Canadian Weed Science Society
Société canadienne de malherbologie

Canadian Society of Agronomy
La Société Canadienne d'Agronomie

Joint Meeting of the Canadian Weed Science Society and the Canadian Society of Agronomy
November 14 – 18 2022

Joint Annual Meeting
November 14th to 18th 2022

Réunion annuelle
14 au 18 novembre 2022

Halifax Marriot
Harbourfront

Visit the Canadian Weed Science Society website at
www.weedscience.ca

Visit the Canadian Society of Agronomy website at
www.agronomycanada.com

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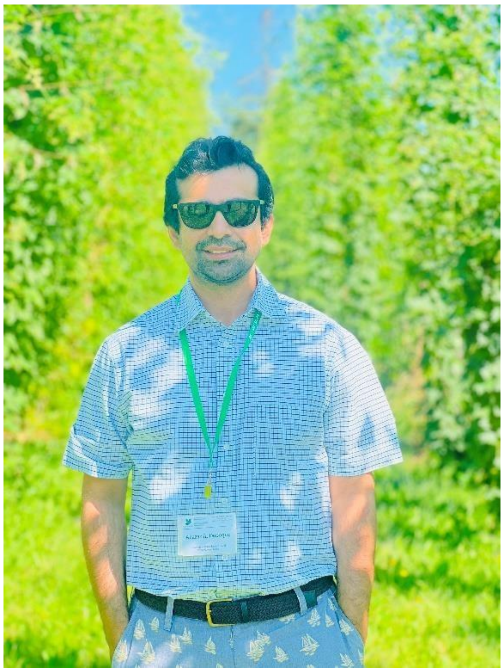
2022 PLENARY SPEAKERS

Dr. Arnold Schumann is a Professor in the Soil, Water and Ecosystem Sciences department, University of Florida, Adjunct Professor in the Faculty of Agriculture, Dalhousie University, and in the School of Sustainable Design Engineering, University of Prince Edward Island. Dr. Schumann has worked with precision agriculture for 21 years. Some of his early research from 2001 focused on ultrasonic mapping of citrus canopy size and the use of electromagnetic induction for mapping shallow groundwater depth. He has worked with researchers at Dalhousie University and blueberry growers in Nova Scotia since 2007 to help develop variable rate sprayers and improve mechanical harvesters for blueberries. In Florida, he successfully developed a variable rate fertilizer applicator for citrus that adjusts fertilizer output based on tree size. The technology was licensed to Chemical Containers Inc. of Florida in 2008, who market the product primarily for citrus, pecan and peach specialty crops. Since 2016 the research efforts were redirected towards the growing arena of artificial intelligence (AI), especially in machine learning and machine vision applications for precision agriculture. New AI research products include smartphone apps for growers, precision herbicide sprayers, and farm robotics.

Louis Longchamps earned his PhD at Laval University working on site-specific weed management exploring the spatial distribution of weeds at the field scale. He followed with postdoctoral studies at Colorado State University working on precision nutrient, seeds, and water management. As a research scientist at Agriculture and Agri-Food Canada, Dr Longchamps continued his work on precision agriculture and conducted workshops on observational research. In his position of assistant professor of digital agronomy at Cornell University, he wants to explore the potential of observational research and on-farm experimentation to accelerate scientific development in agriculture, maintaining productivity while reducing the negative impacts of agriculture on the environment. Dr. Longchamps is the current chair of the On-Farm Experimentation Community of the International Society of Precision Agriculture.

Since 2009, Dr. Cambouris has lead an important research program for Agriculture & Agri-Food Canada (Quebec City) and she is known for her ability to generate new knowledge for the benefit of the agricultural sector mainly related to precision agriculture and potato production. Dr. Cambouris is currently involved in variable rate management of N applications mainly under potato production involving soil and crop sensor systems, remote sensing, geomatics and geostatistics. She conducts research on the delineation of management zones based on the soil and crop sensor systems for potato, corn, switchgrass and forage production. Her expertise with soil sensors related to the spatial variability of soil properties is also well known. For 2002-2022, Dr. Cambouris was the secretary of the board of the International Society for Precision Agriculture (ISPA) and the leader of Precision Nitrogen Management Community of ISPA. She is also the president of the Expert Committee of Precision Agriculture in the province of Québec (2007 – now). She is the author/coauthor of more than 55 scientific publications and four book chapters. She is a member of the: International Society for Precision Agriculture, American Society of Agronomy (ASA), Soil Science Society of America (SSSA), and the *Association Québécoise des Spécialistes en Sciences du Sol*.



Dr. Aitazaz Farooque is working as an Associate Professor & Director - Centre of Excellence in Food Security and Sustainability at the School of Climate Change and Adaptation, University of Prince Edward Island (UPEI). Dr. Farooque's research focuses on fundamental understanding and development of state-of-the-art precision agriculture technologies. Dr. Farooque is actively working on machine vision, application of multispectral and thermal imagery using drone technology, delineation of management zones for site-specific fertilization, deep learning, artificial intelligence, electromagnetic induction methods, remote sensing, sensors for mapping, bio-systems and hydrological modeling, artificial neural network, and analog and digital sensor integration into agricultural equipment for real-time decision making.

Dr. Steve Fennimore is a Professor of Cooperative Extension and Weed Scientist with the University of California, Davis located at Salinas, CA USA. Since 1997, Steve has conducted a research and extension program focused on weed management in vegetables, flowers and strawberries in coastal production areas of California USA. His specialization is in non-chemical weed management for strawberry and vegetable crops. Projects in his lab include automated weed removal, and steam for soil disinfestation. Steve grew up on a vegetable farm in western Oregon. From 1983 to 1993, Steve worked in the Agricultural Chemical industry holding research and development positions in California, Mississippi and Indiana with ICI Americas/Zeneca. He left industry and returned to graduate school at Purdue University where he received his PhD in weed science in 1997.

Dr. Travis Esau is an Associate Professor at the Department of Engineering in the Faculty of Agriculture, Dalhousie University. Dr. Esau is both a Licensed Professional Engineer and a Professional Agrologist. Dr. Esau is a mechanical engineer specializing in machine systems and automation engineering focusing on agricultural mechanized systems, digital agriculture, precision agriculture, data management, automation of agricultural operations and data-driven decision analysis for complex agricultural and biological systems. Traditional agricultural farming is not sustainable and severely requires new engineering advancements to remain competitive in both local and global markets. His research involving advanced mechanized systems increases farm efficiency and uses environmental resources more effectively. His research team consists of research staff and undergraduate/graduate/postdoc students. Dr. Esau is also involved with graduate student supervision at University of Prince Edward Island where he holds an adjust position in Sustainable Design Engineering.

2022 CONFERENCE ORGANIZATIONAL COMMITTEES

For further information about the meeting please contact the Chair or a Local Arrangements Committee member as listed below:

Position	Name	Affiliation	Email
First Vice President (LAC Oversight)	Darren Robinson	University of Guelph	drobinso@uoguelph.ca
Local Arrangements Committee	Scott White (Co-Chair)	Dalhousie University	Scott.white@dal.ca
	Kathleen Glover (Co-Chair)	AAFC Kentville	Kathleen.Glover@AGR.GC.CA
	Andrew McKenzie-Gopsill (CWSS-SCM)	AAFC Charlottetown	andrew.mckenzie-gopsill@AGR.GC.CA
	Mumtaz Cheema (CSA-SCA)	Memorial University Grenfell Campus	mcheema@grenfell.mun.ca
	Andrew Burt (CSA-SCA)	AAFC Ottawa	andrew.burt@AGR.GC.CA
Registration	Kristina Polziehn	CWSS-SCM	kristinapolziehn@gmail.com
	Nancy Zubriski	CSA-SCA	nzubriski@gmail.com
Plenary Session	Scott White (Chair)	Dalhousie University	Scott.white@dal.ca
	Mumtaz Cheema	Memorial University Grenfell Campus	mcheema@grenfell.mun.ca
Hotel Liaison	Scott White	Dalhousie University	Scott.white@dal.ca
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Crop Life Canada rep	Matt Underwood (east)	Syngenta	Matthew.Underwood@syngenta.com
	Graham Collier (west)	Nufarm	graham.collier@nufarm.com
Program Committee	Darren Robinson, see also CWSS-SCM session chairs	University of Guelph	drobinso@uoguelph.ca
	Jamie Larson (Co-Chair, CSA-SCA)	AAFC Vineland	jamie.larson@AGR.GC.CA

Graduate Student Presentations	Darren Robinson (Co-Chair, CWSS-SCM)	University of Guelph	drobinso@uoguelph.ca
	Andrew Burt (Co-Chair, CSA-SCA)	AAFC Ottawa	andrew.burt@AGR.GC.CA
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Grad Student rep	William Kramer (CWSS-SCM)	Colorado State	W.kramer@colostate.edu
	Nate Ort (CSA-SCA)	University of Saskatchewan	Nate.ort@usask.ca
Poster Session	Andrew McKenzie-Gopsill (CWSS-SCM)	AAFC Charlottetown	andrew.mckenzie-gopsill@AGR.GC.CA
Continuing Education / Grower Day	Yousef Papadopoulos (Co-Chair)	AAFC Kentville	yousef.papadopoulos@AGR.GC.CA
	Andrew McKenzie-Gopsill (Co-Chair)	AAFC Charlottetown	andrew.mckenzie-gopsill@AGR.GC.CA
	Kevin Vessey	St. Mary's University	Kevin.vessey@smu.ca
	Gary Koziel	Nova Scotia Department of Agriculture	Gary.koziel@novascotia.ca
Scholarships and Awards Banquet	Charles Geddes (CWSS-SCM)	AAFC Lethbridge	Charles.Geddes@AGR.GC.CA
	Mumtaz Cheema (CSA-SCA)	Memorial University Grenfell Campus	mcheema@grenfell.mun.ca
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	Graham Collier (west)	Nufarm	graham.collier@nufarm.com
	Rigas Karamanos (Co-Chair, CSA-SCA)	Agronomist (retired)	rkgeoponica@gmail.com
	Nate Ort (CSA-SCA)	University of Saskatchewan	Nate.ort@usask.ca

CWSS-SCM CONCURRENT SECTION CHAIRS - 2022

Cereals, Oilseeds and Pulses Charles Geddes charles.geddes@canada.ca	**Soybean, Corn and Edible Beans** Adam Pfeffer adam.j.pfeffer@bayer.com
Horticulture and Specialty Crops Jichul Bae jichul.bae@canada.ca	**Weed Biology and Ecology / Invasive and Noxious Weeds** Martin Laforest martin.laforest@AGR.GC.CA
Provincial Reports / Regulatory Issues Kristen Obeid kristen.obeid@ontario.ca	**Forage, Rangeland, Forestry/ Industrial Vegetative Management** Lisa Jarrett lisa.jarrett@corteva.com

CSA-SCA SECTION CHAIRS - 2022

CSA Presents: The Best of the Best in 2021-2022 Dr. Mumtaz Cheema	**Crop Phenomics** Dr. Valerio Hoyos-Villegas
Nutrient Management Dr. Aaron Mills	**Agronomy, Crop Physiology, and Breeding** Dr. Helen Booker

CWSS-SCM/CSA-SCA 2022 Annual Meeting Agenda

Note that the abstracts for the individual presentations are listed by number in the Abstract section.

Date	Society	Time	Topic/event	Room
Monday November 14	CWSS-SCM/CSA-SCA/BMC	8:00 – 17:00	Conference Registration	Nova Scotia Foyer
	CWSS-SCM/CSA-SCA/BMC	8:00 – 18:00	Commercial exhibits and poster set up	Nova Scotia Foyer
	CWSS-SCM	8:00 – 9:00	CWSS-SCM board meeting Breakfast	Nova Scotia A
	CWSS-SCM	9:00 – 17:00	CWSS-SCM board meeting	Nova Scotia A
	CSA-SCA/BMC	8:00 – 8:40	Biomass Symposium Meet & Greet	Nova Scotia B
		8:40 – 8:50	Opening Biomass Symposium: Dr. Girard, Director General, AAFC	Nova Scotia B
		8:50 – 9:00	Welcome Biomass Symposium: Dr. M. Cheema (CSA-SCA President) and Dr. D. Smith (CEO BioFuelNet) **Synergistic efforts to advance biomass research related to the Canadian bioeconomy.**	Nova Scotia B
	BMS#1	9:00 – 9:45	BMS Keynote Speaker: Mr. Manolis Karampinis **Bioenergy in the EU framework: updates on statistics, policy framework and exploitation models**	Nova Scotia B
	BMS#2	9:45 – 10:00	BMS Keynote Speaker: Dr. Casler **Development of Sustainable Biomass Crops**	Nova Scotia B
	CSA-SCA/BMC	10:00 – 10:30	Refreshments	Nova Scotia B
	CSA-SCA/BMC	11:00 – 12:00	BMS Session 1: Agricultural Residues/Waste as Biomass for the Bioeconomy	Nova Scotia B
	BMS#3	11:00 – 11:15	Conversion of greenhouse/agricultural wastes into hydroponic bio-polyurethane (BPU) foams and their biodegradability	Charles Xu

	BMS#4	11:15-11:30	Insights on Biomass Pelletization as Sustainable and Clean Fuel Source and Biochar Production for Soil Improvements and Carbon Capture	Ajay Dalai
	BMS#5	11:30-11:45	Valorization of agri-food residues and wastes: A closed-loop circular economy concept to address climate change, biogas production, wastewater management, and soil health	Animesh Dutta
	BMS#6	11:45-12:00	Biomass supply chains: Challenges and Opportunities in enabling the development of a sustainable circular economy biorefinery	Edmund Mupondwa
	CSA-SCA/BMC	12:00 – 1:00	Lunch	Nova Scotia B
	CSA-SCA/BMC	13:00 – 14:30	BMS Session 2: Energy Crops as Biomass for the Bioeconomy	Nova Scotia B
	BMS#7	13:00 – 13:15	Development of Biologicals as Low Input, Sustainable Production Practices for Fuel and Residue/Food Production	Don Smith
	BMS#8	13:15 – 13:30	Improving switchgrass for the biomass industry	Annie Classens
	BMS#9	13:30 – 13:45	Adaptability of Miscanthus cultivars across Canada	Yousef Papadopoulos
	BMS#10	13:45 – 14:00	Bridging agriculture and the environment using bioenergy crops	Raju Soolanayakanahally
	BMS#11	14:00 – 14:15	Annual and perennial biomass crop production potential on marginal lands	J. Kevin Vessey
	BMS#12	14:15 – 14:30	Feedstock quality and impact on bioenergy production from four dedicated biomass crops (miscanthus, switchgrass, willow, and poplar).	Xue Li
	CSA-SCA/BMC	14:30 – 14:45	Refreshments	Nova Scotia B
	CSA-SCA/BMC	14:45 – 16:15	BMS Session 3: Biomass to fuel the Bioeconomy	Nova Scotia B
	BMS#13	14:45 – 15:00	Pretreatment of crop residue to improve its utilization and logistical properties	Shahab Sokhansanj
	BMS#14	15:00 – 15:15	Select Pretreatment Options for Agricultural Biomass for	Duncan Cree

			Thermochemical or Biochemical Conversion	
	BMS#15	15:15 - 15:30	Integrated technoeconomic analysis and life cycle assessment (LCA) of four dedicated biomass crops (miscanthus, switchgrass, willow, and poplar) for the production of bioenergy and bioproducts	Edmundo Mupondwa
	BMS#16	15:30 – 15:45	Circular bioeconomies: the role of policy in informing sustainable biomass use	Warren Mabee
	CSA-SCA/BMC	15:45 – 16:25	**Industry Perspectives:** **Dr. Michael Marr**, Technology Development Lead, Renewable Liquid Fuels, Suncor Energy **Mr. Rod Badcock,** Principal Partner, BioApplied Innovations Pathways, Dartmouth, NS **Mr. Geoff Clarke,** Business Development Manager, Port Hawkesbury Paper LP, Port Hawkesbury, NS **Mr. Brock Eidem,** Co-Founder of NULIFE GreenTech, Saskatoon, Saskatchewan **Dr. Fahimeh Yazdan Panah,** Director of Research and Technical Development, Wood Pellet Association of Canada	
	CSA-SCA/BMC	16:25 – 17:25	Open Discussion: Facilitator, Dr. D. Smith, CEO BioFuelNet	Nova Scotia B
	CSA-SCA/BMC	17:25 – 17:30	Closing Remarks	
	CWSS-SCM	17:30 – 18:30	Grad student meet and greet with BOD	Nova Scotia Foyer
	CWSS-SCM/CSA-SCA/BMC	18:30 – 22:00	Sponsorship Acknowledgement and Welcome Reception	Nova Scotia AB

Date	Society	Time	Topic/event	Room
Tuesday November 15	CWSS-SCM/CSA-SCA	7:00 – 17:00	Registration	Nova Scotia Foyer
	CWSS-SCM/CSA-SCA	7:00 – 8:00	Grad student set up	Nova Scotia CD
	CWSS-SCM/CSA-SCA	7:00 – 8:00	Coffee	Nova Scotia Foyer
	CWSS-SCM/CSA-SCA	8:00 – 8:10	Opening remarks – CWSS-SCM President & CSA-SCA President	Nova Scotia CD
	CWSS-SCM/CSA-SCA	8:10 – 09:50	Grad student presentations	Nova Scotia CD
	Abstract #1	8:10 – 8:22	Evaluation of saline-tolerant forage mixtures for establishment, forage yield, and saline soil remediation	Alex Waldner
	2	8:22 - 8:34	Examining the relationship between fall dormancy and winter hardiness of Alfalfa (Medicago sativa) by GWAS (genome-wide association studies)	Aabroo Ahmed
	3	8:34 - 8:46	Effect of drought stress on growth, symbiotic nitrogen fixation, soil nitrogen availability, and soil health parameters in forage legumes	Danielito Dollete
	4	8:46 - 8:58	Physiological thresholds are indicative of wheat yield potential under drought	Gopal Sharma
	5	8:58 - 9:10	Nitrogen in a Prairie Soybean Canopy - How much is there and where is it going?	Nathaniel Ort
	6	9:10 - 9:22	Integrating enhanced efficiency fertilizers and nitrogen rates to improve Canada Western Red Spring wheat production in the Canadian prairies	Adam Fast
	7	9:22 - 9:34	Agronomic responses of milling oat (Avena sativa) to struvite and monoammonium phosphate	Racquelle Peters
	8	9:34 - 9:46	Exploring the Agronomic and Economic Feasibility of Fall Season Cover Crops in Manitoba.	Dale Penner
	CWSS-SCM/CSA-SCA	09:50 – 10:20	Refreshments (authors of even-numbered posters present)	Nova Scotia AB

	CWSS-SCM/CSA-SCA	10:20 – 12:00	Grad student presentations	Nova Scotia CD
	Abstract #9	10:20 – 10:32	Evaluation of Hair Fescue (Festuca filiformis) Management in Wild Blueberry (Vaccinium angustifolium Ait.) using Dichlobenil	Craig MacEachern
	10	10:32 – 10:44	Evaluation of clethodim for management of hair fescue (Festuca filiformis) and red fescue (Festuca rubra) in lowbush blueberry (Vaccinium angustifolium) fields in Atlantic Canada	Tyler MacLean
	11	10:44 – 10:56	The confirmation and characterization of auxinic herbicide resistance in a population of green pigweed (Amaranthus powellii) from Ontario	Isabelle Aicklen
	12	10:56 – 11:08	Synergistic and antagonistic herbicide interactions for control of volunteer corn in glyphosate/glufosinate/2,4-D-resistant soybean	Emily Duenk
	13	11:08 – 11:20	Winter Wheat and Winter Annual Grass Species Metabolic Response to Cloquintocet-Mexyl	William Kramer
	14	11:20 – 11:32	Control of multiple-herbicide-resistant waterhemp (Amaranthus tuberculatus (Moq.) J.D. Sauer) with acetochlor-based tank mixtures in soybean	Hannah Symington
	15	11:32 – 11:44	Ecology and management of cow wheat (Melampyrum lineare Desr.) in lowbush blueberry (Vaccinium angustifolium Ait.) fields in Nova Scotia	Vanessa Deveau
	16	11:44 – 11:56	Investigating the weed seed preferences of earthworms (Lumbricus terrestris L.)	Pengfei Ji
	CWSS-SCM/CSA-SCA	12:00 – 13:00	Lunch	Nova Scotia AB
	CSA-SCA	12:00 – 13:00	CSA-SCA Executive Meeting	Halifax C

	CWSS-SCM/CSA-SCA	13:00 – 14:00	Grad student presentations	Nova Scotia CD
	Abstract #17	13:00 – 13:12	Evaluating the potential of a winter canola-soybean relay intercrop in Ontario	Marinda DeGier
	18	13:12 – 13:24	New tools to improve wild oat management in tame oat	Brianna Senetza
	19	13:24 – 13:36	Siamese Neural Networks for Weed Classification in Wild Blueberry with Minimal Training Images	Patrick Hennessy
	20	13:36 – 13:48	Counting on Canola: Can UAV Imagery Quantify Canola Emergence?	Kaylie Krys
	21	13:48- 14:00	Genetic dissection of seed composition traits in soybean using SoyMAGIC	Seyed Mohammad Hashemisardroud
	CWSS-SCM/CSA-SCA	14:00 – 15:00	CWSS-SCM & CSA-SCA Workshop 1 – CSP/CJPS (Josephine Sciotino)	Halifax B
	CWSS-SCM/CSA-SCA	15:00 – 15:30	Refreshments (authors of odd-numbered posters present)	Nova Scotia AB
	CWSS-SCM/CSA-SCA	15:30 – 17:00	CWSS-SCM & CSA-SCA Workshop 2 – Stats (Andrew McKenzie-Gopsill)	Halifax B
	CWSS-SCM	18:30	CWSS-SCM President's dinner – by invitation only	Off site
	CWSS-SCM/CSA-SCA	18:30	Dine around	Off site

Date	Society	Time	Topic/event	Room
Wednesday November 16	CWSS-SCM/CSA-SCA	7:00 – 8:00	2022 and 2023 LAC Meeting	Nova Scotia A
	CWSS-SCM/CSA-SCA	7:00 – 17:00	Registration	Nova Scotia Foyer
	CWSS-SCM/CSA-SCA	7:30 – 9:30	Coffee	Nova Scotia Foyer
	CWSS-SCM/CSA-SCA	8:20 – 8:30	Presidents welcome and LAC announcements	Nova Scotia CD
	CWSS-SCM/CSA-SCA	8:30 – 9:00	Plenary – Arnold Schumann (remotely): Progress in Precision Agriculture: An Overview	Nova Scotia CD
	CWSS-SCM/CSA-SCA	9:00 – 9:30	Plenary – Louis Longchamps: Digital Agronomy for Understanding Weed Spatial Distribution and Supporting On-farm Experimentation	Nova Scotia CD
	CWSS-SCM/CSA-SCA	9:30 – 10:00	Plenary – Athyna Cambouris: How Soil Sensing Systems Can Improve Your Agronomy	Nova Scotia CD
	CWSS-SCM/CSA-SCA	10:00 – 10:30	Coffee Break (CWSS-SCM & CSA-SCA)	Nova Scotia AB
	CWSS-SCM/CSA-SCA	10:30 – 11:00	Plenary – Aitazaz Farooque: Development of Smart Agriculture Technologies to Improve Farm Profitability and Mitigate Environmental Risks	Nova Scotia CD
	CWSS-SCM/CSA-SCA	11:00 – 11:30	Plenary – Steven Fennimore: Machine Learning and Advanced Control Systems Expand the Reach of Physical Weed Control Tools	Nova Scotia CD
	CWSS-SCM/CSA-SCA	11:30 – 12:00	Plenary – Travis Esau: Precision Agriculture: Using Technology to Optimize the Wild Blueberry Production System	Nova Scotia CD
	CWSS-SCM/CSA-SCA	12:00 – 13:00	Lunch (CWSS-SCM & CSA-SCA)	Nova Scotia AB
	CSA-SCA	12:00 – 13:00	CSA-SCA AGM	Halifax A
	CSA-SCA	14:00 – 14:45	2022 Distinguished Agronomist & CJPS Best Paper presentations	Halifax A
	CWSS-SCM	13:00 – 15:00	Corn, soybean, and edible bean	Halifax C
	Abstract #22	13:00 – 13:15	Diflufenican: a tool for managing Amaranthus species in corn and soybean production systems.	Adam Pfeffer
	23	13:15 – 13:30	Acetochlor plus EngardeTM Herbicide (Mesotrione + Rimsulfuron) for the Control of Problematic Weeds in Corn in Eastern Canada.	Laura Smith

