agricultural Mycology (BSc., MSc., Ph.D), and joined the UQAM (Université du Québec à Montréal) in 1995 as a postdoctoral fellow in Environmental Microbiology and Biotechnology. From 1996-2005 he was a researcher in Mycology and Plant Pathology at the Montreal Botanical Garden and Adjunct Professor at the University of Montreal. He concurrently coordinated Quebec's Environmental Research Center (2001-2003) at McGill University. In 2005, Dr. Vujanovic took an Associate Professor and Agri-Food Innovation Fund (AFIF) Chair position in Agricultural Microbiology and Microbial Bioproducts at the University of Saskatchewan. He is an active Associate Faculty Member of the Shool of Environment and Sustainability, Centre for Agroforestry and Afforestation at the University of Saskatchewan, and is also the Invited Visiting Scientist at the National Research Council Canada (sabbatical leave 2012-13). Prof. Vujanovic is currently teaching five undergraduate and graduate courses at the University of Saskatchewan in Microbial Resources, Environmental Microbiology, Microbial Bioproducts in Agriculture, Industrial Microbiology, and Food Security. His research on discovering plant microbiome resulted in description of a dozen of new fungal species, new mycoparasitic and endophytic fungal resources for the creation of innovative microbial bioproducts in agriculture, agroforestry, horticulture and food sciences. For his achievements, Prof Vujanovic received 2015 SABEX Award for Innovation. As a prolific and internationally recognized scientist, he has published more than a hundred peer-reviewed papers, books and chapters of books that pertain to both research and education and their implications for the creation of green bioproducts and modern-mentor approach teaching practices. Currently, Prof Vujanovic is PI of the $2M Genome Canada-Genome Prairie project, entitled: "Augmenting the Plant Microbiome to Improve Crop Yield and Stress Resilience".

Dr. Odile Carisse

Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, QC, Canada

Keynote lecture: Biotic stresses

Dr Carisse works as plant pathologist with Agriculture and AgriFood Canada since 1992. She is a plant pathologist and a world expert in molecular aerobiology, crop disease management and theoretical crop disease modeling. During the last decade, Dr Carisse' research has taken a path of increasing specialization and of integration of various disciplines namely aerobiology, epidemiology, mathematical modeling, decision/sampling theory and molecular quantification of pathogens inoculum and resistance to fungicides. The resulting knowledge landscape is a powerful driver for solving crop disease problems and for adoptions by stakeholders. She is working with the industry to implement networks of airborne pathogens and fungicide resistance monitoring and improved disease management decision systems. She was awarded by the Canadian Society of Plant Pathology Outstanding Research Award (2015) and elected foreign correspondent of the French Academy of Agriculture. Dr Carisse is spokesperson for the Agriculture and AgriFood Canada Biovigilance research platform. This platform aim at promoting research on temporal and spatial evolution of plant pests as influenced by agricultural systems, protection products, cultivars, farming practices, and climate change.

Dr. Laura L. Van Eerd

University of Guelph, Guelph, ON, Canada

Keynote lecture: Nutrient and water management

Laura grew up on a cash crop and finishing hog farm in near Ridgetown, Ontario. She was in the first class to graduate with a Bachelors Science Degree in Environmental Science at the University of Guelph. Her passion for agriculture kept her at the University where she earned an MSc and PhD in the Department of Environmental Biology. Laura is still at the University of Guelph but located at Ridgetown Campus as an Associate Professor in the School of Environmental Sciences. Within a systems-based approach, her research evaluates nitrogen use efficiency in vegetable and low-acreage crop production, the role of cover crops and crop diversity in the agroecosystem and impacts of management on soil health. In addition to advancing science, this research has the potential to benefit 1) the growers by maximizing economic returns, 2) the government by insuring that current, accurate Ontario vegetable data are used in developing regulations, and 3) the public by developing best management practices that reduce the detrimental environmental impacts and/or increase agroecosystem resiliency.

Professor Fred Stoddard

University of Helsinki, Helsinki, Finland

Keynote lecture: Plant breeding and genetic resources

Fred Stoddard grew up in Boston, Halifax and Ottawa, and did his Honours BSc at Carleton University. In 1981 he went to the University of Cambridge for his PhD, working at the Plant Breeding Institute (PBI) with faba bean breeder David Bond, and showed that spring-sown beans received enough bee-mediated pollination, but that autumn-sown beans often did not, leading to a poor yield distribution. He continued working on faba bean pollination for his first post-doc at the University of Adelaide, and then branched into wheat quality. His job then moved to the University of Sydney, where he continued working on wheat and faba bean, dabbled in some other crops, and married a Finnish-Australian. After 15 years in Australia on short-term contracts, he got a long-term contract to improve the research at the university of Wolver hampton in the UK, but after 4 years, he and his wife took an opportunity to move to her native Finland, where they have been for 11 years (and have no intention of moving again). He has worked on almost every aspect of faba bean, including pollination, agronomy, breeding, genetics, biotic and abiotic stresses, environmental impact, and grain quality. He has held grants from the Academy of Finland and the Finnish Ministry of Agriculture and Forestry, and been a member of several European research consortia on legumes and sustainable agriculture, including the European Union's Framework Programme 5 project "EU-Faba" on faba bean breeding and FP7 project "Legume Futures" on legume-supported cropping systems, an ERA-NET project "Climate CAFE" on climate-smart cropping systems, a report and presentation to the European Parliament on "The environmental role of protein crops in the new Common Agricultural Policy", and chairing the European Innovation Platform's Focus Group on Protein Crops. He was president of the European Society for Agronomy 2010-2012, hosting its biennial congress in Helsinki in 2012. He is on the executive committee of the International Legume Society. After several years in the Crop Sciences team at the University of Helsinki, he is now Professor in the Grain Technology team. He has over 100 refereed research articles, and has supervised or co-supervised 25 completed PhDs.

Dr. Jayasankar Subramanian

Professor- Tree Fruit Breeding and Biotechnology Plant Agriculture-Vineland Station, U of Guelph

Keynote lecture: Genomics and biotechnology

Dr. Subramanian has over 25 years of experience in horticulture, especially fruit crop breeding and biotechnology in India, US and Canada. He has worked with diverse crop species and for the past 18 years has been working with perennial fruit improvement such as mango, grapes and tender fruits- both using conventional and contemporary approaches. He has developed and released 14 improved varieties in India and Canada. He is an investigator in several provincial, national and International grants such as IDRC. Currently he is leading an International project involving 6 countries on reducing post harvest loss in fruits using nanotechnology. He has attended various conferences in several countries and has been invited to deliver key note addresses. Recently he was invited to present his work at the United Nations General Assembly's Market Place in New York and at the Global Affairs Canada, Ottawa. He is a member of the editorial board in three International Journals and has reviewed manuscripts for over 15 International journals. He has also served as a member of grant selection committees in Canada, US and Europe. He has served as an external member for the evaluation of thesis from several countries. Some of his selected accomplishments are listed below.

Dr. Bill Deen

Associate Professor, Department of Plant Agriculture, University of Guelph, Guelph, Canada

Keynote lecture: Agronomy and cropping systems #2

Dr. Bill Deen is a leading agroecologist in research with extensive outreach to growers and industry. The objective of his research program is to develop agroecosystems that are both productive and sustainable. Bill has internationally recognized knowledge of crop rotation, cover crop, tillage and field-based research techniques and experience managing interdisciplinary research efforts based on long-term field trials. Since 2008, he has been actively involved in research related to biomass production systems based on crop residue removal or dedicated C4 perennial grasses.

Abstracts - Oral Presentations

Plenary Lecture

Whither agronomy research

Gilles Saindon

Associate Assistant Deputy Minister, AAFC, Ottawa, Canada

Session 1: Food security and sustainability

Keynote lecture – Food security: Role of technology

Dr. Maurice Moloney

Executive Director and CEO, Global Institute for Food Security (GIFS), University of Saskatchewan, Saskatoon, Canada

1.1- Food and nutritional security: Tackling post-harvest loss with nano-solutions

Jayasankar Subramanian[1], Gopinadhan Paliyath[1], J Alan Sullivan[1], Loong-Tak Lim[1], GJ Janavi[2] and KS Subramanian[2]

[1]University of Guelph, Guelph, Canada; [2]TamilNadu Agricultural University, Coimbatore, India.

Post-harvest losses contribute several billions of dollars worldwide. Surprisingly the amount of loss is not very different between developed and developing nations. With the arable land diminishing due to urbanization, it is becoming imperative that we minimise the post-harvest losses which will help feed the world. Fruits and vegetables are one of the most highly perishable produce due to their tenderness that results in very short shelf life. Most fruits develop some sort of post-harvest 'disease' that accelerates the deterioration. In incidents where such disease incidences are prevented, fruits tend to shrivel and their taste attributes start to decline. Thus minimising membrane damage can lead to extended post-harvest shelf life. Research at the University of Guelph lead to the discovery that an enzyme called phospholipase D (PLD) triggers the onset of membrane deterioration. Further research in this field lead to the discovery of a key natural product, called hexanal that can slow down the action of PLD dramatically. Based on these discoveries, a spray formulation with hexanal as the key ingredient, was developed and tested on a number of fruit crops as a pre harvest spray as well as a post- harvest dip treatment. The results revealed that in addition to the anticipated extension of post-harvest shelf life, fruits in the treated trees were also retained for an additional period of time. These results made a significant impact with the fruit growers who tested these products. The fact that hexanal evaporates very quickly and leaves no ill effects on the fruits also added strength to its use a vapour intervention, in addition to the simplicity of use. When we examined further, we asked if hexanal could be delivered in a sustained manner so the post- harvest shelf life could be extended from more than one point of intervention. This led us to use the nanotechnology approaches for not only sustained delivery, but also at very small doses. As a result of intense research in a multi nation project funded by IDRC-CIFSRF project, several possibilities of such nanotechnology based interventions were examined and the results will be discussed. These interventions can be ideally used by the fruit packaging industry to reduce post harvest loss thus ensuring food and nutritional security.

1.2- Food Security in Northern Canada (Food SINC) project: Development of Northern greenhouse and working prototype

Patricia Gaudet, Mark Cool, Mark Lefsrud

Bioresource Engineering, McGill University. Email for corresponding author: mark.lefsrud@mcgill.ca

Food security has become an increasing concern in northern Canada because fresh nutritious food is not accessible to individuals and families for a number of reasons. High transportation costs inflate the cost of food and the long transportation process degrades the food's quality, while weather and road conditions also limit accessibility during certain periods of the year. The Food Security in Northern Canada Greenhouse (Food SINC) is a possible solution to food insecurity in the region. The Food SINC unit is constructed within a standard shipping container for ease of transport. The structure functions as a closed growth chamber during the winter months and as a solar greenhouse during the summer months, with the transition between growth chamber and solar greenhouse being achieved by closing or opening the unit's outer retractable insulated panels. Closing the panels converts the unit into a growth chamber, thereby limiting heat loss during the cold nights and winter months, while opening the panels allows the unit to function as a solar greenhouse. Integrated within the unit is also a complete heating and ventilation system and a high production rate hydroponic growing system with integrated inter-canopy ventilation, heating and supplemental lighting. A full scale working prototype is currently close to completion at the Macdonald Campus of McGill University under the supervision of Dr. Mark Lefsrud. Once the prototype is complete, the unit will be tested as a whole; continuous experiments on best management and production practices will be conducted while taking into account the unit's dual function, as a solar greenhouse and closed growth chamber. Further optimization of the Food SINC unit will allow for an

efficient and sustainable solution for food insecurity in northern Canada enabling northern communities to produce fresh nutritious food year round.

1.3- Low cost Sustainable Agriculture Kits (SAKs) As an agronomic strategy to improve farmer's livelihoods in Nepal.

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The world's 1.1 billion subsistence farmers do not have access to peer-reviewed knowledge of best agronomic practices, good seeds, or inexpensive farm tools. What is lacking is a means to package, deliver and share these technologies to farmers who earn $1-$2 per day. Like a restaurant menu, Sustainable Agriculture Kits (SAKs) are intended to be regional menus of private sector technologies and ecological practices – from which an individual farmer can purchase one or more items at a cost of $1 (ideally) to assemble a technology kit that is appropriate for his/her own needs. The items are intended for sale at stalls in villages. A SAK consists of 3 components: (1) locally approved seeds, (2) low cost tools and technologies focused on reducing female drudgery, and (3) an agricultural extension picture book to communicate best agronomic practices (indigenous and scientific) to empower illiterate farmers. In rural Nepal, following grassroots surveying of households, we are in the process of conducting on-farm agronomic trials to test the efficacy of the identified SAKs. In parallel we are scaling up SAK products and practices that have previously been validated, using participatory approaches. To enable distribution of these products, we are piggybacking onto a pre-existing snackfood distribution network as well as the franchises of a Nepalese private seed company. The picture book of best agronomic practices is open access and available online.

Session 2: Agronomy and cropping systems #1

Keynote lecture – Making waves ... Einstein's lessons for agricultural science

Dr. Paul E. Fixen

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Meeting the challenge of sustainable food security will require substantial scientific contributions. Evidence-based agriculture seeks the transparent integration of all relevant data and resulting recommended practices with local conditions and associated data. It has the potential to make the science supporting agriculture more swift, nimble and credible and can increase the impact of the data of agricultural science in a big data world. Implementation of evidence-based agriculture involves improvements in data stewardship and in the suitability of articles for synthesis in detailed reviews and analysis. Funding sources are advancing these changes by funding meta-analyses to determine what already exists or is absent in the literature on specific questions, and by requiring open access to data from funded projects. The recent report of physical measurement of gravitational waves provides lessons to agricultural science about the role of an evidence-based approach in the scientific process. These waves were predicted by Albert Einstein in 1916 based on the equations that collectively have been referred to as his General Theory of Relativity. They are distortions in "spacetime" resulting from huge shifts in mass somewhere in the universe. Computer models showed that waves detected last September were caused by the merger of two black holes 1.3 billion light-years from Earth, providing physical evidence that Einstein, 100 years ago, was right! This advance at first appears as a singular event. However, it was actually just one step in a century-long process of incremental advances by numerous scientists, each adding to the discoveries of those who went before. It's no different in agricultural science where our knowledge of practices, products, impacts and systems advance one study at a time. The contribution of each study is defined not only by the original data it contains, but also by the meta-data that allows for the new study to be connected to previous ones and to those yet to come. Another lesson for agricultural science is revealed in the authorship of the journal article reporting the measurement (DOI: 10.1103/PhysRevLett.116.061102). The article has 1,000 listed authors, occupying nearly three pages of the paper! Not only did this advance in the world of physics result from incremental advances across a century, it resulted from 1,000 researchers collaborating and sharing ideas and data. A key role for scientific societies is to promote such collaboration through its committees, publications and at its meetings where personal relationships are built that open doors for collaborative efforts. It's the way to "make waves" in advancing and applying the science of agriculture.

2.1- Corn residue management for soybean production in Manitoba: On-farm trial

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The large amount of corn residue left after harvest is associated with low spring soil temperatures. This is a challenge for farmers interested in growing corn in the shorter growing season areas of Manitoba and has the potential to impede the proposed expansion of corn in western Canada. As soybean acres are growing in Manitoba and soybeans often followed after corn in eastern Canada and in the USA, this project looks at the impact of different

tillage equipment to manage corn residue on soybeans and soil conditions. The experiment was set up as an on-farm trial in Winkler and MacGregor, MB in 2015. The design was a randomized complete block design (RCBD) with four and three replicates at Winkler and MacGregor, respectively. Four tillage practices were compared: 1) conventional double disc; 2) vertical till high disturbance; 3) vertical till low disturbance; 4) strip till. Soil temperature and moisture were recorded hourly at 5 and 30cm. Soybean emergence, flowering and maturity were observed three times a week. Soybeans were harvested using commercial combines and weigh wagons. Fuel consumption and horsepower requirements were measured to compare the equipment included in the study. During soybean emergence, surface (5cm) soil temperature fluctuated in strip till more than all other treatments, with both lower night and higher daytime temperatures. Soybean emergence and final plant stands were similar over all treatments at both locations. Grain yield in MacGregor in strip till was 65 kg/ha ($p=0.0999$) lower than vertical till high disturbance but not significantly different than all other treatments. Winkler showed no differences in yield ($p=0.3634$). Strip till used 2.5 times less fuel per ha than all other tillage treatments compared in the study. This experiment will be repeated again in 2016 and the results will be used to conduct an overall economic analysis. **CSA Student Competition**

2.2- Optimal plant spatial arrangement for dry bean (Phaseolus vulgaris L.) production in Manitoba

Laura Schmidt, Dr. Rob Gulden

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Manitoba accounts for a large proportion of dry bean (Phaseolus vulgaris) acreage in Canada, yet most of the current production recommendations are based on data from other regions and need to be revisited for modern varieties. An optimized spatial arrangement combines row spacing and plant stand density and has been previously shown to be a critical requirement for maximization of yield and biomass accumulation through early resource capture as well as play a key role in increasing the crop's ability to tolerate biotic and abiotic stresses. Since Manitoba has a relatively short growing season early acquisition of resources is essential to maximizing plant productivity. This study aims to determine the optimal combinations of row spacing and plant stand density for different varieties to maximize yield for dry bean production. Field experiments were conducted at Carman and Portage la Prairie, Manitoba in 2015 and will be repeated in 2016. Plant spatial arrangement was evaluated for the two most commonly grown market classes of dry bean in Manitoba, navy and pinto beans. For each market class two varieties were chosen with differing plant architectures, either an indeterminate short vine or a determinate upright short vine, and planted at row spacings of 7.5, 15, 22.5, and 30 inches. Navy beans were planted for target population densities of 20, 30, 40, 50, and 60 plants m-2 and pinto beans were planted for a target population of 10, 20, 30, 40, and 50 plants m-2. Plots were harvested by hand to determine final yield. Initial results indicate that row spacing has a significant effect on dry bean seed yield for all varieties across locations. The narrowest row spacing of 7.5 inches produced the highest yields while the effect of density was inconsistent. The results from this research will lead to increased revenue for Manitoban producers. **CSA Student Competition**

2.3- Survey of herbicide resistance common ragweed and wild oat in Quebec

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Herbicide resistant weeds are becoming increasingly common and widespread. These weeds threaten crop profitability, especially in crops where fewer herbicides are available. The objective of this project was to evaluate the occurrence of herbicide resistance to inhibitors of acetyl CoA carboxylase (ACCase, group 1) in wild oats (Avena fatua L}) and to inhibitors of acetolactate synthase (ALS, group 2) in common ragweed (Ambrosia artemisiifolia L.) in two locations (Saguenay-Lac-Saint-Jean and Montérégie, respectively) in Quebec. In 2014, cereals (wild oat) and non-GMO soybean (ragweed) fields were surveyed and seeds were collected from weeds (> 40 plants/field) that survived to herbicide treatments. 40 samples of wild oats and 74 samples of common ragweed seeds were collected, stored, stratified (common ragweed) and sown in multi-cell flats in a greenhouse. The experiment included 4 repetitions of 15 plants for each treatment. Treatments included two herbicide doses (no herbicide: water + adjuvant, if necessary; and a standard rate) applied on the collected samples as well as control herbicide sensitive and resistant populations. Fenoxaprop-p-ethyl (1.02 L/ha) was applied when the wild oat was at the 3-4 leaf stage and imazethapyr (0.42 L/ha) was applied on common ragweed at the 1-2 leaf stage. Visual assessments of herbicide injury were made two and four weeks after treatment (WAT) and aboveground biomass was collected, dried and weighed four WAT. Of the 40 wild oat samples, 40 % had some level of resistance and 60 % were clearly sensitive. Of the 74 ragweed samples, 77 % had some level of resistance and only 23 % were clearly sensitive. These results confirm the presence of herbicide resistant wild oat and common ragweed populations in Quebec and the need to implement effective management practices to slow their spread. **CSA Student Competition**

2.4- Optimal seeding methods of winter wheat to increase the winter survival and productivity in contrasted climates in Quebec

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Seeding methods should be improved to increase survival of winter wheat in contrasting climates in Quebec. The purpose of this study is to determine the optimal seeding dates, rates and seeding methods to improve survival and productivity of winter wheat. For the first experiment, three winter wheat cultivars are evaluated according to four planting dates and four seeding rates (250-550 grains m-2) at four sites. In the second experiment, three seeding methods and three seeding rates are compared at two sites. In 2015, the winter survival was excellent (> 90%) at two sites while the average survival rate reached 33 % in the two other sites. At the site located near Quebec (Qc), the highest yields were obtained with the two most early dates (early and mid-September) with an average of 6.5 t ha-1. The seeding rates had no effect on yield for early dates while for late dates (late September and mid-October), higher seeding rates (> 350 grains m-2) produced better yield. At the second site near Montreal (Mtl), higher yields were achieved in mid and late September with an average of 6.9 t ha-1. There was no difference in yield between seeding rates regardless of seeding dates. For the second experiment, at Qc, best yields were obtained with direct seeding of winter wheat (5.5 t ha-1) followed by broadcast seeding at 10-20% of soybeans defoliation (4.3 t ha-1) and finally, by broadcast and incorporated seeds after soybean harvest (2.9 t ha-1). No yield differences were observed between seeding methods at Mtl for an average of 4.2 t ha-1. No effect of seeding rates was observed on yields, regardless of seeding methods or sites. The 2016 growing season will confirm the trends observed in 2015 to find the best seeding methods in winter wheat in Quebec. **CSA Student Competition**

Session 3: Abiotic stresses

Keynote lecture – Endosymbionts protect crops and vegetables against abiotic stresses.