	24	13:30 – 13:45	Influence of a Novel Adjuvant System on Deposition, Canopy Penetration, and Drift Reduction of Aerially Applied Spray Mixtures.	Gregory Dahl
	25	13:45 – 14:00	MasterLock: A non-ionic surfactant, deposition aid, and drift control adjuvant for use in Canada.	Joshua Skelton
	26	14:00 – 14:15	Optimisation of rye cover crop termination for improved corn growth	Francois Tardif
	27	14:15 – 14:30	Integrated Weed Management Strategies for the Depletion of Multiple-Herbicide-Resistant Waterhemp Seed in the Soil Seed Bank	Peter Sikkema
	28	14:30 – 14:45	Evaluation of different integrated weed management methods for the control of common waterhemp (Amaranthus tuberculatus (Moq.) J.D. Sauer) in corn and soybean.	Sandra Flores-Mejia
	CWSS-SCM	13:30 – 15:00	Provincial and regulatory reports	Annapolis
	-	13:30 – 13:45	CFIA Report	Wendy Asbil
	30	13:45 – 14:00	PMRA Update	Michael Downs
	31	14:00 – 14:15	Saskatchewan Report	Clark Brenzil
	-	14:15 – 14:30	Manitoba Report	Kim Brown-Livingston
	CWSS-SCM/CSA-SCA	15:00 – 15:30	Light Refreshments	Nova Scotia AB
	CWSS-SCM	15:30 – 17:00	Horticulture and specialty crops	Halifax C
	Abstract #32	15:30 – 15:45	AgRobotics – Innovations in Weed Management	Shaun Sharpe
	33	15:45 – 16:00	Weed emergence and growth under mini-greenhouses in muck and clay soils.	Marie-Joseé Simard
	34	16:00 – 16:15	The potato vine crusher: A new tool for harvest weed seed control	Andrew McKenzie-Gopsill
	35	16:15 – 16:30	Preliminary evaluation of the Weed Zapper electric weeder in Nova Scotia	Scott White
	36	16:30 – 16:45	Effects of soil building practices on weed seedbank dynamics in a potato rotation	Andrew McKenzie-Gopsill
	37	16:45 – 17:00	The Science and Vision behind Envu	Vicki Maloney
	CSA-SCA	15:30 – 17:00	Crop Phenomics	Halifax A
	Abstract #38	15:30-15:45	Phenomics evaluation of agronomic traits in winter wheat	Gavin Humphreys
	39	15:45-16:00	Early detection of the health status of abiotic-stressed crops using electrical signals	Guoqi Wen
	40	16:00-16:15	Image-based estimation of agronomic	Anjika

			influence on Canola flowering phenology to simulate yield	Attanayake
	41	16:15-16:30	Multi-omics approaches for understanding yield and yield stability in wheat	Anjan Neupane
	42	16:30-16:45	Plots Without Borders	Shaun Cambell
	43	16:45-17:00	A Machine Learning Approach to Determine Variables Causing Within-Field Spatial Variability of Canola Yield	Kwabena Nketia
	CWSS-SCM	18:30 – 20:30	CWSS-SCM & CSA-SCA Awards Dinner	Halifax ABC

Date	Society	Time	Topic/event	Room
Thursday November 17	CWSS-SCM/CSA-SCA	7:00 – 9:00	Breakfast	Nova Scotia Foyer and Nova Scotia AB
	CWSS-SCM	7:00 – 9:30	CWSS-SCM AGM	Nova Scotia CD
	CSA-SCA	8:30 – 10:00	Nutrient Management	Halifax A
	Abstract #44	8:30-8:45	Nitrogen management, use efficiency and seed yield of canola hybrids in diverse Canadian production ecosystems	Baoluo Ma
	45	8:45-9:00	Application of Utrisha™ N to enhance nitrogen use efficiency of Western Canadian broad-acre crops.	Cody Chytyk
	46	9:00-9:15	Effect of N sources and crop rotation on soil microbial diversity and structure in podzolic soils in boreal climate	Mumtaz Cheema
	47	9:15-9:30	Nitrate leaching and potato tuber yield response to different crop rotations	Yefang Jiang
	48	9:30-9:45	Legacy soil phosphorus management for improved crop production profitability and sustainability with reduced phosphorus loading to Lake Erie	Tiequan Zhang
	49	9:45-10:00	Impact of sulfur-based fertilizer on establishment and performance of forage legumes when frost or sod seeded into a grass stand.	Yousef Papadopoulos
	CWSS-SCM	9:30 – 11:30	Cereals, oilseeds, and pulses	Halifax C
	Abstract #50	9:30 – 9:45	Resistant Wild Oat Action Committee	Eric Johnson
	51	9:45 – 10:00	Herbicide-resistant wild oat (Avena fatua) in the Lower Saint-Lawrence region of Quebec	Sandra Flores-Mejia
	52	10:00 – 10:15	Precision inter-row wild oat management using non-selective	Eric Johnson

			herbicide application or cultivation	
	53	10:15 – 10:30	INSIGHT®: A new PPO inhibiting herbicide for pre-seed burndown for wheat	Mike Grenier
	54	10:30 – 10:45	A novel mixture of tolpyralate and bromoxynil to manage herbicide resistant and difficult to control weeds in cereal crops of Canada	Kevin Falk
	55	10:45 – 11:00	Crop safety and rotational crop response of a novel cereal herbicide mixture of tolpyralate and bromoxynil in Canada and the USA.	Rory Degenhardt
	56	11:00 – 11:15	Impact of Metribuzin and Water Stress on Chickpea Health	Shaun Sharpe
	57	11:15 – 11:30	Prairie-wide effects of recurrent annual glyphosate applications on the wheat rhizosphere microbiome	Newton Lupwayi
	58	11:30 – 11:45	Accelerated Cropping Systems: opportunities for weed management	Dilshan Benaragama
	59	11:45 – 12:00	Cultural tools contribute strongly to management of multiple herbicide-resistant kochia (Bassia scoparia)	Charles Geddes
	60	12:00 – 12:15	Experiences running a physical impact mill in Alberta fields	Breanne Tidemann
	CWSS-SCM	9:30 – 11:30	Weed biology and ecology	Annapolis
	Abstract #61	9:30 – 9:45	Interspecific differences between carabid-seed mass ratios influence seed selection decisions	Khaldoun ALi
	62	9:45 – 10:00	Genome skimming and protein biotyping in weedy amaranth identification	Leonardo Galindo Gonzalez
	63	10:00 – 10:15	Hybrids between Amaranthus tuberculatus and A. powellii found in a soybean field produced viable herbicide resistant progeny	Marie-Joseé Simard
	64	10:15 – 10:30	Seeing Weeds from Space: Using Satellite Imagery to Map Soil Salinity and Kochia	Steve Shirtliffe
	65	10:30 – 10:45	Genome and Population Genetics of False Cleavers	Sara Martin
	66	10:45 – 11:00	Defense by duplication: the role of EPSPS copy number variation in the evolution of glyphosate resistance in Amaranthus palmeri	Sarah Yakimowski
	67	11:00 – 11:15	Chromosome-Scale Draft Genomes of Common and Giant Ragweed Reveal a	Eric Page

			Potential Mechanism of Glyphosate Resistance	
	68	11:15 – 11:30	Heterosis and the inheritance of paraquat resistance in Canada fleabane	Eric Page
	CSA-SCA	10:00 – 10:15	Coffee	Nova Scotia Foyer
	CSA-SCA	10:15 – 12:15	Agronomy, Crop Physiology and Breeding	Halifax A
	Abstract #69	10:15-10:30	Seed crop management of creeping red fescue: Challenges and opportunities in the Peace region of Canada	Nityananda Khanai
	70	10:30-10:45	G x E study of sainfoin grass mixture	Hari Poudel
	71	10:45-11:00	Intermediate wheatgrass production as a perennial grain for western Canada	Douglas Cattani
	72	11:00-11:15	Assessing yield and resilience of cropping systems on the Canadian Prairies	Kui Liu
	73	11:15-11:30	Erosion and one-time amendments drive long-term wheat production risk	Charles Geddes
	74	11:30-11:45	Investigating the factors influencing canola quality.	Jonathon Rosset
	75	11:45-12:00	Decoding and tuning of oat genes associated with dietary fiber	Jaswinder Singh
	76	12:00-12:15	Two major quantitative trait loci confer complete solidness in all stem internodes of a spring wheat line	Raman Dhariwa
	CWSS-SCM/ CSA-SCA	11:00 – 12:00	Commercial display and poster take Down	Nova Scotia Foyer
	CWSS-SCM	12:00 – 17:30	CWSS-SCM board lunch and meeting	Nova Scotia A

Date	Society	Time	Topic/event	Room
Friday November 18	CWSS-SCM & CSA-SCA	9:00 – 10:00	Registration and coffee	Nova Scotia Foyer
	CWSS-SCM & CSA-SCA	9:30 – 9:40	Welcome to the joint Growers Day of the Canadian Weed Science and the Society Canadian Society of Agronomy and Biomass Canada Tim Marsh, President, Nova Scotia Federation of Agriculture	Halifax AB
	CWSS-SCM & CSA-SCA	9:45 – 10:15	Potential for Harvest Weed Seed Control in Atlantic Canada Dr. Breanne Tidemann, Agriculture and Agri-Food Canada – Lacombe	Halifax AB

			Research and Development Centre, Lacombe, AB	
	CWSS-SCM & CSA-SCA	10:15 – 11:00	Herbicide Carry-Over and Persistence in Horticultural Crops. Dr. Darren Robinson, University of Guelph – Ridgetown Campus, Ridgetown, ON	Halifax AB
	CWSS-SCM & CSA-SCA	11:00 – 11:30	AgRobotics – Innovations in weed management Kristen Obeid, Ontario Ministry of Agriculture and Rural Affairs, Harrow, ON	Halifax AB
	CWSS-SCM & CSA-SCA	11:30 – 12:00	The influence of diversity on potato rotation profitability and sustainability Dr. Aaron Mills, Agriculture and Agri-Food Canada – Charlottetown Research and Development Centre, Charlottetown PE	Halifax AB
	CWSS-SCM & CSA-SCA	12:00 – 13:00	Lunch	Nova Scotia AB
	CWSS-SCM & CSA-SCA	1:00 – 1:30	Annual and perennial biomass crop production potential on marginal lands Dr. J. Kevin Vessey, Saint Mary's University and Dr. Yousef Papadopoulos, Agriculture and Agri-Food Canada.	Halifax AB
	CWSS-SCM & CSA-SCA	1:30 – 1:50	Producing, procuring, and utilizing agricultural biomass in an emerging bioeconomy Mr. Richard (Rick) Corradini, President of Sou'wester Exploration and Technology Inc.	Halifax AB
	CWSS-SCM & CSA-SCA	1:50 – 2:10	Utilization of crop and waste residues Misty Croney – VP and Senior Agrologist LP Consulting	Halifax AB
	CWSS-SCM & CSA-SCA	2:10 – 2:30	Developing and operating an anaerobic digester in Northern Nova Scotia Mr. Terrence Boyle, T.E Boyle Farm & Foresty Ltd., Tracadie, NS	Halifax AB

	CWSS-SCM & CSA-SCA	2:30 – 2:45	Health/Coffee Break	Nova Scotia AB
	CWSS-SCM & CSA-SCA	2:45 – 3:45	Panelists Discussion: "Where do we go from here to increase the production and utilization of agricultural biomass in Atlantic Canada?" Moderator: J. Kevin Vessey, Saint Mary's University Panelists: • Misty Croney – VP and Senior Agrologist LP Consulting • Rick Corradini - President of Sou'wester Exploration and Technology Inc. • Yousef Papadopoulos – AAFC, NS • Paul Richards - Manager, Industrial Biotech & Agritech, Innovacorp	Halifax AB

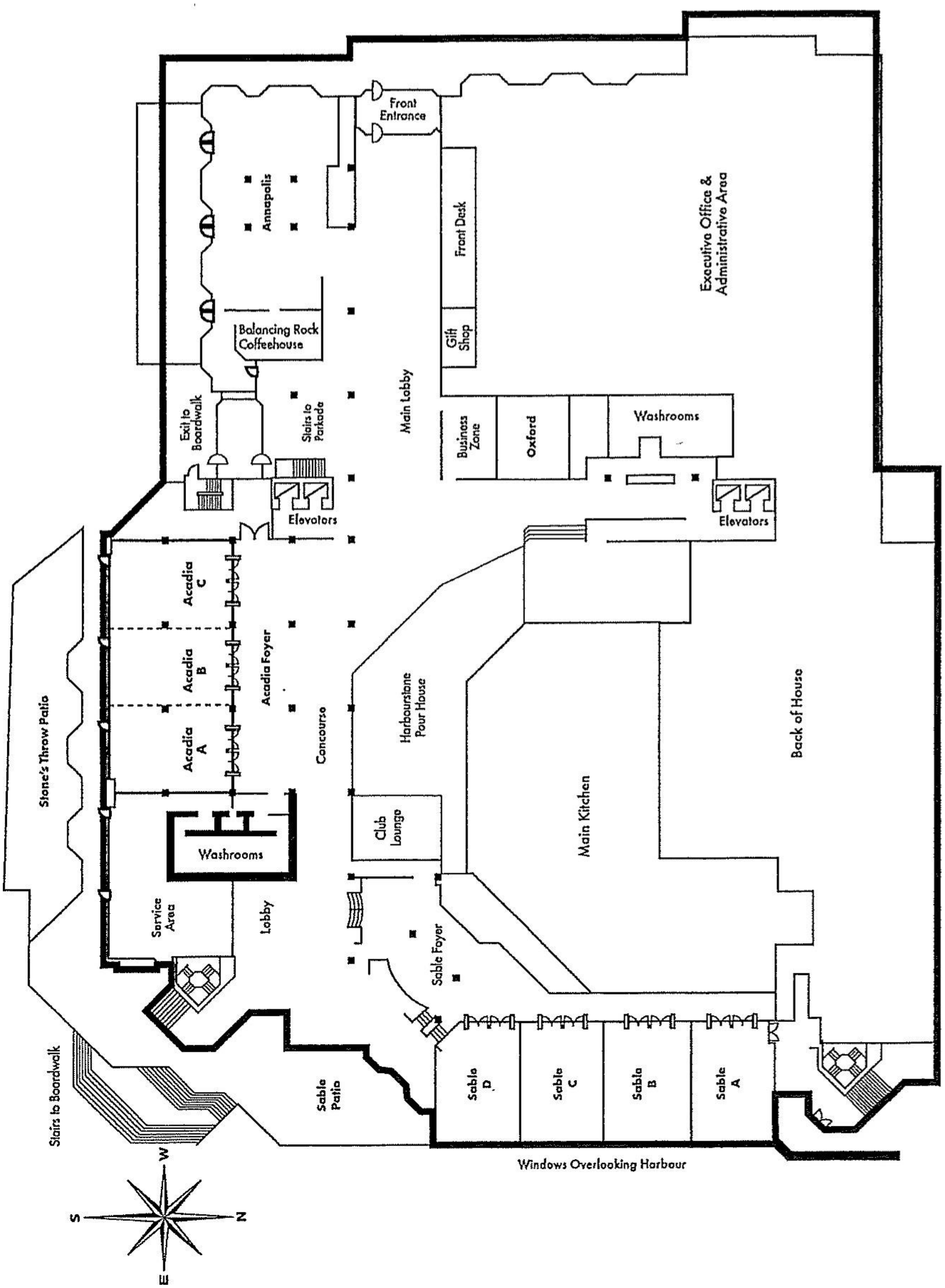
Canadian Weed Science Society
Société canadienne de malherbologie

Canadian Society of Agronomy
La Société Canadienne d'Agronomie

Joint Meeting of the Canadian Weed Science Society and the Canadian Society of Agronomy

November 14 – 18 2022

Ground Floor



Visit the Canadian Weed Science Society website at
www.weedscience.ca

Visit the Canadian Society of Agronomy website at
www.agronomycanada.com

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Société canadienne de malherbologie

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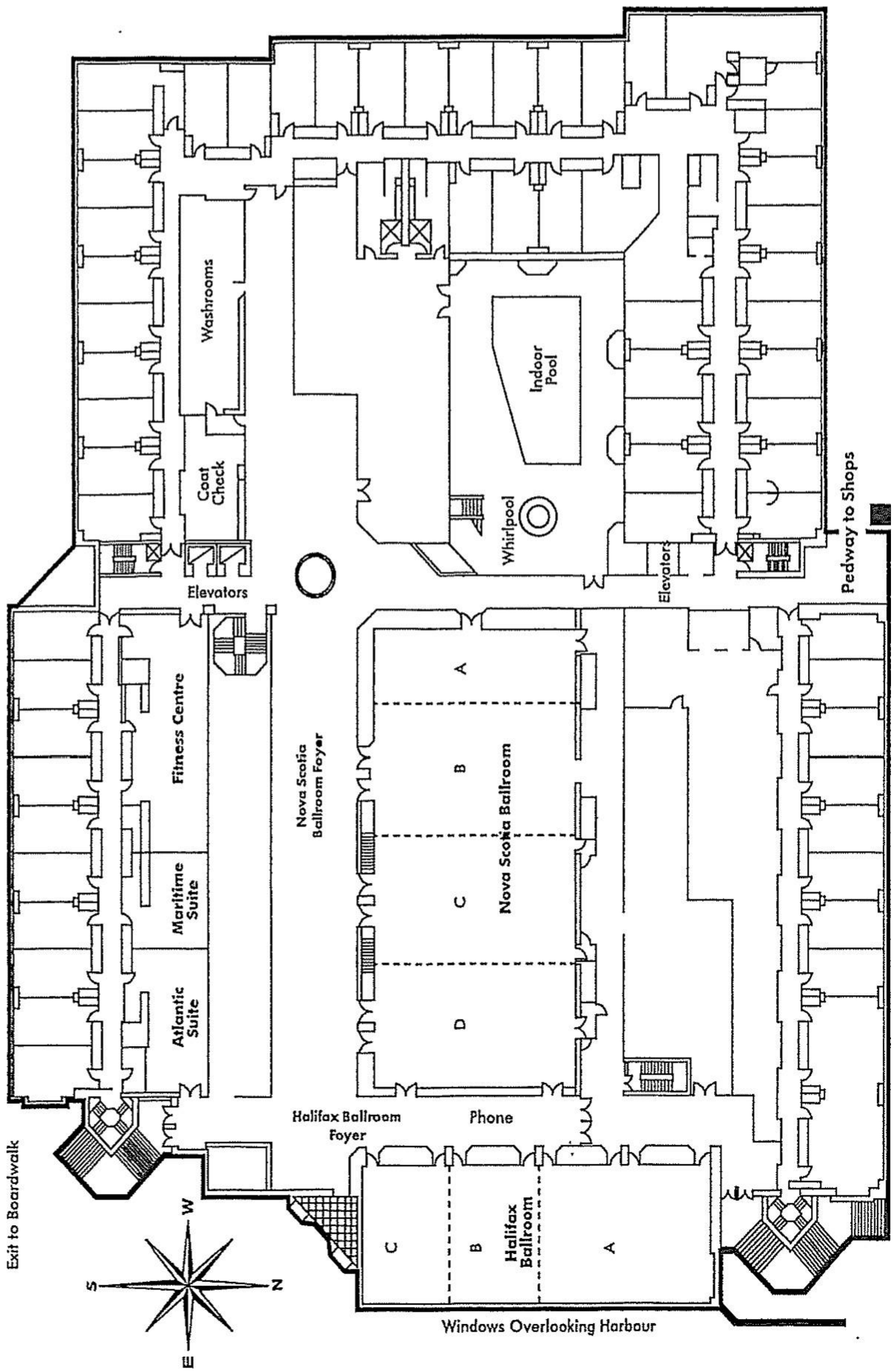
Second Floor



Poster Session

Abstract #	Sub-coding	Title	Author
77	CSA-01	Evaluation of environmental factors that can affect year-to-year variability of Fusarium head blight field screening in winter wheat.	Linda Langille
78	CSA-02	Spectral reflectance indices to differentiate wheat variety response to heat and drought stress	Jatinder Sangha
79	CSA-03	Estimating Wheat Seed Yield – Physical vs. Remote Sensing Data	Robert Gulden
80	CSA-04	Evaluating dry edible beans as a double crop following winter barley, canola and peas	Eric Page
81	CSA-05	Impact of tillage and crop residue on the establishment, survival and yield of winter canola	Eric Page
82	CSA-06	Choice of forage legume cultivar affects establishment when frost or sod seeding	Kathleen Glover
83	CSA-07	Impacts of fall seeding date on intermediate wheatgrass flowering	Douglas Cattani
84	GRAD-01	Effects of nitrogen stabilizers and crop rotation on soil pH, N dynamics and relative abundance of genes involved in nitrification and denitrification processes in podzolic soil in boreal climate	Mumtaz Cheema
85	GRAD-02	Effects of cropping sequence and nitrogen stabilizers on soil carbon pools in boreal climate	Muhammad Usman
86	GRAD-03	Short to medium-term effects of biochar and dairy manure application on soil's physiochemical properties, yield and quality of silage corn in podzol soils under boreal climate.	Hafiz Usama Abid
87	GRAD-04	Can intercropping suppress Rhizoctonia root rot of dry beans under mesic and flooded conditions?	Mark Boudreau
88	GRAD-05	Evaluating the performance of small-scale indoor vertical hydroponics systems for lettuce production.	Abiodun Adelowokan
89	GRAD-06	Lipid enhancement in Alfalfa through CRISPR/Cas9 mediated genome editing	Mohammed Musthafa Mukthar
90	GRAD-07	A novel assessment of Kernza® Intermediate Wheatgrass establishment and agronomy in Atlantic Canada.	Brittany Cole
91	GRAD-08	Purpose-grown biomass crops in Nova Scotia: Statistical predictive yield modeling and real-world verification	Emily Mantin
92	GRAD-09	Good, you bought a drone – Now what?	Seungbum Ryu
93	GRAD-10	Can APSIM be used to predict canola growth and yield in western Canada?	Kristina Polziehn
94	GRAD-11	Evaluating Source-sink relationship in Canola germplasms	Saima Jahan Liza
95	GRAD-12	Effect of humalite for enhancing crop production and as a soil amendment for improving soil health	Sumedha Vaishnavi Nallanthighal
96	GRAD-13	Identifying superior photosynthetic traits in canola germplasm	Fernando Guerrero

			Zurita
97	CWSS-01	A data-driven technique for early detection of emerging herbicide resistance in farm fields via spatiotemporal dynamics	Charles Geddes
98	CWSS-02	Utilizing digital imaging technology to characterize herbicide symptomology	Charles Geddes
99	CWSS-03	The economic threshold for glyphosate-resistant kochia (Bassia scoparia) in canola	Charles Geddes
100	CWSS-04	Alberta survey of herbicide-resistant kochia (Bassia scoparia) in 2021	Charles Geddes
101	CWSS-05	Saskatchewan survey of herbicide-resistant weeds in 2019 and 2020	Charles Geddes
102	CWSS-06	Survey of Glyphosate- and Dicamba-Resistant Kochia in Saskatchewan	Shaun Sharpe
103	CWSS-07	Attempting to Reduce Viable Wild Oat (Avena fatua) Seed Set at Jointing or Panicle Emergence	Breanne Tidemann
104	CWSS-08	Residual Weed Population Shifts in Manitoba – 1978 to 2022	Julia Leeson
105	CWSS-09	When using glyphosate plus dicamba, 2,4-D, halauxifen or pyraflufen/2,4-D for glyphosate-resistant horseweed control in soybean, which third mix partner is better, saflufenacil or metribuzin?	Nader Soltani
106	CWSS-10	Interactions between HPPD inhibiting and reactive oxygen species generating herbicides for the control of annual weed species in corn	Nader Soltani
107	CWSS-11	Palmer Amaranth and spring canola competition: projecting the impact of America's worst weed on Canadian agriculture	Francine Ballantyne
108	CWSS-12	Establishing fall cover crops in Atlantic Canada	Andrew Mckenzie-Gopsill
109	CWSS-13	Available Genetic Testing Enables Early Detection and Mitigation of Herbicide-Resistant Weeds	Martin Laforest
110	CWSS-14	Activation of a singlet oxygen signaling pathway by competition cues in Arabidopsis thaliana	Clarence Swanton
111	CWSS-15	Harmonized surveillance of common waterhemp (Amaranthus tuberculatus (Moq.) J.D. Sauer) as a model of national collaboration	Sandra Flores-Mejia
112	CWSS-16	The genome of Wild Mustard (Sinapis arvensis)	Sara Martin
113	CWSS-17	The importance of species selection in cover crop mixture design	Andrew Mckenzie-Gopsill

Abstracts

1	**Evaluation of saline-tolerant forage mixtures for establishment, forage yield, and saline soil remediation** Alex Waldner[1], Bill Biligetu[1] [1]University of Saskatchewan, Saskatoon, SK Soil salinity on the Canadian prairies threatens crop production by reducing crop yields and proliferating salt-tolerant weeds. Perennial forages offer environmental, agronomic, and economic benefits to these marginal areas; however, their slow establishment limits producer's adoption. The study's objectives were to evaluate stand establishment, forage yield, botanical composition, and soil characteristics of a commercial saline mixture "Saltmaster", a pollinator mixture, hybrid wheatgrass (Elymus hoffmannii), cv. CDC Salt King, and salt-tolerant alfalfa (Medicago sativa), cv. Halo II seeded with and without a barley (Hordeum vulgare) companion crop over two years at saline sites (0.35-5.24 dS/m) in Redvers (Dark Grey soil), Clavet (Dark Brown soil) and Scott (Dark Brown soil) in Saskatchewan. According to preliminary results, companion crop treatments increased yields by 91% compared to no companion crop. Forages seeded with barley resulted in significantly higher ($p < 0.0026$) yields (5191 kg ha^{-1}) than forages seeded without barley (2716 kg ha^{-1}); however, there were no significant differences in yield among four forage mixtures in the seeding year. Additionally, companion crop treatments reduced ($p < 0.0314$) weed biomass by 52% compared to no companion crop. There were no significant differences in weed biomass among the forage mixtures. Forage establishment assessments in June revealed no significant differences between companion crop treatments or forage mixtures. However, botanical composition before harvest showed a forage biomass reduction ($p < 0.0047$) of 85% in the companion crop treatments compared to no companion crop. Altogether, forages established in saline soils with a barley companion crop observed higher yield return and lower weed biomass in the year of seeding, but it also reduced perennial forage establishment.
2	**Examining the relationship between fall dormancy and winter survival of 27 alfalfa (Medicago sativa) populations under field conditions** Aabroo Ahmed[1], Solen Rocher[2], Bill Biligetu[1], Annie Claessens[2], Mireille Thériault[2], David Gagné[2] [1]University of Saskatchewan, Saskatoon, SK, [2]Agriculture and Agri-Food Canada (AAFC), Quebec, QC. Alfalfa (Medicago sativa L.) is an important forage legume in Canada. Fall dormancy (FD) of alfalfa is a common predictor for its winter hardiness because of their close genetic linkage. However, there is an increasing scientific debate that these two traits can be manipulated independently. This study was conducted to re-examine this relationship from 2019 to 2022 at two experimental sites in Quebec and Saskatoon, Canada using 27 alfalfa populations with a varying range of FD scores. These populations were selected from 11 genetic backgrounds of Norseman (FD 1), 6010 (FD 1), Peace (FD 1) and Yellowhead (FD 2), Apica (FD 4), Saranac (FD 4), 55v48 (FD 5), Lahontan (FD 6), Mesilla (FD 6.5), CUF 101 (FD 9), and Wadi Qurayat (FD 10). Phenotypic traits including dry matter yield, fall plant height and spring vigor were measured. Three populations from cultivars

	Wadi Qurayat (FD 10) did not survive the first winter in 2019. High winter survival rate (>90%) was observed in Lahontan (FD 6), 55v48 (FD 5), Apica (FD 4), and Saranac (FD 4), Peace (FD 1-2) and Yellow (FD 1) at the two sites. Fall regrowth was positively correlated with the subsequent year spring vigour. Cultivar 55V48 (FD 5) produced maximum dry matter in Quebec, followed by 6010 (FD1), Apica (FD 4), and Yellow (FD 1), whereas in Saskatoon maximum dry matter was produced by Peace (FD 1-2), followed by Apica (FD 4), Yellow (FD 1) and Saranac (FD 4). Fall regrowth of different dormancy classes was in the order of FD 9>FD 6.5>FD 4>FD 5>FD 6 in Quebec, when the order was FD 5 > FD 9 >FD 1 >FD 5 >FD 6.5 in Saskatoon. Our results showed that it is possible to select less dormant, but high yielding and high winter hardy alfalfa populations
3	**Effect of drought stress on growth, symbiotic nitrogen fixation, soil nitrogen availability, and soil health parameters in forage legumes** Danielito Dollete[1], Rhea Lumactud[1], Malinda Thilakarathna[1] [1]Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB Forage legumes provide high-quality fodder and feed to livestock and improve soil health. They form a symbiotic relationship with rhizobia bacteria that inhabit root nodules to fix atmospheric nitrogen. Recently, drought has been a significant concern as it limits plant growth, yield, and symbiotic nitrogen fixation (SNF) in legumes. Climate change has made drought more prevalent and persistent and is predicted to continue contributing to drought severity. We hypothesize that drought stress can significantly impact plant growth and SNF in forage legumes. We have evaluated the effects of drought stress on nodulation, plant growth, physiological parameters, SNF, soil nitrogen availability, and soil extracellular enzyme activities of alfalfa (Medicago sativa) and red clover (Trifolium pratense) plants grown under controlled environmental conditions. The drought treatments were imposed at the flowering stage, where the soil moisture contents were maintained at 20% field capacity (FC) (severe), 40%FC (moderate), and 80%FC (well-watered) for three weeks. Severe drought had significant negative effects on nodulation, photosynthesis, and shoot and root dry weight. Leaf chlorophyll content increased under both drought treatments in red clover and only in moderate drought treatment in alfalfa. The alfalfa extracellular enzyme assay showed that drought treatments did not affect the enzymes responsible for cycling carbon (β-glucosidase, β-D cellobiosidase) and phosphorous (phosphatase). Conversely, the enzyme for nitrogen cycling (N-acetyl-glucosaminidase) was decreased under drought stress. No effects in extracellular enzyme activity were observed under red clover, except for decreased β-D cellobiosidase activity found under severe drought. This suggests that drought intensity and plant species have varying influences on enzyme activities. Finally, the total available soil nitrogen increased following severe drought conditions in both forage legumes. These results indicate that drought has deleterious effects on nodulation, plant growth, and carbon and nitrogen cycling enzyme, while a positive effect on nitrogen rhizodeposition into the soil.
4	**Physiological thresholds are indicative of yield potential of wheat subjected to drought** Gopal Sharma[1], Gurcharn Brar[1], Thorsten Knipfer[1] [1]University of British Columbia, Vancouver, BC Drought-induced water stress leads to wheat dehydration affecting physiological performance and yield. However, little is known about the underlying physiological stress thresholds of wheat

	cultivars which limits our ability for selection of cultivars with improved drought resistance. We performed our study on 'Superb' (rated as 'drought susceptible' in terms of yield potential), 'Stettler' and 'AAC Viewfield' (both rated as 'drought tolerant'). Plants were grown in large cylindrical pots to minimize root growth restrictions. A drought-stress treatment was imposed at early anthesis. Over the drydown period drought-induced physiological response were determined by measurement of wheat water relations (leaf water potential at predawn and midday, leaf relative water content, solute potential of leaf sap, and stomatal conductance). This was combined with quantification of the onset of leaf rolling using flag leaf width measurements. Our data indicate that physiological stress thresholds are cultivar-specific and depend on soil moisture levels. Furthermore, differences in yield potential among cultivars were linked to physiological stress thresholds. In conclusion, our data highlight that yield potential under drought can be predicted through cultivar-specific knowledge on wheat water relations.
5	**Nitrogen in a Prairie Soybean Canopy - How much is there and where is it going?** Nathaniel Ort[1], Ayza Camargos[1], Connie Briggs[1], Doug Medernach [1], Malcolm Morrison[2], Tom Warkentin[1], Rosalind Bueckert[1] [1]University of Saskatchewan, Saskatoon, SK, [2]Agriculture and Agri-Food Canada (AAFC), Ottawa, ON Protein is required in all human and animal diets and the demand for plant-based protein is increasing. Soybean [Glycine max (L.) Merr.], a legume with high seed protein, is an environmentally and economically sustainable field crop that can be produced in different climates. Soybean production is relatively new to Saskatchewan (SK) and there are challenges that must be addressed for this crop to be more favourable for farmers to produce. One major challenge is to increase the seed protein concentration, which is consistently lower for SK-grown soybean compared to soybean produced in Manitoba and eastern Canada. Environment and latitude influence protein concentration and these factors likely drive lower protein in SK; however, the specific environmental factors resulting in lower seed protein in SK remain unclear. The objective of this study is to gain knowledge on soybean seed protein synthesis in SK in optimal and stress conditions. In 2021, eight soybean cultivars differing in leaf shape, node number, and maturity group were grown in two SK locations under different fertility regimes. Photosynthesis was limited by shade cloth during flowering and seed fill stages to simulate plant stress. Nitrogen concentration was measured in the leaves and stems at flowering and physiological maturity. Cultivars that received fertilizer had greater seed protein than those that received none. When shade was applied at flowering the greatest seed protein was measured, however, this also resulted in less seeds plant^{-1} than the other treatments which is a well reported relationship. At one of the two locations, greater nitrogen concentration in the leaves at flowering was related to higher seed protein. This experiment was repeated in 2022 with additional seed growth and development analysis. The results from this study will generate new information on soybean protein synthesis and determine the plant traits related to high seed protein concentration.
6	**Integrating enhanced efficiency fertilizers and nitrogen rates to improve Canada Western Red Spring wheat production in the Canadian prairies** Adam Fast[1, 2], Dean Spaner[1], Guillermo Hernandez Ramirez[1], Sheri Strydhorst[3], Xiying Hao[2], Greg Semach[2], Jessica Enns[4], Chris Holzapfel[5], Laurel Thompson[6], Brian Beres[1, 2]

	[1]University of Alberta, [2]Agriculture and Agri-Food Canada, [3]Sheri's Ag Consulting, [4]Western Applied Research Corporation, [5]Indian Head Agricultural Research Foundation, [6]Lakeland College Canada Western Red Spring (CWRS) wheat (*Triticum aestivum* L.) is the most widely grown wheat class in western Canada. This is mainly due to its excellent milling and baking qualities, while also having a high protein content. Optimum CWRS production requires sufficient nitrogen (N) supply and is typically applied as granular urea fertilizer during planting. Problems of N loss can arise when using urea, therefore enhanced efficiency fertilizers (EEFs) have been developed. EEFs aim to maintain the integrity of applied N, increase plant nutrient uptake, and reduce N loss to the environment. To determine if EEFs can improve upon conventional methods, a CWRS yield parameter experiment was established in 2019 across four locations in Alberta and two in Saskatchewan, Canada. This experiment consists of two factors: (*i*) N form [urea; urea + urease inhibitor (Agrotain®); urea + nitrification inhibitor (eNtrench®); urea + urease & nitrification inhibitor (SuperU®); urea + urease & nitrification inhibitor (NBPT/DMPSA); and polymer-coated urea (Environmentally Smart Nitrogen® (ESN®))], and (*ii*) N rate [60; 120; 180; and 240kg N ha^{-1}]. Preliminary results indicate N form affected grain yield in Dark Brown Chernozemic (DBC) soils but not in Black & Grey Chernozemic (BGC) soils. In DBC soils, SuperU® increased grain yield relative to urea, while ESN® reduced grain yield. The other N forms attained similar grain yield to urea. Grain protein content was not influenced by N form; however, increasing N rate in both soil groups resulted in quadratic and linear relationships with grain yield and protein content, respectively. Furthermore, N rates of 120 kg N ha^{-1} typically displayed as optimal. These results suggest growers who incorporate certain EEFs in CWRS production can achieve modest increases in yield parameters and are not subject to any reductions relative to conventional urea.
7	**Agronomic responses of milling oat (Avena sativa) to struvite and monoammonium phosphate** Racquelle Peters[1], Eric Johnson[1],Steve Shirtliffe[1] [1]University of Saskatchewan, Saskatoon, SK Organic farmland in western Canada is often found to be limiting in soil available phosphorus (P). Wastewater-recovered struvite is a promising low-solubility P source that has been proven effective as a P fertilizer in some grain crops, such as buckwheat. To date, there have been no field experiments evaluating oats' response to struvite in P-deficient soils. The objective of this study was to compare the growth and yield of oat fertilized with various rates of struvite and monoammonium phosphate (MAP). The experiment was conducted at four sites ranging from deficient to very deficient soil P test levels (3-23 ppm), with three trials in Saskatchewan (SK) and one in Manitoba (MB). All SK sites were conducted as a Systematic Randomized Column-Row Design, while a Randomized Complete Block Design was used at MB. All four sites were fertilized with struvite or MAP at 0, 15, 30, 45, and 60 kg P_2O_5 ha^{-1}. Crop biomass was assessed at the early vegetative stage (4-6 leaf) and at physiological maturity (soft dough). Grain yield quantity was also assessed. Oat early-stage biomass demonstrated a positive linear response to P rate, regardless of P form at two of the three SK sites. At one SK site, struvite resulted in 7% greater late-stage biomass compared to MAP. While MAP resulted in a 6% greater yield quantity compared to struvite at only one SK site. At MB, where soil P was lowest (3 ppm), both forms of P resulted in a positive linear response for early-stage biomass and late-stage biomass. MB yields were found to have a curvilinear P rate response with the greatest yield quantities leveling off at 30 to 45 kg P_2O_5 ha^{-1}. Overall, this research demonstrates that struvite can be an effective P fertilizer for oat grown

	on P-deficient soils in the western prairies.
8	**Exploring the Agronomic and Economic Feasibility of Fall Season Cover Crops in Manitoba.** Dale Penner[1, 2], Yvonne Lawley[1], Jun Zhao[2] [1]University of Manitoba, [2]Agriculture and Agri-Food Canada Cover crops are grown to protect and improve soil during periods when cash crops are not being grown. Cover crop adoption in Manitoba has increased in recent years, largely due to farmers increased interest in soil health building practices. Limited on-farm research on the agronomic and economic impact of growing cover crops in Manitoba is a barrier to further adoption. On-farm experiments with four replicates of paired field length plots were conducted at six sites across southern Manitoba from 2019 to 2021. Participating farmers followed their standard annual grain rotation and added complimentary fall season cover crops for each site year. Fall cover crop treatments were compared to the farmer's standard management practice without cover crops. The accumulation of fall aboveground biomass, ground cover, and the subsequent cash crop yield was measured. Cover crop and subsequent crop management data was collected from participating farmers to calculate the short-term on-farm economic impact of cover crops. Fall season cover crops had a mean cost of \$170 ha^{-1} with a median cost of \$126 ha^{-1} from seven site-years. In eleven of twelve site-years there was no treatment effect on cash crop yield. In one site-year the cover crop treatment cash crop yield was 395 kg ha^{-1} greater than the control. Fall cover crop establishment and growth during the study period was challenged by both dry and excess moisture conditions. Mean fall aboveground biomass from eleven site-years was 788 kg ha^{-1} in the cover crop treatment, while fall volunteers in the control treatment produced 701 kg ha^{-1}. Mean fall ground cover from eleven site-years was 29% in the cover crop treatment versus 16% in the control treatment. This research will provide cover crop cost and impact information to potential adopters. These results can also be used by policymakers to help guide future program development.
9	**Evaluation of Hair Fescue (Festuca filiformis) Management in Wild Blueberry (Vaccinium angustifolium Ait.) using Dichlobenil** Craig MacEachern[1], Travis Esau[1], Scott White[1], Qamar Zaman[1] [1]Dalhousie University, Truro, NS Wild blueberries are Nova Scotia's most economically important crop with a 5-year average farm gate value of \$16.78 million. Despite the success, the industry faces several key challenges, none of which are more prevalent than the pressure of hair fescue. Hair fescue has rapidly spread throughout Nova Scotian wild blueberry fields and limited management options is only compounding the problem. Pronamide is largely the only product employed by growers leading to its potential selection for herbicide resistance. Dichlobenil represents a possible solution to this issue as it has seen very little employment in wild blueberries. This study was set up to assess the effects of dichlobenil for managing hair fescue and compare its effectiveness to pronamide. As anticipated, pronamide continued to perform well across all studies. Results from the dichlobenil plots were likewise encouraging as high rates of the product were able to provide a similar level of control to pronamide with respect to living tuft count, flowering tuft percentage and seed head

	count. Interestingly, plots treated with high rates of dichlobenil resulted in the highest average yield among harvested plots. Results of this study are encouraging as they provide a recommendation on a suitable product to interchange with pronamide. While the researchers still feel that pronamide is the superior product for controlling hair fescue, dichlobenil can provide a similar level of control.
10	**Evaluation of clethodim for management of hair fescue (Festuca filiformis) and red fescue (Festuca rubra) in lowbush blueberry (Vaccinium angustifolium) fields in Atlantic Canada** Tyler MacLean[1], Scott White[1], Travis Esau[1], Andrew McKenzie-Gopsill[2] [1]Dalhousie University, [2]Agriculture and Agri-Food Canada Hair fescue is found in 75% of lowbush blueberry fields in Nova Scotia and reduces yield by up to 50%. Pronamide is the only herbicide currently providing effective control during the full two year growing cycle and foramsulfuron provides suppression in the non-bearing year only. Additional herbicide treatments are needed to reduce growers' reliance on pronamide and prevent the development of resistant biotypes. Clethodim previously suppressed hair fescue in a limited number of non-bearing year fields, suggesting this herbicide may contribute to hair fescue management. The objectives of this research were to 1) determine clethodim efficacy on multiple hair fescue populations in Nova Scotia, 2) determine the bearing year efficacy of clethodim on hair fescue, and 3) determine the effect of clethodim application rate on hair fescue using a dose response experiment. Clethodim was applied at 91.2 g a.i. ha^{-1} with 2000ml Amigo surfactant ha^{-1} for objectives 1 and 2 and at 0, 0.25, 0.5, 1, 2, 4, 8, and 16X (X = 45.6g a.i. ha^{-1}) with 2000ml Amigo surfactant ha-1 for objective 3. Clethodim reduced hair fescue flower tuft density and tuft inflorescence number in 6 of 8 non-bearing year populations evaluated and reduced flower tuft density and tuft influence number at all bearing year sites evaluated. The anticipated label rate of 91.2 g clethodim ha^{-1} reduced flower tuft density by 81, 95, and 95% at the three dose response sites, suggesting this application rate is likely sufficient for hair fescue suppression in lowbush blueberry. The anticipated registration of clethodim in lowbush blueberry should therefore provide a new herbicide site of action for hair fescue management for the entire growing cycle.
11	**The confirmation and characterization of auxinic herbicide resistance in a population of green pigweed (Amaranthus powellii) from Ontario** Isabelle Aicklen[1], Peter Smith[1], Brendan Metzger[1], Todd Gaines[2], Mithila Jugulam[3], Darren Robinson[1], Peter Sikkema[1], Francois Tardif[1] [1]University of Guelph, [2]Colorado State University, [3]Kansas State University Auxinic herbicides are used for the selective control of dicot weeds in crop production. These herbicides are becoming less effective due to the development of herbicide resistant weeds, creating management challenges for farmers. A population of green pigweed with suspected resistance (R) to the auxinic herbicide MCPA has been reported in Ontario. The objective of this study is to confirm resistance of this population of green pigweed to MCPA and to determine the pattern of cross resistance to other auxinic herbicides. Dose response experiments were conducted to compare differences in GR_{50} values (dose causing growth reduction of 50%) between R and a known susceptible green pigweed population using MCPA amine, mecoprop, 2,4-D ester, dichlorprop, halauxifen-methyl, dicamba, and aminocyclopyrachlor. Field trials were conducted

	using auxinic herbicides applied post emergence in corn to evaluate the control of green pigweed and to confirm herbicide resistance at the field level. Dose response results confirmed that R has 4.4-fold resistance to MCPA with cross resistance to aminocyclopyrachlor (3.0-fold), dichlorprop (2.5-fold), and mecoprop (2.4-fold). Field trials showed that dicamba provided superior control (>80%) at 56 days after application but control was 30% with MCPA alone, 46% with MCPA + fluroxypyr, and 36% with MCPA + fluroxypyr/halauxifen-methyl. This confirms that the level of resistance observed in the lab brings the effectiveness of MCPA or MCPA with other auxinic herbicides below commercially acceptable levels. Future studies will focus on determining the mechanism of resistance and further confirming the pattern of cross resistance.
12	**Synergistic and antagonistic herbicide interactions for control of volunteer corn in glyphosate/glufosinate/2,4-D-resistant soybean** Emily Duenk[1], Nader Soltani[1], Robert Miller[2], David Hooker[1], Darren Robinson[1], Peter Sikkema[1] [1]University of Guelph, Ridgetown, ON, [2]BASF Canada Inc., Mississauga, ON Weed interference from glyphosate/glufosinate-resistant (GGR) volunteer corn can reduce soybean yield and quality. The release of glyphosate/glufosinate/2,4-D choline-resistant (GG2) soybean will allow for expanded POST herbicide tank-mixture options for broad-spectrum weed control. Herbicide antagonism between ACCase-inhibiting graminicides and synthetic auxin herbicides has been widely reported for several grass weed species, including volunteer corn. Four field trials were conducted over a two-year period (2021, 2022) in southwestern Ontario to assess volunteer corn control between combinations of glufosinate, 2,4-D choline, or dicamba with clethodim or quizalofop-p-ethyl applied POST to GG2 soybean. Quizalofop-p-ethyl and quizalofop-p-ethyl + glufosinate controlled GGR volunteer corn 95 and 98%, respectively, 6 weeks after application (WAA); the addition of 2,4-D choline or dicamba to quizalofop-p-ethyl reduced control to ≤15%. Clethodim controlled GGR volunteer corn 81%, and the addition of glufosinate increased control to 97%. In contrast, the addition of 2,4-D choline or dicamba to clethodim reduced GGR volunteer corn control to 58 and 45%, respectively at 6 WAA. ACCase-inhibiting herbicides co-applied with glufosinate resulted in a synergistic improvement in GGR volunteer corn control while co-applications with synthetic auxin herbicides resulted in antagonistic interactions. Greater antagonism occurred when the synthetic auxin herbicides were co-applied with quizalofop-p-ethyl than clethodim. All tank-mixes of quizalofop-p-ethyl or clethodim with synthetic auxin herbicides resulted in unacceptable control of GGR volunteer corn.
13	**Winter Wheat and Winter Annual Grass Species Metabolic Response to Cloquintocet-Mexyl** William Kramer[1], Todd Gaines[1], Franck Dayan[1] [1]Colorado State University, Fort Collins, CO, USA Cloquintocet-mexyl is a post-emergent safener used in combination with herbicides to selectively boost crop herbicide metabolism while not compromising weed control. This increase in crop safety is achieved through increased expression of genes encoding herbicide metabolizing enzymes. Previous literature has connected cloquintocet-mexyl to transcriptional activation of genes that encode for various detoxifying enzymes, particularly glutathione-S-transferase. In this research, cloquintocet-mexyl is used as a tool to modulate herbicide metabolism in winter wheat to identify potential genes contributing to herbicide tolerance. The effect of cloquintocet-mexyl on