Dr. Vladimir Vujanovic

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Globally, microbial inoculants provide sufficient agricultural and horticultural advantages to merit subsidy. Plant microbiome appears to be one of the key determinants to plant health and productivity. A new generation of microbial inoculants which consist of endosymbiotic fungal and bacterial partners attached to plant's seed and root, are ground-breaking discoveries for innovation and biotechnology. Endosymbionts can benefit crops and vegetables in a variety of ways, via myco- and bactovitality and myco- and bactotrophy, to enhance plant's tolerance to abiotic stress; thus improving yield and complementing or replacing synthetic chemicals and fertilizers.

3.1- Induced tolerance to abiotic stress in tomato plants

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Plants are sessile organisms and cannot escape from a wide range of environmental stresses, both biotic and abiotic. Thus, during evolution, plants developed a basal immune system which can be primed, increasing defenses and augmenting stress resistance. A plant's defensive capacity can be enhanced by specific stimuli. Induction of tolerance can be elicited by biotic and abiotic stress factors and through treatment with chemical resistance-inducers. Following induction, plants are primed to express enhanced defense reactions visible as a faster and stronger activation of defense upon further stress. A well-known inducer of biotic stress tolerance in tomato is the non-protein amino acid beta-aminobutyric acid (BABA). Since BABA has been shown to also induce tolerance to abiotic stress in Arabidopsis, the goal of the present project is to characterize BABA-induced priming for drought and salt stress tolerance in two tomato cultivars (a highly stress-susceptible (Coeur de Boeuf) and a tolerant one (Marmande)). Due to water deficit and soil salinity problems in field-grown tomato cultures, a better adaptation of these plants to such stresses is highly desirable. Microscopic analysis of leaves treated with BABA at different levels of water and salt stress revealed induction of lignin accumulation and reduction of hydrogen peroxide (H2O2) production. In addition, chemical analysis showed an increase of total antioxidant activity, as well as of Chlorophyll 'a' and 'b' comparing to untreated plants. These results showed an effectively priming of defense responses in treated tomato plants under abiotic stress, thus increasing the tolerance.

3.2- Preharvest UV c radiation triggers accumulation of volatile organic compounds in strawberry leaves

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The role of plant volatiles as semiochemicals in both biotic and abiotic interactions is well characterized. Plant volatiles act as pollinator attractants, are deterrents to natural enemies (herbivores, pathogens, and pests), and are involved in intra- and inter-plant signaling and direct defense. Recent studies have highlighted that preharvest UV C can be an environmentally friendly approach to limit disease development in growing plants. In an attempt to understand the mode of action of preharvest UV C, a preliminary study was conducted to evaluate the potential impact of that treatment on strawberry semiochemicals. Growth-chamber-grown strawberry plants were exposed to UV C radiation at 3 different dosages from flower set until fruit ripening, for a period of 7 weeks. Fully expanded leaves were collected at the end of the survey period. A total of 41 volatile compounds were identified by gas chromatography–mass spectrometry. Of that total, 29 were significantly influenced by preharvest UV C treatment in a dose-dependent manner. Partial least square discriminant analysis revealed that 26 volatiles, 18 of which were fatty-acid-derived volatiles, were significantly affected by preharvest UV C radiation. Among the identified volatiles, a subset of 9 fatty-acid-derived volatiles and 3 isoprene-derived volatiles (acetone, hexanal, (E) 2-hexenal, 2-hexenal, (Z) 3-hexen-1 ol, 1 hexanol, heptanal, 1 octen-3 ol, nonanal, cis-linalool oxide, linalool, and β pinene) have been described in the literature for their role in plant–microbe interactions. Based on these observations, it is worth suggesting that changes in the volatile profile may be an integrated part of the lower disease incidence that occurs in strawberry plants treated with preharvest UV C radiation. **CSHS Student Competition**

3.3- Genetic transformation of Canadian pea (Pisum sativum L.) for drought tolerance using DREB2a and PR10a genes

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Canada is world's largest producer and exporter of field pea. However, crop productivity can be greatly reduced by abiotic stresses including drought, salinity and freezing. Modern plant biotechnology tools provide hope for creating crops with enhanced drought tolerance expressing variety of genes induced by stress. In the present study, we report development of drought tolerant transgenic pea from line MP1862 co-expressing PR10a from potato (*Solanum tuberosum* L.) and transcription factor DREB2a from rice (*Oryza sativa* L.) using dicistronic vector through Agrobacterium-mediated gene transformation. Based on the PCR positive transgenic shoots, 25 transgenic shoots were obtained from a total of 684 transformed explants giving a transformation efficiency of 3.65 %. The genomic integration and inheritance of the introduced genes were validated by molecular and functional analyses (PCR, leaf paint assay).Gene expression using RT-PCR was conducted on the PCR positive transgenic plants. The expected PCR product was detected in the cDNA of the transgenic plants while no amplification was observed in negative and water controls. A preliminary drought bioassay (three weeks water withholding) under laboratory conditions showed greater drought tolerance of the developed transgenic lines compared to non-transgenic lines. T3 generation of the same have been obtained and imported to Canada. Further testing for efficacy of the traits is required. This research provides an opportunity for transfer of genetically engineered drought tolerant pea technology to Canadian germplasm which may open an avenue for drought resistant pea development. **CSA Student Competition, CSHS Student Competition**

3.4- Incorporating synchrotron technology as a tool to address plant responses to abiotic and biotic stress

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While synchrotron radiation is a powerful tool in material and biomedical sciences, it is still underutilized in plant research. This talk introduces the potential of synchrotron-based spectroscopic and imaging methods and their applications to plant sciences. Synchrotron based Fourier transform infrared spectroscopy, X-ray absorption and fluorescence techniques, two and three dimensional imaging techniques are examined. We also discuss the limitations of synchrotron based research in plant sciences, specifically the types of plant samples that can be used. Despite limitations, the unique features of synchrotron radiation such as high brightness, polarization and pulse properties offer great advantages over conventional spectroscopic and imaging tools and enables the correlation of structure and chemical composition of plants with biochemical function. Modern detector technologies and experimental methodologies are thus enabling plant scientists to non-destructively investigate aspects of plant biotic and abiotic stress responses such as imaging of Fusarium Head Blight, epicuticular waxes, mineral deposition and speciation, spatial localization and dynamics of cell wall structure and composition in unprecedented ways using synchrotron beamlines. The potential for the

automation of some of these synchrotron technologies and their application to plant phenotyping is also explored.

Session 4: Biotic stresses

Keynote lecture – Biovigilance: a framework to address the increasing complexity of plant protection

Dr. Odile Carisse

Agriculture and Agri-Food Canada, Research and Development Centre, Saint-Jean-sur-Richelieu, Quebec, Canada.

Biovigilance is a research approach aimed at maintaining crop health. It consists of monitoring changes in pests and risk factors over time. Biovigilance networks make it possible to detect significant temporal and spatial trends that may be linked to agricultural practices, new plant protection products, the cultivars grown, climate conditions, or new and emerging pests. Ultimately, biovigilance provides a framework to address the increasing complexity of plant protection. From our ancestral beginnings, humans have been in direct competition with plant pests. The first attempt to control pests involved pulling up and discarding unhealthy plants. Plant protection initially consisted of rotating crops, planting in more fertile areas, and using seeds from healthy plants. However, the development of machines and industrialization allowed for more intensive agriculture and led to an acute need to protect crops from pests. The increasing demand for food during the second half of the last century caused profound transformations in agricultural practices, including massive use of plant protection products and genetic improvement of crops. Reliance on fungicides and host resistance led to resistance to fungicides, breakdown of host resistance, outbreaks of secondary diseases, and resurgence of primary diseases. Coupled with uncontrolled dissemination of plant material and climate change, plant protection has reached an unexpected level of complexity. The conventional approach in plant protection research is to react to a problem only once it reaches an unacceptable level. Using a biovigilance approach, it is possible to anticipate pest problems and to react in a timely fashion, before major economic, agronomic, environmental and social consequences occur. Examples will be presented during this talk.

4.1- The role of fungicide spray coverage and population heterogeneity on the selection for resistance in Botrytis squamosa in onion plants

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The use of chemicals against crop pathogens has been heavily compromised by the un-optimized applications of fungicides, resulting in the selection for resistance. In this study, we aimed to establish a correlation between fungicide spray heterogeneity and the selection for resistances in *Botrytis squamosa*. *B. squamosa* is an important fungal pathogen which causes botrytis leaf blight in onion plants. The first objective is to determine the threshold of resistant strains needed in a population to cause a drastic reduction in the efficacy of the fungicide. The second part of the objective is to adjust the spraying bench and investigate whether the increasing coverage of the fungicide spray correlates to the control of lesion rates. In order to do so, five combinations of resistant/sensitive strains were inoculated onto onion plants (0%/100%, 25%/75%, 50%/50%, 75%/25% and 100%/0%) and the lesions rates produced by *B. squamosa* were noted. Following the inoculation, fungicide iprodione were applied onto onion plants, using five different set of coverages (0%, 25%, 50%, 75% and 100%). A qPCR assay of the *B. squamosa* spores were conducted at the end to investigate the shift in the ratio between resistant and sensitive strains, and conclude on whether the coverage of the application plays a role in the selection for resistance.

4.2- Low UV-C dose exposition elicits disease resistance against bacterial leaf spot caused by Xanthomonas hortorum pv.vitians in lettuce

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Postharvest application of short wave ultraviolet (UV-C) is claimed to increase disease resistance of fresh fruits and vegetables during storage. However, little is known about the potential of UV-C hormesis on growing plants. Low dose of UV-C was applied to lettuce cultivars with different level of susceptibility to bacterial leaf spot and the effect of this treatment on symptoms development was analyzed. Two susceptible lettuce cultivars ('Chief' and 'Paris Island Cos') and one resistant cultivar ('Little Gem') were treated every other day over a period of 8 days with a radiation dose of 0.4 kJ.m-2 for 60 s. Forty-eight hours following the UV-C treatment, control and treated plants were inoculated with a bacterial suspension of *Xanthomonas hortorum* pv. vitians strain B07-007. Severity of the bacterial leaf spot was evaluated 14 days after inoculation. For the two susceptible cultivars, the severity index was significantly lower in UV-C treated plants than it was for the control plants. Disease severity indices of 'Chief' were 2.47 and

4.97 (P = 0.0004) for UV-C treated and control plants, respectively, while indices for 'Paris Island Cos' were 2.45 and 4.47 (P = 0.0081), respectively. However, the UV-C treatment did not cause significant change in disease severity (P = 0. 2891) for the resistant cultivar 'Little Gem'. Work is in progress to assess the possible involvement of phytoalexin production in the enhanced resistance of lettuce to *X. hortorum* pv. *vitians* following UV-C exposition. **CSHS Student Competition**

4.3- Identification of QTL conferring resistance to common bacterial blight and days to maturity in common bean (*Phaseolus vulgaris* L.)

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Common bacterial blight (CBB), caused by Amthomonas campestris pv, phaseoli (smith), causes severe yield and quality loss in dry beans. Breeding for resistance to CBB is a promising strategy to control the disease. Most of the released CBB-resistant common bean varieties are late maturing. We developed a population of recombinant inbred lines (RILs) originating from a cross between OAC Spark (an early season variety) and ACUG10-7 (a breeding line with high levels of quantitative resistance to CBB) constructed a linkage map, and identified a total of 8 QTLs for CBB resistance and days to maturity. One of the identified QTLs for CBB resistance and days to maturity were from the same genomic location in chromosome 4. The possibility of pleiotropic effects of this region will be discussed.

4.4- A neural network model to predict wheat stem sawfly cutting in solid-stemmed wheat cultivars

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The wheat stem sawfly, *Cephus cinctus* Norton (Hymenoptera: Cephidae), has been a major pest of wheat (*Triticum aestivum* L.) in the northern Great Plains of North America for more than 100 years. The combined losses from stem boring and eventual cutting by the larva causes the stem to topple to the ground where it is usually not recovered at harvest. The use of solid-stemmed cultivars helps mitigate crop losses and can also affect the survivorship of *C. cinctus*. The efficacy of 'resistance' is based on the plant's ability to develop pith in the culm of the stem, which is influenced greatly by interactions between the genotype and the environment in which it is grown. Precipitation-related weather interferes with photoperiod and results in reduced pith expression or solidness in solid-stemmed wheat. Given the extensive hectares planted to solid-stemmed wheat, a model that can accurately predict pith expression could serve as a vital quality assurance tool to prevent losses by alerting producers if in-season precipitation patterns have caused less than ideal pith expression in a solid-stemmed cultivar. Neural Network (NN) models are used to make predictions for complex, non-linear systems with many co-related variables. Our objective was to improve upon past models that used regression analyses by deploying a NN model to predict in-season stem cutting of wheat by wheat stem sawfly. Results indicate that stem cutting is influenced by the precipitation within a 6-wk period from May 25 to July 5. These results were successfully deployed in a model that should assist with predictions of potential late season stem cutting. Deployment of this NN model as a transferable executable file should help facilitate predictions of stem cutting by wheat stem sawfly in any given year. Such predictions would alert producers to implement management strategies to reduce losses from wheat stem sawfly.

4.5- Influence of atmospheric carbon dioxide and nitrate fertilization on Arabidopsis metabolism.

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Increased atmospheric carbon dioxide (CO_2) levels predicted to occur before the end of the century will impact plant photosynthesis and, thus, flux into primary and specialized metabolism. In addition, nitrate availability impacts multiple metabolic pathways and levels of nitrogen-containing defense compounds, such as glucosinolates (GSLs). We compared Arabidopsis foliar metabolic profiles in plants grown under two CO_2 regimes (440 ppm vs 880 ppm), nitrate fertilization (1 mM vs 10 mM) and in response to mechanical damage of rosette leaves. Constitutive foliar metabolites in nitrate-limited plants show distinct patterns based on atmospheric CO_2 levels. Plants grown under high nitrate fertilization and elevated atmospheric CO_2 conditions, have a unique metabolite signature. In mechanically damaged plants, nitrate fertilization dampens the jasmonate burst in

response to wounding in plants grown at elevated CO_2 levels. Focusing on GSL biosynthesis, atmospheric CO_2 levels appeared to have the greatest influence on MYB transcription factor expression and individual indole GSL levels.

4.6- Race characterization of Puccinia striiformis f. sp. tritici, the cause of wheat stripe rust, in Saskatchewan and southern Alberta, Canada and virulence comparison with races from the USA

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Wheat stripe rust, caused by *Puccinia striiformis* Westend. f. sp. tritici Erikss. (Pst), is common across Saskatchewan, Canada since 2000. Fifa-nine isolates of Pst, collected between 2011 and 2013 from Saskatchewan and southern Alberta were analyzed for virulence frequency and diversity and compared with isolates characterized in the USA. Thirty-one wheat differentials, including 21 near-isogenic lines and one triticale variety differentiated 59 Pst isolates into 33 races, of which one race, C-PST-1, represented 31% of the isolates. None of the races were virulent on Yr5, Yr15, or YrSP. Virulence frequency ranged from 65-98% on YrA, Yr2, Yr8, Yr27, Yr29, Yr32, YrSu, 'Heines VII', and 'Nord Deprez'. Race C-PST-6 was virulent on the greatest number of the differentials (25) and C-PST-21 on the fewest (15). Discriminant analysis of principal components and multivariate cluster analyses detected three and four major groups, respectively, which differed from each other in terms of virulence spectrum and year of collection. The diversity of the Pst population in southern Alberta was greater than Saskatchewan, which indicated that although Pst is primarily wind-borne over great distances and does not usually overwinter, there are detectable differences in virulence between these regions of western Canada. Comparative analyses of virulence frequency of Saskatchewan or southern Alberta isolates with isolates representing races from the Great Plains and the Pacific Northwest of the USA indicated greater similarity of Saskatchewan races to the Great Plains despite strong correlations with both parts of the USA. This suggests that the Pst population in Saskatchewan is a mixture of inoculum from both parts of the USA. **CSA Student Competition**

Plenary Lecture

Incorporating synchrotron techniques as tools to improve agricultural production under the increasing complexities

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While synchrotron techniques are powerful tools in material and environmental sciences, it is still underutilized in plant research. The Canadian Light Source synchrotron located on the campus of the University of Saskatchewan is the only such facility in Canada and is open to academic and government researchers, and industrial clients. This talk introduces the potential of synchrotron-based spectroscopic imaging methods and their applications to plant sciences. Synchrotron based Fourier transform mid infrared spectroscopy, X-ray absorption and fluorescence, two and three dimensional imaging techniques are among the techniques that will be presented. Examples range from non-destructive analysis of pollen surface lipid composition in heat resistant and sensitive crop varieties; exploring potential Fusarium head blight structural resistance mechanisms through imaging wheat spikes; analysis of the leaf epicuticular layer related to drought and cold stress; spatial localization and dynamics of cell wall structure; and composition to micro-localization of nutrients in seeds. Modern detector technologies and experimental methodologies are thus enabling plant scientists to non-destructively investigate plant responses in unprecedented ways using synchrotron techniques. The potential for the automation of some of these synchrotron technologies and their application to plant phenotyping is also discussed.

Session 5: Nutrient and water management

Keynote lecture – Managing nitrogen fertility in horticultural systems with an aim to balance crop productivity and N

Dr. Laura L. Van Eerd

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Within vegetable and low-acreage cropping systems, Dr. Van Eerd's research focuses on nitrogen dynamics in a systems-based approach. Vegetables are important horticultural commodities with high farm gate values and nutritional quality. The processes governing N cycling are a complex of biological, physical, and chemical factors, which are impacted by management practices, climatic conditions and soil properties. Moreover, optimizing N

inputs in vegetable crops within environmentally sustainable constrains is challenging for various reasons including 1) vegetable crops are most often grown on light soils prone to leaching losses to ground and surface waters; 2) the very high cost ratio of crop yield to N fertilizer favors high application rates; 3) marketable crop quality may or may not be impacted by N fertility depending on the crop; and 4) many crops are harvested before physiological maturity thus the quantity and quality of N remaining in the field at harvest is often greater than grain crops. Thus, N management in vegetable production is complex. While previous research has focused on in-season N management strategies of improving nitrogen use efficiency (such as controlled-release N, split fertilizer N applications, and adjusting N fertilizer rates based on soil mineral N), there is a great opportunity for post-harvest strategies to minimize N losses in the non-cropping season by applying high carbon organic amendments, removing crop residues, and planting a cover crop, which ideally mineralize in the subsequent growing season. The use of partial N budgets, 15N tracer field studies and a long-term cover crop trial provide insight into the complexity of the system and opportunities for meaningful strategies to improve N management in horticultural systems.

5.1- Canola N nutrition and productivity as affected by a combination of cover crop and organic or mineral fertilization

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Canola (*Brassica napus* L.) is a widespread crop with high N needs. Legume cover crops (CC) can serve as an organic N source and increase subsequent crop yield. The objective of this study was to (i) measure the impact of a red and white clover CC (*Trifolium pratense* L., *Trifolium repens* L.) on canola N uptake and yields, and (ii) compare canola response to mineral and organic fertilizer as supplemental N sources. An experiment was conducted for two years at two sites with contrasting climatic conditions, in a 2x2x4 factorial split-plot design with preceding crop (barley only or barley intercropped with clover) as main plots, and fertilizer type (mineral (27-0-0) or organic (pig slurry)) and N rates (0, 50, 100, 150 kg N/ha) as sub-plots. At fall termination of the CC, the clover provided 28 to 158 kg N ha-1. No interaction was observed between CC and fertilizer type on the variables studied. The CC increased canola yields with a mineral fertilizer replacement value of 22 to 82 kg N ha-1. Without N fertilizer, the CC increased yields from 6 to 42%, the increase being inversely related to the N rate. Canola N uptake and yields were lower with pig slurry, compared to mineral fertilizer, possibly because ammonia loss occurred through volatilization after slurry application. Thus, the canola yield response regression curves did not reach a maximum value with the tested N rates (up to 150 kg N ha-1), whereas a maximum yield was reached at 120 to 174 kg N ha-1 with the mineral fertilizer. In conclusion, the clover CC improved canola yields with a mineral fertilizer replacement value of up to 82 kg N ha-1. The mineral fertilizer was more efficient than pig slurry for canola, and pig slurry rates should be raised to obtain similar fertilizer value. **CSA Student Competition, CSHS Student Competition**

5.2- Techniques for management of variable rate irrigation in potatoes

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Variable rate irrigation (VRI) technologies are gaining in use and interest in irrigated potato production in Manitoba. A series of studies were initiated at the Canada-Manitoba Crop Diversification Centre to address questions on the development and in-season management of VRI prescriptions. As soil moisture levels are dynamic properties in a field during the growing season, robust and simple techniques to monitor and map soil moisture in-season must be developed to allow for timely in-season changes to VRI prescriptions. In 2016, an Unmanned Aerial Vehicle (UAV) equipped with a radiometer will measure surface soil moisture of two potato fields grown under prescription irrigation maps with VRI technology at three separate time periods in-season. Ground measured surface soil moisture values will be collected at the time of the UAV flights across the fields to validate radiometer readings. This study will evaluate the effectiveness of this technology to produce surface soil maps for the purpose of developing and managing prescription irrigation maps. Preliminary field results will be presented.