	the rate of quizalofop-p-ethyl (QPE) metabolism was analyzed in wheat by liquid chromatography-mass spectrometry. QPE was metabolized faster in cloquintocet-methyl treated wheat than in plants exposed to QPE alone, suggesting that enhanced metabolism of QPE may contribute to the overall wheat response to this herbicide. To investigate the transcriptomic response associated with this potential differential metabolism, wheat was sprayed with 10 g ha $^{-1}$ of cloquintocet-mexyl and leaf-tissue was sampled 12-hours after application. Total RNA was extracted and used to generate paired-end cDNA Illumina libraries for sequencing. Differential gene expression results indicate that various metabolic enzymes are responding to cloquintocet-mexyl applications. Many upregulated genes are directly associated with GST enzyme induction and have previously been reported to respond to cloquintocet-mexyl applications. The selected GST genes will serve as targets to further understand the molecular mechanism associated with cloquintocet-mexyl applications in wheat. Ultimately, inducible GSTs genes involved in QPE metabolism can be used as molecular markers for future wheat breeding programs.
14	**Control of multiple-herbicide-resistant waterhemp (Amaranthus tuberculatus (Moq.) J.D. Sauer) with acetochlor-based tank mixtures in soybean** Hannah Symington[1], Nader Soltani[1], Allan Kaastra[2], David Hooker[1], Darren Robinson[1], Peter Sikkema[1] [1]University of Guelph, Ridgetown, ON, [2]Bayer CropScience Canada, Guelph, ON Waterhemp has evolved resistance to Group 2, 5, 9, 14, and 27 herbicides in Ontario, Canada making control of this challenging weed even more difficult. Acetochlor is a Group 15, chloroacetanilide herbicide that has activity on many annual grasses and some small-seeded annual broadleaf weeds including waterhemp. The objective of this study was to determine if acetochlor tank mixtures with broadleaf herbicides (dicamba, metribuzin, diflufenican, sulfentrazone, or flumioxazin), applied preemergence (PRE) increases the control of multiple-herbicide-resistant (MHR) waterhemp in soybean. Five trials were conducted over two years (2021-2022). The acetochlor tank mixtures caused ≤2% soybean injury except acetochlor plus flumioxazin which caused 11% soybean injury. Acetochlor applied PRE controlled MHR waterhemp 82% at 12 weeks after application (WAA). Dicamba, metribuzin, diflufenican, sulfentrazone, or flumioxazin controlled MHR waterhemp 37, 53, 38, 55, and 81%, respectively at 12 WAA. Acetochlor applied in a tank mixture with dicamba, metribuzin, diflufenican, sulfentrazone, or flumioxazin controlled MHR waterhemp 89 to 97%, similar to acetochlor applied alone. Acetochlor reduced MHR waterhemp density and biomass 98 and 93%; the tank mixture of acetochlor + flumioxazin reduced waterhemp density and biomass by an additional 2 and 7%, respectively. This research concludes that acetochlor applied in a tank mixture with flumioxazin reduces MHR waterhemp density and biomass; this was the most efficacious tank mixture evaluated.
15	**Ecology and management of cow wheat (*Melampyrum lineare* Desr.) in lowbush blueberry (*Vaccinium angustifolium* Ait.) fields in Nova Scotia.** Deveau, V.T. [1]., White, S.N.[1]., MacLean, N.L[1]., and MacDonald, M.T[1]. [1]Department of Plant, Food, and Environmental Sciences, Dalhousie University Faculty of Agriculture, Bible Hill, NS. Cow wheat *(Melampyrum lineare* Desr.) is an annual hemiparasitic weed that is increasing in occurrence in lowbush blueberry fields in Nova Scotia. Growers are concerned about possible yield

reductions in cow wheat-infested fields, but little is known about the general biology, seedbank characteristics, seedling establishment, or management of cow wheat in lowbush blueberry fields. The objectives of this research were to 1) determine cow wheat seed bank characteristics in lowbush blueberry fields, 2) determine the extent and timing of cow wheat seedling emergence in lowbush blueberry fields, and 3) evaluate a range of herbicides for cow wheat management in lowbush blueberry fields. Cow wheat formed seedbanks in lowbush blueberry fields, with an average of 18,400 ± 1946, 6789 ± 1014, 2286 ± 489, and 9260 ± 1479 seeds m^{-2} occurring in soil surface samples and 7 ± 2.2, 5 ± 1.0, 3 ± 1.0, and 7 ± 1.7 seeds m^{-2} occurring in soil subsurface samples (7-cm depth, 333 cm^{-3} sample) collected from four lowbush blueberry fields. Cow wheat seedlings emerged between April 18 to April 25 and 50% and 90% seedling emergence occurred by May 2 and May 26, respectively. Cow wheat density was reduced by PRE applications of hexazinone (1920 g a.i. ha^{-1}), terbacil (2000 g a.i. ha^{-1}), sulfentrazone (139 g a.i. ha^{-1}), indaziflam (75 g a.i. ha^{-1}), tribenuron-methyl (30 g a.i. ha^{-1}), nicosulfuron + rimsulfuron (16.7 + 8.3 g a.i. ha^{-1}), and flazasulfuron (50 g a.i. ha^{-1}) and POST applications of mesotrione (144 g a.i. ha^{-1}), clopyralid (151 g a.i. ha^{-1}), and foramsulfuron (35 g a.i. ha^{-1}). Many of these herbicides are applied prior to late May in lowbush blueberry fields, suggesting cow wheat emergence timing and susceptibility to these herbicides should enable growers to readily manage this weed species.

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Investigating the weed seed preferences of earthworms (Lumbricus terrestris L.)

Pengfei Ji[1]

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Earthworms are well-recognized ecosystem engineers that have been studied for their significant role in plant ecology, including seed dispersal and consumption. More recently, the preferences of earthworms for various seed species have also been studied in China, but this study did not use weed seeds typical of those found in North America. The objective of our research was to determine if an exotic earthworm species exhibited preferences for different species of weed seeds. We selected nine weed seed species that are widespread across Canada, and one common exotic earthworm species, *Lumbricus terrestris*, to study seed preferences of this earthworm species. A series of choice and no-choice experiments were conducted under laboratory conditions for each weed species. The results indicate that *Lumbricus terrestris* most preferred wild mustard, both when dry seeds and imbibed seeds were presented. Contrary to what we expected, earthworms select kochia as the next most preferable to wild mustard (0.015 and 0.007g separately, $p<0.05$). This research will help us to better understand how earthworms find, select and consume seeds, which helps us determine their role in weed management and weed species community assembly.

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Evaluating the potential of a winter canola-soybean relay intercrop in Ontario

Eric Page[1], Marinda DeGier[2], Francois Tardiff[1], Meghan Moran[3], Joshua Nasielski[3]

[1]Co-Advisor, [2]MSc Candidate, [3]Committee Member

Relay intercropping is the practice of two crops grown in the field simultaneously throughout a growing season. A second crop is planted into an initial crop that is already established. The first crop then comes to maturity and is harvested prior to the second being harvested. To date, no prior research has been done in Ontario or elsewhere looking at relay intercropping soybean with

	winter canola. Given the economic potential of these crops, there is an opportunity to enhance the sustainability and profitability of cropping systems in Ontario. Through this research project, we will be studying the effectiveness of a winter canola-soybean relay intercrop by evaluating the agronomic factors that may drive its success. Spring fertility and winter canola seeding rate are two factors that will be evaluate. Winter canola is planted in the fall at two densities on 30 inch or wide row spacing. Two spring fertilizer treatments, with and without spring fertilizer, will then be applied to the canola prior to planting soybeans between the canola rows. Throughout the growing season measurements will be taken on both crops to evaluate their phenology and physiology. Finally, yield will be taken to determine the success of the system. These studies will be carried out over the 2022 and 2023 growing seasons in four locations across south-western Ontario. The results of this research will not only evaluate the profitability and practicality of relay intercropping soybean with winter canola but it will also offer new insights into the agronomic factors that may help to determine the success of this alternative cropping system.
18	**New tools to improve wild oat (Avena fatua L) management in cultivated oat(Avena sativa L.)** Brianna Senetza[1], Chris Willenborg[1], William May[2] [1]University of Saskatchewan, [2]Agriculture and Agri-Food Canada - Indian Head Sk. Wild oat (*Avena fatua* L) is responsible for more economic loss than any other weed in Canada. Wild oat was found to be the second most abundant weed species present in crop fields throughout Western Canada. This competitive weed poses a significant problem in many crops but, perhaps the most troublesome in cultivated oat (*Avena sativa* L). The genetic similarity between the two species restricts management by selective herbicides, limiting control options for growers. Utilizing new technology may make it possible to better manage wild oat in oat crops. The objective of this research was to determine the potential of utilizing inter-row spraying and weed wicking non-selective herbicides in controlling wild oat in oat. These objectives were tested using field experiments. The combination of weed wicking and inter-row spraying at the 4 leaf followed by 6 leaf application timing and 6 leaf followed by the flag leaf application timing, reduced wild oat populations most effectively. There was no significant impact of spray treatments on cultivated oat yield. However, the combination treatments of wicking and interrow spraying at the 4 leaf followed by 6 leaf application timing and 6 leaf followed by flag leaf application timing had a favorable impact on grain quality, increasing the percent of plump grains by 23%. By spraying a non-selective herbicide between crop rows and utilizing a weed wick to manage weeds that are taller than the crop canopy, there may be potential to have a chemical control option to manage wild oat in cultivated oat.
19	**Siamese Neural Networks for Weed Classification in Wild Blueberry with Minimal Training Images** Patrick Hennessy[1], Travis Esau[1], Arnold Schumann[2], Scott White[1], Aitazaz Farooque[3], Qamar Zaman[1] [1]Dalhousie University, Truro, NS, [2]Citrus Research and Education Center, University of Florida, Lake Alfred, Florida, USA, [3]University of Prince Edward Island, Charlottetown, PE Convolutional neural networks (CNNs) are image-processing algorithms that can automatically classify images with high levels of accuracy. They have gained popularity in recent years for image

	identification tasks in agriculture such as weed and disease classification. Iterative optimization algorithms use datasets containing thousands of images of each image class to train CNNs. A recent survey of Nova Scotia wild blueberry (Vaccinium angustifolium Ait.) fields found more than 200 unique species of weeds. Collecting an image dataset containing thousands of images of each weed species to train a CNN would be time-consuming and impractical. Siamese neural networks (SNNs) allow for the identification of new image classes using very few training images, typically one or five. In this study, an SNN was trained to identify weed species using the Keras-TensorFlow deep learning framework. An image dataset consisting of nine species of weeds from wild blueberry fields in Nova Scotia was collected from April through June 2019, 2020, and 2021. A public dataset, DeepWeeds, was used to pre-train the SNN using 1000 images per class of eight weed species found in Australia. The SNN was then re-trained using transfer learning to identify the weeds found in Nova Scotia wild blueberry fields using one, five, and ten images per species. Future work will involve adding compatibility for more weed species and using SNNs to identify common diseases in the wild blueberry crop. The trained SNNs will be deployed in a downloadable smartphone application and an online web-based application to facilitate streamlined weed identification and management information delivery to wild blueberry growers
20	**Counting on Canola: Can UAV Imagery Quantify Canola Emergence?** Kaylie Krys[1], Steve Shirtliffe[1], Erik Andvaag[1], Ian Stavness[1], Anjika Attanayake[1], Eric Johnson[1], Hema Duddu[2] [1]University of Saskatchewan, Saskatoon, SK, [2]Agriculture and Agri-Food Canada, Saskatoon, SK Current practices to estimate canola emergence consist of time-consuming manual plant population counts that are prone to human-based inconsistencies and limited by the ability to physically reach sample sites within a field. Another consideration is determining the minimum number of survey points to efficiently estimate the plants/m^2 within a set field area with minimum errors. The objective of this research was to evaluate the accuracy and precision of Convolutional Neuro Network (CNN) plant counts from Unoccupied Aerial Vehicle (UAV) imagery of canola plant population. Research blocks consisting of 0.4 ha square areas within commercial canola fields in central Saskatchewan. The research blocks were managed as part of the field as a whole and situated in different topographic areas. Canola within the blocks were imaged at emergence and stitched to produce an orthomosaic. Each block was point-sample-surveyed with a UAV taking 40 images for comparison. The CNN model used to predict canola seedlings has shown an accuracy of 90.6% and an F1 Score of 0.951 in a preliminary accuracy assessment. Bootstrap sampling will be used as a resampling technique to determine the minimum number of samples to estimate the plant counts received from the orthomosaic efficiently. This will allow fields to be more thoroughly surveyed and deliver detailed results on canola emergence, which can be applied to early growing season decision-making.
21	**Genetic dissection of seed composition traits in soybean using SoyMAGIC** Seyedmohammad Hashemisardroud[1], Milad Eskandari[1] [1]University of Guelph, Guelph, ON Multi-parent Advanced Generation Inter-Cross (MAGIC) populations are emerging genetic platforms for dissecting genetic architecture of quantitative traits. In the current study, the first soybean MAGIC (SoyMAGIC) population with 721 recombinant inbred lines (RILs) was established

	through inter-mating of eight genetically diverse soybean founders, each carrying different agronomic and seed composition traits. In addition to introducing the first soybean MAGIC population to North American soybean community, we aimed to capitalize on this novel opportunity to discover and fine map of quantitative trait loci (QTL) associated with the target traits using Genome Wide Association Studies (GWAS). The RILs were evaluated for important seed composition traits, such as protein, oil, and fatty acid compositions, across three environments in southwestern Ontario. The RILs were genotyped using genotyping-by-sequencing (GBS) method to discover polymorphic SNP markers among the RILs, which in turn was used to identify marker-trait associations using genome-wide association study (GWAS). A high-density linkage map was constructed through inclusive composite interval mapping (ICIM). The linkage map was 3770.75 cM in length and contained 12,007 SNP markers. Transgressive segregation of the selected traits and higher recombination frequency across the genome was observed, confirming the high resolution of SoyMAGIC for genetic studies. A total of 97 SNPs, which divided into 87 genomic regions, were found to be significantly associated with the seed composition traits. Six of them were stable across multiple environments and three regions indicated pleiotropic effects underlying multiple traits. Within the regions, 696 putative genes were identified, of which 15 genes with known functions were detected as potential candidate genes. The results of this study can facilitate the development of soybeans with a wide range of seed quality to address the needs of different markets.
22	**Diflufenican: a tool for managing Amaranthus species in corn and soybean production systems.** Adam Pfeffer[1], Allan Kaastra[1], Andrew Leplante[1] [1]Bayer CropScience Canada, Ontario, Canada The continued development and spread of herbicide resistant weed populations constitutes a major threat to the efficiency and profitability of corn and soybean production. Weeds such as Amaranthus species have developed resistance to multiple herbicide modes- and sites- of action and are among the most challenging broadleaf weeds in North America. Bayer Crop Science is developing an herbicide platform that features the use of diflufenican, a new site of action for weed control in corn and soybean production systems, pending approval by the PMRA and EPA. Diflufenican functions as a phytoene desaturase inhibitor classified by WSSA as a Group 12 herbicide in the pyridinecarboxamide family. This active ingredient has been used outside of North America for control of broadleaf weeds in cereals, peas, lentils, lupins, clover pastures, and oilseed poppy. Given the increasing challenge of managing herbicide-resistant weeds, diflufenican was evaluated in field trials for residual activity on Amaranthus species. Crop selectivity in corn and soybean shows promising results to be used as part of an integrated weed management plan in these production systems.
23	**Acetochlor plus EngardeTM Herbicide (Mesotrione + Rimsulfuron) for the Control of Problematic Weeds in Corn in Eastern Canada.** Jamshid Ashigh[1], Laura Smith[1] [1]Corteva Agriscience, Calgary, AB Acetochlor is an excellent pre-emergence herbicide for control of certain grass and small-seeded broadleaf weeds. However, to provide broad-spectrum weed control and delay the onset of herbicide resistance, it is important to tank-mix acetochlor with herbicides that contain additional

	modes of action. In research trials conducted in Eastern Canada in 2020, and 2021, acetochlor, along with glyphosate, was combined and evaluated with Engarde™ Herbicide, which is a combination of rimsulfuron and mesotrione that is commonly used in corn production areas of Eastern Canada. Applications were applied pre-emerge up to the V1 stage of the corn crop and targeted control of three weeds: redroot pigweed (Amaranthus retroflexus), large crabgrass (Digitaria sanguinalis) and green foxtail (Setaria viridis). Results concluded that acetochlor plus Engarde tank-mix effectively suppressed or controlled these weed species equivalent or better than the products applied individually. Acetochlor is demonstrated to be an effective tank-mix partner for Engarde™ Herbicide applied pre-emerge to V1 crop stage, providing broad-spectrum residual control of many common yield-reducing weeds found in Eastern Canada. ™® Trademarks of Corteva Agriscience and their affiliated companies or their respective owners.
24	**Influence of a Novel Adjuvant System on Deposition, Canopy Penetration, and Drift Reduction of Aerially Applied Spray Mixtures.** Gregory Dahl[1], Eric Spandl[1], Joshua Skelton[1], David Van Dam[2], Ryan Edwards[1], Steven Fredericks[1] [1]Winfield United, Minnesota, USA, [2]Winfield United Canada, Winnipeg, MB A crop-based adjuvant has been developed that contains a nonionic surfactant combined with modified vegetable oils. The new adjuvant provided improved herbicide deposition, canopy penetration and reduced spray drift. It reduced the amount of fine spray particles without creating large droplets or thickening the spray mixture. The adjuvant has this effect with many nozzle types, sizes, and spray mixtures. An aerially applied study was conducted in Wisconsin in 2016. Spray mixtures were applied aerially to compare and analyze the deposition, swath displacement and off-target movement. The study was conducted with an Air Tractor 502A equipped with 36 CP 11 TT nozzles that operated at 276 kilopascals. The treatments were applied at 18.7 or 46.8 liters per hectare at 241 kilometers per hour per hour with a boom height of 3 meters. The airplane sprayed lengthwise on a grass runway surrounded by soybeans. Collectors were placed perpendicular to the flight path across the pattern. These were spaced at 3-meter intervals including upwind, under the flight path and downwind. Kromocote cards were placed on collectors to evaluate deposition. Wind movement was perpendicular to the direction of the flight path. Each mixture was sprayed 4 times. Cards were collected between each pass. Videos of each pass with the airplane were made with a digital video camera. The mixtures applied included water and rhodamine dye at 250 milliliters per 100 liters. Several adjuvants were added to spray mixtures and applied. The swath of the water treatment moved downwind and drifted notably as demonstrated both by video and collection cards. The nonionic surfactant plus deposition adjuvant reduced the swath displacement and downwind drift as demonstrated by both the videos and the collection cards.
25	**MasterLock: A non-ionic surfactant, deposition aid, and drift control adjuvant for use in Canada.**

Joshua Skelton[1], Errin Willenborg[2], Gregory Dahl[1], David Van Dam[2]

[1]WinField United, [2]WinField United Canada

MasterLock® is a newly registered activator adjuvant for use in Canada with herbicides, fungicides, desiccants, and insecticides across major crops. MasterLock® is a nonylphenol ethoxylate (NPE)-free non-ionic surfactant, deposition aid, and drift reduction adjuvant that is effective at low use rates. It has been sold and utilized in the United States for 10 years with proven efficacy and crop safety across many crops and pesticides. MasterLock® influences pesticide performance by increasing droplet adhesion and spreading on the leaf surface; improving spray solution canopy penetration; reducing off-target movement of the spray solution. During the growing seasons of 2021 and 2022, MasterLock® has been researched in 174 field trials with ten different herbicide active ingredients, 17 herbicide products, seven crop species, and in eight different provinces or US states for registration in Canada. Future research will include additional herbicides and tank-mixtures. In 2021, MasterLock® statistically increased herbicide efficacy in 82% of trials compared to the herbicide alone treatment. In a study with a tank-mixture of clethodim and glyphosate in soybean, MasterLock® increased volunteer corn control 65% resulting in 12 bushels per acre greater yield and raised revenue by 27% compared to the herbicides alone. MasterLock® significantly reduced the volume of spray droplets prone to off-target movement with glufosinate in a wind tunnel study by 11% when an XR11004 nozzle was used and 4% with an AIXR11004 nozzle. When averaged across nozzle types, MasterLock® reduced driftable sized droplets from 14% to 7% with glufosinate. MasterLock® is an effective adjuvant for improving herbicide performance, increasing weed control, and reducing the risk of off-target movement in Canadian cropping systems.

26 **Optimisation of rye cover crop termination for improved corn growth**

Olivia Noorenberghe[1], François Tardif[1], Michael Cowbrough[2], Peter Smith[1], Peter Sikkema[3], David Hooker[3]

[1]University of Guelph, Guelph, ON, [2] Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, ON, [3]University of Guelph, Ridgetown, ON

Winter rye provides many benefits as a cover crop; however, it can often negatively affect corn that follows in the rotation. The causes of these negative effects are unclear, but we hypothesize that low quality light [low red to far-red light ratio (R/FR)], reflected by neighboring rye plants, may influence corn seedlings. Three field experiments were conducted in southwestern Ontario in 2020 and 2021 to determine whether planting corn without tillage into rye free strips or terminating rye with different application timings and herbicides prior to corn planting can mitigate any negative impact on corn performance while maximizing rye biomass. The R/FR of reflected and transmitted light was influenced by the timing of rye termination, with delayed termination at 7 days after planting (DAP) causing corn seedlings to be exposed to the lowest light quality. The quality of the light reaching corn seedlings improved by terminating rye 1 to 14 days before planting (DBP), regardless of planting pattern or herbicide used for termination. Mitigating negative impacts by using fast-acting herbicide was not observed due to apparent antagonism when glyphosate and glufosinate were co-applied. Rye reduced weed density and biomass as termination timing was delayed to 7 DAP. In general, there was a trend for corn yield to decline as rye termination was

	delayed from 14 DBP to 7 DAP, however, a significant yield decrease was only observed 7 DAP at Woodstock in 2021. At either year in Elora, rye termination 7 DAP did not reduce corn yield when averaged across planting patterns and herbicides compared to other termination timings. Though delaying termination until 1 DBP or 7 DAP reduced nitrate availability and light quality, it is not known whether these factors are the primary drivers of reduced corn performance, or a combination of allelopathy, light quality/quantity, weed density, and nitrate availability.
27	**Integrated Weed Management Strategies for the Depletion of Multiple-Herbicide-Resistant Waterhemp Seed in the Soil Seed Bank** Peter Sikkema[1], Nader Soltani[1] [1]University of Guelph, Ridgetown, ON The development of an Integrated Multiple Herbicide-Resistant (MHR) Waterhemp Management strategy based on a more holistic approach that includes crop rotation, cover crops, reduced crop width, and efficacious herbicides can provide field crop producers with a strategy that provides excellent MHR control and depletes the number of waterhemp seeds in the soil seedbank. Field experiments were established on two commercial Ontario farms with MHR waterhemp in 2017. The objective of the study was to document the depletion in the number of waterhemp seeds in the soil seedbank after years 3, 6, and 9 years (the spring of 2020, 2023, and 2026) of this nine-year study. The study included five crop rotations: continuous soybean, corn/soybean, soybean/wheat, corn/soybean/wheat, and corn/soybean/wheat plus a cover crop after winter wheat seeding; two soybean rows widths (37.5 and 75 cm); cover crop of oat plus oilseed radish seeded after winter wheat combining; and eight herbicide modes of action. The number of waterhemp seeds in the soil seedbank at the Cottam and Walpole Island sites prior to establishing the experiments was 413 and 40 million seeds/hectare, respectively. MHR waterhemp ground cover on the first of September was reduced from 79% in the glyphosate only treatment to less than 1% with all other Integrated Waterhemp Management (IWM) strategies evaluated. At Cottam, after 3 years of this study, the number of waterhemp seeds in the seedbank increased 31% with continuous soybean and the only herbicide used was glyphosate. In contrast, the number of waterhemp seeds in the soil seedbank was reduced 59% to 66% with the other IWM strategies evaluated. Results indicate that IWM strategies can provide excellent MHR control and reduce the number of waterhemp seeds in the seedbank.
28	**Evaluation of different integrated weed management methods for the control of common waterhemp (Amaranthus tuberculatus (Moq.) J.D. Sauer) in corn and soybean.** Sandra Flores-Mejia[1], Firmo Sousa[1], Gabriel Verret[1], Marie Bipfubusa[1], Stéphanie Mathieu[2], Yvan Faucher[2], Brigitte Duval[2], Annie Marcoux[3], Michel Dupuis[4] [1]CÉROM, [2]MAPAQ, [3]LEDP-MAPAQ, [4]CSC Common waterhemp (AMATU) is considered one of the most problematic and difficult weeds to control. The presence of multiple herbicide resistance makes the reliance of solely the use of herbicides (notably glyphosate and atrazine) not sustainable in the long term. It is therefore necessary to evaluate other integrated weed management options such as cover crops, hand-weeding, and herbicide rotation.