5.3- Effect of urea and urea + ESN blend on MasterGraze corn and sorghum sudangrass for silage production in northwestern Ontario

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MasterGraze corn and sorghum sudangrass fit well in the short growing season of NWO. Urea is subject to high N losses. ESN could be an alternative to urea; though in cold weather it may be too slow to release N. Part substitution of N from urea with ESN could be better than urea alone. A field experiment, with 13 treatments (a no N check, N @ 50, 100, 150 and 200 kg ha-1 from urea/and urea + ESN (3:1 on N basis) blend for MasterGraze corn, and N @ 150 and 200 kg ha-1 from urea/and urea + ESN (3:1 on N basis)

blend for sorghum sudan grass) was conducted in completely randomized block design, replicated four times, during 2013-'15 at Thunder Bay, Ontario. Pooled analysis over 3 years, indicated that 150 kg ha-1 was optimum for MasterGraze corn leading to 2.3 Mg ha-1 higher production than no N. Dry matter yield from urea + ESN @ 100 kg N ha-1 equalled that from urea @ 150 kg N ha-1. At the same N rates, sorghum sudangrass (in 2 cuts) didn't give higher yield than MasterGraze corn and 200 kg N ha-1 didn't increase yield over 150 kg N ha-1. Forage protein content in MasterGraze corn ranged from 9.9 % to 14.7 % with urea @ 50-150 N ha-1 and from 13.5 % to 15.2 % with urea + ESN @ 50-150 N ha-1. Protein content in sorghum sudangrass @ 150 kg N ha-1 was 5 % and 3.2 % point higher than MasterGraze corn with urea and urea + ESN, respectively.

5.4- Concentration and uptake of mineral nutrients in soybean, pea, lentil, and in following rotational crops in Saskatchewan, Canada

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Mineral nutrition of crops in rotation is important for yield and nutritional quality. As pulse crop acreage increases and new crops like soybean expand into the western prairies, there is need to assess the mineral nutrient uptake by these crops and those that commonly follow in rotation. The aim of this study was to assess the concentrations and uptake of mineral nutrients including K, Ca, Mg, S, Cu, and Zn, in the grain and straw of soybean in comparison to pea and lentil, and in the wheat and canola grown on the stubble of the three crops. The research was conducted at four locations in the Dark Brown (Saskatoon, Scott) and Black (Rosthern, Yorkton) soil climatic zones over two years in Saskatchewan, Canada. Soybean grain had superior K (16.8-20.3 g K kg-1), Ca (2.1-2.7 g Ca kg-1), Mg (2.6-2.7 g Mg kg-1), and S (3.2-3.5 g S kg-1) concentrations, and medium to high levels of Cu (10.2-14.8 mg Cu kg-1) and Zn (30.7-44.4 mg Zn kg-1) compared to pea and lentil. Concentrations in the pulse straw were more variable and showed different patterns, with soybean having intermediate straw nutrient contents (11.3-16.8 g K kg-1, 7.2-13.0 g Ca kg-1, 4.5-6.2 g Mg kg-1, 0.2-1.7 g S kg-1, 2.6-4.2 mg Cu kg-1, and 5.5-53.3 mg Zn kg-1) compared to pea and lentil. Soybean had consistently higher grain Ca removals (2.2-8.1 kg Ca ha-1) than pea (1.1-5.1 kg Ca ha-1) and lentil (1.0-2.4 kg Ca ha-1) across the locations, while the three crops did not show consistent differences in the grain and straw uptake of the other mineral nutrients evaluated. In the subsequent year, wheat and canola grown on soybean, pea, and lentil stubble had similar grain and straw mineral contents and removals, respectively, implying comparable impacts on the following crop. **CSA Student Competition**

Session 6: Plant breeding and genetic resources

Keynote lecture – Breeding faba bean for climate change

Dr. Fred Stoddard

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Grain legumes are important break-crops and protein sources, but are under-represented in European agriculture. After soybean, faba bean (*Vicia faba*) delivers the highest protein yields, and is adapted to cool-temperate climates. It is grown from 62°N in Finland to 45°S in New Zealand, in tropical highlands and Mediterranean winters. Like most grain legumes, its breeding has lagged behind that of the cereals, so the disease and stress resistance of most cultivars is limited. Global change is altering the combination of phenological adaptation, quality traits, and biotic and abiotic stress resistances required in future cultivars. Hence, we have devised schemes to select germplasm for testing from the 20,000 accessions in world gene banks. For those traits where provenance should be informative, we chose the Focused Identification of Germplasm Strategy (FIGS), while for others, a core collection has been developed. The FIGS approach has allowed us in collaboration with ICARDA to identify sources of stomatal traits affecting water deficit response, and we are now exploring root traits affecting access to water, tolerance to soil acidity, and aluminium toxicity. By using a set of 200 single nucleotide polymorphisms (SNPs) on 200 recombinant inbred lines of the cross of Mélodie/2 x ILB938/2, we found two important QTLs for stomatal activity, and root traits of this population will be studied. Flowering time is an important adaptive trait, and we found that in addition to photoperiod and temperature, cloudiness and water deficit affect it. In collaboration with partners from Denmark, the UK and Saskatchewan, a core collection of ~300 accessions has been established for association mapping for high-latitude agriculture, using genotyping-by-sequencing modified to capture the relatively small gene space in this very large (13 Gb) genome. The outcomes will provide tools to accelerate breeding by genomic selection.

6.1- Innovative technologies to accelerate industry transition from "wild" to cultivated cool climate small fruit crop production systems

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Commercially important cool climate small fruit crops include, but are not limited to, blueberry (*Vaccinium* spp. L.), cranberry (*V. macrocarpon* Ait.) and lingonberry (*V. vitis-idaea*. L.). Consumption of Vaccinium fruits is believed to have important therapeutic values, including antitumor, antiulcer, antioxidant and antiinflammatory activities. Blueberry production systems are changing from "wild" production to a more intensive cultivated system. In this respect, there is an urgent need to develop innovative techniques for selecting and establishing high-yielding, insect tolerant blueberry crops which are well-adapted to diverse biotic and abiotic conditions in cool climates of Canada. The presentation focuses on: berry germplasm and hybrid development, characterization and improvement using in vitro and molecular techniques; sustainable crop production systems including the use of bioinoculants and organic fertilizer; and integrated pest management. Bioreactor micropropagation in a liquid medium has been developed/improved for berry crops. EST-PCR, EST- SSR and genomic SSR markers have been used for genetic diversity and structure analyses in blueberry and cranberry clones, cultivars and/or hybrids, and to monitor clonal fidelity in micropropagated small fruit crops. The total phenolic and oxygen radical absorbance capacity (ORAC) of blueberry tissue culture plants and of wild clones and cultivars of blueberries and cranberries were estimated. Molecular analysis has been used for the application of marker-assisted selection in blueberry and to study the DNA-methylation and epigenetic factors in blueberry micropropagules. Hybrids obtained through crossing between half-high/highbush and lowbush blueberry genotypes and between Canadian and European lingonberries are being evaluated for frost, drought and pest resistance under greenhouse and field conditions. 'MF-1.3' isolated from lowbush blueberry roots was identified as a strain of Penicillium decumbens Thom. which might be a potential beneficial bioinoculant. In a field trial with blueberry cultivars, black plastic mulch had a higher occurrence of flowering than other treatments.

6.2- Study of genetic diversity among various blueberries (Vaccinium spp.) using molecular markers

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Blueberry (*Vaccinium* spp., family: Ericaceae) has gained lot of attention due to its potential health benefits and economic importance. It is very important to develop genotypes which are high in health promoting factors and economic value to meet present world needs. Thus, study of genetic diversity becomes an important tool. This study aims to identify potential genotypes which can withstand the extreme cold temperature while keeping its high nutritional value. Genetic diversity provides species stability and also allows necessary adaptations to environmental changes and to survive those changes. For diversity analysis of 38 wild lowbush blueberry clones representing five provinces of Canada and 29 hybrids and 4 cultivars were selected. Polymerase chain reaction (PCR) - based molecular markers such as, 10 Expressed Sequenced Tags - Simple Sequence Repeats (EST-SSR), 8 Genomic SSR and 10 EST-PCR markers were employed for analysis. Data interpretation provides the molecular basis of the diversity. A substantial degree of genetic similarity was found among the wild clones. Cluster analysis was done by the unweighted pair-group method with arithmetic averages (UPGMA) to separate the 38 genotypes into main clusters. Within main clusters, the genotypes tended to form sub-clusters that were in checked whether they are in agreement with the principal co-ordinate (PCO) analysis. Analysis of molecular variance (AMOVA) gives geographical distribution of cultivars, wildtype lowbush and hybrid blueberries. **CSA Student Competition, CSHS Student Competition**

6.3- Predictive biomarkers for cold-induced sweetening resistance and improved long term storability.

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An approach has been developed to predict cold-induced sweetening (CIS) resistance and storability of potato tubers. Two key enzymes responsible for reducing sugar accumulation during long term cold storage were identified which could be used as predictors for reducing sugar accumulation during cold storage. A total of 192 genetically diverse clones from various breeding programs in USA were analyzed over two years for the two key enzymes and sugar concentration. Clones were categorized by class A, B, or C according to their resistance to sweetening following storage for six months at 5.5°C. Those with a specific activity of acid invertase (AcInv) less than 1, coupled with high level of expression of A-II isozymes of UDP-glucose pyrophosphorylase (UGPase) (class A), had the greatest resistance. The predictability for CIS resistance during cold storage was 94% both years. Clones classified as class A accumulated low concentration of reducing sugar glucose during cold storage. The biomarkers have also been used to screen large number of clones for CIS resistance in breeding programs. By identifying appropriate parents, progeny have been obtained with a much higher frequency of desirable sugar levels and chip color. It is suggested that two predictor enzymes, i.e., UGPase and AcInv will accelerate the early selection of superior storing and processing clones in breeding programs.

6.4- Genomics of drought tolerance in flax (*Linum usitatissimum* L)

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Flax (*Linum usitatissimum*) belongs to the family Linaceae with a chromosome number of 2n=2x=30 and a genome size of approximately 370MB. It is one of the earliest cultivated crops to have been used as human food and as raw material for the textile industry. Recent findings of its nutritional and medicinal values have attracted the food, feed and pharmaceutical industries. However, production of flax is constrained by a number of biotic and abiotic factors, including water stress which severely limits flax production. Variation in level of tolerance to different moisture regimes exists among flax germlines providing a scope of opportunities for breeders to exploit. Genome-Wide Association Studies (GWAS) employ high density markers to investigate the contribution of genomic regions to the target traits. Currently, more than 1300 simple sequence repeat (SSR) and 1.7 million single nucleotide polymorphism (SNP) markers have been developed for flax. This data was filtered for a collection of 112 lines representing more than 95% of the genetic variability of Canadian flax core collection (n=407). Phylogenetic and population structure analyses using a total of approximately 700,000 SNPs and 450 SSRs were conducted. The fiber and oil morphotypes are noticeably distinguished suggesting a historical selection effect. Clustering also tended to follow geographic origin. The target lines (n=112), grown in the field under two water regimes, are being phenotyped for many traits including canopy temperature, disease, yield and others. Root architecture is also being phenotyped indoor. The ultimate goal of the research is to gain insights into the genetic architecture of drought-related traits towards marker-assisted breeding and genomic selection.

Session 7: Plant breeding and genetic resources

Keynote lecture – Genomics and biotechnology in horticultural crops: Recent advances in stone Fruits

Dr. Jayasankar Subramanian

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Crop improvements in perennial crops such as tree fruits have long been done based on phenotypical traits. However, this approach is a long process involving high costs due to time and space. Further, there is always the risk of losing a valuable germplasm that looks phenotypically similar but genetically different. Recently there have been tremendous increases in differentiating genotypes that are exhibiting only subtle differences using highly sensitive molecular techniques. Early molecular techniques were largely PCR based such as RAPD, AFLP etc. Recent techniques are more sequence based which can identify mutations within a gene that can result in a new genotype. Currently we have techniques that can sequence considerable lengths of genome in a relatively short time. These techniques allow us to look for mutations such as SNPs within the gene in a comparative manner, which helps to increase validity. Identifying such SNPs and the genetic diversity that is unravelled due to these subtle but powerful mutations should allow us to sustainably create and access genetic profiles that fit the changing needs. Genotyping by Sequencing (GBS) is a relatively new technique. It has been successfully utilized in several crop plants where large populations of diverse genotypes are easy to obtain. However, they are far and few in horticultural crops, especially perennial fruits. We are utilizing GBS to unravel SNPs associated with important traits such as season, acidity and disease resistance and use this method for crop improvement in stone fruits, where large populations are quite difficult to obtain. Results of these studies will be discussed. RAPD-Random Amplified Polymorphic DNA; AFLP-Amplified Fragment Length Polymorphism; SNP-Single Nucloetide Polymorphism; GBS- Genotyping by Sequencing.

7.1- Cellulose synthase (CesA) gene family and its relation to cell wall traits in wheat

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Cellulose is world's most abundant renewable carbon source and a major target for biofuel industry. In plants it is synthesized by a family of genes called *Cellulose synthase A (CesA*). Wheat is the most widely grown of all the crops globally, yet information on its *CesA* gene family is limited. We have identified 22 *CesA* genes from bread wheat, which include homoeologs from each of the three genomes, and named them as (*TaCesAXA*, *TaCesAXB* or *TaCesAXD*), where X denotes the gene number and the last suffix stands for the respective genome. Sequence analyses of the CESA proteins from wheat and their orthologs from barley, maize, rice, and several dicot species (Arabidopsis, beet, cotton, poplar, potato, rose gum and soybean) revealed motifs unique to monocots (Poales) or dicots. Novel structural motifs CQIC and SVICEIWFA were identified, which distinguished the CESAs involved in the formation of primary and secondary cell wall (PCW and SCW) in all the species. We also identified several new motifs specific to monocots or dicots. The conserved motifs identified in this study possibly play functional roles specific to PCW or SCW formation. The new insights from this study advance our knowledge about the structure, function and evolution of the *CesA* family in plants in general and wheat in particular. This information will be useful in improving culm strength to reduce lodging or alter wall composition to improve biofuel production. **CSA Student Competition, CSHS Student Competition**

7.2- Characterization of vernalization and photoperiod response in fall-planted wheat in South Western Ontario

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Flowering and maturity time of wheat (*Triticum aestivum* L.) are important characteristics that govern adaptation to diverse geographical regions and avoidance of abiotic and biotic stresses, which protect yield. Flowering and maturity of wheat are controlled by the interaction of vernalization (Vrn) and photoperiod (Ppd) response genes, in addition to minor effects of the earliness per se (Eps) loci. The objective of this research was to examine the adaptation of fall-planted wheat in Ontario as influenced by the allelic forms of the major Vrn and Ppd genes. A diverse panel of 208 winter and spring wheat genotypes, representing a wide range of maturity was phenotyped for number of growing degree-days (GDD) to reach important phenological stages in fall-planted field trials in three locations across South-Western Ontario. The panel was genotyped using allele-specific markers of the major Vrn and Ppd loci Vrn-A1, Vrn-B1, Vrn-D1, Vrn-B3, Ppd-A1, Ppd-B1, and Ppd-D1. Ten genotypic groups of Vrn and Ppd gene combinations were identified. The photoperiod-sensitive alleles Ppd-D1b and Ppd-A1b were present in 127 and 166 genotypes, respectively. Genotypes carrying the photoperiod-sensitive allele at the Ppd-D1 locus, on average, required additional 43.6, 44.9, 46.2, and 56.5 GDD to reach booting, anthesis, heading, and maturity, respectively, and were 10.7 cm taller. Similarly, genotypes carrying the photoperiod-sensitive allele at the Ppd-A1 locus required additional 33.8, 38.9, and 34.0 GDD to reach booting, heading, and anthesis, respectively. The winter allele vrn-A1 was present in 179 genotypes. These genotypes, on average, required additional 76.5 and 51.8 GDD for maturity and the grain filling period, respectively, and had 0.8 t ha-1 higher yield and 4.2 g heavier 1000 kernel weight than those with spring allele. Results are expected to contribute to a better understanding of adaptation of winter wheat genotypes in Ontario, as influenced by Vrn and Ppd genes. **CSA Student Competition**

7.3- A Whole cell biosensor (glnlux) to measure and visualize symbiotic nitrogen fixation in legumes

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Rhizobia bacteria provide humanity with dietary protein and organic nitrogen fertilizer through symbiotic nitrogen fixation (SNF) with legumes (e.g. lentils, soybeans), but SNF rates are sub-optimal globally. New SNF diagnostic technologies are needed to detect and improve sub-optimal SNF rates. Identification of active sites of symbiotic nitrogen fixation (SNF) in nodulated roots in legumes is a challenge. Here we present a whole cell biosensor to locate and image active sites of SNF in nodulated legume roots. A whole cell biosensor (GlnLux) for Glutamine (Gln) was previously constructed by transforming a bacterial Gln auxotroph with a constitutive lux reporter. GlnLux detects glutamine, a fixed-N assimilation product, and then emits photons. For imaging of Gln in whole plant organs, tissues were freeze-thawed to cause Gln leakage, placed on agar pre-embedded with GlnLux (GlnLux agar), and then imaged using a photon capture camera. Here we demonstrate that the GlnLux agar method can locate active sites of nitrogen fixation in amide exporting legumes (lentil, alfalfa) as well as ureide exporting legumes (common bean, soybean). Furthermore the technology was adapted for relative measurements of SNF output using single leaf punch extracts from plants grown under controlled conditions. Leaf extracts were incubated with GlnLux cells and luminescence was measured using a 96-well luminometer. The leaf punch method permits measurements of SNF output for large numbers of plant samples rapidly and inexpensively. The GlnLux methodologies effectively identified the effect of different rhizobia strains on SNF in both amide exporting and ureide exporting legumes.

7.4- The involvement of protein-carbohydrate module in barley malting quality

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Barley is a vital ingredient in malting and brewing industry. More than 250 quantitative trait loci (QTL) have been associated with 19 malting quality phenotypes in barley. We used synteny based approaches to fish out the genes present on the QTL2 of barley affecting various malting quality traits like malt extract, beta-glucan, diastatic power and α-β- amylases etc. A total 24 candidate genes were identified and MSB12 was found to be differentially expressed among commonly used malting and feed barley varieties. The computational study revealed that it has a carbohydrate binding motif and eight paralogs in barley genome. Moreover, expression studies using Morex RNA seq. data suggested that these genes are mainly expressed in embryo, young root and shoot. Interestingly, biochemical analysis like binding assays and ELISA confirms the involvement of MSB12 gene in β-glucan regulation. Results obtained from various redox treatments to the E.coli purified MSB12 protein also positively supports our hypothesis. Therefore, taken together our results confirm

that this gene is a major gene that can affect malt extract or level of β-glucan, and thus can control the malting traits. **CSA Student Competition**

7.5- Differential regulation of developmental genes expression and Methylation status of phytoplasma and insect infested Brassica napus L.

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Phytoplasmas are phloem-restricted plant pathogenic bacteria belonging to the class Mollicutes. They are transmitted from plant to plant by insect vectors. Phytoplasma infection and insect attack are one of the big issues that influence the physiology as well as morphology of plants ultimately reducing the yield of major agricultural crops. In order to come up with a sustainable solution for this devastating disease we must understand it's underlying genetics and physiological mechanisms. In phytoplasma-infected brassica, flower abnormalities have been associated with changes in the expression of floral development genes that were down-regulated. To determine whether methylation was involved in down-regulation of flower developmental genes, the process of DNA methylation and Demethylation was investigated as a possible mechanism for regulation of floral gene expression in phytoplasma infected and their insect vector (aphid) infested brassica by using RT-PCR, MSRE-PCR, Southern blotting and bisulfite sequencing etc. Transcriptional expression of methylase and demethylase genes was found to be differentially regulated in plants infected with phytoplasma, but not severely in those infested by insect vectors. These results also show that genes, particularly orthologous to Arabidopsis APETALA3 involved in petal formation, was down-regulated in phytoplasma-infected brassica and revealing the fact that phytoplasma and insects induce variation in developmental gene expression. The DNA methylation status of brassica of phytoplasma infected plants with 5-azacytidine restored flower gene expression strongly suggesting that DNA methylation is involved in down-regulation of floral development genes in phytoplasma infected Brassica napus. The azacytidine treatment in combination with any good pathogen control strategy could be a way to reduce the effect of these biotic stresses and improve our agricultural production.

Session 8: Agronomy and cropping systems #2

Keynote lecture – Biomass: Understanding the risks and opportunities for agriculture?

Dr. Bill Deen

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Abstract: Markets for biomass are emerging across Canada however considerable concern has been expressed regarding the ability of Canada's arable land base to sustainably meet this emerging demand. Using Ontario as a case study, this talk will outline economic and environmental considerations that must be considered when designing biomass production systems based on either crop residues or dedicated perennial crops, such as miscanthus or switchgrass. Economic and environmental risks and opportunities of biomass production have been demonstrated to be a function of the source of biomass, land availability, land classification, and existing land use patterns. The Southern Ontario landscape has a growing prevalence of corn/soybean rotations, a stable to declining land base, a high percentage of total arable land under the Canada Land Inventory categorized as Class 1 and 2, and geographically dispersed Class 3-5 land. These characteristics directly influence the economic and environmental risks and opportunities for biomass systems in this region.

8.1- Forage species and cultivars in grass-legume mixtures that perform well under cattle grazing

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Although most forage produced in Canada is comprised of species mixtures, there is limited research on identifying the best species, and cultivars, to include within the mixtures. We determined the long-term agronomic performance of binary grass-legume mixtures of six grass species, three legume species and three cultivars of each grass species. Grass species were timothy (*Phleum pratense* L.), Kentucky bluegrass (*Poa pratensis* L.), tall fescue [*Schedonorus phoenix* (Scop.) Holub], orchardgrass (*Dactylis glomerata* L.), meadow fescue (*Festuca elatior* L.), and meadow brome (*Bromus biebersteinii* Roemer & J.A. Schultes). Legume species were birdsfoot trefoil (*Lotus corniculatus* L.), alfalfa (*Medicago sativa* L.), and white clover (*Trifolium repens* L.). Rotational mob grazing was used on the 54 binary mixtures over the 4-year study conducted in Nappan (NS). Legume, grass species and grass cultivars in the mixture significantly affected annual

dry matter yield (DMY) and seeded grass plant counts over the four years. Average annual DMY ranged from 6.0 t· ha-1 for timothy-based mixtures to 7.1 t ha-1 for tall fescue-based mixtures and from 6.3 t ha-1 for white clover- and birdsfoot trefoil-based mixtures to 6.8 t ha-1 for alfalfa-based mixtures. Yield of grass species and cultivars in mixtures depended on the legume present. High yielding binary mixtures across the four years included white clover and 'Courtenay' tall fescue (7.5 t ha-1), trefoil and 'Kokanee' tall fescue (7.5 t ha-1), trefoil and 'Artic' orchardgrass (7.0 t ha-1), alfalfa and 'Express' timothy (7.5 t ha-1), and alfalfa and 'Kokanee' tall fescue (7.4 t ha-1). White clover binary mixtures had the greatest seeded legume plant counts over the four years, but generally showed the least legume contribution to yield. These results indicate that the choice of grass species, grass cultivars, and legume species in binary grass-legume mixtures affect forage yield and the survival of grass plants in grazed swards.

8.2- Nitrogen requirements of winter cereals for forage production in northwestern Ontario

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Winter cereals could protect soils in fall/winter, overcome risk of forage shortage due to winter kill of hay crops, and vacate the fields in time for a summer forage crop. Nitrogen could be critical for optimum yield of quality forage. A field experiment, replicated 4 times in split plot design, with combination of 3 winter cereals (wheat, rye and triticale) and two sources of N; urea and urea + ESN blend (3:1 on N basis) in main plots; split for 4 rates of N (0, 50, 100 and 150 kg ha-1), was conducted at Thunder Bay, Ontario, during 2012-'15, to know the optimum rates of N for winter cereals from urea/and urea + ESN. Pooled analysis over three harvest years, indicated that there was no significant difference between the dry matter yields of the 3 winter cereals (wheat 2.56 Mg ha-1, rye 2.73 Mg ha-1 and triticale 2.45 Mg ha-1) harvested at flag leaf stage. Replacing 25 % N from urea with ESN appeared to improve forage yield of only winter wheat by 0.34 Mg ha-1. Protein content was higher in winter wheat (15.7 %) than in rye/triticale (14.5/14.4 %). Interaction between crops and N sources was not significant. Averaged over crops, dry matter yield registered a linear increase with increasing rates of N from 0 to 100 kg ha-1 and exhibited a diminishing trend thereafter. However, the protein content continued to increase with each successive increase of N from 0 (13.0 %) to 150 kg N ha-1 (16.3 %). ADF, NDF, TDN, Energy Values and RFV remained unaffected by the sources or rates of N. Winter rye had higher ADF and NDF, but lower TDN, Energy Values and RFV than wheat/or triticale.

8.3- Meta-analysis of cover cropping systems: The effects of cover crops on subsequent cash crop yields

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The integration of cover crops (CC) in cropping systems is a best management practice recommended to retain post-harvest nutrients in agroecosystems and minimize erosion. Cover crops also have considerable potential to maintain or enhance crop yields. The potential benefits of CC to crop productivity are largely determined by the CC type (legumes, non-legumes, and mixtures), the CC biomass production, and the timing and methods of CC termination. Further, synchrony between crop N demand and CC mineralization is critical in this process for which climatic conditions, soil properties and management practices act as important modulators. Consequently, the influence of CC on following crop yield often depends on site-specific factors, making it difficult to identify best management practices. In this study, we performed a meta-analysis of data from 110 field experiments published in peer-reviewed (83) or grey (27) literature to provide a comprehensive approach of assessing CC influence to cash crop systems. More specifically, we quantified (1) the effect of CC on subsequent cash crop yields (compared to bare fallow), and (2) the variation of these impacts across a wide range of systems. Data were included if they met the following criteria: (1) CC were grown (intercropping, successive or full season systems) with a subsequent annual cash crop (corn, soybean, canola, cereals); (2) a control treatment without CC was present; (3) the treatments were replicated; (4) the study has been conducted under humid temperate climate; and (5) cash crop yields were reported, which allowed us to estimate the relative contribution of CC to subsequent cash crop yields in terms of yield ratio (Yield with CC \Control Yield without CC). The influence of CC types, soil properties, management practices and environmental conditions will be described.

8.4- The effect of weeds on soil arbuscular mycorrhizal fungi and agronomic traits in spring wheat (Triticum aestivum L.) under organic management in Canada

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Understanding the influence of weeds in agroecosystems may aid in developing efficient and sustainable organic wheat production systems. We examined the effect of weeds on soil microbial communities and the performance of spring wheat (*Triticum aestivum* L.) under organic management in Edmonton, AB, Canada. We grew 13 Canadian spring wheat cultivars in organically managed hand-weeded less-weedy and weedy treatments in 2010 and 2011. The less-weedy treatment exhibited greater grain yield and tillers per square meter, while kernel weight, test weight, days to maturity, plant height, grain P and protein content were not altered by weed treatment. Canada Western Red Spring (CWRS) wheat cultivars CDC Go and CDC Kernen were the most yield-stable because they minimized fertile tiller reduction in response to weed pressure (10 and 13% reduction, respectively, compared with the average reduction of 20%). Other cultivars exhibited yield stability through increased kernel weight. The contribution of arbuscular mycorrhizal fungi (AMF) to the total phospholipid fatty acid increased in both treatments; however, the rate of this increase was greater in the weedy treatment than the less-weedy treatment (from 2.9 to 3.9%, from 2.8 to 3.1%, respectively). Weed dry biomass was positively correlated with AMF% in the less-weedy treatment only. Organic systems tend to be weedier than conventional systems. We found that weeds are important determinants of AMF proliferation in soil. In addition, choosing wheat cultivars that maintain important yield components under severe weed stress is one strategy to maximize yields in organic systems.

8.5- Effect of cultivar and environment on end-use quality of winter wheat in Canada

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Wheat is a staple food crop for almost half the world's human population, and one of the main sources of minerals and protein in most developing countries. Thus, wheat plays a crucial role in food security and human health. The effect of the environment on the quality of wheat produced including winter wheat (*Triticum aestivum* L.) is of significant interest to breeders, producers, grain handlers, millers, and bakers. In this study, 25 Canadian winter wheat varieties were grown in 3 different locations using randomized complete block design with 3 replications. Flour yield, whole grain protein content, flour protein content, grain hardness (PSI) and dough strength [gluten peak maximum time (PMT) and gluten torque maximum (TM)], were measured. Highly significant differences were detected among environments and cultivars for each of the quality variables ($P<0.01$). In Lethbridge, the test weight, kernel weight and FPC were significantly lower than Ottawa and Beloeil, and the GPC and TM were significantly higher than the other locations. In Ottawa, falling numbers were significantly higher than Beloeil, but not significantly higher than Lethbridge. PMT in Beloeil was significantly higher than Lethbridge but not significantly higher than Ottawa. Flour yield was affected by both location and grain hardness. Among hard wheat entries, the highest flour yields were detected at Beloeil; while for soft wheat entries, the highest flour yields were observed for samples from Ottawa. Test weight, PSI and grain protein content were significantly correlated with flour yield and TM ($P<0.05$). Cultivars with good soft and hard wheat quality were identified.

8.6- Micropropagation of American chestnut (Castanea dentata (Marsh.) Borkh.)

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American chestnut (*Castanea dentata* (Marsh.) Borkh.) was once one of the most common hardwoods on the east coast of North America. In the early 1900s, an introduced fungal pathogen known as (*Cryphonectria parasitica*) (Murrill) Barr decimated the species through a disease known as chestnut blight. Historical populations were reduced to less than 99 % of their original size, and have yet to recover. In Canada, a recent survey noted than less than 11 % of the remaining population were actively reproducing, a level not sufficient to sustain the population. Large scale propagation would greatly benefit the species. However many of the characteristics of both *C. dentata* and the blight prevent propagation and distribution by conventional means. *C. dentata* does not root by cuttings and has a high failure rate in grafting. As well, the blight is still active in the environment and moving plant material between sites may also transfer the pathogen. Micropropagation is a tissue culture propagation technique which can allow for the mass clonal propagation of elite genotypes, while ensuring that the resulting trees do not spread any microbial contaminants from the source trees. In this study, a micropropagation system for *C. dentata* was developed and refined to commercial levels. Previously documented levels of shoot tip necrosis were reduced significantly through the use of different gelling agents and addition of supplementary calcium. Micropropagation rates were improved to between 6 and 10 times per 6 week interval. This method provides a viable alternative to conventional propagation for *C. dentata* and could be used effectively to safely propagate and disseminate *C. dentata* trees throughout Canada and the United States.

Abstracts - Poster Presentations

P1- Growing sweet potatoes in containers for intensive urban food production

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The sweet potato *Ipomoea batatas*, a highly productive and nutritious vegetable, is one of the most important crops in the world. Small-scale production of this crop could help improve the diets of city-dwellers. Production in containers may be a suitable growing technique for urban residents who have only limited access to soil and space. We assessed the feasibility of growing sweet potatoes cv. Covington in re-usable plastic containers filled with 70 l of soilless growing media. The containers weighed approximately 20 kg when filled with wet growing media. We also measured the effect of two planting densities (2 plants per container=5 plants/m2 versus 4 plants per container=10 plants/m2) on yields and quality of sweet potatoes. The storage roots and foliage were harvested 105 days after planting. Total yields of roots were very high (2.8-3.3 kg/container or 7.3-8.6 kg/m2), compared to field production of the same cultivar (1.4 kg/m2). There was no statistical difference in total or marketable yields between the two planting densities (2 versus 4 plants per container). However, containers with the lower planting density produced more marketable roots (9.5 sweet potatoes per container) than at the higher plant density (2.75 per container). Less than half (35%-44%) of the roots were considered marketable, mainly because of their small size or poor shape. There were high yields of fresh foliage too (1.8-2.1 kg/container) but, as with the roots, changing the plant spacing had no significant effect. The cost to prepare one container was about $CAN 31. The main costs were for the container itself and the growing media.

P2- Organic Farming: A pathway for sustainable agriculture in Uttarakhand (India)

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The World cannot stop producing food and arguably the world can little afford to loose more of its biological diversity. The challenge, therefore, is to find a system of agriculture production that will produce food in a sustainable manner that enhances the environmental quality and bio-diversity rather than deflecting it. Moreover, the benefits of organic farming are not only in terms of eco-sustainability of agriculture in long term but also in increasing revenues which has high premium in national & international markets. Researches on organic farming under different aspects of management practices are going on at G.B. Pant University of Agriculture and Technology, Pantnagar, India since 2004-05 to explore possible outcomes of sustainable production of organic basmati rice based system in terms of productivity, soil & plant health, water use efficiency etc. During initial year of conversion, less productivity was observed in almost all the crops especially in cereals which has boosted after two years and later on higher productivity was observed in organic mode as compared to chemical mode. Less disease infestation & micronutrient deficiency being observed under organic mode. Irrigation water applied efficiency can also be increased by adopting system of rice intensification and direct seeded rice establishment systems. Over ten years of continued crop cycles, bulk density of soil is decreasing under organic system thereby decreasing the energy requirement. Buildup of soil organic matter which almost doubled after one decade of continuous organic farming is a key to adaptation in enhanced agriculture complexities through increase in water holding capacity, improved soil ability to store the nutrients, proper aeration, to provide media for soil microorganism & buffering capacity, enzymatic activity which ultimately results in increasing availability of both macro and micro-nutrients enhanced under organic as compared to chemical system.

P3- Weed management for sustaining rice-wheat production through conservation agriculture

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Weeds one of the responsible factors for production of rice-wheat cropping system, causing enormous losses in yield, if not managed, substitute methods are required to reduce cost of production, conserve natural resources and enhance productivity. Thus, RCT like DSR and ZTW along with residue retention being promoted in rice-wheat cropping system. A field experiment was conducted in strip plot at N.E.B. CRC of GBPUA&T, Pantnagar (2012-13 to 2014-15). In rice, total grassy weeds were controlled under DSR(ZT)-wheat(ZT)-Sesbania(ZT) among different establishment system during 2013-15, while the BLWs and sedges were successfully controlled under TPR(CT)-wheat(ZT)-Sesbania(ZT) and TPR(CT)-wheat(CT), respectively. The average total biomass of weeds was found lowest under TPR(CT)-wheat(ZT)-Sesbania(ZT). The yield was gradually increased with TPR(CT)-wheat(CT) during 3 years study while the average was achieved highest under TPR(CT)-wheat(ZT)-Sesbania (ZT) and it have highest B:C ratio. Among weed management practices, lowest density

and biomass of all weeds with highest yield was under IWM (bispyribac-Na 20 g/ha+1 HW) and have maximum B:C ratio. In wheat, average total density and biomass of weeds was lowest under DSR(ZT)+R- wheat(ZT)+R-Sesbania(ZT). The density of grasses decreased gradually under DSR(CT)-wheat(CT)-Sesbania(ZT) over three years while, sedges were completely disappeared after Ist under different establishment methods and weed management practices. The yield of wheat gradually increased after Ist year under DSR(ZT)-wheat(ZT)-Sesbania(ZT) cropping system with maximum B:C ratio while average of three years in respect to highest yield was recorded under DSR(ZT)+R-wheat(ZT)+R-Sesbania(ZT). Among the weed management practices, IWM (clodinafop+MSM @ 60+4 g/ha) resulted in lower total density and biomass of weeds achieving highest yield with average B:C ratio which was equally effective to sole application of herbicide.

P4- Unraveling vasculature histology using Synchrotron Light: Use of X-ray phase-contrast imaging with silver nitrate as a contrast agent and K-edge subtraction technique

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Vasculature or vascular system, consisting of water and nutrient passing conduits, is the most important part of plants. Yield of cereals is dependent on the distribution of assimilates in heads or ears as it has a significant influence on flower and fruit development. The sink capacity of assimilates and photosynthates in turn depends on the vascular bundles. Thus, it is important to examine the plant vasculature in real-time to better understand the metabolism and movement of nutrients, photosynthates and assimilates.Although electron microscopes have better resolution (<1-2 nm), but fail to image the live plant in real-time. Despite the fact that electron microscopic examination of dissected and disrupted plant organs has been improved over time, there is always some trade-off associated with easy application and artefacts during sample handling, affecting accuracy of information gained.• Here, we have developed a protocol to study plant vasculature in metabolically-active plant organs in real-time. The method incorporates the use of AgNO3 as a contrast agent, advantages associated with the synchrotron's X-ray phase-contrast imaging, computed tomography of plant organs and then application of K-edge subtraction to visualize and quantify hydraulically active vascular tissues. Using the described methodology, we found that data collection can be completed in reasonable time. Visual difference in genotypes using AgNO3 gives first indication of differences in genotypes. Data processing and image reconstruction revealed the vasculature conductivity in rachis, awns, and florets.The results from this study builds a base for many future studies to successfully examine vasculature in diverse range of plant species using AgNO3 as an ideal contrast agent. **CSA Student Competition**

P5- Optimization of drying processes for *Humulus Lupulus*.

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The Canadian medical marijuana industry is currently worth $80-$100 million and includes 50,000 licensed users and 26 licensed producers. With the transition of government policy, legalization of recreational marijuana use is pending and analysts are predicting that the industry will grow into a $5 billion market. With this projected growth, the development of a cost effective drying process that preserves product quality is important for increased market competition. McGill University has recently partnered with DelShen Therapeutics with the objective of evaluating different low temperature, non-destructive drying techniques that can simultaneously dry whole plants from ~80% to 8-10% m.c., and maintain the terpenoids in the buds (to conserve the flavor profile). In order to limit costs and the government permits required to carry out this study, this research focuses on testing the drying procedures on Humulus Lupulus (common hops). Hops belong to the same family (Cannabaceae) and exhibit similar physiological traits as medical Cannabis (medical marijuana), and the chemical composition of the two species show resemblances as well with the same major flavonoids and terpenes. The outcomes of this research will lead to cost savings, significant product improvements and multiple end uses of marijuana plants.

P6- Predictive equations of alfalfa-grass mixture nutritive value under Québec environmental conditions

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To predict when forages should be harvested, a simple method is needed to estimate the optimal neutral detergent fibre (NDF) concentration of mixed alfalfa-grass fields. The PEAQ (Predictive Equations for Alfalfa Quality) method, created for alfalfa (*Medicago sativa* L.) fields, was successfully modified for use in mixed alfalfa-grass fields in New York State. This method uses simple field measurements and growing degree days (GDD, base 0°C) to predict forage NDF. An experiment was established at three sites in Québec (Sainte-Anne-de-Bellevue, Lévis, and Normandin) to test whether these equations can be used

locally. Fields were seeded in 2014 with different alfalfa/grass proportions. In 2015, observations of alfalfa and grass morphological traits were collected prior to the first and second cuts and samples were taken. Simple linear regression was used to compare first cut NDF predicted using equations developed in New York State (x) against data from corresponding chemical analyses (y). Regressions using PEAQ equations including or not GDD were y = 0.97x - 1.54 (R2 = 0.80) and y = 0.77x + 6.40 (R2 = 0.79), respectively. Predicted NDF for combined first and second cut samples using equations with and without GDD gave respective regressions of y = 1.04x - 5.48 (R2 = 0.74) and y = 0.82x + 4.31 (R2 = 0.72). New predictive equations based on local data were developed: aNDF = 167.8 + 1.58(AMXHT) + 1.16(GMXHT) + 278.9(GEST) (AMXHT = alfalfa maximum height; GMXHT = grass maximum height; GEST = Grass estimate). The regression for first cut predicted NDF (x) against data from chemical analyses (y) was y = 1.0x + 0.39 (R2=0.84). Preliminary results indicate that existing predictive equations could be used in Québec but equations created using these local data and those of a second year may provide better predictive capabilities.

P7- Nutritive value of alfalfa and timothy grown in contrasted climatic regions

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Studies conducted under controlled conditions revealed that forage nutritive value is affected by growth temperature. However, the effect of regions with different air temperatures on forage nutritive value has never been documented. Our objective was to compare the forage nutritive value of three contrasted sites in the province of Quebec (Sainte-Anne-de-Bellevue, 2098 degree-days; St-Augustin-de-Desmaures, 1712 degree-days; and Normandin, 1359 degree-days) by quantifying the changes in forage nutritive value with developmental stages of alfalfa (*Medicago sativa* L.) and timothy (*Phleum pretense* L.). Dry matter (DM) yield was measured and forage samples were taken once a week until alfalfa reached at least the late bud stage at each site during the primary growth in 2015. At late buds for alfalfa and early heading for timothy, concentrations of acid detergent fibre (ADF, g/kg DM) and neutral detergent fibre (NDF, g/kg DM) as well as DM yield (Mg/ha) estimated by regression were, respectively, less at Normandin (326, 402, 4.3; 353, 600, 4.7) than at Saint-Augustin (447, 530, 6.1; 431, 664, 7.7) and Sainte-Anne-de-Bellevue (372, 476, 6.8; 411, 666, 6.3). The lower ADF and NDF concentrations at the northernmost site (Normandin) were partly explained by the well-established positive relationship between fibre concentrations and DM yield. There were also site differences in forage {in vitro} true digestibility of DM and {in vitro} NDF digestibility and these differences were greater in alfalfa than timothy. These results suggest that timothy and alfalfa have a superior nutritive value but a lower productivity at the northernmost site than at the other two sites. Results from a second harvest year are necessary to validate these preliminary observations.

P8- What are the best alternatives to timothy grown in mixture with alfalfa?

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Timothy (*Phleum pratense* L.) is the main forage grass species cultivated with alfalfa (*Medicago sativa* L.), but its regrowth under dry and warm summer conditions is poor. We compared six grass species in binary mixture with alfalfa at three contrasting sites in Quebec (Ste-Anne-de-Bellevue [2098 degree-days], St-Augustin-de-Desmaures [1712 degree-days], and Normandin [1359 degree-days]) in an effort to find alternatives to timothy in the context of climate change. Six binary mixtures of alfalfa with timothy, tall fescue (*Lolium arundinaceae* Schreb.), meadow fescue (*Lolium pratense* Huds.), perennial ryegrass (*Lolium perenne* L.), festulolium (x *Festulolium* Asch. & Graebn.) and meadow brome (*Bromus biebersteinii* Roem. & Schult.) were seeded in 2014 and harvested in 2015, either at the early bud or early flower stages of alfalfa. Forage dry matter (DM) yield and the yield contribution of the different seeded species were measured at each harvest. Festulolium (7.0 Mg ha-1) and perennial ryegrass (7.18 Mg ha-1) with alfalfa had a lower seasonal DM yield averaged across the three sites than other mixtures (7.99 to 8.42 Mg ha-1). The grass yield contribution averaged across harvests varied among grass species from 0 to 26 % at Normandin, 12 to 32% at St-Augustin-de-Desmaures, and 41 to 58% at Ste-Anne-de-Bellevue. Festulolium and perennial ryegrass did not contribute to yield at Normandin because of winter damages. The alfalfa developmental stage at harvest did not significantly affect the grass yield contribution or the seasonal DM yield at each site, even though an additional harvest was taken at the early bud stage. These preliminary results suggest that alfalfa-based binary mixtures with tall fescue, meadow fescue and meadow brome have a similar or superior productivity than an alfalfa-timothy mixture, and they confirm winter survival issues of festulolium and perennial ryegrass at the northernmost site. However, results from a second harvest year will be necessary to make recommendations.

P9- Contribution of different grass species to the dry matter yield in alfalfa-grass mixtures.