	During the 2021 season, two experimental sites, one site in corn (site A) and one in soybean (site B), were established in the Monteregie region of Quebec. For each experimental site, a complete randomized block design with twelve treatments and four repetitions was established. The treatments included: hand-weeding, pre-emergence (PRE) herbicide, PRE + cover crop (CC), post-emergence (POST) herbicide, POST+ CC, glyphosate + CC, PRE+POST, PRE+POST+ atrazine (in corn) or glyphosate (in soybean), a weed-free and a weedy treatment. For some treatments, different active ingredients or combinations were tested. The herbicides were chosen to be compatible with the crops and with the cover crops. The efficacy to control AMATU was evaluated at 2, 4, 6 and 8 weeks after treatment. The establishment of the cover crop and the yield of the crop were also analysed. The efficacy to control AMATU in corn varied between 65% and 99 %. However, there was no significant difference in yield between the different treatments (14.8 t/ha in average). In the case of the soybean, the AMATU control varied between 38 % and 97 %. There was a statistical difference in the yield between treatments: 2.4 t/ha for the weedy treatment, 3.6 t/ha for both the hand-weeded and the PRE+CC treatments. The rest of the treatments had yields up to 4.4 t/ha, with no statistical difference among them. There was no significant difference between PRE+POST herbicide with or without atrazine (in corn) nor with glyphosate (in soybean).
29	**Prince Edward Island Provincial Report** Eileen Beaton[1] [1]Prince Edward Island Department of Agriculture and Land
30	**PMRA Update** Michael Downs[1] [1]Pest Management Regulatory Agency (PMRA), Ottawa, ON This presentation will provide an overview of upcoming changes to labelling requirements for tank mixes. On July 3, 2020, the PMRA posted a document for public consultation, entitled "Regulatory Proposal PRO2020-01, Streamlined Category B Submissions and Tank Mix Labelling." Related to tank mixing, this consultation document proposed revisions to several documents to clarify labelling requirements for tank mixes. In consideration of the comments received, the PMRA has drafted an updated guidance document, which is expected to be published in the near future. This presentation will provide a summary of the new guidance document.
31	**Saskatchewan Report** Clark Brenzil
32	**AgRobotics – Innovations in Weed Management** Kristen Obeid[1], Shaun Sharpe[2], Jason Gharibo[3], Grant Elgie[3], Chuck Baresich[3] [1]Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), Harrow, ON, [2]Agriculture and Agri-Food Canada, Saskatoon, SK, [3]Haggerty AgRobotics, Bothwell, Ontario Since 2021, an AgRobotics Working Group comprised of more than 70 people (OMAFRA staff, Haggerty Creek AgRobotics, growers, grower associations, agri-business, universities and colleges,

	federal and municipal government and technology companies) have been meeting weekly. The group brainstorms about available and future technologies, builds networks and collaborations, conducts on-farm demonstrations, and builds cross-functional teams to apply for funding opportunities in hopes of ground truthing these technologies in Canadian production systems. In 2022, the AgRobotics Working Group trialed three autonomous weeding robots in commercial grower fields compared to grower standards. The FarmDroid was trialed in sugar beets and rutabagas, the Naio Dino was trialed in carrots, celery and hemp and the Nexus Goat was trialed in carrots and onions. Each of the robots were assessed for efficiency, accuracy of weed removal and cost effectiveness compared to grower standards.
33	**Weed emergence and growth under mini-greenhouses in muck and clay soils.** Marie-Josee Simard[1], Etienne Lord[1], Robert Nurse[2], Martin Laforest[1], Tyler Smith[3], Benoit Lacasse[1] [1]Agriculture and Agri-Food Canada (AAFC), Saint-Jean-sur-Richelieu, QC, [2]Agriculture and Agri-Food Canada (AAFC), Harrow, ON, [3]Agriculture and Agri-Food Canada (AAFC), Ottawa, ON As the growing season starts, knowing precisely when a given weed population will emerge in a field could increase the cost effectiveness of weeding operations. Instead of relying on multiple models based on species specific attributes, crop microclimate and local weather, weed emergence could be monitored and validated in situ through the accelerated development and monitoring of local populations. Mini-greenhouses ("weed sentinels") were placed in fields located in muck and clay soil to determine if these sentinels would allow a gain of more than three days compared to weed emergence under open control conditions. The experiment included quadrats (50 X50 cm) under plastic tents and open control conditions. The quadrats were also seeded with control crop species (Canola: Brassica napus and oats: Avena sativa). Emergence counts, growth stage and leaf area (using images) were recorded every week. Soil temperature was recorded continuously. Results indicate weed development was accelerated under the mini-greenhouses ($p<0.01$). A follow-up project with more locations will validate the observations.
34	**The potato vine crusher: A new tool for harvest weed seed control** Andrew McKenzie-Gopsill[1], Laura Anderson[1], Ashley Nicolle MacDonald[1], Scott White[2], Christine Noronha[1] [1]Agriculture and Agri-Food Canada, [2]Dalhousie University Harvest weed seed control (HWSC), an evolving paradigm in weed management, is highly effective for control of a variety of weed species in North American cropping systems. Previous devices for weed seed devitalization at harvest have been limited to tow-behind and integrated combine systems. The potato vine crusher (PVC) is a harvester-mounted set of rollers originally designed for crushing and control of *Ostrinia nubilalis* larvae during potato harvest. To evaluate potential of the PVC for HWSC, we conducted stationary testing of spring tension and roller speed settings to maximize control of *Chenopodium album*, the most problematic weed species in Canadian potato production. In addition, we evaluated efficacy of the PVC for control of several pernicious weed species under controlled conditions and during a simulated harvest. Increasing PVC spring tension reduced *C. album* control whereas roller speed had minimal effect. In contrast, maximized spring tension and minimized roller speed significantly reduced *C. album* germination (53%) in field soil. Hypocotyl and radical elongation was observed from *C. album* seed fragments under controlled

	conditions potentially contributing to increased control in field soil through fatal germination. High levels of control (65 – 94%) was observed for all tested species under controlled conditions. During simulated harvest, control of large weed seeds (50 – 63%) was observed whereas smaller seeds were not impacted signifying the importance of seed size for PVC efficacy. These studies demonstrate the PVC as a promising new tool for HWSC in Canadian potato production systems.
35	**Preliminary evaluation of the Weed Zapper electric weeder in Nova Scotia** Scott White[1], Travis Esau[1], Chloe Toombs[1], Spencer Hauser[1] [1]Dalhousie University, Bible Hill, NS Lowbush blueberry stems seldom exceed 25cm in height in commercially managed fields. Many weeds routinely exceed this height, creating a height differential between the crop and weeds that facilitates selective above-canopy weed management. Selective control of tall weeds in lowbush blueberry can be achieved with weed wiper/roller applicators, though these can drip herbicide onto lowbush blueberry plants and are not acceptable for use in organic fields. This research focused on the use of The Weed Zapper (Weed Zapper Annihilator 12R30, Old School Manufacturing, Missouri, USA) for control of tall weeds in lowbush blueberry fields. The prototype Weed Zapper model evaluated was equipped with a 155 kW generator that delivered 15,000 volts to a 4.6m rigid copper boom. The unit was attached to a Case IH Maxxum 145 tractor (108 kW) and was powered by the tractor power take off (PTO) operating at 1000 rpm at 90 kW. Target weed species were spreading dogbane (Apocynum androsaemifolium L.) and narrowleaf goldenrod (Euthamia graminifolia), among others. The experiment consisted of 1) a non-treated control, 2) weed control by clipping weeds above the blueberry canopy, and 3) weed control with The Weed Zapper. Plots were 30m long X 5m wide, and one plot was established for each treatment at each site. The Weed Zapper caused 85 – 100% injury to spreading dogbane and narrowleaf goldenrod by 28 days after treatment and no regrowth was observed from shoots contacted by the Weed Zapper. In contrast, clipped spreading dogbane and narrowleaf goldenrod shoots produced 0.4 – 7.6 branches per clipped shoot and were not completely controlled. The Weed Zapper also gave >80% control of horseweed (Conyza canadensis), other goldenrods (Solidago spp.), and bracken fern (Pteridium aquilinum). Electrical weed control may contribute to nonchemical weed management in lowbush blueberry and should be evaluated further.
36	**Effects of soil building practices on weed seedbank dynamics in a potato rotation** Andrew McKenzie-Gopsill[1], Sherry Fillmore[1], Judith Nyiraneza[1] [1]Agriculture and Agri-Food Canada Stagnant yields and declining soil health are a common characteristic of high-intensity, low-residue cropping systems, such as those including potato. The incorporation of soil building practices including annual cover cropping and manure application represents a mechanism of combating declines in agroecosystem health and potato productivity. Manure application and the use of cover crops, however, may exasperate weed issues through seedbank additions. The present study evaluated the use of eight cover crop mixtures consisting of annual and perennial grasses and legumes grown over two years with and without manure on weed seedbank dynamics within a three year potato rotation. Manure applied in year one of the study resulted in an initial increase in weed seedbank density and weed species richness, however, this did not increase in-season

	weed biomass. Manure application resulted in a gradual decline in weed seedbank density over time regardless of cover crop treatment. Further, manure application increased in-season competitive ability of cover crops resulting in greater weed suppression per unit of cover crop biomass. In contrast, in the absence of manure, weed seedbank density remained largely unchanged through time regardless of cover crop treatment. Together our results demonstrate that the combination of perennial cover crops and manure application contributes to weed suppression and should be considered important components of a sustainable potato rotation.
37	**The Science and Vision behind Envu** Vicki Maloney[1] [1]Envu Canada Discover Envu. Having recently divested from Bayer Environmental Science, Envu is poised to make history as an independent industry leader in environmental science built on years of Bayer experience, for the sole purpose of advancing healthy environments for everyone, everywhere. Across each of our lines of business, we focus our work on chemistry and beyond, collaborating with our customers to come up with innovative solutions that will work today and well into the future. This presentation will introduce Envu and address the science behind our vegetation management product portfolio and the markets that we hope to serve in the future. This science includes previous research on indaziflam, a cellulose biosynthesis-inhibiting (CBI) herbicide, indicating that it has increased activity on monocots at reduced concentrations compared with dicots (Sebastian et al, 2017). Furthermore, trial data from across North America will be presented to provide evidence of the efficacy of indaziflam on the long-term control of invasive annual grasses in Canada's endangered grassland ecosystems.
38	**Phenomics evaluation of agronomic traits in winter wheat.** Gavin Humphreys[1], Malcolm Morrison[1], Claire Gahagan[1], Thomas Hotte[1], Christina Thomsen[1], Julia Nicoll[1], Malcolm Hawkesford[2], Andrew Riche[2], Robert Graf[3], Elizabeth Brauer[1], Andrew Burt[1] [1]Agriculture and Agri-Food Canada (AAFC), Ottawa, ON, [2]Rothamsted Research, Hertfordshire, UK , [3]Agriculture and Agri-Food Canada (AAFC), Lethbridge, AB Winter survival is the most critical attribute of a successful winter wheat cultivar. There are many pieces to the winter survival puzzle that need to be evaluated such as fall stand establishment and vegetative growth rate, seedling diseases, spring recovery and spring growth rate. Phenomics is the use of cameras and sensors to physically describe a plant's architecture and physiology. We used the PlotCam, a cost effective, highly portable, proximal phenomics platform to capture RGB images and height data from 44 Canadian and 44 UK winter wheat varieties. Strategically planned measurements resulted in data collected on fall biomass production and growth rates prior to snow cover. Imaging continued in early spring, shortly after snow cover was gone. Differences in fall and spring biomass provided a precise, qualitative measure of winter survival as opposed to a field estimated percent survival. Preliminary analysis indicated that UK varieties had higher fall growth rates than Canadian lines, but lower winter survival and spring growth recovery rates. Phenomics was a useful tool to describe the effects of seedling fungal diseases on stand

	establishment and winter hardiness. Generally, higher biomass was associated with greater winter survival. Our experiments proves the usefulness of incorporating phenomics into wheat breeding to tactically describe winter hardiness.
39	**Early detection of the health status of abiotic-stressed crops using electrical signals** Guoqi Wen[1], Bao-Luo Ma[1] [1]Agriculture and Agri-Food Canada, Ottawa, ON Drought and heat stress are major constraints to crop production. Quantification of physiological and morphological responses is generally used to identify the health gradients of crops under unfavorable environments. However, traditional measurements of these responses are time-consuming and laborious, sometimes requiring destructive sampling. In this study, we tested the feasibility of using an electrical sensor-based signal platform to early quantify plant root morphological and leaf photosynthetic features without damaging the plants. A series of water- and temperature-control experiments were conducted using canola and oat as model crops. The results showed that plant photosynthetic capacity and root architectural traits changed significantly after 10 or 15 days of high temperature and drought treatment, and grain yield decreased by 30-80%, depending on the extent of stress and species. Changes in electrical signal measurements explained at least 33%, 55%, and 73% of canola root traits in 1, 5, and 10-min, respectively. However, high belowground competition and integrity root structure reduced the measured variation in electrical signals used for oat root quantification compared with canola. For both crops, the signal variations simulated more than 65% of photosynthetic properties, including photosynthesis and respiration rates over a 30-min period. Based on random forest model, 1-h signal measurement could explain over 80% of yield variation and 85% of above-ground biomass accumulation. Our study indicated that electrical signal measurement is a promising method to quickly identify stress-induced crop health status, enabling plant breeders to select stress-tolerant traits and allowing producers to take preventive measures when needed.
40	**Determination of agronomical dependencies and optimum timeframe for image-based Canola yield simulations using ground cover and flowering phenology** Anjika Attanayake[1], Eric Johnson[1], Steve Shirtliffe[1] [1]University of Saskatchewan, Saskatoon, SK. Agronomic technological advancements provide more precise means to establish methodologies that can estimate yield potential in many ways for modern farming. Most predictive models with higher accuracy use either leaf area index, biomass, or flowering intensity to simulate yield. The influence of agronomic factors on simulation predictors and the optimum timeframe for predictive models to perform efficiently has been the least studied, and the outcome would be valuable for image-based methodological advancements. The study imposed agronomic variability on plants' growth and spatial distribution by altering row spacing and seeding rate. The digital image assessments and temporal models are based on the Normalized Difference Yellowness Index (NDYI) and Visible Band Difference Vegetation Index (VDVI). The integral of the temporal ground cover and flowering intensity functions were used to regress against yield to establish yield models. The research indicates that the green ground cover accumulation over time is sufficiently correlated with the yield (R^2=0.7532) where validations support the above statement. Further, the cumulative flowering intensity model is well correlated with the yield (R^2=0.7349). The cumulative

	ground cover and flower intensity parameters show a linear trend (R^2=0.7921), indicating a proportional relationship valuable for yield simulations. The results indicate that both image-based estimates behave similarly to yield response with seeding rate and actual plant, indicating that the predictor's influence on all response variables is similar. Groundcover model optimization suggests that the variability observed with foliage at its early stages diminishes with time, and stable levels of the foliage are reached after ~30-35 days after emergence. In contrast, the flowering intensity model reaches the most stable predictive performance at ~20-25 days after the flower initiation, which is ~ 55 days after the emergence. Based on the evidence, we can state that the cumulative ground cover is an early predictor of the Canola's yield response compared to the flowering intensity, which is a strongly associated yield predictor of the Canola. In general, the productivities of crops relate to their biomass, crop volume, leaf area index, etc., and are likely proportional to the final yield. Our findings suggest that the daily ground cover and flowering intensity cumulation process behaves similarly to the above parameters, producing a proportional value to three-dimensional space occupancy and acting as a predictive factor of Canola productivity for precision management.
41	**Multi-omics approaches for understanding yield and yield stability in wheat (Triticum aestivum)** Anjan Neupane[1], Malcolm Morrison[1], Gavin Humphreys[1], Richard Cuthbert[2], Ron Knox[2], Simon Griffiths[3], Malcolm Hawkesford[4], Andrew Riche[4], Colin Hiebert[5], Santosh Kumar[6], Robert Graf[7], Elizabeth Brauer[1], Claire Gahagan[1], Thomas Hotte[1], Mirko Tabori[1], Xuelian Wang[1], Erin McDonald[1], Christina Thomsen[1], Julia Nicoll[1], Andrew Burt[1] [1]Agriculture and Agri-Food Canada (AAFC), Ottawa, ON, [2]Agriculture and Agri-Food Canada (AAFC), Swift Current, SK, [3]John Innes Centre, Norwich, UK, [4]Rothamsted Research, Hertfordshire, UK, [5]Agriculture and Agri-Food Canada (AAFC), Morden, MB, [6]Agriculture and Agri-Food Canada (AAFC), Brandon, MB, [7]Agriculture and Agri-Food Canada (AAFC), Lethbridge, AB This project is supported by the International Wheat Yield Partnership and utilizes multi-omics approaches to improve the understanding of wheat yield stability across diverse growing environments. Three populations were phenotyped using proximal imaging and manual measurements from 2019 to 2022 at four Canadian sites (Ottawa, Brandon, Lethbridge, and Swift Current), and in the United Kingdom (Rothamsted). The populations consisted of a double haploid spring wheat population (AAC Brandon/Pasteur), a near-isogenic line spring wheat population in the cv. Paragon background, and a winter wheat diversity panel containing Canadian and UK lines with a total of six to ten site-years of data collected for each population. The agronomic data and phenometric measures, derived through PlotCam images, are being used to develop yield predication models, correlation among traits, and to capture yield stability across environments. Genotypic data from SNP-based array platforms will be combined with the phenotypic data to detect associated QTL, alleles, and haplotypes that can be introgressed in the development of new varieties. This project has the potential to facilitate genetic improvements for yield and yield stability in spring and winter wheat germplasm.
42	**Plots Without Borders** Shaun Campbell[1], Steve Shirtliffe[1], Eric Johnson[1], Sydney Beresh[1] [1]University of Saskatchewan, Saskatoon, SK Over the last few seasons at the University of Saskatchewan Kernen Research Farm we have tried

	to find new techniques to conduct agronomy research trials. Our initial main goals were to develop ways to improve the accuracy and efficiency of our trials, while at the same time making them easier to execute with less labour. Using GPS and Harvest Master MIRUIS software, we are replacing the traditional four replicate trials containing mowed or tilled pathways and stakes placed in front of every plot with large solid seeded areas containing more replications and minimal signage. The addition of variable rate technology on our plot drills means that we no longer weigh packets of seed or fertilizer or watch for trip lines in the field to manually trip the cone seeder at the proper time. Spraying with a $C0_2$ propelled 2m hand boom sprayer using a metronome to ensure accurate spray application has been replaced with a high-clearance multi-boom sprayer that utilizes MIRUIS software to apply according to plot maps. In the future, visual ratings and plant biomass collection may be replaced with UAV digital imagery. Handling and processing full harvest bags has been eliminated with the addition of GPS, HarvestMaster weigh systems and a Polytec NIR. This presentation will provide an overview and introduction into the designs and procedures we have created for working on agronomy research trials
43	**A Machine Learning Approach to Determine Variables Causing Within-Field Spatial Variability of Canola Yield** Kwabena Nketia[1], Thuan Ha[1], Hansanee Fernando[1], Seungbum Ryu[1], Steve Shirtliffe[1] [1]University of Saskatchewan, Saskatoon, SK The demand for increased canola production, which is imperative for boosting Canadian economy implies the need for early canola yield predictions at sub-field scales. Yields are only reported or mapped at sub-field scales for some sections of Western Canada mostly after harvest, with many spatial extents not mapped at all. With increasing availability of quality data repositories, it is now possible to explicitly map canola yields at sub-field scales prior to start of the next growing season. However, due to high spatial variability of soil, environmental and landscape factors coupled with high temporal variability across seasons – which can result in variable yield patterns – scaling existing methodologies to adequately map sub-field scale canola yields earlier across Western Canada remains a challenge. For this reason, we report at sub-field scales the deterministic spatio-temporal importance of static, dynamic and process-based digital agriculture datasets in predicting sub-field scale yield variability and their use for early mapping purposes. Static variables include soil class and properties, dynamic variables include crop phenology, temperature, precipitation, and growing degree days. Process-based variables are derived from digital elevation model and other pedo-transfer functions. As a test of concept prior to a scalable early-crop-yield prediction system at sub-field scales, we use datasets from ~120 canola fields across three growing seasons. Modelling framework used to draw conclusion on soil-environment-landscape factors involved the use of a 2-scale explainable ensemble machine learning approach. Such an understanding is core to field scale variability assessment and an early canola yield predictions system for Canada
44	**Nitrogen management, use efficiency and seed yield of canola hybrids in diverse Canadian production ecosystems** Baoluo Ma[1] [1]Agriculture and Agri-Food Canada, Ottawa, ON Increasing crop yields while maintaining agro-ecosystem sustainability is critical for continued global food security and improved nutrition. Canola (Brassica napus L.) is a major rapeseed crop

	that requires more nitrogen (N) and other nutrients for growth, development and production than small grain cereals. However, an inappropriate nutrient application could significantly aggravate environmental pressure and reduce crop yields. The main objectives of this study were to determine site-specific economically optimum nitrogen rates (EONR) and develop best management strategies to promote canola productivity, profitability as well as sustaining the environment. A field experiment consisting of 8 N fertilizer rate and application time combinations were conducted for 4 yr at 8 locations. The results showed that split-N fertilization strategy generally resulted in similar or significantly increased canola yields (5 cases), but decreased yields under extreme drought and heat stress conditions, compared with the equivalent preplant N application. The split-N application appeared to be a better strategy for improving producer profitability and reducing negative environmental impacts, as it can improve use efficiency compared to applying an equal amount of N fertilizer only at planting. Overall, the study recommended a fertilization rate of 80-100 kg N ha^{-1} for brown soil zones, such as Swift Current and 100-140 kg N ha^{-1} in split supply for the other regions. A rate of 160-200 kg N ha^{-1} may be required to produce the target seed yield of 3500 kg ha^{-1} set by the Canola Council of Canada in favorable growing seasons. Our findings also suggest that there is an urgent need to develop agronomic solutions to alleviate the damaging constraints on canola production caused by climate change.
45	**Application of Utrisha™ N to enhance nitrogen use efficiency of Western Canadian broad-acre crops.** Cody Chytyk[1], Rory Degenhardt[1], Kevin Falk[1], Michael Moechnig[1] [1]Corteva Agriscience, Calgary, AB Utrisha N is a biostimulant containing Methylobacteria symbioticum in a wettable powder formulation. Upon foliar application, the bacteria readily enters the plant through stomata and colonizes photosynthetically active cells. These endophytic bacteria have been demonstrated to fix atmospheric nitrogen into ammonium (NH_4^+), which the plant can use to offset its own nitrogen requirements. M. Symbioticum utilizes single-carbon molecules (methanol and dissolved methane) as an energy source. Effective colonization occurs within 14 days of application and the bacteria is active during the entire lifecycle of the plant. Trials were conducted in 2022 by Corteva Agriscience to investigate Utrisha N activity in canola (Brassica napus) in Western Canada. Utrisha N-treated canola fertilized with 85% of the soil-test recommended N rate yielded the same as non-treated canola plots that were fertilized with 100% of the soil-test recommended N rate. Utrisha N is currently registered in Canada for foliar application to several broad-acre crops. Our results suggest that growers could rely on Utrisha N as a supplemental N source to optimize productivity and improve the use efficiency of applied nitrogen. It offers farmers the flexibility to optimize fertilizer application rates and minimize the environmental impact of excess nitrogen. ™® Trademarks of Corteva Agriscience and their affiliated companies or their respective owners.
46	**Effect of nitrogen sources and crop rotation on soil microbial diversity and structure in podzolic soils in boreal climate** Mumtaz Cheema[1], Irfan Mushtaq[1], Yeukai Katanda[1], Svetlana Yurgel[2], Lakshman Galagedara[1], Raymond Thomas[1]