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Alfalfa-grass mixtures are important feed for dairy cattle. Among grasses, timothy is the most popular species associated with alfalfa but its regrowth after the first harvest is weak. Thus, at the second and other harvests, the mixture is composed principally of alfalfa. Intensive management may increase this phenomenon, as timothy is not adapted to frequent harvesting. One of the objectives was to evaluate other grass species more adapted to frequent harvest and determine their contribution to dry matter (DM) yield. In 2013, four alfalfa mixtures and pure alfalfa (cv. Brador) were seeded at two sites (Princeville, QC and New-Liskeard, ON). Grasses associated were tall fescue (cv. Tower), meadow fescue (cv. Laura), Festulolium (cv. Fojtan) and timothy (cv. Ovation). All plots were harvested at early-to late bud stage with three cuts at New-Liskeard site and four cuts at Princeville site during two years. Seasonal DM yield was higher at Princeville by nearly 1 t DM ha-1 than at New-Liskeard with one more harvest. On average, meadow fescue was the grass species that had the highest contribution to the DM yield at the first harvest on both post-seeding years (2174 kg DM ha-1 to 2619 kg DM ha-1) except in 2014 at Princeville. At New-Liskeard site, timothy was always the species with the lowest contribution to the DM yield after first harvest. Tall fescue, meadow fescue and Festulolium have potential to be associated with alfalfa as their DM yield after first harvest is similar at each harvest. However, nutritive value must be evaluated as well as their ensilability for silage making before any recommendation.

P10- Ability of sainfoin and cicer milkvetch populations to establish in old depleted pasture

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A multiyear and multilocation study was initiated to determine if sainfoin and cicer milkvetch (CMV) can be used to rejuvenate old and depleted pasture. Four sainfoin and three CMV populations were seeded directly into the existing pasture using 3 different seeding methods (baker drill, pan drill and pan drill after cultivation). Biomass yield and quality of mixed pastures were determined in the four times replicated plots arranged as in a split-plot design. At Lethbridge new established Nova plants contributed 28% of the total plot DM which was higher than all other sainfoin populations; the proportions were 21%, 19.5% and 17% for LRC3519, LRC3432 and LRC3902, respectively. New plants of AAC Mountainview (LRC3902) contributed 4.5% to the total DM yield which was highest of all plots in grass pastures of Ponoka. CMV populations did not show differences in DM contribution. Plant counts taken during the first year indicated that baker drill is superior to pan drill. Legume-legume mixtures at Lethbridge and grass-legume mixtures at Ponoka had a range of 32-36% and 44-47% neutral detergent fibre (NDF) concentrations respectively. All of the mixtures had >18% CP. At Lethbridge available soil nitrogen of samples collected from a depth of 0-30 cm increased from 54 kg ha-1 to 62 kg ha-1 in the second year after new legumes were introduced. This elevated soil N is expected to improve productivity of old depleted pasture. The results suggest that new populations of sainfoin have ability to establish in existing alfalfa stands while contributing >15% DM for bloat reduction in grazing ruminants. **CSA Student Competition, CSHS Student Competition**

P11- Effect of subsoiling on physical properties of Solonetzic Soils

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Deep tillage has been used to address soil physical limitations inherent to Solonetzic soils, in particular due to the dense sodium and clay enriched B horizon that limits water infiltration and plant root growth. Minimum till subsoiling involves the loosening of soil at depth using a foot lifting the soil at the bottom of a low profile shank, with limited surface disturbance. A study was initiated in the Dark Brown soil zone in the fall of 2015 in southern Saskatchewan to examine the effect of subsoiling on an annually cultivated Solonetzic soil. A minimum disturbance subsoiling implement set to operate at a 30 cm depth was used in a replicated block experiment set up on an identified Solonetzic area of a field. On post subsoiling soil samples obtained from the 0-15, 15-30 and 30-60 cm depths in the fall of 2015, soil bulk density in the 15-30 cm depth decreased from 1.8 Mg m3 in non-subsoiled plots to 1.7 Mg m3 in subsoiled plots while soil gravimetric moisture at the same depth significantly ($P \leq 0.10$) decreased from 22.9 % in non-subsoiled plots to 20.7% in subsoiled plots. Soil bulk density increased slightly in the 0-15 and 30-60 cm depths. This could be due to the subsoiling implement shank action pushing soil aside as it moves through the profile, creating a zone of more compressed and moisture depleted soil. Soil density and soil strength measurements were made again in the spring of 2016. The results of this study will benefit producers with new information regarding potential improvements in soil physical conditions from low disturbance subsoiling.

P12- Wheat residue management for soybean production in Manitoba

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Soybeans are an expanding crop in Manitoba, planted on over 1 million acres for the past three years. The expansion of soybean has mainly been in areas with shorter growing seasons, where minimum or no-till systems are traditionally used. To accommodate the lengthy soybean growing season, these minimum or no-till systems have been abandoned for increased tillage to facilitate fast soil warming. The purpose of this study was to compare wheat residue management techniques that could reduce tillage before planting a soybean crop, and compare them to current tillage practices. The following wheat residue management treatments were established in the fall of 2013 and 2014 near Carman, MB and Melita, MB in 2014: conventional till (disc), strip-till, no-till short stubble (15 cm stubble height), no-till tall stubble (40 cm stubble height), and a fall rye cover crop. A soybean test crop was planted the following spring in 2014 and 2015. Surface soil temperature at 5 cm was found to have a significantly higher daytime temperature before and after soybean planting in the strip-till treatment compared to all other residue management treatments. No-till treatments had a cooler daytime temperature compared to strip-till and conventional tillage, however the no-till treatments still produced soil temperatures above the recommended average soil temperature for planting soybean (10oC) before soybean planting occurred (May 28, 2014 and May 22, 2015 at Carman; May 29, 2015 at Melita). Soil moisture was recorded for the soybean growing season at 5 and 30 cm, and was found to be conserved under no-till treatments throughout the entire growing season. Soybean yield was not significantly different for all treatments in 2015, and was not significantly different for strip-till, disc, and tall stubble treatments in 2014. These results indicate that tillage can be reduced prior to planting soybeans in Manitoba.

P13- Estimating growth and maintenance respiration of field-grown maize at different growth stages.

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Total plant respiration (Rt) includes the C loss to provide energy and reducing equivalents for the conversion of photosynthate into final biomass ("growth respiration", Rg) and the respiration required for maintenance of the existing biomass ("maintenance respiration", Rm). It is experimentally challenging to separate these two components. In the field, Rm may be estimated by the measured minimum daily respiration (Rmd). Since Rm is directly temperature-dependent and Rg is primarily dependent on current substrate availability, the Rmd/Rt can vary strongly over the course of a day and across the season. The objective of this study was to estimate the Rt, Rm and Rg of maize at different growth stages in the field. The experiment was conducted in Ponsonby ON in 2015. One hybrid was sampled on 27, 42, 63, 82 and 91 days after emergence. Three plants were taken from the field every 2-5 h to make respiration measurements over a 24-h period. Then, plants were oven-dried and weighed. The integration of all the daily measurements was considered the total respiration for the day. The respiration measured before sunrise was taken as Rmd and was adjusted for temperature at other times of day. The integration of the temperature-adjusted Rmd was taken as the estimate of daily Rm. Rg was estimated as the difference between the integrated Rt and Rmd. Plant dry matter and respiration increased across the season while respiration by unit biomass declined exponentially across the season. Maximum respiration of the day was reached between noon and 4 pm from 42 DAE, and the minimum respiration of the day was reached from midnight to 6 am. The relationship between Rg and Rmd indicated that the Rg was increasing proportionally to Rmd up to silking and thereafter declined until physiological maturity.

P14- The effects of growth stage and temperature on respiratory Q10 in maize (Zea mays L.)

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Growth and maintenance respiration (Rg and Rm) are important biological processes within plants to synthesize new biomass and keep existing biomass functional. Rm is temperature-sensitive whereas Rg is proportional with changes in growth. The respiratory Q10 is the fractional change in the rate of respiration with a 10°C increase in temperature. The value of 2 if often used as a Q10 for Rm but since Q10 itself is temperature-sensitive a fixed value is not adequate for modelling respiration across a broad temperature range. In addition to temperature, it is possible that growth stage could also affect the respiratory Q10. The objective of this study was to calculate the respiratory Q10 of maize at different growth stages and temperatures. Plants were grown hydroponically in a greenhouse at the University of Guelph. Rm was measured at 23, 44, 65 and 86 days after emergence at four different temperatures (10, 18, 26 and 34°C). Measurements were made after extended dark adaptation (> 8 h) at the measurement temperature, and were therefore assumed to represent primarily maintenance respiration. Plant dry biomass was also recorded. Rm by unit biomass increased with increasing temperature, and decreased with increasing plant maturity. The Q10 was not a function of growth stage; however, it was highly temperature-dependent. The average Q10 at 30°C was 1.23, at 22°C it was 2.04 and at 14°C it was 3.61. Since there was no evidence that Q10 was a function of growth stage, the data were pooled across growth stages to better model the temperature response. The function published by O'Connell (1990) provided a good fit to the relationship between measurement temperature and

normalized respiration (specific respiration divided by specific respiration at 20°C). This approach should provide suitable temperature adjustment of Rm estimates across a broad range of temperatures and growth stages.

P15- Hybrid and site-specific management strategies in corn (Zea mays L.)

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Advances in global positioning and information systems has presented the opportunity to manage agronomic inputs on a site-specific basis within a field. A better understanding of soil and plant factors that could guide variable rate inputs in corn production is needed, particularly under Ontario field conditions. The objective of the study is to characterize the response of corn hybrids and their interactions to inputs across spatially variable landscapes. Four field trials will be conducted in Ontario between 2014 and 2016. Treatments consist of five corn hybrids with a combination of eight management strategies of nitrogen, fungicide and population density rates planted in zones to account for the spatial variation in topography and soil characteristics. Various sensor technologies will be utilized to identify and quantify soil conditions and crop responses to treatments. The use of variable rate application has the potential to increase yield and profitability while reducing environmental impacts.

P16- Distribution of tocopherol in non-transgenic soybean seeds

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Soybean seed contains several high-value health-beneficial compounds including tocopherols. Seed coats, soy germs, cotyledons, and whole seeds of six soybean cultivars grown at three sites were analyzed by high pressure liquid chromatography for α-, γ-, δ- and total tocopherol concentrations determinations. Cultivars differed in their α-tocopherol concentration as well as in their concentration of other tocopherols, ranking depending on the tocopherol; cultivar performance was, however, stable across sites. Seed parts was the most important source affecting variation for α-tocopherol concentration (71% of total variation), cultivars, and the cultivar × seed part interaction also had a significant effect but explained less than 12% of the variation. Tocopherol concentrations varied considerably between seed parts, α-, γ-, and total tocopherol concentrations being greater in the soy germ than in cotyledons; these differences were consistent across cultivars and sites. Cotyledons had, in contrast, greater δ-tocopherol concentrations. No tocopherols were detected in seed coats. Soy germs contained 332% more α-tocopherol than cotyledons, while cotyledons had 200% more δ-tocopherol than soy germs and these differences were even higher in high α-tocopherol cultivars than low ones for both isomers. Results suggested that specific cultivars and their soy germs in particular may be a preferred source of α-tocopherol for the nutraceutical and functional food industries.

P17- Tillage and nutrient dynamics in wheat under rice-wheat cropping system

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In low land puddled rice- wheat cropping system after rice harvest, puddled soils, upon drying shrink, become compact and hard, which increases penetration resistance against the root growth in soil, causing less nutrient and water availability, retarded growth and ultimate reduction in yield of succeeding wheat crop. To overcome this issue and improving growth and yield of both the crops an experiment was conducted at Crop Research Centre, GB Pant University of Agriculture and Technology, Pantnagar for three consecutive years during 2012-13 to 14-15 in strip plot design with three replications. Vertical strips were contained three tillage treatments [viz. no chiseling followed by conventional tillage (CT) which included two times disc harrow operation, chiseling followed by CT and chiseling followed by rotary tillage (RT)]. Three nutrient management treatments were applied in horizontal strips viz. recommended dose of fertilizer (RDF) i.e. 15:60:40 kg NPK/ha, RDF+ FYM @ 15t/ha and 125% RDF+ FYM. Chiseling was found to be responsible for significantly increase in various growth and yield characters of wheat. Chiseling followed by conventional tillage produced taller plants, higher dry matter, yield/ha with superiority of yield attributing characters; however all these characters were found to be at par in chiseling combination with conventional tillage and rotary tillage. Deeper tillage can break plow pan layer after puddle rice which results into the increase root depth, improve infiltration and water storage along with nutrient availability and it might ultimately increase crop yield. The yield increase in this treatment was 112% and 106% higher over only RDF and RDF with FYM, respectively. Inclusion of chiseling operation before conventional or rotary tillage along with application of 125% recommended NPK combined with FYM @ 15t/ha may produce higher growth and yield of wheat crop under transplanted rice- wheat cropping system.

P18- Assessment of growing media on vegetative, flowering and vase life characteristics of lilium *Lilium*

***longiflorum* cvs. Bach and Pavia in the foothills of Himalayas**

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The experiment was carried out to investigate the effect of different growing media on vegetative, flowering and vase life characteristics of two LA lily hybrids Bach and Pavia in 2 factorial randomized block design with three replications. Of the two factors, first factor was two varieties namely, Bach and Pavia and the second factor was five growing media including (1) garden soil, (2) cocopeat, (3) cocopeat + sand (1:1) and (4) garden soil + sand (1:1). However, bulbs of LA lily hybrids were planted in plastic crates containing different growing media with 10 bulbs in each crate, placed inside 50 percent shadenet house. Final plant height (116.63 cm.) and number of flower buds (7.27) was highest in cv. Pavia at 60 days after planting. However, quickest flower bud appearance (29.53days) and maximum vase life (11.26 days) was in cv. Bach. Among the potting media, cocopeat found to be superior for enhancing all characteristics along with both the cultivars.

P19- Flower occurrence in a 2012 planting of four half-high blueberry cultivars in eastern Newfoundland as affected by surface mulch type

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Commercial half-high blueberry (*Vaccinium corymbosum* L. x *Vaccinium angustifolium* Ait.) producers on the Cochrane soil series in eastern Newfoundland have suffered major crop losses in new plantings due to frost heaving and waterlogging. These high silt soils are prone to compaction and often have intermittent perched water tables caused by a shallow hard pan. Highbush blueberry (*V. corymbosum* L.) is not native to the Island of Newfoundland but producers are evaluating half-high blueberries as a new U-Pick crop. A field experiment was planted in 2012 at St. John's using four year old commercial half-high cultivars from four maturity classes (Bluetta – early, Reka – early to midseason, Chippewa – midseason, Bonus – mid to late season). These were assessed for plant establishment characteristics under three surface mulch types (sawdust, wood chips, and black plastic). The experimental design was a cultivar x mulch type factorial complete randomized block design with five plants per plot and five replications. The field site was deep tilled and tile drained, raised beds 30 cm high were prepared, and twin drip irrigation lines were installed in the root zone on each side of the plants for scheduled fertigation and irrigation. Due to intermittent snow cover, winter damage each year was moderately severe on upper stem flower buds and leaf buds. Plant flower occurrence in the first two growing seasons was near zero for Bluetta and Bonus, low for Reka (12 %) and moderate for Chippewa (55 %). Blueberry plant flower occurrence on sawdust (12 %) and wood chip mulch (12 %) was less than half of flower occurrence under black plastic mulch (28 %). Assessment of flower occurrence and berry yield will continue through the 2017 production season.

P20- Small, modular green roofs as hands-on educational tools.

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Green roofs offer rich learning opportunities for students, combining "high-tech" skills of micro-climate monitoring with hands-on horticulture. However, green roofs *in situ* have restricted accessibility, slow growth rates and seasonal growth cycles which place constraints on teaching and learning. Small green roofs could serve as proxies in a controlled environment such as a greenhouse in order to simulate conditions that they might experience if situated on an actual roof. The main objective of this project was to create a hands-on educational experience involving green roof technology for undergraduate students. The secondary objectives were to investigate the feasibility of constructing small (1.5 m by 0.8 m) extensive green roofs in a greenhouse, to measure temperature and water runoff on/from the green roofs to determine if these would adequately simulate the performance of extensive green roofs located on top of buildings and to compare the growth and performance of several plants including {Sedum} sp. and other {Crassulaceae} as well as plants native to North America. The 24-hour average surface temperatures on the vegetated roofs were 1.5° to 5.5°C cooler than on an asphalt shingle roof. The cooling effect of vegetation was more pronounced during the day than at night. Temperatures of asphalt shingle roofs exceeded 30°C approximately 14-31% of the time whereas temperatures of vegetated roofs less than 10% of the time. The vegetated roofs had much lower runoff than asphalt shingle roofs after a simulated rainfall of 1 cm: only 12-40% of water applied ran off vegetated roofs within 1 hour compared to 90-91% runoff from asphalt shingle roofs within 10 minutes. Plant survival and growth varied with species: *Sedum acre*, *S. rupestre* and *Achillea millefolium* were among the most successful.

P21- Natural ventilation augmented cooling (NVAC) greenhouse: analysis of microclimate and plant responses.

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Traditional greenhouse designs use exhaust fan and fan and pad ventilation systems to decrease inside air temperature and provide fresh air to the crop. Such systems are energy intensive, require maintenance and are prone to failure in storms making them unsuitable for tropical locations. In addition, most tropical greenhouse designs rely solely on natural ventilation and convection which makes them suitable for only the most heat-tolerant crops. A potential solution is a natural ventilation augmented cooling (NVAC) greenhouse. A NVAC greenhouse is an open roof design improved by coupling natural ventilation with an unconventional misting system. The misting system located in the rafters of the greenhouse sprays a mist of water into the rising warm air within a channel. The newly cooled air flows down onto an added inside roof and collapses into the lower space of the greenhouse. This effect cools the air and enhances air movement in the greenhouse without using fans. Two prototypes were built at McGill University in Ste-Anne-de-Bellevue, QC, and one commercial scale prototype was built in Trents, Barbados. When the misting system is functional, without any wind effect or fans, significant air movement occurs inside the NVAC greenhouse and the daytime temperature inside the greenhouse is always lower than external conditions. The NVAC design thus allows for less stagnant air in the greenhouse. Plant response to the NVAC greenhouse design was investigated by measuring plant leaf temperature in pepper ({Capsicum annuum}) using fine gauge thermocouples both with the NVAC misting system non-functional, as a control, and with the misting system functional. **CSA Student Competition, CSHS Student Competition**

P22- Sequencing of small RNA transcriptome demonstrates distinct temporal expression pattern of stress regulated miRNA in wheat

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MicroRNAs (miRNAs) guided post-transcriptional regulation has emerged as an essential component of stress response in plants. Critical understanding of plant adaptation to abiotic stresses has implications in plant breeding, especially in the context of climate change. In the present study, wheat plants were exposed to one of the following stresses: continuous light, heat or ultraviolet radiations over five consecutive days and, leaf tissues from three biological replicates were harvested at 0, 1, 2, 3, 7 and 10 days after treatment (DAT). A total of 72 small RNA libraries were sequenced on the Illumina platform, generating ~524 million reads corresponding to ~129 million distinct tags. The latter were mapped to previously annotated wheat miRNA precursor sequences and a total of 232 conserved miRNAs were identified. One, two and 79 miRNAs were differentially expressed following exposure to ultraviolet radiations, continuous light and heat stress, respectively. Approximately 55% of the differentially expressed miRNAs were downregulated in response to heat stress at 0 and 1 DAT. The differentially expressed miRNA were predicted to target more than 104 putative mRNAs. Members of miR398, miR528 and miR156 families were primarily downregulated in response to heat stress and were predicted to target mRNA involved in activation of signal transduction pathways, antioxidant activity and flowering. miRNAs induced in response to heat stress were associated with histone variant proteins, auxin response factors and nutrient transport and storage proteins. These results suggest a temporal miRNA-guided post-transcriptional regulation that enables wheat to respond to abiotic stresses, particularly heat. Designing novel wheat breeding strategies such as 'regulatory gene based'-marker assisted selection depends on the accurate identification of stress induced miRNAs.

P23- Effects of flooding on growth and recovery of forage plants

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Flooding is a common agricultural problem affecting crop performance and yield. Waterlogged soils create low oxygen environments, preventing aerobic respiration in the roots and limiting their ATP production. Lack of available energy negatively impacts root growth and function, affecting the entire plant. Adaptations exist in plants which can aid in maintaining root function and improve survival under flooding conditions. Aerenchyma improves internal gas movement through a series of connected air spaces from the exposed shoot to the submerged roots, increasing oxygen availability in the root. Phytoglobins (Hb) are involved nitric oxide (NO) level-regulation. NO production is increased under low oxygen conditions and causes cell damage and death. Three groups of plants were investigated for their response to flooding; forage legumes including red clover, birds-foot trefoil and three alfalfa cultivars with different rooting architecture; forage grasses including timothy, reed canarygrass, and three lines of intermediate wheatgrass, and; a group of Hb overexpressing alfalfa lines. Mature plants were flooded to 3 cm above the crown in controlled environments simulating spring conditions. Flooding treatments were two and four weeks, followed by a two week period of recovery. Shoot height, biomass, and discolouration was measured at removal and after recovery. Root length, damage, and presence of aerenchyma was measured after recovery. Most plants were negatively affected by flooding,

with impacts greater after four weeks. Timothy and reed canarygrass growth improved with flooding. Aerenchyma was found in red clover, birds-foot trefoil, timothy, and reed canarygrass. Plants which produced aerenchyma were less affected by flooding, having greater growth and less root damage. Alfalfa rooting cultivars, intermediate wheatgrass lines, and Hb alfalfa lines responded differently to flooding. **CSA Student Competition**

P24- Comparison of in-situ root biomass quantification techniques

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Climate stressors greatly impact canola production. Studying tolerance of root systems can provide insight about crop response to climate stressors as well as crop resilience to stress events. Conventional methods of quantifying root biomass are destructive, time and labour intensive and are inadequate in capturing the fine roots of canola. The objective of this study is to determine whether root capacitance and root derived carbon methods can be used for the estimation of root biomass of field-grown canola crop. Experimental work took place at the Emile A. Lods Agronomy Research Station in Sainte Anne-de-Bellevue, Quebec. Root biomass measurements were compared using three different methods: 1) manual root washing and weighing, 2) root capacitance (based on a correlation between root biomass and the electrical capacitance of the root system), and 3) root derived carbon method (based on the distribution of 13C in roots of 13CO2 enriched plants). Four nitrogen treatments were used to induce differences in root growth: 50, 100, 150 and 200 kg N ha-1. Root samples were collected at the following critical stages of canola crop development: early flowering, late flowering and pod formation. Relationships between root biomass and above ground biomass are evaluated using robust statistical and crop growth models and detailed analysis will be presented. Evaluation of these methods will provide greater accuracy in quantifying root biomass dynamics in relation to abiotic stressors. This will be important for plant breeders and agronomists in selecting varieties with desirable root systems that tolerate climate stressors, since these considerations are needed to adapt and sustain canola production in Québec to a changing climate.