	[1]Memorial University of Newfoundland, Corner Brook, Newfoundland and Labrador, [2]USDA Agricultural Research Service Grain Legume Genetics Physiology Research Unit, Pullman, WA Crop rotation has numerous advantages including improving the soil physiochemical properties, soil quality and health, and microbial community structure and abundance. Microbes are involved in many soil biogeochemical processes including nutrient cycling, which impacts soil quality and health. Anthropogenic activities as a result of nitrogen (N) addition influence soil environment due to more N losses. To evaluate the effect of crop rotation and N sources on soil microbial community structure and abundance, a field trial was conducted at Pynn's Brook Research Station, Pasadena in a randomized complete block design with split plot arrangement and replicated four times. The experimental treatments were three crop rotations: silage corn-silage corn (c-c), silage corn-wheat (c-w), silage corn-faba bean (c-fb) and five N sources: control, urea, agrotain, entrench and super-U. Three soil samples from each experimental unit/plot were collected from 0-20 cm depth, 15 days after fertilization. Extracted DNA samples were sent to the Dalhousie University, NS for amplicon sequencing analysis. Results showed that N sources had no significant effect on fungal and bacterial community structure and abundance. However, crop rotation had significant effects on both fungal and bacterial community structure and abundances. Fungal classes like Mortierellomycetes mean relative frequency (MRF) was significantly increased in c-w rotation as compared to c-c rotation, Leotiomycetes MRF was significantly increased in c-fb rotation as compared to c-w rotation, while Tremellomycetes MRF was significantly increased in c-c rotation when compared to c-w and c-fb rotation. Cereal legume (c-fb) rotation significantly increased bacterial classes including Actinobacteria, Thermoleophilia, Polyangia, Acidimicrobiia and KD4-96 MRF as compared to c-w and c-c rotation. Based on results, we may conclude that corn-faba bean (cereal-legume) rotation could be a significant factor in reshaping the soil microbiome involved in different soil processes in podzolic soil of boreal climate
47	**Nitrate leaching and potato tuber yield response to different crop rotations** Yefang Jiang[1], Kang Liang[2], Mohammad Amir Azimi[3], Judith Nyiraneza[1], Ana Kostic[1], Christine Noronha[1], Aaron Mills[4] [1]Agriculture and Agri-Food Canada, Charlottetown, PE, [2]University of Maryland, College Park, MD, USA, [3]University of New Brunswick, Fredericton, NB, [4]Agriculture and Agri-Food Canada, Harrington, PE Potato production in Atlantic Canada accounts for about 40% of annual potato crops in Canada, contributing significantly to the regional and national economy. Intensive potato production has been associated with drinking water nitrate contamination and surface water eutrophication. Three studies were conducted to investigate the influence of different crop rotations on nitrate leaching and tuber yield using plot-based lysimeter sampling in combination with numerical modelling in Prince Edward Island (PEI). The crop rotations included grain–forages–potatoes, soybean–grain–potatoes and buckwheat–buckwheat–potatoes. The studies consistently demonstrated that N fixation by the red clover in the forages of the industry standard potatoes–grain–forages rotation could be as high as 35−252 kg N/ha. Accounting for only 17 kg N/ha supply from the plowed-down red clover by following the provincial recommendations underestimated N supply to the potatoes. Inadequately accounting for N credits from the red clover resulted in over fertilization, leading to excessive nitrate leaching and tuber yield suppression. These findings suggest that N surplus was the key explanatory variable for the variations in nitrate leaching and

	tuber yield, and adequately accounting for N credits from the preceding rotation crop (especially red clover) is important to minimize nitrate leaching while maximizing potato productivity.
48	**Legacy soil phosphorus management for improved crop production profitability and sustainability with reduced phosphorus loading to Lake Erie** Tiequan Zhang[1], Yutao Wang[1], Yu Jia[1] [1]Agriculture and Agri-Food Canada, Harrow, ON Optimum management of soil legacy P (SLP) can be an effective way to improve crop production profitability and surface water quality. An on-going field study has been started since 2019 to address knowledge gaps, based on which to develop BMPs for best use of SLP. In a clay loam soil, soil test P (STP, Olsen P) declined linearly with P drawdown (i.e., utilization of SLP; PDD). A critical STP level was observed at 10.3-12.3 mg kg^{-1} in 2019 (corn), 2020 (soybean), and 2021 (winter wheat), below which crop yields increased with increases in STP. In this case, fertilizer P addition would be required to achieve optimum grain yield. Once STP reached the critical level, further SLP increase did not increase crop yields. In contrast, fertilizer P additions did not increase crop yields compared to PDD, confirming that SLP is as crop-available as freshly added P. It appeared that P addition is not required in the clay loam soil when STP is above 10.3-12.3 mg kg^{-1}, which, however, are lower than those recommended in Ontario. A sandy loam soil is also included in the study, but with a different story told: STP remained similar over the three PDD cropping years; crop yields were similar among different SLP levels under PDD, but fertilizer P additions increased corn yields by 15-18% despite high SLP levels (> 25 mg Olsen P kg^{-1}). It seems that in the sandy loam soil crops may need a booster of fertilizer P to compromise the temporal shortage of soil available P, due to low diffusion P supply resulted from low soil water flow connectivity, to ensure optimum crop growth even when SLP is very high. Relative to fertilizer P additions, PDD decreased soil P losses in runoff water by 30%. Our results are useful for developing BMPs for best use of SLP and fertilizer P re-application strategies and technologies to maximize production profitability in an water quality sustainable manner.
49	**Impact of sulfur-based fertilizer on establishment and performance of forage legumes when frost or sod seeded into a grass stand.** Yousef Papadopoulos[1], Julie Lejeunesse[2], Kathleen Glover[1], Sherry Fillmore[3], Matthew Crouse[1], Samuel Fromm[4] [1]Agriculture and Agri-Food Canada (AAFC), Truro, NS, [2]Agriculture and Agri-Food Canada (AAFC), Normandin, QC, [3]Agriculture and Agri-Food Canada (AAFC), Kentville, NS, [4]Agriculture and Agri-Food Canada (AAFC), Nappan, NS Sulphur (S) is important to legume seedling development and persistence and an establishing legume would be anticipated to benefit from S application. The response of different legume species to nitrogen (N) and S fertility during frost or sod seeding has not been studied. Our study was initiated at 2 locations (Nappan, Nova Scotia and Normandin, Quebec) to determine the agronomic performance of three legume species (alfalfa, birdsfoot trefoil and red clover) when frost or sod seeded into a grass stand grown under 4 fertility treatments (no N or S applied ; 48 kg ha^{-1} S as potassium sulfate; 48 kg ha^{-1} S as ammonium sulfate; and 4) 40 kg ha^{-1} N + 48 kg ha^{-1} S as potassium sulfate) applied post first cut harvest in the establishment and two post seeding years. There was a significant effect of fertility for each year for both seasonal yield and legume content

	of the forage stand. The lowest yield and legume content was obtained with no N or S fertilizer application. Both N and S fertilization significantly increased dry matter yield and legume content with the combined N and potassium sulfate treatment producing the largest seasonal forage yield over the three years. Fertility appears to be a significant factor in the success of no-till seeding methods with N and S fertilization significantly increased dry matter yield and legume content. While the largest herbage yield was obtained with potassium sulfate in combination with 40 kg ha^{-1} of nitrogen, the legume content was improved by potassium sulfate alone or in combination with N.
50	**Resistant Wild Oat Action Committee** Eric Johnson[1], Nathan Eshpeter[2] [1]University of Saskatchewan, [2]Resistant Wild Oat Action Committee Wild oat (*Avena fatua* L.) resistance is prevalent on the Canadian prairies, and remaining herbicide options are limited. A cross-industry Resistant Wild Oat Action Committee (RWOAC) was formed in 2020 with a mission to develop herbicide resistant wild oat management solutions through producer engagement, knowledge transfer, and research. Two project proposals were submitted to the Alberta Funding Consortium (AFC) and the Results Driven Agriculture Research (RDAR) Program. The RWOAC is not a legal entity; therefore, the proposals were submitted through CWSS-SCM. Both proposals were accepted with funds administered by CWSS-SCM. AFC, with contributions from the Alberta Wheat Commission, Saskatchewan Wheat Commission, Manitoba Crop Alliance, and the Saskatchewan Forage Seed Development Commission, funded a 2-year project that commenced in April 2021. Nathan Eshpeter from Daysland, AB was hired as Project Manager. Nathan has organized a community-based organization in central Alberta that organizes extension activities (meetings, field days) and applied on-farm research trials. A resistance testing and survey project was also initiated that targets growers who are suspicious of resistance but have not tested previously. The RDAR project entitled "Farmers Talk About Herbicide Resistance" is an extension project with matching funds provided by the Alberta Wheat Commission, Saskatchewan Wheat Commission, Saskatchewan Barley Commission, and the Manitoba Crop Alliance. This project has resulted in the production of a video entitled "Understanding Resistant Wild Oats", which has been widely distributed. Additionally, 13 infographics have been produced. The video and infographics are available on the CWSS-SCM website (https://weedscience.ca/wild-oat-action-committee/). The RWOAC has been successful in increasing awareness and engaging producers in Central Alberta to proactively address wild oat resistance.
51	**Herbicide-resistant wild oat (Avena fatua) in the Lower Saint-Lawrence region of Quebec** Sandra Flores-Mejia[1], Firmo Sousa[1], Gabriel Verret[1], Ayitre Akpakouma[2], Jalinets Navarro[2], Marc Tétrault[3], Yan Gosselin[3], Eric Pagé[3], Annie Marcoux[4], Michel Dupuis[5], Samuel Comtois[6], Mario Handfield[7], Salah Zoghlami[8] [1]CÉROM, [2]MAPAQ, [3]FUPABSL, [4]LEDP-MAPAQ, [5]CSC, [6]Groupe PleineTerre, [7]UQAR, [8]PGQ Wild oat (*A. fatua,* AVEFA) is considered among the most damaging weeds in temperate zones worldwide and resistance to group 1 herbicides (1-HR) is also predominant. Previous studies have shown that 1-HR populations are widespread in the Canadian prairies and in the Saguenay-Lac-Saint-Jean region of Quebec, with up to 78 % and 35 % of the sampled populations, respectively.

	Up to 2020, no official survey nor sampling of AVEFA had been done in the Lower Saint-Lawrence (Bas-Saint-Laurent, BSL) region of Quebec. Our project aims to carry out the first inventory of the presence of 1-HR AVEFA in the BSL region; to identify the agricultural practices associated with its development; and to use collaborative methods in order to develop and adopt integrated control methods for this species. During the first year of the project (2021), 24 farms and 66 fields were surveyed. Wild oat populations were found in 87 % of the farms and 77 % of the fields. A subsample of the surveyed fields (19/66) was tested for herbicide resistance during the winter 2022, via a whole-plant bioassay. Each population was tested to three active ingredients of herbicides registered in Quebec for the control of AVEFA in cereals, belonging to each of the three classes of group 1: FOPs (fenoxaprop-ethyl), DIMs (tralkoxydim) and DENs (pinoxaden). Herbicide resistance was detected in 94 % of the sampled fields. Cross-resistance was also confirmed, with 27 % and 44 % of the samples, being resistant to 2 and 3 of the active ingredients tested, respectively. Resistance to FOPs was more predominant (84.2 %), followed by the DENs (76.5 %) and the DIMs (61.1%). This is the first study to show that AVEFA is widespread in the BSL region, with a majority of the populations being resistant to group 1 herbicides.
52	**Precision inter-row wild oat management using non-selective herbicide application or cultivation** Eric Johnson[1], Chris Willenborg[1], Steve Shirtliffe[1] [1]University of Saskatchewan Herbicide resistant wild oat (*Avena fatua* L.) is prevalent in the Canadian Prairies, with surveys reporting multiple resistance to ACCase and ALS inhibiting herbicides in 25 to 40% of sampled fields. The use of inter-row (IR) weed management such as cultivation or non-selective herbicide application for managing wild oat in wheat crops has not been widely researched. Previous research by our lab found that IR cultivation, integrated with other agronomic practices, successfully controlled broadleaf weeds in pulse crops. To assess non-selective IR herbicide application, a shrouded sprayer was constructed and attached to a steerable cultivator. Through much trial and error, the sprayer was able to target IR weeds and minimize, but not eliminate, crop injury. A study investigating the potential of IR weed management to control wild oat in a spring wheat management system was conducted at three sites near Saskatoon in 2021-22. The study consisted of three factors: 1) fall triallate application (none, 1400 g ai ha^{-1}); 2) wheat planting density (150, 300, 450 seeds m^{-2}); and 3) IR weed management (none, IR glufosinate at 600 g ai ha^{-1}, IR cultivation). Fall triallate application, increased planting density, IR cultivation, and IR herbicide application reduced wild oat biomass production by 82, 65, 34, and 49%, respectively. The effect of planting density and IR weed management on wild oat biomass was much greater in treatments that did not receive triallate. Triallate application increased wheat yield by as much as 35%, while planting density and IR weed management resulted in small, inconsistent yield responses. IR weed management has the potential to control residual wild oats that escape PRE herbicide application or other cultural practices. Further refinement of non-selective IR herbicide application is required, and alternative experimental designs may be required to properly assess this technology.
53	**INSIGHT®: A new PPO inhibiting herbicide for pre-seed burndown for wheat.**

	Mike Grenier[1], Glenda Clezy[1] [1]Gowan Canada Insight® 339SC herbicide containing the active ingredient tiafenacil is now registered in Canada for pre-seed and pre-emergence burndown use. Tiafenacil is a contact non-selective PPO inhibiting herbicide (Group 14) with unique activity on both grassy and broadleaf weeds. It is registered for use in spring wheat, corn and for use in chem-fallow. Field trial studies were conducted across western Canada from 2019-2022 to evaluate the efficacy on wild oat (*Avena fatua* L)*,* kochia (*Kochia scoparia* L.), volunteer canola (*Brassica napus* L.), redroot pigweed (*Amaranthus retroflexus* L.), lambsquarters (*Chenopodium album* L.) and wild buckwheat (*Polvgonum convolvulus* L.). Insight® 339SC provided excellent fast acting control of broadleaf weed species equivalent to commercial standards included in the field trials. Insight demonstrated unique activity on grass species providing a high level of commercially acceptable control of wild oat. This level of non-selective control of both grassy and broadleaf weeds provides growers with a group 14 mode of action for effective herbicide layering when tankmixing with glyphosate in pre-seed burndown programs.
54	**A novel mixture of tolpyralate and bromoxynil to manage herbicide resistant and difficult to control weeds in cereal crops of Canada** Kevin Falk[1], Rory Degenhardt[1], Jamshid Ashigh[1], Cody Chytyk[1], Laura Smith[1], Swaroop Kher[1] [1]Corteva Agriscience Novel broadleaf and grass herbicide mixture of tolpyralate and bromoxynil for post-emergence application to cereals in Canada OnDeck™ is a new post-emergence cereal herbicide developed by Corteva Agriscience in partnership with ISK Biosciences Corporation. OnDeck™ (18.66 g ai/L of ISK Biosciences' tolpyralate (Group 27) + 186.6 g ae/L bromoxynil-octanoate (Group 6) formulated as an EC) is a broadleaf and grass herbicide for post-emergence application to wheat (including spring, winter, and durum) and barley that works by interrupting photosynthesis and disrupting pigment biosynthesis. At the standard application rate of 805 ml product/ha, OnDeck™ delivers 150 g bromoxynil-octanoate ae/ha and 15 g tolpyralate ai/ha. This herbicide controls a unique spectrum of annual and perennial broadleaf and grass weed species. Field research was conducted between the 2019 and 2022 cropping seasons at multiple locations across Western Canada and the U.S. Northern Plains, to evaluate OnDeck™ efficacy in spring wheat. OnDeck™ was applied with and without the tank-mix partner MCPA ester. OnDeck™ provided control of several agronomically relevant broadleaf and grass weeds, including red-root pigweed (Amaranthus retroflexus), volunteer canola (Brassica napus), lambsquarters (Chenopodium album), hempnettle (Galeopsis tetrahit), cleavers (Galium aparine), wild buckwheat (Polygonum convolvulus), kochia (Bassia scoparia), yellow foxtail (Setaria helvola), green foxtail (Setaria viridis), wild mustard (Sinapis arvensis), ladysthumb (smartweed; Persicaria maculosa), stinkweed (Thlaspi arvense), Shepard's Purse (Capsella bursa-pastoris), and narrow-leaved hawksbeard (Crepis tectorum). OnDeck™ herbicide will provide cereal growers with a new tool for controlling many difficult to control broadleaf and grass weeds, including many weeds that have developed resistance to Group 2 or 9 modes of action, including kochia, cleavers,

	green foxtail, yellow foxtail, and volunteer canola. ™® Trademarks of Corteva Agriscience and their affiliated companies or their respective owners.
55	**Crop safety and rotational crop response of a novel cereal herbicide mixture of tolpyralate and bromoxynil in Canada and the USA.** Rory Degenhardt[1], Kevin Falk[1], Dave Johnson[1], Cody Chytyk[1], Ryan Humann[1], Jamshid Ashigh[1], Joseph Yenish[1], Laura Smith[1] [1]Corteva Agriscience OnDeck™ is the newest post-emergence cereal herbicide developed by Corteva Agriscience in partnership with ISK Biosciences Corporation. OnDeck herbicide is a convenient liquid formulation containing the Group 27 active ingredient tolpyralate and the Group 6 active ingredient bromoxynil. Tolpyralate is a novel active ingredient in cereals, and the sensitivity of rotational crops typical of the Northern Great Plains, where rainfall can be limiting and cool soils can persist for extended periods of the year, has not been well characterized. Between 2019 and 2022, small plot field research trials were established across Western Canada and the Northern USA to evaluate safety of rotational crops planted 10–12 months after an application of tolpyralate herbicide at various rates. No significant crop injury or yield loss were detected in any of the rotation trials, and results confirmed that many crops, including lentils (Lens culinaris), chickpeas (Cicer arietinum), canola (Brassica napus), field peas (Pisum sativum), soybeans (Glycine max) and flax (Linum usitatissimum), can safely be planted the season after treatment. OnDeck herbicide will be an excellent tool for the safe management of hard-to-kill weeds in cereals crops and will give farmers across Canada flexibility to choose whatever rotational crops fit with the production, sustainability and stewardship goals they have for their operations. ™® Trademarks of Corteva Agriscience and their affiliated companies or their respective owners.
56	**Impact of Metribuzin and Water Stress on Chickpea Health** Shaun Sharpe[1], Michelle Hubbard[2], Jeff Schoenau[3] [1]Agriculture and Agri-Food Canada (AAFC), Saskatoon, SK, [2]Agriculture and Agri-Food Canada (AAFC), Swift Current, SK, [3]University of Saskatchewan, Saskatoon, SK Saskatchewan chickpea production has been impacted by an emerging health issue. The health issue has manifested across both whole-fields or patches within fields with diverse symptomology. The study objective was to evaluate the impact of post-emergence metribuzin application and water stress on chickpea health in the greenhouse. The experimental design was a two factor factorial arranged as a randomized complete block. The first factor was metribuzin dose at 0, 0.5, 1X (206 g ai ha^{-1}), and 2X doses. The second factor was water stress sustained over a 3 week interval where plants were kept either well-watered or watered only once the wilting point was reached. There was an impact of metribuzin dose on chickpea accumulated chlorosis ($p<0.01$) 2 weeks after treatment (WAT). The 1X metribuzin dose induced 25% chickpea mortality and 42% accumulated chlorosis. At 6 WAT, water-stressed chickpeas showed no difference between

	metribuzin doses on accumulated chlorosis (36% average chlorosis) while well-watered chickpeas suffered 56 to 91% accumulated chlorosis (1X and 2X metribuzin doses, respectively) compared to the untreated control (2%). At 6 WAT, the well-watered 0 and 0.5X metribuzin treated chickpeas had longer branches (36 to 37 cm) compared to well-watered, higher metribuzin doses and all water stressed treatments (18 to 27 cm). There was interaction between water stress and metribuzin dose on chickpea pod production (p=0.03). Well-watered chickpeas treated with the 0 or 0.5X metribuzin dose produced more pods (60 to 73 plant^{-1}) compared to well-watered, higher metribuzin doses and all water-stressed treatments (3 to 14 plant^{-1}). While both water stress and metribuzin applications reproduced some symptoms, neither induced apical wilting consistent with the health issue. This may indicate the underlying health issue is related to the phloem, either due to impaction or translocation of a pathogen or molecule to the growing tip.
57	**Prairie-wide effects of recurrent annual glyphosate applications on the wheat rhizosphere microbiome** Newton Lupwayi[1], Charles Geddes[1], Renee Petri[2], Rob Dunn[3] [1]Agriculture and Agri-Food Canada (AAFC), Lethbridge, AB, [2]Agriculture and Agri-Food Canada, Sherbrooke, QC, [3]FarmWise Inc., Lethbridge, AB Glyphosate herbicide is extensively used worldwide, but its effects on the soil microbiome are inconsistent. In a four-year (2013-2016) study, we consecutively applied glyphosate to a wheat–field pea–canola–wheat crop rotation at five sites in the Canadian prairies. The glyphosate rates were 0, 1, 2, 4 and 8 kg ae ha^{-1}, applied pre-seeding and post-harvest every year. The wheat rhizosphere was sampled in the final year of the study and analysed for microbial biomass C (MBC), the composition and diversity of the microbiome, and activities β-glucosidase (C cycling), N-acetyl-β-glucosiminidase (C and N cycling), acid phosphomonoesterase (P cycling) and arylsulphatase (S cycling). Glyphosate did not affect MBC, the composition and diversity of the microbiome, and the activities of three of the four enzymes measured in the wheat rhizosphere. The one effect of glyphosate was a wave-like response of N-acetyl-β-glucosaminidase activity with increasing application rates. The experimental sites had much greater effects, driven by soil pH and organic C, on the soil microbiome composition and enzyme activities than glyphosate. Soil pH was positively correlated with the relative abundance of Acidobacteriota but negatively correlated with that of Actinobacteriota and Basidiomycota. Soil organic C was positively correlated with the relative abundances of Proteobacteriota and Verrucomicrobiota, but negatively correlated with the relative abundance of Crenachaeota. The activity of acid phosphomonoesterase declined with increasing relative abundance of Acidobacteriota, but increased with that of Actinobacteriota and Basidiomycota. The activity of N-acetyl-β-glucosaminidase also increased with increasing relative abundance of Actinobacteriota but decreased with that of Mortierellomycota. β-glucosidase activity also decreased with increasing relative abundance of Mortierellomycota. Therefore, this prairie-wide study revealed no significant effects of 4-year applications of glyphosate applied at different rates on most soil microbial properties despite differences in the properties among sites. Nonetheless, continuous evaluation of this widely-used herbicide is essential.
58	**Accelerated Cropping Systems: opportunities for weed management** Dilshan Benaragama[1], Christian Willenborg[2] [1]University of Manitoba, Winnipeg, MB, [2]University of Saskatchewan, Saskatoon, SK

	Accelerated Crop Production Systems (ACS), the production of three crops in two growing seasons using a combination of spring and winter crops, can be an alternative to long-term crop rotations to manage difficult-to-control weed species. Two cropping systems experiments were conducted to test the effect of two different uses of winter crops with spring crops to form three crops in two years. In the Accelerated Crop Rotation System (ACR), a winter cereal (triticale, fall rye) was seeded in alternate rows with spring wheat in the first-year spring, and the winter cereal was cut for silage in the second year, followed by seeding and harvesting of an early maturing spring crop. The second experiment Accelerated Inter-crop system (AIC), consisted of seeding a winter cereal in alternate rows with spring wheat and allowing it to form a relay intercrop in the second year with either canola or pea. Both experiments completed three crop cycles at two locations in Saskatoon SK. The ACR study revealed that the three-crop system had no advantage over the two-crop system for reducing overall weed biomass during the second year. However, the rotations that had wheat+winter triticale in the first year had a low (32%) wild oat density compared with wheat in the first year. Further, when all crops were averaged, crops grown after wheat + winter cereal had 26 % lower wild oat density than after a wheat monoculture in the first year. The AIC trial revealed that the two-crop mono-crop system had 78% lower weed biomass than the average of all the pea-based three-crop intercrop systems. No difference was observed among canola systems, indicating similar weed control. No difference in wild oat density among these cropping systems revealed that AIC system provided similar wild oat management to the conventional two-crop system, even without using herbicides. Both these accelerated systems showed some potential in wild oat management particularly when the second-year crop is canola.
59	**Cultural tools contribute strongly to management of multiple herbicide-resistant kochia (Bassia scoparia)** Charles Geddes[1], Louis Molnar[1], Cindy Gampe[2], Prabhath Lokuruge[2] [1]Agriculture and Agri-Food Canada (AAFC), Lethbridge, AB, [2]Agriculture and Agri-Food Canada (AAFC), Scott, SK Kochia [Bassia scoparia (L.) A.J. Scott] management is a growing issue for many farmers in western North America. High genetic diversity combined with efficient cross-pollination of this tumbleweed result in rapid evolution and spread of herbicide resistance. Kochia populations exhibiting resistance to acetolactate synthase inhibitors, glyphosate, and synthetic auxins are increasing in occurrence in the Canadian prairies, leaving limited effective herbicide options. Two different fully-phased four-year crop rotation studies were conducted to assess whether (a) crop row spacing and seeding rate, and (b) crop diversity and crop life cycle diversity, augment management of multiple herbicide-resistant kochia while also implementing herbicide layering. The former study was conducted in Lethbridge, AB from 2018–2021, while the latter was conducted in Lethbridge, AB and Scott, SK from 2019–2022. Doubling crop seeding rates in a spring wheat–canola–spring wheat–lentil rotation decreased kochia biomass in the 3rd and 4th year by 64% overall. Reducing row spacing from 46–23 cm decreased kochia biomass by 56%. When combined, narrow rows and double seeding rates decreased kochia biomass by 80% compared with wide rows and recommended seeding rates; equivalent to the threshold considered control by herbicide regulators. This suggests that optimizing crop spatial arrangement can result in kochia management equivalent to a new effective herbicide site of action. The Lethbridge site of the crop diversity study had sufficient kochia densities to derive treatment differences. Crop rotations that replaced spring wheat with winter wheat had 74% and 64% lower kochia density and biomass,