P25- Prospecting resources for drought tolerant cover crops from dry season naturalized plants

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Poverty and food insecurity is exacerbated in sub-tropical regions with a dry season. Drought inhibits the growth of most crops; as a result, the scarcity of food and fodder is a seasonal event. Most subsistence farmers struggle to adapt to climate change with limited access to agricultural inputs, including improved techniques and technology. Drought tolerant cover crops preserve and enhance soil fertility in addition to providing a source of food and animal feed during the lean season. Selecting drought tolerant and locally adapted plant species contributes to the development of dry season crops that improve to food security, the conservation of scarce resources, and ultimately alleviating poverty. An ethnobotanical survey was conducted throughout mid-hill regions of Nepal to identify genetic resources for the development and improvement of drought tolerant legume crops. A novel high-throughput phenotyping system was developed to facilitate screening candidates for traits conferring drought tolerance. **CSA Student Competition**

P26- Cross-talk between abiotic and biotic stress in tomato plants

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A plant's defensive capacity can be enhanced by treatment with various synthetic and natural compounds like the non-protein amino acid beta-aminobutyric acid (BABA) that are capable to improve the immune system of the stressed plants and make it more resistant, this is called priming. Primed plants express faster and stronger enhanced defense upon encountering either abiotic or biotic stress. Traditionally, plant stress has been studied by applying a single type of stress such as drought, salinity or infection and analyzing the phenotypic and molecular aspects of the resulting plant phenotype. However, this type of analysis is in sharp contrast to natural conditions where plants are simultaneously subjected to a combination of different abiotic and biotic stresses that limit crop yields. Recent evidence shows that a combination of abiotic and biotic stress can have a positive effect on plant performance by reducing the susceptibility to biotic stress. Such an interaction between both types of stress points to crosstalk between their respective signaling pathways. We found in my project that BABA treated plant showed earlier and higher expression of PR1 and PR5 genes following combination of salt stress and infection with Botrytis cinerea comparing to the unstressed plants with salt.

P27- Spectral signatures of bio-polymer changes in the wheat cell-wall resulting from Puccinia striiformis f. sp. tritici infection in compatible and incompatible interaction on Yr10.

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Wheat stripe rust, caused by Puccinia striiformis f. sp. tritici, is becoming a serious issue in Canada. The biotrophic fungus produces uredia, consisting asexual urediospores, on wheat leaves along the veins and obtains nutrition from host through haustoria. In a compatible interaction, the fungus damages the cell-wall in a susceptible cultivar, however in a resistant cultivar the incompatible interaction occurs as a result of hypersensitive cell death in the host. The purpose of this study was to understand the biomolecular changes in cell-wall compounds in each of the interactions. Two Avocet lines: one carrying Yr10 and other susceptible (no resistance allele) were inoculated with two isolates (one virulent on both and the other virulent only on Yr10). Infected and freeze dried leaves collected at 1 day and 15 days post inoculation were assessed by Fourier transform infrared (IR) spectroscopy to probe changes in cell wall components following infection of the pathogen. A significant difference in disease severity was observed between the two wheat lines. Principal component analysis of the IR spectra indicated substantial differences in the cell-wall components of the two wheat lines before and after pathogenic infection. There was a significant difference in the biomolecular changes between compatible and incompatible interactions. The most important IR peaks in the leaf cell wall that contributed to such differences were assigned to phenolic and aromatic rings, and proteins. This is the first study showing the use of mid-infrared light to unravel biopolymeric changes in wheat-Puccini pathosystem. **CSA Student Competition**

P28- Comparison of total phenolic content and antioxidant capacity of mycorrhizal-colonized spring wheat (Triticum aestivum L.) genotypes

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Wheat (*Triticum aestivum* L.) is one of the world's most valuable crops, not only as a diet component but also as a source of dietary antioxidants. It is well known that wheat inoculated with mycorrhizal strains usually has a higher yield and stronger tolerance to stresses. However, information on the effect of mycorrhizal inoculation on the antioxidant capacity of wheat grains is scarce. The objective of this study was therefore to investigate and compare the total phenolic content and DPPH scavenging capacity of grains from four selected spring wheat varieties. The results demonstrated that the purple 13NQW1265, had the strongest DPPH scavenging capacity and the highest TPC in grains among all selected wheat genotypes, whereas the wheat variety Snowbird had a lower antioxidant capacity. As expected, a significant positive correlation was found between DPPH scavenging capacity and TPC, the main contributor to antioxidant capacity. The results suggest that mycorrhizal colonization could increase antioxidant compounds in wheat subject to wheat variety and mycorrhizal strain.

P29- Evaluation of winter wheat from Eastern and Western Canada for agronomic characteristics and resistance to fusarium head blight in Ridgetown, Ontario in 2015

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Experimental plots of twenty five winter wheat cultivars from Eastern and Western Canada were planted in October 2014 at Ridgetown in southwestern Ontario. Each cultivar had 4 replications and plot size was 1.15 m by 4.00 m. Heading date, plant height and disease severity (0-9 scale) for powdery mildew (*Blumeria graminis* (DC.) Speer f. sp. tritici emend. É.J. Marchal) and septoria tritici blotch (*Mycosphaerella graminicola* (Fuckel) J. Schröt.) were estimated. Grain was harvested by a small plot combine and reported at 14% moisture content. In addition, the cultivars were evaluated for fusarium head blight (fhb) resistance in *Fusarium graminearum* inoculated nursery. The plots were planted in three replications, in single rows, 2 m long and spaced 17.8 cm apart. Each plot was spray inoculated with 100 mL of combined suspension of macroconidia (50,000 spores/mL) of four *Fusarium graminearum* isolates per plot. Plots were misted daily beginning after the first plots were inoculated. The mist system was engaged until three days after the last cultivar was inoculated with *F. graminearum*. FHB symptoms were recorded as incidence (percent of heads infected) and severity (percent of spikelets infected). FHB index for each plot was the product of severity and incidence divided by 100. Our results showed that heading date and plant height were similar among wheat from Eastern and Western Canada included in the test and ranged from 147 to 156 days and from 69 cm to 110 cm, respectively. Moderate level of powdery mildew and septoria tritici blotch were estimated across all cultivars. The highest yield was recorded in cultivar AC Morley from Eastern Canada (4.7 t/ha), while the lowest FHB index was recorded in cultivar Emerson (20.7 %) from Western Canada. Funding for this project was provided by the Grain Farmers of Ontario, WGRF and AAFC under National Wheat Improvement Program.

P30- Introgression of resistance to Leptosphaeria maculans from Brassica juncea into B. napus and analysis of blackleg resistance in synthetic hexaploid Brassica species

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Canola (*B. napus*), one of the most valuable oilseed crops in the world, has been reported with significant yield losses of up to 100% due to blackleg disease caused by *Leptosphaeria maculans*. High levels of blackleg resistance can be introduced from *B. juncea* and synthetic hexaploid Brassica into canola through interspecific hybridization. The good seed setting and higher resistance rate showed in the progenies derived from synthetic Brassica will benefit further breeding studies for blackleg resistance. Introduction: Blackleg, a devastating disease in canola, can be controlled effectively using genetic resistance. Brassica species containing the B-genome, i.e. *B. juncea* (AABB) and synthetic hexaploid *Brassica* (AABBCC), are known to have high levels of blackleg resistance. Materials/Methods: Fifty *B. juncea* accessions (UM collection) and eight lines of synthetic *Brassica* developed by Dr. Meng were initially tested for blackleg resistance. Fifteen resistant UM lines were used for introgression of the resistance by backcrossing with a susceptible canola Westar. Three completely resistant synthetic 'Meng' lines were crossed with the partially susceptible UM line, and evaluated for blackleg resistance. Results/Discussion: High resistance was found in a small number of cases in backcrossed derivations of the resistant UM lines and Westar; improved plant fertility was also found. The 3:1 ratio of resistant to susceptible in BC1 implies that two loci responsible for blackleg resistance are segregating in the backcross populations derived between the susceptible UM line and 'Meng' lines. Conclusion: Although a high level of blackleg resistance can exist in the crosses of two tetraploids *B. juncea/B. napus*, it is harder than anticipated to introduce such resistance through hybridization between hexaploid and tetraploid. Higher resistance rates and better seed sets suggest that synthetic lines are feasible for developing blackleg resistance; understanding the mechanism of blackleg resistance in hexaploid 'Meng' lines will lay a foundation for introducing blackleg resistance to canola.

P31- Evaluation of Phytohormone Induced Resistance by application of methyl jasmonate, salicyclic acid and a biological control agent 'D. rapae parasitoid' against cabbage aphid in oil seed rape (Brassica napus L.)

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Aphids being destructive insect pests of canola, suck the plant juice through their sharp mouthparts causing severe damage. They attract fungal spores by production of honey dew and also serve as a vector of deadly plant viruses. This study was conducted to evaluate the effectiveness of exogenous application of Methyl Jasmonate (MeJA), Salicylic acid (SA) and the aphid parasitoid *Diaretiella rapae* as a bio control agent on oilseed rape plants (*Brassica napus* L.) against aphid infestation and to see whether it induces any specific resistance in plants. Various concentrations of MeJA (0 µM, 50µM, 100µM, 300µM) and SA (0 µM, 0.25 mM, 0.5 mM, 1 mM) were applied as foliar spray treatment after every fifteen days starting from 3 week old seedling stage. Cabbage aphids was reared and allowed (10 on each plant) to attack the plants exactly one day after the first spray. Aphids were allowed to feed on the leaves after which they were directly counted 3, 7, 15, 18 and 21 days after the treatments. For parasitoid treatment, a total of 10 *D. rapea* were allowed to parasitize each plant. The most effective level of treatments was also determined by studying the expression pattern of SA and MeJA dependent markers genes. The cross talk of MeJA and SA dependent genes was elaborated by studying the defense related genes expression through RT-PCR. The pathogenesis related protein 1 (PR1) and proteinase inhibitor (PIN2) were shown to be activated against aphid infestation. Upon treatment of SA, PR1 was activated but PIN2 was down-regulated whereas application of MeJA activated the PIN2 but down-regulated PR1 genes. Phytohormones application and biological control agent alone and in combination proved their worth by controlling aphids on *Brassica napus* L. plants suggesting it as unique and effective control measure instead of indiscriminate use of synthetic insecticides.

P32- Molecular and histological detection of Phytoplasma in Brassica campestris plants in Punjab Pakistan

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All over the world many crops are being damaged by diseases caused by phytoplasma. It preferentially damages the plant phloem tissues causing various morphological, anatomical and molecular changes in plants. Phytoplasma disease infects a large variety of ornamentals, vegetables, fruit plants like tomato and reduces the crop yield and quality which leads to great economic losses. A phytoplasma associated disease was observed in sarsoon (*Brassica campestris*) during a survey conducted in Punjab,

Pakistan during 2013-2015. Plant samples of both diseased and healthy types of *Brassica* were collected from Brassica crop fields from Khanewal Dist., Punjab, Pakistan. The symptomatic plants showed characteristic symptoms of phyllody, virescence, severe stunting, excessive proliferation of shoots, inflorescence-clustering, small leaves and witches' broom structures, large internodal distance and reddening of stem and leaves. Sections of healthy and infected plants were cut with sharp razor blade and then stained with toluidine blue and Diene's stain. The infected phloem cells were stained blue with Diene's stain while purplish pink with toluidine blue stain. Phytoplasma presence was further confirmed by nested polymerase chain reaction followed by RFLP analysis of the 16S rRNA and tuf genes and sequencing of the 16S rDNA plus part of the spacer region. The phytoplasmas were identified as members of a new subgroup.

P33- Management of three geographical distinct populations of Brassica army worm (Spodoptera lituraF.) pest through microbial insecticides-Nucleopolyhedroviruses and spinosad

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The use of bio-pesticides against destructive insect pests of field crops has obtained a high level of significance these days. This natural/biological control approach may serve as a potential replacement when insect pests gain resistance against synthetic residual insecticides. In the present investigation, laboratory trials were conducted to investigate the effect of locally isolated new Nucleopolyhedroses virus (NPV) and sub-lethal dosage of Spinosad alone and in combination against three field populations of army worm (Spodopteralitura -Lepidoptera: Noctuidae). Three dose rates of NPV (2 x 109; 3 x 109; and 4 x 109 POB mL-1) and Spinosad at the dose rate of (0.01 ppm) were applied alone and in combination against 2ndand 4thinstar larvae from different geographical areas of Punjab (Pakistan) province. The data regarding mortality was recorded after every 24 h and the last count was recorded till pupation, adult emergence and egg eclosion for both larval instars. All the bioassays were carried out at 25±2°C, 75% r.h. and L16: D8 h photoperiod. The difference in larval mortality occurred due to treatments, larval instar and different localities. The higher dose rate of NPV with Spinosad exhibited synergistic interaction while the rest of combinations were additive in all the tested populations. Our results showed that the army worm population from Rahim Yarkhan was least susceptible whereas that of Faisalabad was highly susceptible. Moreover, it may be inferred that spinosad and NPV mixtures can prove as a potential Integrated Pest Management (IPM) strategy against S. litura in vegetable crop growing areas.

P34- Effects of Beauveria bassiana and/or Bacillus thuringiensis on the mortality, mycosis and sporulation in the cadavers of Red palm weevil Rhynchophorus ferrugineus Olivier

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The use of bio-pesticides is the potential replacement of synthetic residual insecticides to cope with the insect pest's resistance problem. Here, we conducted the laboratory trials to investigate the alone and integrated effect of Beauveria bassiana (Balsamo) Vuillemin (1.8 × 107 and 1.8 × 108 conidia ml-1) and Bacillus thuringiensis (Berliner) at the dose rate of (0.5 and 1 µg g-1) against 5th and 6th larval instars of Rhynchophorus ferrugineus Olivier (Curculionidae: Coleoptera). Results revealed that the combined application of B. bassiana at the rate of 1.8 × 108 conidia ml-1 and B. thuringiensis at 0.5 and 1 µg g-1 exhibited synergistic effects, while at its lower dose rate combination of B. bassiana with both dose rates of B. thuringiensis showed additive effect against both target larval instars of R. ferrugineus. Moreover, the mortality data explained that 5th instar larvae were more susceptible than 6th instar to all the treatment combinations. The data for mycosis and sporulation revealed that maximum rate of mycosis and sporulation in the dead larvae of R. ferrugineus was recorded where B. bassiana was applied at dose rate of 1.8 × 107 conidia ml-1. Findings of the current study work suggest that the effectiveness of B. bassiana could be fortified in the presence of B. thuringiensis against R. ferrugineus on the date palms.

P36- Molecular detection of NPV and its biological activity for the control of army worm Spodoptera litura Fabricius

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The cotton army worm *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae) is a destructive pest of various field crops and brassica vegetables in Pakistan. Development of bio pesticide is an attractive strategy to minimize the problems of pest resistance, environmental pollution and human health concerns. Three isolates of S. litura Nucleopolyhedroviruses (SLNPV) were collected from infected larvae fed on natural field crops. The rapid

and sensitive polymerase chain reaction (PCR) technique was used for the molecular detection of NPV gene from different geographical NPV isolates. The deduced amino acid sequences of the polyhedrin sequence of these isolates were compared with different NPVs isolate available in Genbank. The biological activities of these NPV isolates were investigated under laboratory and field condition. The highest mortality of *S. litura* was observed at early instars. The LC50 values of various NPV isolate of about 105 OB/ml were recorded against second and forth instars of *S. litura*. The median lethal time (LT50) of various isolates was 3.5 days on second instar and 6 d on fourth instar, respectively. This study provides an opportunity to cut down the use of synthetic approaches and develop safe biological/microbial insecticides from NPV isolates, which in future may effectively control *S. litura*.

P37- Cadmium uptake by potato plants in soils amended with super absorbent polymer (SAP) and plantain peel biochar (PPB)

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Wastewater is used for irrigation in many countries. Despite the benefits of wastewater irrigation, presence of contaminants such as heavy metals is a cause of concern. Cadmium, a common heavy metal found in wastewater, poses a serious threat to humans as it can induce bone, kidney and pulmonary disorders. Cadmium is known to be bioavailable and can be easily taken by the plants. Majority of cadmium exposure in an average human occurs via consumption of vegetables. Thus, uptake of heavy metals by food crops under wastewater irrigation should be studied. In our study we investigated the effect of addition of super absorbent polymers (SAP) and plantain peel biochar (PPB) in soil on uptake of cadmium by potato plants. Potato plants were grown in sandy soil in lysimeters (45 dia. X 100 cm, above ground PVC cylinders packed with soil), and were irrigated regularly with laboratory prepared synthetic wastewater. Soil was amended with SAP, PPB as well as SAP+PPB mix (1% w/w application rate). Upon harvest, parts of potato plant (tuber flesh, tuber peel, root, stem and leaves) were sampled and were analyzed for cadmium concentrations using ICP-MS. Results indicated that use of SAP and SAP+PPB mix soil amendments, reduced average cadmium uptake by 77.7% and 94.2% respectively for potato peel and by 53.1% and 80.0% respectively for potato tuber flesh samples. **CSA Student Competition**

P38- Uptake of heavy metals in potatoes irrigated with untreated wastewater

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Potatoes, a vital source of antioxidants, proteins and starch, are among the most important tuber crops grown in the world. One of the modern potato cultivars, Russet Burbank (RB), is known to be sensitive to soil available water and requires regular irrigation. Since several farmers in developing countries irrigate with untreated wastewater, the uptake of contaminants by potato plants is of great concern. Among such contaminants are heavy metals, which are known carcinogens, mutagens and teratogens. Therefore, we investigated the uptake of four heavy metals (Cd, Cu, Pb and Zn) by RB potato, irrigated with untreated wastewater, in a sandy soil amended with plantain peel biochar. Biochar is a carbon-rich pyrogenic material, produced from waste biomass, to enhance soil filtering capacity, while, at the same time, sequestering carbon. Six above-ground PVC lysimeters (100 cm X 45 cm) were packed with sandy soil, biochar (1%) was mixed in the top 10 cm of soil in triplicate against a control (no biochar). Synthetic wastewater was applied, at the just ponding rate, every 10 days in all the treatments. The potato tissues (root, tuber, stem, peel and flesh) were sampled, extracted, and analysed on ICP-MS for heavy metal analysis. A significant decrease in the concentrations of all the trace metals was observed in the below ground parts (root, peel, and flesh) of the potato grown in the biochar-amended lysimeters against the control. However, no difference was found in the concentrations of trace metals in the above ground parts (stem and leaf) for both the biochar treatment and control. **CSA Student Competition, CSHS Student Competition**

P39- Soil mineral nitrogen supply and grain yield estimation of canola in relation to growing season canopy reflectance measurements

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Non-destructive method with the capability of determining the crop N status at early growth stages would be extremely helpful to allow in-season N adjustments according to the soil mineral N (SMN) supply and also to estimate the potential crop yield in its current, specific environment during the growing season of canola (*Brassica napus* L.). A field experiment was conducted in a cool and humid environment in northern Ontario from 2013-2014, to assess the feasibility of in-season canopy reflectance measurements to characterize soil N supplying power at early growth stage of canola crop and also to estimate potential grain yield of canola, in response to various combinations of preplant (0, 50, 100, 150, 200 kg/ha) and

sidedress (50+50, 50+100, 50+150 kg/ha) N applications. Field data were collected throughout the growing period. CropScan was used to get canopy reflectance measurements from pre-sidedressing to early flowering and data were used to compute the normalized difference vegetation index (NDVI). The NDVI values had a strong correlation with SMN levels measured at 20% flowering stage, indicating that canopy reflectance signature is a good indicator of soil N supplying power at early growth stage of canola and could be used for the determination of the required N amounts as sidedress. A strong correlation between NDVI values and canola yields in plots that received different combinations of preplant and sidedressed N indicate that canopy reflectance measurements can be used for estimating potential grain yield of canola. Moreover, split N was more efficiently utilized by canola, leading to greater grain yields than with applying the crop's entire N requirements at seeding, showing the requirement of in-season N application for canola crop production.