	respectively, by the third year. Kochia density and biomass were reduced by 89% and 99%, respectively, by perennial alfalfa/meadow brome compared with the rotations containing spring wheat. Together, these results suggest that narrow row spacing, increased seeding rates, and crop life cycle diversity contribute strongly to integrated management of multiple herbicide-resistant kochia.
60	**Experiences running a physical impact mill in Alberta fields** Breanne Tidemann[1], K. Neil Harker[2], Hugh Beckie[2], Jennifer Zuidhof[1], Patty Reid[1] [1]Agriculture and Agri-Food Canada, [2]Retired Alternative weed control strategies are needed to continue to manage herbicide resistant weeds in crops. Physical impact mills are one such strategy being implemented globally to prevent weed seedbank additions at harvest. A physical impact mill was tested from 2017-2020 in 20 producer fields within an approximately 50km radius of Lacombe, AB. In each producer field a patch with substantial weed density was identified and mapped, and divided into three replicates. Each replicate contained an untreated check treatment, and a treatment where a physical impact mill, in this case the tow-behind Harrington Seed Destructor, was operational as part of crop harvest. The mill was operated for three harvests, 2017, 2018 and 2019, with pre-harvest weed density assessments conducted, as well as pre-spraying seedling weed densities the following spring (2018, 2019 and 2020, respectively). Soil seedbank samples were also collected in spring of 2020 to allow for an estimated measure of the full weed population in a single time point. ANOVA statistical analysis of 2020 seedling density and total weed population was conducted for the most abundant weeds in each field using Proc. GLIMMIX in SAS 9.4. Very few analyses found any significant difference between weed population in the untreated and physical impact mill treatments. While some of the species tested, such as wild oat (*Avena* fatua), have been previously identified as unlikely to show population density impacts from harvest weed seed control, other species in the study such as false cleavers (*Galium spurium*) would have been expected to respond to the implementation of a harvest weed seed control strategy. Limitations to the study design that may have limited the ability to detect differences between the impact mill and the untreated check include high weed seedbank densities, non-optimal combine settings, limited timeframe of study, unmeasured seed losses at harvest and high weed density variability. Some of these factors could be addressed through additional research to ensure the technology and management strategy is being effectively evaluated for its potential in Canadian fields.
61	**Interspecific differences between carabid-seed mass ratios influence seed selection decisions** Khaldoun Ali[1], Christian Willenborg[1] [1]University of Saskatchewan, Saskatoon, SK Seed choice in seed-feeding omnivorous carabid (ground) beetles (Coleoptera: Carabidae) is influenced by numerous ecological factors, including the chemical and physical properties of seed species. Chemical seed traits seem to guide seed selection decisions when the seed species presented to carabid predators are equal in terms of size and mass. Therefore, seed chemical properties may not always explain or accurately predict seed selection decisions. Instead, carabid-to-seed mass ratio scaling relationships may drive seed choice when seed species of different mass are presented to carabid species varying in body mass. In a model system composed of eight

	carabid species and seeds of three brassicaceous weeds, we found smaller seed species were more preferably chosen by smaller carabid species. In this case, mass of the preferable seed species increased as a function of the body mass of carabid species. The taxon-specific mass of carabid predators in relation to the species-averaged mass of available seeds was the main driver of seed choice decisions in the model system under study. These mass-driven changes in seed preferences suggest that feeding interactions between carabid and seed species in agricultural fields are likely driven by mass-structured dynamics. Given this, the intensity of predation pressure imposed by carabids on weed species in the field may be determined by the distribution of seed mass in the weed community and the structure of functional body mass in the carabid community. If this holds true, seed predation by carabids would still act as an ecological filter to weed community assembly, but outcomes would be based on the size relationship between the carabid and weed community.
62	**Genome skimming and protein biotyping in weedy amaranth identification** Irina Gymninova[1], Julia Hubert[1], Sarah Kyte[1], Naana Duah[1, 2], Leonardo Galindo Gonzalez[1] [1]Ottawa Plant Laboratory, Canadian Food Inspection Agency, Ottawa, ON, [2]University of Ottawa. Ottawa, ON Weed identification is a key component in regulating plant trade and controlling the entry of invasive and noxious species affecting crop production, human health and the environment. Some amaranths species are invasive/noxious, and bear multiple herbicide resistance mechanisms. For example Amaranthus palmeri is an aggressive and prolific weed that has evolved herbicide resistance in multiple populations in the United States, and has impacted the production of crops like corn and soybean. While DNA barcoding is now commonplace in plant identification, a universal DNA plant barcode is absent and some taxa are not sufficiently resolved by typical plant barcoding genes like ITS, psbA, matK or rbcL. Additionally, novel methodologies including protein biotyping are seldom tested as alternatives for distinguishing plant species/populations. We used Illumina sequencing on 15 amaranth species to perform Genome skimming to assemble full chloroplast genomes and find novel DNA barcodes. Our results showed that genome skimming was effective for high coverage (>500X) assembly of full chloroplast genomes, allowing design of new barcodes with high species resolution. The full genomes were also used to build a well-supported phylogenetic tree for amaranths. We also tested Matrix Assisted Laser Desorption/Ionization (MALDI) protein biotyping to see if amaranth seeds would provide consistent and distinctive protein spectra for species classification. Preliminary analysis with seeds from Brassicaceae showed clustering success between 80 and 100% for samples from the same species. The methodology was then applied to 17 amaranth species showing that protein spectra in this genus can be used to cluster or perform database comparisons to distinguish noxious weeds (e.g., A. palmeri and A. tuberculatus). In conclusion, both omic methodologies can be implemented to classify samples in the Amaranth family and are potentially transferable to other taxa.
63	**Hybrids between Amaranthus tuberculatus and A. powellii found in a soybean field produced viable herbicide resistant progeny** Marie-Josee Simard[1], Martin Laforest[1], Sara Martin[2], Amélie Picard[3], David Miville[3] [1]Agriculture and Agri-Food Canada (AAFC), Saint-Jean-sur-Richelieu, QC, [2]Agriculture and Agri-Food Canada (AAFC), Ottawa, ON, [3]Laboratoire d'expertise et de diagnostic en phytoprotection (LEDP-

	MAPAQ), Québec, QC Waterhemp (Amaranthus tuberculatus) populations resistant to multiple herbicide groups (initially to gr. 2, 5 and 9) are reported in the province of Québec since 2017 and are increasingly found in corn and soybean fields, sometimes with added resistance (gr. 14 and 27). Green pigweed (Amaranthus powellii) populations are present in the province since at least the 1980s. Hybrids between herbicide resistant Amaranthus tuberculatus and A. powellii and were found in a soybean field in 2021. The plants were cut during harvest operations but a few seeds (20) were salvaged. These seeds were germinated, plants were grown in a greenhouse and tested for ploidy, herbicide resistance (using molecular markers) and pollen viability. Eleven seeds germinated (55%). All resultant plants were hybrids (intermediate ploidy). All plants were dioecious like waterhemp (5 male and 6 female). Four were resistant to group 2 herbicides only, one was resistant to group 9 and six had multiple herbicide resistance (9 + 2). Pollen viability was low (3.75%) and no seeds were formed on the female plants until pollen from a green pigweed was added.
64	**Seeing Weeds from Space: Using Satellite Imagery to Map Soil Salinity and Kochia** <u>Steve Shirtliffe</u>[1], Jap Sandhu[1], Thuan Ha[1], Kwabena Nketia[1] [1]University of Saskatchewan, Saskatoon, SK Kochia (Kochia scoparium (L.) Schrad.) is one of the worst weeds on the Canadian prairies and has evolved resistance to several herbicide groups including glyphosate which makes control difficult. It is often found in saline areas within fields as it can tolerate levels of salinity which suppress the growth of most crop species. Identifying and mapping areas where kochia is growing or may invade can facilitate patch-based control measures such as mowing. The objective of this research is to utilize aerial imagery platforms to map the location of kochia within fields. Kochia was mapped in and manually ground referenced within commercial agriculture field using a fixed wing unoccupied aerial vehicle with a ground sampling distance of 2.5 cm. A workflow was developed to classify kochia within these images. The UAV classified images were used to train a machine learning (ML) algorithm to identify kochia using multispectral Sentinel 2 satellite images. Of the ML models evaluated, the random forest model performed the best with an overall accuracy of 0.69 and a Kappa value of 0.88. The accuracy was affected by the crop type the kochia was growing is with accuracy being greatest in lentil and lowest in flax. This may be a function of the differential phenology of crops with early senescent crops facilitating kochia identification.
65	**Genome and Population Genetics of False Cleavers** <u>Sarah Martin</u>[1], Tracey James[1], Liz Sears[1], Breanne Tidemann[2] [1]Agriculture and Agri-Food Canada (AAFC), Ottawa, ON, [2]Agriculture and Agri-Food Canada (AAFC), Lacombe, AB Galium is the largest and widest spread genus within the Rubiaceae with 600-700 species that have a cosmopolitan distribution that primarily centers on temperate regions. Unlike other scientifically important species from the family such as Coffea arabica L., Galium's main economic impact are as weeds. Eighteen species from the genus are listed by Holm as weeds in jurisdictions around the world. Two particularly problematic species, cleavers (Galium aparine L. 2n = 66, 2C = 2 pg) and false cleavers (G. spurium L., 2n = 20, 2C = 0.75, 370 Mb), can cause significant crop losses in cereals, canola and sugar beet. The large variability of G. aparine and G. spurium have resulting in

	numerous synonyms and misidentifications. This is, in part, due to their position as part of a polymorphic polyploid complex. Here we produce a chromosome level draft of the more aggressive of these species' genomes, G. spurium, as a step toward untangling this complex species group. Here, we use this genome to facilitate investigation of the species population genetics and to examine the potential linkage between genetic variation and phenotypic variation observed in the greenhouse.
66	**Defense by duplication: the role of EPSPS copy number variation in the evolution of glyphosate resistance in Amaranthus palmeri** Sarah Yakimowski[1], Zachary Teitel[2], Christina Caruso[2], Lisa Han[1] [1]Queen's University, [2]University of Guelph Gene copy number variation (CNV) has been increasingly associated with the evolution of glyphosate resistance. Investigating the quantitative relation between CNV and phenotypic resistance is critical for understanding the effects of carrying a large number of copies of a resistance gene. In this study we quantify the relation between variation in *EPSPS* (5-enolpyruvylshikimate-3-phosphate synthase) copy number using digital drop PCR and variation in phenotypic glyphosate resistance in 22 populations of *Amaranthus palmeri* (Palmer Amaranth) from Georgia, North Carolina and Illinois, USA. We detected a significant positive relation between population mean copy number and resistance. The majority of populations exhibited high mean phenotypic glyphosate resistance, yet maintained low-resistance individuals, resulting in bimodality of phenotypic resistance. We investigated threshold models for the relation between copy number and resistance, and detected a threshold of ~15 *EPSPS* copies: there was a steep increase in resistance below the threshold, followed by a much shallower increase in phenotypic resistance as copy number increases to ~160 copies. Across 924 individuals, as copy number increased the range of variation in resistance decreased, yielding an increasing frequency of high phenotypic resistance individuals. Among populations we detected a decline in variation (s.d.) as mean phenotypic resistance increased from moderate to high, consistent with the prediction that as phenotypic resistance increases in populations, stabilizing selection decreases trait variation. We also investigated the inheritance of *EPSPS* copies using 30 parental pairs from glyphosate-resistant populations and 900 F1 progeny. We detected a substantial decline in heritability after a threshold point of 48.8 mean parental *EPSPS* CNV. The weaker heritability of gene copy number variation at high CNV suggests there may be little evolutionary potential for *EPSPS* copy number to further increase. This is consistent with our finding that high copy number individuals are only found at very low frequency in agricultural populations.
67	**Chromosome-Scale Draft Genomes of Common and Giant Ragweed Reveal a Potential Mechanism of Glyphosate Resistance** Martin Laforest[1], Sara Martin[1], Katherine Bisaillon[1], Brahim Soufiane[1], Sydney Meloche[1], François Tardif[2], Eric Page[1] [1]Agriculture and Agri-Food Canada, [2]University of Guelph *Ambrosia artemisiifolia* L. (common ragweed) and *Ambrosia trifida* L. (giant ragweed) are two of the most widely distributed and economically important pest species in the world. Across their native North American ranges these species are important weeds of agriculture that cause

	significant yield losses when left uncontrolled. Both species have developed resistance to many of the most commonly utilized herbicides, including inhibitors of acetolactate synthase (ALS) and enolpyruvyl shikimate 3-phosphate synthase (EPSPS). Although rare, *A. artemisiifolia* and *A. trifida* have also been observed to hybridize, with hybrid individuals reported to contain 30 chromosomes, 18 from *A. artemisiifolia* and 12 from *A. trifida*. In this research, chromosome scale draft genomes of *A. artemisiifolia* and *A. trifida* were produced via a trio binning approach whereby the haploid genomes of hybrid ragweed as well as the diploid genomes of the parental species were sequenced using Pacific Bioscience long read technology. The genomes of the parental species were assembled individually and these results served as reference to sort the sequence reads of the hybrid into 2 groups, referring to the origin of the chromosomes, and therefore permitting the resolution of haplotypes for both species. Genomic assemblies of *A. artemisiifolia* and *A. trifida* facilitated the production of complete sequences of herbicide target site genes, including the three copies of EPSPS. These results revealed a previously unreported Proline to Serine mutation at position 106 (P106S) of EPSP2S in both *A. artemisiifolia* and *A. trifida*. While this mutation has been reported to confer resistance to glyphosate in several other weed species, it is unclear at present what contribution this mutation may make to the level of glyphosate resistance observed in these species.
68	**Heterosis and the inheritance of paraquat resistance in Canada fleabane** Hayley Hickmott[1], François Tardif[2], Martin Laforest[3], Istvan Rajcan[2], Sydney Meloche[3], <u>Eric Page</u>[3] [1]Pest Management Regulatory Agency, [2]University of Guelph, [3]Agriculture and Agri-Food Canada Heterosis, or hybrid vigour, refers to the phenomenon whereby the progeny of a diverse cross exhibits enhanced growth, development or fertility compared to either parent. While heterosis as a research subject is common to much of the plant breeding literature, there are few weed science studies that discuss heterosis and, in particular, its potential impact on the inheritance of herbicide resistance. The objective of this research was to observe the inheritance of paraquat resistance in *C. canadensis* in three reciprocal crosses that were comprised of two resistant biotypes from unique evolutionary origins and a susceptible standard. Previously described SSR markers were used to genotype the parental biotypes and to ensure the successful production of the F1 generation. Segregating F2 generations were screened at two doses of paraquat: i) a discriminating dose (i.e., the lowest dose that discriminated the parents based on their dose responses) and ii) a parental eliminating dose (i.e., the dose at which both parental biotypes were controlled). Results of this research indicated that F2 families deviated from the expected 3:1 ratio for single gene inheritance. Evaluated digenic models suggested an 11:5 ratio may best describe paraquat resistance in *C. canadensis*. At both the discriminating and parental eliminating doses, F2 progeny from the cross of a paraquat resistant and susceptible parent displayed heterosis in survivorship and biomass accumulation whereas the F2 progeny of two resistant biotypes did not. In fact, the survivorship and biomass accumulation of F2 progeny from resistant parents declined, indicating that they were less fit than their parental biotypes. This suggest that resistant biotypes from unique evolutionary origins may have similarly fixed regions in their genomes due to the selection pressure exerted by the herbicide and that this then limits the potential for heterosis.
69	**Seed crop management of creeping red fescue (Festuca rubra L.): Challenges and opportunities in the Peace region of Canada.**

Nityananda Khanal[1], Noabur Rahman[2], Bishnu Pandey[2], Calvin Yoder[3], Talon Gauthier[4]

[1]Agriculture and Agri-Food Canada, Lacombe, AB, [2]Agriculture and Agri-Food Canada, [3]SARDA Agricultural Research, Falher, AB, [4]Peace Region Forage Seed Association, Dawson Creek, BC

Creeping red fescue is a popular turf grass. Peace region of Canada is the world leader in creeping red fescue seed crop area and production. Its seed is one of the major export commodities of Canada with $29.45 million export value in 2019/20. The seed productivity of this crop in Canada is lower than other seed exporting countries. It is a perennial vernalization obligate crop, hence no seed production in the establishment year. Seed yield declines rapidly after the first seed harvest year. Plant nutrient management and growth regulation measures were not effective in prolonging the productivity for additional years. The seed crop responded to moderate level of nitrogen fertilizer (60-70 kg N ha^{-1}) and supplemental irrigation up to 50% of total precipitation in a typical or drier years. In the crust-forming Luvisolic soil, which predominates in the region, uniform crop establishment is a challenge resulting in weed pressure. Lack of public breeding program in Canada and unavailability of resilient cultivars has led to a heavy reliance of seed producers and turf industry on a single public cultivar 'Boreal' registered in 1966. Signs of disease susceptibility, and degeneration of phenotypic and seed quality traits were evident in the Boreal. Despite multiple constraints, the profitability of creeping red fescue seed production was comparable to annual cash crops such as wheat, canola and peas. Inclusion of creeping red fescue seed crop in crop rotations was 20-30% more profitable than tight rotations of annual crops. Its perennial growth enhanced soil carbon stock by 45%, while reducing the runoff and soil erosion by 33% and 380%, respectively. Development of effective crop residue management and non-chemical bio-tillage termination options can enhance the potential of creeping red fescue seed crop to contribute to climate change adaptation, carbon sequestration, economic viability and resiliency of the cropping systems.

70 **G X E and stability of sainfoin (Onobrychis viciifolia Scop.) under grass mixture in western Canada.**

Hari Poudel[1], Bill Biligetu[2], Douglas Cattani[3], Mohammed M. Mukthar[1, 4], Surya Acharya[1]

[1]Agriculture and Agri-Food Canada, Lethbridge, AB, [2]University of Saskatchewan, [3]University of Manitoba, [4]University of Alberta

The stability of biomass yield and proportion of sainfoin in grass mixture are important selection criteria for the genetic improvement of sainfoin. The effects of G X E on these two traits were evaluated at four environments (Lethbridge-2018, Lethbridge-2019, Saskatoon-2018 and Carman-2018) across western Canada by seeding five sainfoin populations with three grass species using two seeding methods (N=30). Data were collected over three years under 2-3 cuts management after establishment. For both traits, the pooled analysis of variance revealed highly significant variations in environment, harvest-year, and cut(harvest-year); and lower but significant variations in sainfoin genotype and G X E. The least squared means of genotype estimated for each environment separately by considering harvest-year as a repeated measure and cuts(harvest-year) as a random factor was used for GXE analysis considering year as a replication. A two-dimensional GGE biplot generated using the first two principal components accounted for 73 and 80% variability in sainfoin composition and biomass yield, respectively. The who-won-where GGE biplot

	for sainfoin composition revealed Mountainview sainfoin with orchardgrass in alternate rows in both Lethbridge environments but Melrose with the same combination in the other two environments as the best genotype. For herbage biomass, LRC-4498 sainfoin with meadow bromegrass was the winner in three environments. All sainfoin populations with orchardgrass had greater than average sainfoin composition but lower herbage biomass. The combined Shukla stability index (50% weight to both biomass and % sainfoin composition) ranked LRC-4498 sainfoin with orchardgrass in the same row, with hybrid brome in the alternate row, and with meadow bromegrass in alternate rows as the top three performing genotypes across all environments. Our result suggests LRC-4498 as a suitable choice for growing with grass species across western Canada.
71	**Intermediate wheatgrass production as a perennial grain for western Canada** Douglas Cattani[1], Patrick Le Heiget[1], Bill Biligetu[2], Emma McGeough[1] [1]University of Manitoba, Winnipeg, MB, [2]University of Saskatchewan, Saskatoon, SK Two studies are reported herein. A four-site study was used to investigate the impact of three treatments on the potential grain yield of intermediate wheatgrass as a perennial grain. Trials were established at Brandon, Carman and Glenlea MB and at Clavet, SK in either 2019 or 2020. One (Glenlea), two (Clavet) or three successive harvests were made. The three treatments were: 1) a treatment that was seeded in alternate rows to IWG and alsike clover; 2) a treatment that received 50kg ha^{-1} N after the first grain harvest; and 3) an unfertilized control. In general, the fertilized treatment out yielded the others in grain harvests two and three, significantly so in year three. Other seed yield components were variable across treatments and years due in large part to three successive years of drought and a final year of excess precipitation (2022). One site year was negatively impacted by cutworms in 2020, while the Glenlea site had to be abandoned in the spring of 2022 due to up to eight weeks of submersion by the Red River after the initiation of regrowth. A second series of studies (Carman and Winnipeg MB) investigated establishment strategies including seeding times of spring and fall, spring underseeding to wheat and conventional versus organic systems. Fall seedings were not successful as they were negatively influenced by drought or flowered much later than spring seedings indicating vernalization issues that need to be understood. Yield response to underseeding to wheat was either suppressed due to drought or not a factor under adequate rainfall.
72	**Assessing yield and resilience of cropping systems on the Canadian Prairies** Kui Liu[1], Ahmed Lasisi[1], Martin Entz[2], Francis Larney[3], Henry Chau[3], Hiroshi Kubota[4], Greg Semach[5], Gary Peng[6], Prabhath Lokuruge[7], Sheri Strydhorst[8], Mohammad Khakbazan[9], Haben Asgedom[6], Mervin St. Luce[1], Reynald Lemke[6], Breanne Tidemann[4], Shaun Sharpe[6], Michelle Hubbard[1], Newton Lupwayi[3], Jennifer Town[6], Guillermo Hernan-Ramirez[10], Sisi Lin[1], Dilip Biswas[1], Ekene Iheshiulo[3], Samantha Curtis[2], Yantai Gan[1] [1]Swift Current Research and Development Centre, [2]University of Manitoba, [3]Lethbridge Research and Development Centre, [4]Lacombe Research and Development Centre, [5]Beaverlodge Research and Development Centre, [6]Saskatoon Research and Development Centre, [7]Scott Research Farm, [8]Sheri's Ag Consulting Inc., [9]Brandon Research and Development Centre, [10]University of Alberta Agriculture faces grand challenges of improving productivity and profitability under climate uncertainty. A systems approach is required when designing cropping systems to achieve a long-

	term goal of sustainability. A 4-year crop rotation study was established in 2018 at seven sites across the Canadian Prairies, including Beaverlodge, Lacombe, and Lethbridge, AB; Melfort, Scott, and Swift Current, SK; and Carman, MB. The overall objective of this project is to develop resilient cropping systems for different ecozones on the Canadian Prairies. This study tested six cropping systems: 1) conventional cropping system (Control), 2) oilseed or pulse crops intensified cropping system (OPCICS), 3) diversified cropping system (DCS), 4) market-driven cropping system (MCS), 5) high risk and high reward cropping system (HRHRCS), and 6) soil health enhancing cropping system (SHCS). The performance of cropping systems was assessed using a group of system indicators, including productivity, soil health, resource use efficiency, pest pressure, economic returns, carbon footprint, and resilience. Preliminary results over the first 4 years indicated that the average system production (e.g. canola equivalent yield, CEY) for MCS (2004 kg ha^{-1}) and OPCICS (1806 kg ha^{-1}) were 23 and 11% higher than the Control (1630 kg ha^{-1}), respectively. The CEY for DCS (1603 kg ha^{-1}), HRHRCS (1517 kg ha^{-1}) and SHCS (1281 kg ha^{-1}), however, were 2, 71, and 21% lower than the Control, respectively. Yield stability as indicated by the coefficient of variation of CEY followed the order of OPCICS > DCS > SHCS > Control > HRHRCS = MCS. As indicated by the highest yield crisis severity, MCS was least resilient among all tested cropping systems. Overall, these preliminary results suggest that a balance between yield and resilience should be considered when designing cropping systems.
73	**Erosion and one-time amendments drive long-term wheat production risk** Brendan Alexander[1], Francis Larney[1], Henry Chau[1], Anthony Curtis[1], Kyle Shade[1], Charles Geddes[1] [1]Agriculture and Agri-Food Canada (AAFC), Lethbridge, AB. High wheat yields are good, but high wheat yields with high reliability and low-risk are better. Food security is threatened by climate change and global conflicts and it is therefore increasingly critical that Canada remains a primary source of production for staple foods like wheat. This study used data from a long-term (30 year) experiment examining the effects of artificial erosion and one-time soil amendments on spring wheat yield near Lethbridge, Alberta. We applied a mix of linear and linear mixed-models to evaluate wheat yield stability (Shukla's stability), adaptability (Finlay-Wilkinson regression), and production risk (Eskridge safety-first). Statistical learning methods (CART and random forest) provided a means to explore the sources of substantial year-to-year variability by incorporating historical climate data. Using a simple linear model we found that ~85% of the sums of squares were attributable to year-to-year variation rather than the erosion and amendment treatments or the treatment × year interaction. Using CART and random forest we found that growing season precipitation, growing degree days, and previous-year precipitation account for much of the year-to-year variability and resulted in values of ~0.59 and ~0.89 (respectively) on held-out test data. Simulated erosion resulted in decreased adaptability and increased production risk. One-time soil amendments of manure, topsoil, or fertilizer resulted in beneficial long-term effects on yield, increases in adaptability, and decreases in production risk (manure > topsoil > fertilizer > no amendment). Soil erosion can cause long-term negative effects for adaptability and production risk that may be mitigated in part by one-time soil amendments. However, environmental conditions remain the major source of variation in wheat production in this region. Therefore, further efforts are warranted to decrease production risk and increase the adaptability of wheat cultivars to variable environments projected to experience increased uncertainty under a changing climate.
74	**Investigating the factors influencing canola quality**

Jonathan Rosset[1], Robert Gulden[1]

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Canola (Brassica napus L.) is an important oilseed crop in western Canada. Canola seed oil and protein contents vary greatly from year to year, however, the factors that contribute to this variation are not well understood. The purpose of this study was to determine the contribution of agronomic, climatic, edaphic, and genotypic factors to canola seed oil, and protein content. A partial least squares regression analysis was conducted using the Corteva Agriscience small plot research data from multiple locations across western Canada between 2017 and 2020. The dataset contained approximately 16,000 observations. Weather variables were calculated at weekly intervals from daily observations. Edaphic and management factors also were included in the model. The PLS regression model explained about 60 percent of the variation in canola seed oil and protein content and over 50 percent when canola yield was also included as a dependent variable. Weather variables were among the most significant contributors to canola yield and seed quality. Canola seed protein content and yield were both positively associated with the cumulative number of days with maximum temperatures between 21 and 24 Celsius prior to anthesis, the cumulative number of days with minimum temperatures between 8 and 12 Celsius prior to stem elongation, and the 3 week daily average maximum temperature from pod filling to ripening whereas the opposite association was observed for canola seed oil content. In addition, canola seed protein was associated positively with the amount of applied nitrogen; canola yield was associated positively with the 3 week daily average precipitation during the period of seed filling and associated negatively with seeding date and the number of days to anthesis; and canola oil content was associated positively with the number of days between anthesis and maturity and associated negatively with applied nitrogen. This study highlights the importance of weather and nitrogen fertilization on canola seed quality and yield.