P40- Spatial characterization of soil mineral nitrogen, crop growth, and yield of canola as affected by nitrogen application

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Understanding spatial variability of soil mineral nitrogen (SMN) and crop growth patterns is important for implementing precision nitrogen (N) management strategies for canola {Brassica napus L.}. A field experiment was conducted from 2012-2014 in northern Ontario to investigate within field spatial variability of SMN in relation to in-season soil and crop growth measurements and yield map data. A commercial canola field was divided into 12 large strips and each of four rates of pre-plant N (0, 50, 100 and 150 kg/ha) was implemented. Data were collected throughout the growing season and yields were recorded using yield monitors. Data in 2012 was reported here addressing some key findings. SMN (0-30 cm depth) varied significantly across the field-strips and within the field-strips that received the same treatment, indicating the significance of spatial variability in crop N availability at field level. Some crop parameters (LAI, biomass, branches, pods and plants numbers) varied widely across the field with high coefficient of variation, and varied even within the field-strips that received the same treatment. Some crop parameters (plant height, branch numbers) and plant N contents had strong correlations with SMN measured at early flowering, suggesting good potential for in-season site-specific N management for canola. Yield varied significantly (1.7-2.6 t/ha) across the field and among field-strips that received the same treatment. Although yield responded positively to N, yield did not increase consistently with N rates. Compared to the control, only 100N had significantly higher yield, while 50N and 150N had insignificant increases, indicating fertilizer N was not utilized efficiently by canola crop due to the influence of large spatial variability within field. The strong association between spatial variability in SMN with crop growth measurements and grain yield of canola provide substantial evidence for site-specific N recommendation for canola based on SMN variability.

P41- Micronutrient deficiencies in prairie soils and crop yield responses to fertilization

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Assessing the need for micronutrient fertilization and factors influencing the likelihood of crop response is a concern in the development of crop nutrition plans for growers on the prairies. It is not well known what specific soil conditions contribute to the low availability of Cu, Zn and B in the soil, to what extent deficiencies conclusively exist across the prairies, and the degree to which these crops may respond to fertilization with these micronutrients in different crops. The overall objective of this research is to examine the forms and amounts of Cu, Zn and B in prairie soils, and their relationship with soil properties and crop yield. This research work first involves the collection of 47 soils from across the Canadian prairies to provide contrast in basic soil properties like soil organic matter content, texture and pH. Afterward, five soils with a range of micronutrient fertility from deficient to sufficient according to standard soil test method are used to grow wheat, pea and canola crops. There was a significant negative correlation between DTPA-extractable Cu and sand percentage, whereas hot-water extractable B showed significant positive correlations with pH and CO3 content. A significant positive correlation was also observed between availability and supply (resin-membrane) of Zn, but not with any of the soil properties. The grain yield of wheat was significantly increased by Cu fertilization in two of the five soils. Initial Cu fertility was below critical level in one soil (Ukalta), while the other one considered as sufficient (Sceptre) based on soil-test result interpretations. No significant response of peas to Zn fertilization was recorded on any of the five soils. Canola significantly responded to B fertilization on one soil (Whitefox), which was critically deficient in B and only soil application was effective in correcting the problems for Canola production.
CSA Student Competition

P42- Response of complex grass-legume mixtures to nitrogen fertilization under cattle grazing.

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Complex grass-legume mixtures have been studied in recent years to identify the best species for high dry matter (DM) yield in forage systems for grazing livestock but little is known on their N requirements. Our objective was to evaluate the effect of N fertilization on the DM yield of complex grass-legume pasture mixtures. Two grass mixtures (GM1: timothy, meadow fescue, reed canary grass, and Kentucky bluegrass; GM2: tall fescue, meadow bromegrass, reed canarygrass, and Kentucky bluegrass) were seeded in 2013 with alfalfa (cv. CRS-1001) or birdsfoot trefoil (cv. AC Langille) at New-Liskeard (ON). These mixtures were evaluated under three N rates (0, 60, and 120 kg N ha-1 year-1) with half of the N applied in the spring and the second half applied after the second grazing cycle. Nitrogen fertilization did not significantly affect DM yield (3.0 to 3.9 t ha-1) in the first post-seeding year but it significantly increased DM yield by nearly 1 t ha-1 in the second post-seeding year. The contribution of the two legume species to DM yield ranged from 18 to 49 % in the first post-seeding year and from 1 to 6% in the second post-seeding year. The DM yield of the GM1-based mixture was the same with both legume species, while the GM2-based mixture yielded more with birdsfoot trefoil than with alfalfa in first post-seeding year (4.0 vs 3.1 t ha-1) and in second post seeding year (10.5 vs 10.0 t ha-1). In the second post-seeding year, tall fescue contributed more than 65% to the DM yield of the GM2-based mixture, while timothy and meadow fescue contributed more than 42% to the DM yield of the GM1-based mixture. Our results demonstrate the importance of legume species for the N nutrition of grass-legume pasture mixtures.

P43- Growth response of soybean *Glycine max* (L.) Merr. to controlled environment simulation of field soil water conditions using 1-m rooting columns

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Soil water deficits significantly limit Ontario's soybean yield in most growing seasons with demonstrated losses ranging from 8 to 24%. The pattern of soil water availability in frequently watered small pots is different from a field environment. In small pots, volumetric soil water content (VSWC) is relatively high throughout the rooting zone due to lack of suction to remove water from large and midsize capillaries. This necessitates the use of growing media with relatively large pore space to avoid anaerobic conditions, and so prohibits the use of field soil in small pots. However, in 1-m rooting columns the 0.01-MPa gravitational potential difference between top and bottom may permit the use of lightly-amended field soil as a growing medium and provide for realistic soil water profile variation with depth. This study aimed at developing a controlled environment culture system that permits realistic rooting depths and establishment of soil water profile gradients that mimic field conditions, and selecting the best growth medium based on rooting depth, soil water distribution, and biomass accumulation. The soybean cultivar OAC Bayfield was grown in a field soil (FS) amended with different volumes of granitic sand and peat-based potting mix in polyvinyl chloride tubes having an inside diameter of 10 cm and length of 100 cm. We tested 3 soil mixtures (0, 50, and 67% FS mix), watered to 75 and 100% tube capacity. VSWC was calculated from time-domain reflectometry (TDR) measurements. The 67% FS mix watered to 100% tube capacity resulted in a uniform field-like soil water profile with depth, and the highest biomass accumulation. Watering to 75% tube capacity of the 67% FS mix significantly reduced shoot, root, and whole-plant dry matter accumulation by 27, 20, and 26% respectively. These results suggest the 67% FS mix as the best growth medium for subsequent experiments. **CSA Student Competition**

P44- Yield and uptake of nitrogen and phosphorus in soybean, pea, and lentil, and effects on soil nutrient supply and crop yield in the succeeding year in saskatchewan, canada

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Soybean production is expanding in western Canada, but there is limited information on the yield, nutrient requirements, and rotational benefits of soybean grown under western Canadian conditions. Through a two-year field experiment conducted at four locations in Saskatchewan, this study quantified grain and straw yield and N and P uptake by three short-season soybean varieties in comparison to three varieties of pea and lentil, and in the following year assessed the soil supplies of available N and P and the grain and straw yield and N and P uptake by wheat and canola. Soybean grain yields (929.2 - 3534.0 kg ha-1) were comparable to other results from western Canada, but about 20 % lower than results from eastern Canada or the mid-western USA. Compared to pea and lentil, selected soybean varieties had medium to high grain yields, relatively high N (39.3 - 47.6 g N kg-1) and P (5.1 - 6.8 g P kg-1) concentrations and uptake (40.4 - 168.0 kg N ha-1 and 5.8 - 21.2 kg P ha-1) in the grain, and lower N and P concentrations and uptake in the straw. In the following year, soil supply of available N was lower under soybean stubble than lentil stubble in the first two month following seeding, and soil supply of available P was higher under soybean stubble than lentil stubble throughout most of the growing season at one site. Wheat and canola had similar yields and N and P uptake from soybean, pea, and lentil stubbles across the sites, implying comparable rotational

benefits of soybean to pea and lentil under Saskatchewan conditions. High grain P removals of soybean need to be considered in long-term fertility maintenance planning for rotations, and studies examining rotational effects over several cycles of the rotation would be desirable under western Canadian soil-climatic conditions. **CSA Student Competition**

P45- Application of site-specific management in hard red wheat

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Site-specific nitrogen (N) management approach in hard red winter wheat (*Triticum aestivum*) has been suggested as one means of increasing N use efficiency for grain yield and protein. This approach can be accomplished by delineating the field into potential management zones for the variable application of N, with a uniform rate of N optimized for each specific zone. Field studies were conducted in southwestern Ontario to investigate grain yield and protein concentration responses to several N management strategies across variable landscapes. Nine N trwoodeatments were arranged in a randomized complete block design with four replications along the length of the field, with each replication subdivided into eight management zones. These treatments consisted of various combinations of N rates, sources and timings relative to crop development. Grain yield and protein percentage response to applied fertilizer N rates were characterized using a quadratic model. The N rate of 168 kg N /ha had the highest yield, as the grain yield response ranged from -0.56 to 4 tonne/ha depending on the management zone. Moreover, foliar late application of N (GS70) was found to increase grain protein concentration at all sites. Wheat response to N fertilizer, as measured by delta yield and delta protein, was highly variable spatially across each field which led to identifying optimal N treatment for each zone in the field.

P46- Screening synthetic hexaploid wheat derivatives for phosphorus use efficiency

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Phosphorus (P) is a non-renewable resource, where current high quality reserves have approximately 60 to 130 years remaining based on current removal rates. Agricultural production worldwide harvests 12 MT of P annually for fertilizer use. Not only are current removal rates unsustainable, fertilizer application from agriculture production is a major source of P loading into water bodies around the world. Developing more P efficient crops through genetic improvement may improve the P balance efficiency of the entire cropping system by preventing dissolved P from being lost, exported and accumulated in the field. As a major cereal crop worldwide, Wheat has the potential to be improved in terms of its genetic diversity for P use efficiency (PUE). We hypothesize that synthetic hexaploid wheat (SHW) lines contain significant variation for desirable quantitative traits, including P uptake and P utilization efficiency, that can be used for breeding purposes. To investigate this, 194 SHW accessions from The International Maize and Wheat Improvement Centre (CIMMYT) will be grown and phenotypically evaluated for traits associated with PUE under optimal P conditions and P deficient conditions in a low P field in Elora, Ontario. A genome wide association study using the 194 genotypes will be conducted to identify genomic regions associated with PUE. GWAS will allow for the identification of the association between genotype and phenotype. In addition, tissue culture will be conducted using three levels of phosphorus to examine root traits of each genotype under each condition. Results from the phenotypic analysis in the growth room and through tissue culture will be presented. **CSA Student Competition, CSHS Student Competition**

P47- The effect of copper fertilizer rates, forms, and application method on wheat growth in a range of prairie soils

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Copper (Cu) is an essential plant micronutrient that is most often deficient for cereal production in prairie soils. Wheat is especially sensitive to low soil Cu supply, and increasing soil Cu removal with higher yielding varieties may lead to more Cu-deficient soils. The objectives of this greenhouse study were to examine the effect of different forms, rates, and application methods of fertilizer Cu on yield and Cu uptake of hard red spring wheat (AC® Waskada) grown in a variety of prairie soils, and to develop an improved method for detecting soil Cu deficiencies across a broad range of western Canadian soil types. Fifteen soils (12 mineral and three organic) were collected throughout Alberta, Saskatchewan, and Manitoba with five fertilizer Cu treatments imposed: an unfertilized Control; two foliar applications of 0.25 kg Cu/ha (either CuSO4 or chelated-Cu; applied at the flag leaf stage); and two banded applications (either CuSO4 or chelated-Cu) at rates from 1 to 5 kg Cu/ha, depending on fertilizer form and soil type. The banded CuSO4 generally provided the best response, especially for the organic soils. The foliar Cu corrected Cu-deficiency symptoms and prevented yield loss of wheat growing in mineral soils, but not in the organic soils; possibly reflecting a need for early Cu supply in these highly deficient soils. Foliar CuSO4 was as effective as foliar chelated-Cu for most soils. There was a strong inverse relationship between the initial soil Cu level, when

measured using a novel DTPA-treated ion-exchange resin membrane, and the observed wheat yield response to the added fertilizers. The DTPA-treated resin membrane appeared to provide a reliable index of soil Cu supply for identifying mineral soils that are responsive to Cu fertilization.

P48- Growth yield and economics of wheat (Triticum aestivum L.) in relation to tillage and precision nutrient management practices

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Conventional tillage and faulty nitrogen management has led to extensive use of energy which results negative soil and environmental impacts, therefore modifications in these practices area required to achieve sustainability, profitability and safe environment. Considering the importance of the above, two years investigations were carried out at Norman E. Borloug Crop Research Center of G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar (Uttarakhand), India during rabi season of 2013-14 and 2014-2015. Strip plot design with three replications were used for study. Three tillage practices viz. conventional tillage, reduced tillage and zero tillage were kept in horizontal strip and precision nutrient management practices viz recommended NPK, SSNM based nutrient management & SSNM+ Green Seeker based nutrient management were kept in Vertical strip. Results revealed that all the growth parameter viz emergence tillers, plant height, dry matter accumulation and yield attributing characters i.e effective tillers, spike length, number of grains/spike, 1000 grain weight, grain, straw yield, N, P and K content in grain and straw, total N uptake and benefit cost ration were significantly higher in reduced tillage as compared to other tillage practices. The values of SPAD meter and Green Seeker was found statistically similar in all tillage practices. However, the energy use efficiency was higher in zero tillage. Recommended NPK i.e 150 :60: 40 kg/ha, produced significantly higher value of all the growth and yield parameters as compared to SSNM and SSNM+ Green Seeker based nutrient management. Thus on the basis of findings , it can be concluded that all the tillage practices are equally important but reduced tillage produced better growth , yield and other parameters in wheat. While among nutrient management practices, recommended NPK is beneficial over SSNM and SSNM+ Green Seeker based nutrient management practice.

P49- A novel 'wicking' method for estimating the field capacity of mineral and organic soils.

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The need to develop plant varieties tolerant of variable soil moisture conditions requires growing different genotypes at varied target soil moisture levels. To accomplish this, a simple and reliable means of estimating the moisture content of the soil at field capacity is needed. Ceramic pressure plate extractors are most commonly used to estimate the soil moisture content at field capacity, however, these specialized instruments are difficult to access and require weeks to process each soil sample. The efficacy of a novel method to rapidly estimate the field capacity moisture content for a broad range of soil types was assessed. The method uses simple water absorption through capillary action. Fifty-seven contrasting prairie soils were used to evaluate the method by comparing capillary water uptake to the conventional pressure plate method. A strong correlation between methods was observed, indicating the "wicking" approach to be a promising rapid alternative to the pressure plate method for estimating the field capacity of soil.

P50- Nitrogen placement and the role of enhanced efficiency fertilizers

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There are three major losses of nitrogen (N) from the soil-plant system, namely, volatilization, denitrification and leaching. There have been a number of practices recommended to reducing volatilization of urea-based fertilizers, e.g., use of urease inhibitors, slow-release forms, and, irrigation shortly after application. However, the most common practice in western Canada has been incorporation of the fertilizer into the soil, especially in bands. This practice now is under scrutiny as shallow banding of urea-based is proving to be less efficient in affording protection of urea-based fertilizers than deep banding. This study compared deep-, shallow-banded and broadcast urea with or without the addition of stabilizers. Agrotain® stabilized urea (NBPT) and SuperUâ (NBPT and DCD) fertilizer were used (NBPT is a urease and DCD a nitrification inhibitor). There were no differences in yield when fertilizers were deep banded (6-8 cm); however, broadcasting or shallow banding (1-4 cm) non-stabilized urea resulted in significant yield reductions.

P51- Optimal fertilizer placement and timing in sugarbeet (Beta vulgaris l.) based on nitrogen use efficiency and yield

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For sugarbeets, crop consultants have recommended including N fertilizer with the planter in a 5-by-5 cm band but this practice has not been evaluated and may influence fertilizer N use efficacy (NUE) and root and sucrose yield. In Southwestern Ontario at two locations per year in 2013-2015, a randomized complete block design experiment with four replicates was established to determine the impact of fertilizer placement and timing on sugarbeet productivity. Treatments were a 5-by-5 cm band of N and P applied together (trt5-NPband) or alone (trt3-Nband; trt4-Pband) at 45 kg ha-1. Except in the zero-NP control (trt1-0NPcontrol), total fertilizer N applied in all treatments was 112 kg N ha-1 and other controls included pre-plant broadcast incorporated N (trt9-Npreplant) and in-season, injected N (trt2-Nin-season). Plots were 6m (8 rows) by 10m with two 4m long center rows harvested. Pooled over all site-years, trt5-NPband root and recoverable white sucrose yields were 78 and 9.7 Mg ha-1 yr-1, respectively which were 17.8% and 14.8% higher than trt1-0NPcontrol ($P<0.05$) but yields were not different than other fertilizer treatments. Fertilizer treatments were not different between each other in most NUE indices but all differed from the trt1-0NPcontrol. A two-way interaction between treatment and harvest date in apparent fertilizer N recovery in the root (proportion of N in root compared to zero-NP), fertilizer uptake efficiency (fertilizer derived plant N increased relative to trt1-0NPcontrol), and N uptake efficiency (N in plant compared to available N in soil) indices suggest no differences between trt-Nband or trt4-Pband and trt5-NPband at each harvest. Thus, numerically higher yields and no differences in NUE parameters between treatments favour the adaption of N and P applied in a 5-by-5 cm band with planter (trt5-NPband), which supports the new fertilizer recommendation. However, there is little evidence based on yield and NUE to suggest growers change planter equipment.

P52- Decomposition and nutrient release characteristics of ten annual crop residues in South-Central Saskatchewan.

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Quantifying crop residue decomposition will help to improve our understanding of carbon sequestration and nutrient cycling within agroecosystems, while providing valuable data for model development and validation. The objective of this study is to quantify the decomposition and associated nutrient release dynamics of post-harvest residues from a variety of annual cereal, pulse, and oil seed crops grown in Saskatchewan: barley, wheat, oats, field pea, soybean, faba bean, lentil, canola, flax, and hemp. Litter bags were placed on the soil surface in the fall of 2015 prior to snowfall and will be collected in the spring of 2016 (six-months), fall 2016 (1-yr), fall 2017 (2-yrs), and fall 2018 (3-yrs), in order to model the rates of mass loss and release of nitrogen, phosphorus, potassium, and sulphur to the plant available soil nutrient pool. We hypothesize that the decomposition and nutrient-release characteristics will vary among crop residues and nutrients, with relatively narrow carbon-to-nitrogen ratio residues exhibiting faster decomposition rates. Results from the initial six-month period will be presented.

P53- Nitrogen inputs from cover crops in combination with mineral and organic fertilization

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Estimation of the contribution of nitrogen (N) from cover crops (CC) to subsequent crops remains a challenge because N inputs depend on CC biomass and its N concentration and mineralization rate. The objective of this project was to evaluate the impact of four CCs with or without mineral and organic fertilization, on N inputs to a subsequent spring wheat (*Triticum aestivum* L.). A field experiment was conducted near Quebec (Qc) for two years. The factorial experiment included five CC types (control without CC, a mixture or red clover (*Trifolium pretense* L.) and white clover (*Trifolium repens* L.) intercropped with barley, and oat (*Avena sativa* L.), field pea (*Pisum sativum* L. var. arvense) and oilseed radish (*Raphanus sativus* L.)) grown as catch crops after barley; and three fertilization types (0N, 50N mineral - 27-0-0 or 50N organic - pig slurry). Microplots were included in the main plots where 15N-labeled fertilizers were applied to determine the actual N cycling in the soil-plant system. In fall 2014, the clover mixture produced a greater aboveground biomass (3.8 t MS ha-1) and accumulated more N (108 kg N ha-1) than the other CCs, while in 2015, field pea, oilseed radish and clover had similar biomasses (about 3 t MS ha-1). In 2014, fertilizers treatments increased biomass production and N uptake in oat and oilseed radish. By contrast, field pea did not respond to fertilization, whereas the biomass of clover decreased. In 2015, fertilizer treatments had a positive effect on biomass of all CCs. On average in both experimental years, more N was returned to the soil with legume than non-legume CCs. Compared to the control treatment without CC, significant increases in wheat yield in the following year occurred with clover (23%), followed by field pea and oilseed radish (mean of 8%).

P54- Long term effect of liquid dairy manure application, crop rotation and tillage practices on soil nitrogen stocks

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The use of liquid dairy manure as fertilizer is a common practice in dairy-based cropping systems which provides considerable quantities of nitrogen to the soil. The response of nitrogen stocks to repeated dairy manure applications has not yet been thoroughly studied despite its significance for plant nutrient supply and risks of environmental losses. The response of soil nitrogen stocks may vary depending on the nitrogen form (organic or mineral) and with the associated management practices such as tillage or crop rotations. The objective of this project situated in a nordic area of the province of Quebec (48°50'N, 73°33'E), was to estimate the nitrogen budget and to determine the response of nitrogen stocks along a soil profile (0-50 cm) to long-term (21 years) application of liquid dairy manure in combination with two crop sequences (continuous cereals vs. cereal-perennial forage rotation) and two fall primary tillage practices (moldboard plowing vs. chisel plowing). The nitrogen budget revealed the importance of the contribution of the atmospheric nitrogen fixation by the legumes to the soil nitrogen stocks. After 21 years, soil N stocks were 17% greater in the cereal-forage rotation than under continuous cereals. Moreover, the effect of manure was greater (+24%) when applied in the perennial-based rotation than under continuous cereals, suggesting a synergy in the effects of manure and the presence of perennial forages in the rotation.

P55- Interaction of copper and zinc with variable soil phosphorus for crop production in rotation

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Managing soils to provide a continuous and balanced supply of all essential plant nutrients is important for optimizing the yield and nutritional quality of food crops. Several nutrient interactions such as interactions between micronutrients and between micro and macronutrients are not well understood but is attributed to the origin of nutrient deficiencies in crop production under some circumstances. A growth chamber study was conducted using phytotron facilities at the University of Saskatchewan to evaluate the mechanism involved in "induced deficiency'' of nutrients resulted from different nutrient interactions. It was hypothesized that high levels of soil P will induce Cu and Zn deficiency by reducing nutrient supply to the crop plants due to the formation of insoluble precipitates or chemical species. The antagonistic relationship of Cu and Zn in the plant uptake process was also considered. Treatment evaluation includes two P rates (0 and 100 kg ha-1 of P2O5) into which different micronutrient additions were made: 1) control (no micronutrients); 2) Cu; 3) Zn, and 4) Cu+Zn. The study was designed to grow wheat as first crop followed by yellow pea as the second crop with normal (recommended) macronutrient fertilizer practices to assess year of application and second-year residual effects of the nutrient interactions. There was a significant interaction between micro and macronutrient fertilization for wheat production. The effect of Cu and Zn fertilization was not significant with added P, but a strong antagonistic effect was recorded without P fertilization. The growth and yield of wheat significantly decreased with combine addition of Cu and Zn compared to control and individual applications of Cu or Zn. Pea yield was not significantly affected by the residual effects of any these treatment interactions. **CSA Student Competition**

P56- Global nitrous oxide emission factors from agricultural soils after addition of organic amendments: a meta-analysis.

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Agricultural soils receiving synthetic fertilizers and organic amendments containing nitrogen contribute a large part to anthropogenic nitrous oxide (N2O) emissions. As a source of nitrate that undergoes reduction to N2O, organic amendments also change soil C availability and redox potential, which influences the N2O emission factor (EF) of organically-amended soils. The objective of this study was to conduct a meta-analysis of N2O EF from agricultural soils receiving organic amendments. A global survey of peer-reviewed literature resulted in the selection of 38 studies including 422 observations at 43 sites in 12 countries. The analysis yielded a global EF for all organic sources, EForg, equal to 0.57 ± 0.30%, which is lower than the IPCC default EF of 1 for synthetic fertilizers. Three groups of organic amendments with similar EFs were identified: the high-risk group including animal slurries, waste waters and biosolids (1.21 ± 0.14%); the medium-risk group including solid manure, composts + fertilizers and crop residues + fertilizers (0.35 ± 0.13%); and the low-risk group including composts, crop residues, paper mill sludge and pellets (0.02 ± 0.13%). The EF was higher when soils received organic amendments in combination with

synthetic fertilizers, such as liquid manures + fertilizers (2.14 ± 0.53%), composts + fertilizers (0.37 ± 0.24%), and crop residues + fertilizers (0.59 ± 0.27%). The EF was modulated by amendment (C/N ratio), soil (texture, drainage, organic C and N) and climatic (precipitation) factors. For example, EFs were on average 2.8 times greater in fine-textured than coarse-textured soils. We recommend site-specific EFs that consider organic amendment chemistry, soil characteristics, climate conditions and whether the organic amendment is applied alone or in combination with synthetic fertilizers.

P57- Oat avenins: Do they all contain celiac causing epitopes?

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Intolerance to gluten storage proteins in cereals like wheat, rye, barley and oat are known to cause celiac disease. These proteins, known as gluten (glaidin, and glutenin) in wheat, secalin in rye, hordein in barley and avenin in oat, are proline and glutamine-rice. When ingested by certain genetically predisposed individuals, can trigger an autoimmune response in the small intestine of these individuals, irrespective of their age. For celiac disease, the only available therapy is following a lifelong gluten free diet. This disease has been found to have a very strong association with human leukocyte antigens HLA-DQ2 and/or HLA-DQ8, which release CD4+ T cells in lamina propria of the small intestine upon presentation of gluten proteins. Since oats are less related to wheat than are barley and rye, a number of reports have identified oats as being safe for consumption by celiac patients. Oats also differ from other small grain cereals in percentage of gluten proteins with oats containing only 16-20%, while wheat, rye and barley have ~70%, 50% and 52% respectively. However, some studies suggest that T-cell epitopes, the protein sequence presented to host T-cells, of avenins cause immunogenic reaction in celiac patients. To better understand these contradictory results, we performed bioinformatic analysis of 10 oat varieties. We complied a list of all the available avenin sequences. We then used command-line blast to align these sequences to cDNA libraries from 10 *Avena sativa* varieties. We found sequence variation in the avenins present in different oat varieties, as well as variation in abundance of T-cell epitopes among those varieties. Furthermore, PCR analysis of DNA from different oat varieties using avenin specific primers showed polymorphism in avenins, leading us to speculate that the variation in avenins and their T-cell epitopes may differentiate between safe and unsafe oat varieties. **CSA Student Competition**

P58- Molecular markers assisted verification of hybrid of different intervarietal crosses of gladiolus (Gladiolus grandiflorus L.)

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Randomly amplified polymorphic DNA (RAPD) and inter simple sequence repeat (ISSR) were used to assess the hybrid verification of the crosses Careless and Red Beauty, Jester × American beauty, Careless × Jester, Nathan red × Jester, Red Beauty × Jester of gladiolus *Gladiolus grandiflorus* L. . DNA from the leaf samples were isolated and detected by 8 primers of the 15 ISSR primers used and 5 primers of the 15 RAPD primers used. The remaining 7 ISSR and 10 RAPD primers did not amplify polymorphic DNA bands among the parental lines. The primers which gave polymorphic bands in parents were then selected and used for assessing hybridity of different F1's. In these hybrids, 3 out of 8 ISSR primers used, 3ASSR01, 3ASSR42, 3ASSR53, amplified specific bands which were present in the parental lines. Though the RAPD primers amplified polymorphic bands in parents, it failed to give any results in the hybrids. Since the primers 3ASSR01, 3ASSR42, 3ASSR53 provided clear DNA patterns, it could be used for verifying the hybridity of the different crosses of gladiolus. It was concluded that use of molecular markers allow the differentiation of true hybrids from selfed individuals and outcrossed individuals with foreign pollen. Presence of non-essential genotypes observed among the hybrid seedlings established the importance of hybrid purity tests and those false hybrids could be removed. Among the two primers, ISSR proved to be more useful in assessing the hybridity of F1's and can be used as an effective tool for identification of hybrids. The ISSR marker information through this study will be of immense help to select appropriate marker combinations and assess hybrid purity of the F's.

P59- DNA marker genotyping of Brazilian spring wheat germplasm

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It is estimated that by 2050, the world will need to feed over 9 billion people. Wheat production will need to increase by more than 60% to meet the demands of these consumers. However, wheat demand has outstripped production in 8 of the 15 years from 1998 to 2013. Improved wheat varieties and modern agronomic practices can greatly improve production. Genetic variability is a crucial element in any wheat breeding program. Eighty-one wheat lines from a variety of Brazilian breeding

institutions were received in 2014 as part of a Canada-Brazil germplasm exchange. The lines were distributed to a group of Canadian wheat researchers for further study. It was anticipated that the material would be a valuable source of disease resistance, particularly for fusarium head blight (FHB) and leaf rust. At the Agriculture & Agri-Food Canada Ottawa Research and Development Centre, 79 of these lines were characterised using over 20 DNA markers (including SSR, STS and SNP based markers) for more than 10 wheat characteristics. Traits included resistance to important diseases such as FHB, leaf and stem rusts including Ug99 races; grain quality (*Glu-B1)* overexpressed Bx7); and plant height (*Rht-B1, Rht-D1, Rht8*). We have identified a number of Brazilian lines that may have useful genes for breeding purposes. For example, Brazilian wheat lines have been found that carry DNA markers for *Sr2*, overexpressed Bx7 and *Rht8*.

P60- 00Ar134-1, a spring wheat line of intergeneric origin

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00Ar134-1 is an intergeneric spring wheat line derived from *Elymus repens* (quack grass). The line was developed as a potentially new source of resistance to Fusarium head blight (FHB) of wheat. 00Ar134-1 is resistant to Fusarium head blight and as well as leaf rust, stem rust, and common bunt. Although lower yielding and taller than commercial cultivars, this line is of similar maturity and kernel weight. 00Ar134-1 can potentially be used as a resistant parent for improving Fusarium head blight resistance in common wheat. **CSA Student Competition**

P61- Agronomic characteristics and quality of selected advanced purple wheat lines

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The phenolic and antioxidant content of Canadian purple wheats such as CDC Prime Purple may present market opportunities as functional foods, however information on their end-use quality is lacking. The aim of this study was to identify high yielding varieties of purple wheat with good resistance to plant diseases (e.g. Fusarium head blight) among a set of advanced lines to carry forward for quality analysis. A set of 36 lines (25 advanced lines, 11 commercial varieties) of hard spring wheat (red, white, and purple) was harvested in 2015 in two locations (Guelph and Ottawa). Agronomic parameters were assessed to select 10 lines to carry forward for further quality analysis. Close evaluation of the 36 lines showed that the yield in Guelph was higher (-2000 kg/HA) than that for Ottawa, but the yield ranking remained consistent between sites. The opposite was observed for test weight: Guelph test weights tended to be lower (-8 kg/hL) than those observed in Ottawa. The average days to heading was consistent at about 185 days. Leaf rust ratings indicated that most lines were strongly to moderately resistant, with lower ratings associated with higher protein contents ($r = -0.322$, $p < 0.01$). Based on the yield, disease ratings, and protein content, a set of 10 lines with appropriate commercial controls (red, white, or purple) was selected for further quality analysis. According to the data from Guelph location. Flour yield was generally lower (~5 – 10% lower) for all advanced purple lines. Ash content trended higher for all purple lines (+12%) indicating that the bran may be more friable during milling. Flour protein content was ~0.60% lower on average for all purple lines. Additional quality and nutritional analyses are being performed to further elucidate the end-use and nutritional quality of the selected purple wheat lines.

P62- The Three-Sisters value chain: characteristics and bread-making potential of the ancestral lineages.

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Traditionally, Native Americans cultivated a group of plants consisting of maize, squash and beans called the "Three Sisters." Our objective was to characterize the attributes and functionality of the "Three Sisters". Seeds of ancestral lineages (Maize: 'Gaspé Flint'; Squashes: 'Algonquin' and 'Canada Crookneck'; Beans: 'Hopi black', 'Early Mohawk', 'Amish Nuttle' and 'GaGa Hut Pinto') were cultivated with minimal agricultural input during the spring of 2015 and the crops harvested during the fall. Some bioactive compounds, which are beneficial to human health, were evaluated as well as the functionality and attributes of transformed ingredients. Inter- and intra-species differences were assessed in the bioactives composition of the "Three Sisters". The main bioactives found in dried beans were anthocyanins and flavonols,

'Hopi black' had the highest anthocyanins content, while 'Amish Nuttle' had the highest flavonols titer. Carotenoids profiles differed among the two squash lineages, with higher b- and a-carotene in 'Crookneck' and higher Xanthophylls in 'Algonquin'. The highest antioxidant capacities were detected in 'Hopi black' beans and 'Canada Crookneck' squashes. Flours derived from maize, squashes and beans were processed by traditional methods. Their rheological properties, as well as their bread-making potential were assessed, for a substitution level of 10%, and compared to commercial wheat flour. The squashes were processed with or without the peel. For maize and beans, 'Gaspé Flint', 'Amish Nuttle' and 'Early Mohawk' had the best bread-making potential, while for the squashes 'Canada Crookneck' (with or without peel) and 'Algonquin' without peel showed the best potential.

P63- EMS-Mutagenized Pre-breeding potato lines tolerant to greening when exposed to light

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Potato and its processed products are major components in the modern diets. However, 2-3% of potato productions are lost at the farm gate and during postharvest storage due to undesirable tuber greening following light exposure. Tuber greening involves chlorophyll and toxic glycoalkaloid compound accumulation in the light-exposed area. Thus, elimination of this undesirable trait may involve the alteration of more than one biosynthetic pathway. We have developed and characterized an EMS mutagenized dihaploid potato population with the aim of identifying potato lines low in anti-nutritional factors. Six tubers from each of 520 EMS-treated and 21 non-treated control lines, derived from seven crosses, were exposed 24 h at room temperature under 34W cool white fluorescent tubes fixed on a table for 8 days, and the color changes were measured every 2 days using a CR410- Chroma Meter. A total of 11 EMS-treated lines were found to be tolerant to greening when compared with their respective non-EMS treated controls. Work is in progress to determine the physiological mechanisms behind these observations.

P64- In vitro culture maintains genetic fidelity but causes epigenetic variation in lowbush blueberry

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In vitro culture can induce a variety of genetic and epigenetic variations in micropropagules. DNA methylation plays an important role in the regulation of gene expression, development and differentiation in plants and has been proposed to be occurred frequently during in vitro culture. The global DNA methylation polymorphism was evaluated in two lowbush blueberry (*Vaccinium angustifolium* Ait.) genotypes propagated by conventional softwood cutting and in vitro propagation, using the methylation-sensitive amplification polymorphism (MSAP) technique based on the differential sensitivity of a pair of isoschizomers MspI and HpaII to methylation of cytosine at their recognition site. In all, 106 and 107 fragments, each representing a recognition site cleaved by either or both of the isoschizomers, were amplified using sixteen combinations of primers in a conventionally propagated wild clone and the cultivar Fundy, respectively. In case of micropropagation, 105 fragments in the wild clone and 109 in Fundy were amplified. A total of 24.5% were found to be methylated at cytosine in the genome of softwood cutting QB9C plants and that was 18.7% in softwood cutting Fundy plants. In contrast, a total of 28.6% and 20.2% were found to be methylated at cytosine in the genome of micropropagated wild clone and Fundy plants, respectively. Overall, micropropagated blueberry plants demonstrated higher methylation events in compare to softwood cutting plants. Although the micropropagules showed no genetic alteration in expressed sequence tag-polymerase chain reaction (EST-PCR) analysis, methylation polymorphism was observed in some extend among the tissue culture regenerated plants in both genotypes. No DNA methylation polymorphisms were detected in conventionally propagated blueberry plants. Different pattern of DNA methylation and polymorphism in the methylated DNA in plants propagated in vitro and in vivo conditions suggest the possibility of involvement of these fragments in the processes regulating plant growth and development under prevailing growth conditions.

P65- The involvement of protein-carbohydrate module in barley malting quality

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Barley is a vital ingredient in malting and brewing industry. More than 250 quantitative trait loci (QTL) have been associated with 19 malting quality phenotypes in barley. We used synteny based approaches to fish out the genes present on the QTL2 of barley affecting various malting quality traits like malt extract, beta-glucan, diastatic power and α and β- amylases etc. A total 24 candidate genes were identified and MSB12 was found to be differentially expressed among commonly used malting and feed barley varieties. The computational study revealed that it has a carbohydrate binding motif and eight paralogs in barley genome. Moreover, expression studies using Morex RNA

seq. data suggested that these genes are mainly expressed in embryo, young root and shoot. Interestingly, biochemical analysis like binding assays and ELISA confirms the involvement of MSB12 gene in β-glucan regulation. Results obtained from various redox treatments to the E.coli purified MSB12 protein also positively supports our hypothesis. Therefore, taken together our results confirm that this gene is a major gene that can affect malt extract or level of β-glucan, and thus can control the malting traits. **CSA Student Competition**

P66- High throughput phenotyping of seedling roots in a panel of spring wheat genotypes

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Root architecture plays a significant role in the growth and development of any crop. Importance of root morphology of the crops becomes more vital under water-stressed conditions. Evaluation of physiologically-mature roots is extremely resource-consuming and is practically applicable to only a limited number of genotypes. We phenotyped the seedling roots of a panel of 350 wheat genotypes of the Nepali Wheat (*Triticum aestivum* L.) Diversity Panel (NWDP) with the objective to establish that evaluation of root traits at the early stage of the crop growth can be a potential high throughput method for screening drought-tolerant varieties based on seedling root traits. Details of the phenotyping protocol, including root image analysis and the phenotyping results will be presented. **CSA Student Competition**

P67- Genome-wide DNA methylation analysis in blueberry –From leaves to callus formation

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Unlike other eukaryotic organisms, highly developed multicellular life forms such as plants; shows higher level of DNA methylation in their genome. DNA methylation regulates gene expression and various cellular processes by suppressing DNA-transcription factor associations. DNA methylation is the key regulatory mechanism of cell and organ differentiation during plant development. In the in vitro system during the callus formation, plant cells undergo dedifferentiation which is predominantly controlled epigenetically. Eventually, the callus begins regenerating and proliferating through the process of redifferentiation. In regenerating callus, redifferentiation is stimulated with the introduction of differential effects of plant growth regulators (PGRs) in the culture medium, ultimately leading to organogenesis or regeneration of plantlets. Available evidences showed that DNA methylation is the fundamental mechanism of tissue culture induced mutagenesis. Here, we focused on the comparative dynamics of DNA methylation in blueberry leaves collected from greenhouse and in vitro-derived callus; analysed using methylation-sensitive amplification polymorphism (MSAP). MSAP is an amplified fragment length polymorphism (AFLP) based cost-effective, rapid and easy executable technique for non-model organisms. The study of the MSAP profiles from both leaves and callus genomic DNA revealed that calluses were more polymorphic and highly methylated than the leaves. Within the callus tissues differential methylation pattern was observed in a genotype specific as well as treatment specific manner. These results demonstrated the effect of tissue culture process on DNA methylation during callus formation. **CSHS Student Competition**

P68- Lipo-chitooligosaccharide and Thuricin 17 induce changes in the transcriptome and the proteome of germinating corn seeds

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Lipo-chitooligosaccharide (LCO) and Thuricin 17 (Th17) have been shown to stimulate plant growth in soybean, corn, canola, tomato. Since seed treatment is an important component for commercial application of these compounds, this study explores the effects of LCO and Th17 on corn seeds on the transcriptome (RNA sequencing) and proteome (shotgun proteomics) at 48 h post germination. Total dehydrogenase activity was conducted at 24 and 48 h of seed germination and both LCO and Th17 treatments significantly increased dehydrogenase activity at 24 h. A reference-based transcriptome analysis using the Illumina NextSeq 500 platform was performed on the total RNA extracted from the corn seeds. Compared to control, 124 genes were up-regulated and 60 down-regulated in LCO treated seeds and 179 genes up-regulated and 101 down-regulated in Th17 treated seeds. Th17 treated seeds had 139 genes up-regulated and 108 down-regulated in comparison with LCO treatment alone. In all only 2 genes (GRMZM2G124799 and GRMZM2G125196) were found to be commonly regulated among all the treatment contrasts. GRMZM2G124799 is located on chromosome 6 and probably codes for an unknown enzyme responsible for the reaction between 5-pentadecatrienyl resorcinol and S-adenosyl-L-methionine; GRMZM2G125196 is located on chromosome 2 probably coding for a 2-alkenal reductase. Among the abundant proteins analysed using LTQ-Orbitrap Velos, LCO treated seeds showed up-regulation of aldehyde dehydrogenase, G-quadruplex binding nucleoside diphosphate kinase, cytochrome P450 monooxygenase, auxin binding protein, phosphoenolpyruvate carboxylase and nine unknown proteins. In addition to the above mentioned proteins, Th17 up-regulated cytosolic

orthophosphate dikinase and amylose extender starch branching enzyme. Our study confirms the role of dehydrogenase in LCO and Th17 mediated corn seed germination. And also that Th17 invokes stronger responses than LCO in corn seeds.

P69- Hexanal induced changes in gene expression during Fruit Ripening in Strawberry (*Fragaria ananassa*)

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The role of hormones in fruit development and ripening in strawberry (*Fragaria ananassa)* is poorly understood. In this study, two strawberry cultivars ('Jewel' and 'Wendy') were chosen based on their shelf life quality, intermediate and excellent, respectively. Fruits treated with Enhanced Freshness Formulation (a formulation with hexanal as the key ingredient) showed enhanced shelf life in both cultivars. Auxin application reduced fruit firmness while ABA accelerated ripening. The regulation of gene expression during ripening in relation to hexanal and hormones were examined in 21 genes that are potentially involved in cell wall breakdown. Gene expression profiles show similar pattern in the two cultivars with more prominent amplitude in Wendy. The expression of hormone responsive genes responded in an antagonistic manner to the hormones supporting their role in ripening and fruit development. Hexanal application caused a clear reduction in the transcript level of two Phospholipase D genes and other key enzymes involved in cell wall degradation. These finding indicate that ripening in strawberry is associated with the expression of specific genes and the modulation of this gene expression by hexanal supports its role in increasing the fruit shelf-life.

P70- Oil and lipid content improvements in the field pea

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Canada is the world's largest producer and exporter of field pea (*Pisum sativum* L.) (AAFC, 2011). Though soybean and canola are currently the leading oilseeds used for biofuel production in Canada, recent research has identified the filed pea as a potential source of bio-oil. As a leguminous crop, the nitrogen fixing abilities of the field pea gives it an advantage over traditional oil seeds. The field pea requires less fertilizer and supports soil health through nitrogen fixation. However, while soybean and canola have average lipid contents of 15.1% and 40.8% respectively, the average lipid content of the field pea has been reported at 1.3 ± 0.5% (Khodapanahi et al. 2012). For the field pea to be a viable bio-oil source, it is necessary to increase its lipid content through selective breeding using knowledge of genes that are responsible for lipid production. Our project aims to improve the oil and lipid concentrations in the field pea through the exploration of natural variation and genetic enhancement of fatty acid accumulation in several field pea varieties. Using techniques studied previously in our lab to extract and profile fatty acids, we will analyze the lipid content of several varieties of field peas. Both field and greenhouse trials will be used to test and to naturally increase the genetic diversity off our varieties. Genetic enhancement will also be explored through a biolistic particle delivery system. Field pea has been recalcitrant to transformation and an important part of this project will be to develop efficient and reproducible methods of transformation. Resultant lines will be analyzed for lipid content and correlated with the genetics to help ascertain which loci are involved in lipid biosynthesis in field pea. Successful transformants will be analyzed and tested. The long-term goal of the project is to establish novel cultivars of field pea suitable for growth under a range of Canadian climatic conditions and to develop the infrastructure required to handle and process these oilseed peas.

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