75 **Decoding and tuning of oat genes associated with dietary fiber**

Jaswinder Singh[1], Thomas Donoso[1], Rajvinder Kaur[1], Zhou Zhou[1], Rajiv Tripathi[1], Mehtab Singh[1]

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Oat has lagged behind other cereals in the genetic and genomic studies attributed to its large and complex genomes. Recent efforts to sequence the oat genomes encourage researchers to unravel the complexity of genomes with respect to gene function. We use transposon-mediated and CRISPR- based functional genomics approaches to characterize genes in oat. To develop gene tagging for oat, maize Activator (Ac) and Dissociation (Ds) transposons were introduced into the oat genome using the biolistic-delivery system. Stable transgenic events were obtained with transformation frequencies up to 19.0%, on bialaphos and hygromycine selection. The Ds elements were successfully mobilized by the expression of AcTPase which led to a transposition frequency up to 16.8%. Ds flanking sequences revealed the Ds- tagged genes are associated with gibberellin 20-oxidase 3, (1,3;1,4)-beta-D-glucan synthase, and Aspartate kinase. We have also made efforts to edit TLP8 (Thaumatin-like protein 8) gene in the oat genome. TLP8 has been reported recently for its interaction with beta-glucan in barley. We have identified transformants with potential with edited TLP8 gene. Transposon mutagenesis and CRISPR- based gene editing systems could facilitate and expedite functional genomic studies in oat. This could potentially identify novel mutants for the development of future generation of healthy, and productive cereals

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Two major quantitative trait loci confer complete solidness in all stem internodes of a spring wheat line

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The stems of some wheat cultivars are filled with 'pith'. Breeding solid-stemmed cultivars is the most effective way to decrease the impact of wheat stem sawfly (Cephus cinctus Norton). Although a major solid stem gene has been previously identified from durum wheat, it produces an intermediate level of stem solidness in common wheat which is insufficient to provide the required level of WSS resistance. Thus, to identify a secondary source of solidness in common wheat, we developed three mapping populations from wheat cvs. Sadash, 'AAC Innova' and 'AAC Cameron', each crossed separately with P2711, a completely solid stemmed hexaploid wheat line. All populations were genotyped using either wheat 15K or 90K Infinium iSelect SNP assay and high -density linkage maps were generated along with consensus maps for chromosomes 3B and 3D. 'Sadash/P2711' and 'AAC Innova/P2711' populations were subjected to extensive phenotyping in ≥3 environments followed by quantitative trait loci (QTL) analyses using population-specific and consensus linkage maps. We identified two major solid stem QTLs in the distal regions of chromosome arms 3BL and 3DL in both populations in addition to several population-specific or common minor QTLs. Internode-specific QTL analyses detected both major QTLs of chromosomes 3B and 3D across internodes, from top to bottom of the stalk, but minor QTLs were largely detected in upper or middle internodes. Comparative and haplotype analyses showed that the 3B locus is homoeologous to 3D and mapped to a 1.1 Mb genomic region. Major QTLs identified in this study can easily be transferred to new breeding lines using their flanking/linked markers to achieve maximum pith expression.

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Evaluation of environmental factors that can affect year-to-year variability of Fusarium head blight field screening in winter wheat.

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Fusarium head blight (FHB), also known as scab, is caused by various Fusarium species such as Fusarium graminearum. It is estimated that this disease has cost the Canadian wheat industry more than $1 billion dollars over the past thirty years. Yield loss is mainly due to a reduction in grain filling due to shriveled and/or discolored kernels, and contamination of grain with trichothecene mycotoxins, including deoxynivalenol. To select for resistance, the Ottawa winter wheat improvement program annually operates a FHB screening nursery. Germplasm is inoculated at anthesis with an active conidial solution containing three highly virulent strains of Fusarium graminearum, followed by mist irrigation of the nursery. The objectives of this study were to determine the degree of year-to-year variability for FHB field ratings (Incidence, Severity and FHB

	index) and the effect of year-to-year environmental conditions on these ratings, using a group of nine winter wheat varieties. Incidence is a field measure of type 1 resistance (resistance to infection), whereas Severity is an estimate of type 2 resistance (resistance to spread of infection in the spike). Significant variability (P < 0.05) among entries was observed for all three FHB ratings parameters. In addition, Year and Year x Entry effects were significant for Severity and FHB Index. In contrast, the Year and Year x Entry effects were not significant (P > 0.05) for Incidence. It appears that the use of spray inoculation combined with mist irrigation mitigates year-to-year variability for Incidence. We present the relationship between Severity and FHB index with environmental conditions in the FHB nursery (ambient temperature, growing degree days) and discuss the implications for conducting effective FHB screening nurseries
78	**Spectral reflectance indices to differentiate wheat variety response to heat and drought stress** Jatinder Sangha[1], Weiwei Wang[1], Richard Cuthbert[1], Yuefeng Ruan[1], Ron Knox[1], Raju Soolanayakanahally[2], Raja Ragupathy[3] [1]Agriculture and Agri-Food Canada (AAFC), Swift Current, SK, [2]Agriculture and Agri-Food Canada (AAFC), Saskatoon, SK, [3]Agriculture and Agri-Food Canada (AAFC), Lethbridge, AB Developing crop varieties with reliability against a changing climate requires the challenging task of screening a large number of germplasm lines under diverse field environments. To explore a fast, cost-effective, and non-destructive approach to phenotype bread wheat (Triticum aestivum L.) response to heat and drought stress, we used a spectroradiometer (325–1075 nm) for collecting canopy spectral reflectance indices (CSRI). In 2022, thirty bread wheat lines were seeded in replicated plots (1.2 x 3 m) at Agriculture and Agri-Food Canada's research sites in Swift Current (SC) SK (low rainfall, high temperature), Indian Head (IH) SK (high rainfall, moderate temperature) and Lethbridge (LB) AB (early drought, moderate temperature). Spectral data was collected at the grain filling stage for photochemical reflectance index (PRI), red normalized difference vegetation index (RNDVI), green normalized difference vegetation index (GNDVI), vegetation index (VI) simple ratio (SR), water index (WI), and two normalized water indices (NWI-1, NWI-2). Grain yield per plot ranged from 578 to 820 g at SC, 909 to 1296 g at IH, and 498 to 914 g at LB. Swift Current and Lethbridge experienced moderate drought conditions. The CSRI represented by NDVI, SR, VI and PRI showed significant (p<0.05) positive correlation with grain yield whereas WI, NWI, and NWI2 showed significant (p<0.05) negative correlation with grain yield. However, the relationship for all these indices with grain yield was weak for the Indian Head location that received excessive moisture throughout the growing season. The results suggest that CSRI based on NDVI, VI, and WI have potential for use in predicting reliable grain yield in wheat under heat and drought environments. Application of CSRI in germplasm selections, especially in plots with small size such as hills or single rows will be highly appreciated in breeding programs.
79	**Estimating Wheat Seed Yield – Physical vs. Remote Sensing Data** Samantha Clemis[1], Robert Gulden[1] [1]University of Manitoba Estimation of crop yield and performance using remote sensing techniques is of great interest. Wheat yield was estimated using remote sensing data and this method was compared to estimating seed yield using yield components and other physical data generated from a large multi-factor experiment that investigated spatial arrangement of wheat plants to maximize wheat

	seed yield. The data from five locations (2019-2021) of this multi-factors experiment (variety, seeding density, row spacing, and stubble type) was used to model wheat yield using Partial Least Squares regression. Wheat yield was estimated using physical data (yield components, height and biomass) and remote sensing data (ground cover data at five different wheat developmental stages from which the area under the ground cover curve also was determined). Physical data alone explained 71.1% of the variation in wheat seed yield with row spacing, seeds per head, plant height and plant biomass as the significant contributing factors. Remote sensing data on the other hand, only explained 51.0% of the variation in seed yield with all ground cover dates contributing to seed yield. Physical and remote sensing data were combined explained 73.2% of the variation in wheat seed yield which was not much better than using physical data alone. Late ground cover readings were more important in the combined analysis while plant height and early ground cover data were no longer included in the trimmed model. Area under the ground cover curve, surprisingly, was a poor predictor of wheat seed yield and was not included in any of the trimmed models. The importance of late season physical data and late season remote sensing data suggest that the crop may have experienced resource limitations. The dry conditions during the growing season at all site years (55-70% of the 30-yr average) may have contributed to the low predictability of wheat seed yield.
80	**Evaluating dry edible beans as a double crop following winter barley, canola and peas** <u>Eric Page</u>[1], Sydney Meloche[1], Alyssa Thibodeau[1], Meghan Moran[2], Jamie Larsen[1], Jichul Bae[1] [1]Agriculture and Agri-Food Canada, [2]Ontario Ministry of Agriculture and Rural Affairs Weed control is one of the primary challenge associated with dry edible bean production in southern Ontario. Season long weed control can be difficult to achieve because there are few herbicide active ingredients available that do no injure the crop and are efficacious on a wide range of weed species. Integrated weed management practices that help to suppress weed emergence are needed in order to reduce the reliance on herbicides. options are need . Double cropping, or the practice of growing a summer crop immediately following a winter crop, has the potential to simultaneously suppress early season weed emergence and shift the growth and development of less competitive crops to periods of the growing season where weed emergence is reduced. Field trials to evaluate double cropping with dry edible beans were established in 2020 and 2021 at the Harrow Research and Development Centre. Dry edible beans were seeded in early July of both years, following winter barley, canola and peas respectively. Spring seeded plots of conventionally managed dry beans were included as the benchmark and weedy and weed-free dry beans treatments were established in order to evaluate the impact on crop yields. Results of the research demonstrate that, while double crop dry beans yield less than the conventional control, the system as a whole has the potential to be more profitable than dry beans as a sole crop.
81	**Impact of tillage and crop residue on the establishment, survival and yield of winter canola** <u>Eric Page</u>[1], Sydney Meloche[1], Alyssa Thibodeau[1], Meghan Moran[2] [1]Agriculture and Agri-Food Canada, [2]Ontario Ministry of Agriculture and Rural Affairs Winter canola production in eastern Canada is a growing segment of the Canadian canola industry. Winter canola acreage in Ontario, for example, has increased from less than 100 acres in 2015 to

	over 10,000 planted in the fall of 2021. Many of these acres are clustered in the most southern counties of the province where interest in the crop is being driven by high commodity prices and record yields. While farmers in this region are familiar with corn and soybeans, the management of winter canola and its incorporation it into existing rotations is a new challenge. It is often recommended that winter canola be seeded into tilled ground following winter wheat. In southern Ontario, however, it is conceivable that winter canola could also follow early harvested soybean, in which case no till practices could help accelerate the timeliness of seeding. Field trials were established at the Harrow Research and Development Centre in 2019 , 2020 and 2021 to assess the impact of crop residue (winter wheat or soybean) and tillage (no-till, strip till and conventional tillage) on the establishment, over winter survival and yield of winter canola. Stand losses during the fall and winter were generally acceptable in all treatments and the type of residue did not appear to have an influence. There was no difference in yield when canola was seeded into winter wheat or soybean residue but yields were higher in conventional and strip till than in no-till. Results indicate that, while crop residue and its management through tillage are important factors influencing the establishment of winter canola, farmers in southern Ontario can successfully produce winter canola using a wide range of crop management practices.
82	**Choice of forage legume cultivar affects establishment when frost or sod seeding** Kathleen Glover[1], John Duynisveld[2], Julie Lajeunesse[3], Yousef Papadopoulos[1], Sherry Fillmore[4], Samuel Fromm[2], Matthew Crouse[1] [1]Agriculture and Agri-Food Canada (AAFC), Truro, NS, [2]Agriculture and Agri-Food Canada (AAFC), Nappan, NS, [3]Agriculture and Agri-Food Canada (AAFC), Normandin, QC, [4]Agriculture and Agri-Food Canada (AAFC), Kentville, NS Maintaining high quality pasture continues to be the most cost effective means to increase ruminant animal production and while long-lived pasture stands are a highly effective way to reduce greenhouse gas emissions and increase carbon sequestration, a reduction in legume content often leads to tillage and re-establishment of the forage stand. This study evaluates the effect of legume species and cultivar on no-till forage stand renovation. Three cultivars of each of two legume species (AC Langille, AC Bruce and Leo birdsfoot trefoil; AAC Trueman, Spredor4 and AC Caribou alfalfa) were frost or sod seeded at two locations (Nappan, Nova Scotia and Normandin, Quebec). In the establishment and two production years, seeded legume plant density (plants/m^2), sward botanical composition (% legume dry matter (DM) content) and forage DM yield (t/ha) were measured. There were no significant differences in sod versus frost seeding at either location with respect to legume yield or content. There was a significant effect of year for these variables. At Nappan the amount of seeded legume increased from 0.8% of total DM yield in the establishment year to 10.1% in the 2nd production year while Normandin saw an increase from 0.6% to 30.6% legume over the same time period. There were also significant differences between the legume species and cultivars within species with respect to the amount of legume established. For both locations birdsfoot trefoil produced a higher legume DM content than alfalfa: 6.2% versus 1.2% and 20.3% versus 14.0% for Nappan and Normandin respectively. A similar effect on the number of plants/ m^2 was also observed. At Normandin there was a significant difference in the three birdsfoot trefoil cultivars evaluated with both Langille (24.2%) and Bruce (22.5%) producing higher legume DM content than Leo (14.3%). Results indicate that frost seeding is as effective as sod seeding in increasing the legume content of a grass stand and that legume cultivar is an important consideration in effectiveness of either no-till seeding method.

83	**Impacts of fall seeding date on intermediate wheatgrass flowering** Douglas Cattani[1], Patrick Le Heiget[1] [1]University of Manitoba Fall seeding of intermediate wheatgrass for grain production in western Canada is likely risky with respect to reproductive effort and yield. Experience is showing reduced yields in the first reproductive year. Fall seeding dates were used to investigate pre-winter development on the next year's reproductive development. Seeding in the falls of 2020 and 2021 indicate that seeding dates are important in reproductive development with earlier fall seeding dates providing larger inflorescences including more florets. Anthesis occurs earlier with longer pre-winter growth periods, however all fall seeding dates produced prolonged non-synchronous flowering periods.
84	**Effects of nitrogen stabilizers and crop rotation on soil pH, N dynamics and relative abundance of genes involved in nitrification and denitrification processes in podzolic soil in boreal climate** Irfan Mushtaq[1], Raymond Thomas[1], Svetlana Yurgel[2], Lakshman Galgedara[1], Muhammad Nadeem[1], Yeukai Katanda[1], Hafiz Usama Abid[1], Muhammad Usman[1], Mumtaz Cheema[1] [1]Memorial University of Newfoundland, Corner Brook, Newfoundland and Labrador, [2]USDA Agricultural Research Service Grain Legume Genetics Physiology Research Unit, Pullman, WA Nitrogen (N) is an essential macronutrient required to increase crop growth, development and yield. Increase N application result in N losses which can vary between 50-70% in different cropping systems. Crop rotation and N stabilizers may affect the N mineralization and consequently limit N losses. This study was designed to evaluate the effect of crop rotation and N stabilizers on soil pH, soil mineral N, and genes involved during nitrification and denitrification processes. The experiment was conducted in small plots (3 m × 4 m) and laid out in a randomized complete block design (RCBD) with split plot arrangement with four replications. The experimental treatments were three crop rotations [(silage corn-silage corn (c-c), silage corn-Wheat (c-w), silage corn-Faba bean (c-fb)] and five nitrogen sources (Control, Urea, Agrotain, Entrench, and Super-U). Results showed that both N sources and crop rotation had no significant effect on soil EC. However, soil pH was significantly affected by N sources and non-significantly affected by crop rotation. Furthermore, c-fb crop rotation significantly reduced soil NH_4^+ and NO_3^- and relative abundance of all genes involved in N cycle as compared to c-c rotation. However, N stabilizers had no significant effect on soil NH_4^+ and NO_3^- as compared to urea. N stabilizers significantly suppressed the relative abundance of genes involved in nitrification (amoA AOB, amoA AOA, nxr), and denitrification (nirK and nosZ) compared to urea. According to the results of this study, we may conclude that N stabilizers can impede the normal nitrification and denitrification processes and can improve N uptake by plants
85	**Effects of cropping sequence and nitrogen stabilizers on soil carbon pools in boreal climate** Muhammad Usman[1], Hafiz Usama Abid[1], Muhammad Nadeem[1], Yeukai Katanda[1], Judith Nyiraneza[2], Lakshman Galagedara[1], Raymond Thomas[1], Mumtaz Cheema[1] [1]Memorial University of Newfoundland, Corner Brook, Newfoundland and Labrador, [2]Agriculture and Agri-Food Canada, Charlottetown, PE. Soil carbon (C) plays a vital role in soil heath by improving soil structure, enhancing water and

	nutrient retention, reducing erosion and nutrient leaching which ultimately increase crop productivity. Soil C may be affected by land use change, crop management practices (fertilizer application, cover crops, crop rotation) and climate change. Nitrogen (N) fertilizers application and long-term crop rotation is known to improve soil C in different cropping systems. However, effects of short-term crop rotation and N stabilizers on soil C pools in boreal climate remains unclear. This study aimed to investigate the effect of short-term crop rotation and N stabilizers on total C (TC), total N (TN), particulate organic matter C (POM-C), particulate organic matter N (POM-N), microbial biomass carbon (MBC), and microbial biomass nitrogen (MBN) in podzolic soil under boreal climate. Experimental treatments included three crop rotations: (corn-corn (c-c), corn-wheat (c-w) and corn-faba bean (c-fb); and five nitrogen sources: urea (single dose), urea (split-applied), and N stabilizers (Agrotain™, Entrench™, and super-U™) were compared to an unfertilized control. Results showed that N sources had significant effects on POM-N ($p<0.043$), TC ($p<0.042$) and TN ($p<0.003$), and no significant effects on MBN, MBC and POM-C. Crop rotation had significant effects on MBN ($p<0.020$), MBC ($p<0.000$), and POM-C ($p<0.007$) while no-significant impact on TN, TC, POM-N. c-fb rotation showed 26.5 % higher MBN compared to c-w, while c-w rotation exhibited 58.8 % higher MBC as compared to c-fb. On the other hand, c-c had 8.98 % and 10.7 % greater POM-C compared to c-w and c-fb, respectively. Overall, N stabilizers and crop rotation significantly affected soil C pools and played role in C retention in the soil. However, long term crop rotation and N stabilizers studies are required to enhance our understanding and knowledge on C pools in podzolic soils under boreal climate.
86	**Short to medium-term effects of biochar and dairy manure application on soil's physiochemical properties, yield and quality of silage corn in podzol soils under boreal climate.** Hafiz Usama Abid[1], Muhammad Usman[1], Muhammad Nadeem[1], Lakshman Galagadera[1], Svetlana Yurgel[2], Mumtaz Cheema[1] [1]Memorial University of Newfoundland and Labrador, Corner Brook, NL, [2]USDA Agricultural Research Service Grain Legume Genetics Physiology Research Unit, Pullman, WA Newfoundland and Labrador's (NL) soils are shallow, stony with low pH, and poor in fertility making it unsuitable for agriculture. Dairy manure (DM) application adds nutrients and carbon and improves crop yield. However, DM application is vulnerable to leaching and may cause nutrient leaching, water contamination and greenhouse gas emissions (GHGE). Biochar (BC) amendment is known to improve physiochemical properties, C and adsorb nutrients and mitigate GHGE. A field experiment was initiated at Western Agriculture Research Station, Pasadena, during 2016 to determine the short to medium term application DM and BC application on soil's physiochemical properties, yield and quality of silage corn. The experimental treatments were: 1) DM with high N conc. (0.23%) (DM1), 2) DM with low N conc. (0.079%) (DM2), 3) Inorganic nitrogen (IN), 4) DM1+BC, 5) DM2 + BC, 6) IN+BC, and 7) Control (N0). BC was applied once in 2016 @ 20 ton/ha before seeding and DM was applied @ 30,000 L/ha till 2021 except 2019. Results showed that IN+BC treatment significantly ($p < 0.0001$) increased total soil C and nitrogen and reduced soil bulk density, though statistically at par with DM amended BC treatments compared to control. DM1+BC treatment produced significantly ($p< 0.01$) higher forage yield compared to the control. In terms of qualitative indices, DM amended treatments increased total digestible nutrient, net energy for lactation, maintenance and gain though statistically at par with IN + BC treatment. Likewise, DM amended treatments produced higher milk though statistically at par with IN + BC treatment and lowest was recorded in control. Based on results, we may conclude that DM and BC amendment

	has the potential to increase the silage corn yield, quality indices, total carbon and nitrogen while improving bulk density in podzolic soils in boreal climate.
87	**Can intercropping suppress Rhizoctonia root rot of dry beans under mesic and flooded conditions?** Alika Mattheisen[1], Khalidah Ballan[1], Mark Boudreau[1] [1]Penn State Brandywine Intercropping may be an effective measure to reduce disease in certain species of plant. In addition, climate change is increasingly important in relation to pathogenesis, and intercropping may specifically help ameliorate damping off and root rot. This may be particularly useful on land susceptible to more frequent flooding, a current and future outcome of climate change. We evaluated the effectiveness of intercropping common bean (*Phaseolus vulgaris*) with species grown in dry bean production areas under mesic and flooded conditions in a series of pot assays. We first screened several crops to determine promising candidates for disease reduction, ultimately selecting barley, winter squash, and kale for further study. We planted dark red kidney beans ('Montcalm') in soil inoculated with *Rhizoctonia solani* and grew them indoors under LED lights for 2-3 weeks. Experimental design was two-factor completely randomized with four levels of intercrop (bean monocrop, barley, winter squash, and kale intercrop), two levels of moisture (mesic and flooded), and seven to nine replicates. In the flooded treatment, pot drainage was curtailed, and flooding was imitated by placing pots in standing water for 24-48 hours. We evaluated bean growth by recording date of emergence, presence of open trifoliate leaves, and dry weight of roots and shoots. We rated disease on a standard scale of 1-9 for *R. solani* infection at harvest. Our first experiments suggest intercropping with barley and squash reduce disease. Flooding clearly inhibits emergence and growth, and interacts with intercropping to increase, rather than suppress, disease, counter to our hypothesis. Nevertheless, our results suggest that some crop species in association with beans contribute factors which impact infection of *P. vulgaris* by *R. solani* and may have application to farming practices with further research.
88	**Evaluating the performance of small-scale indoor vertical hydroponics systems for lettuce production.** Abiodun Adelowokan[1], Cheema Mumtaz[1], Lakshman Galagadera[1], Raymond Thomas[1], Oludoyin Adigun[1], Elham Fathidarehnijeh[1], Kamsika Jeyarasa[1] [1]Memorial University of Newfoundland, Grenfell Campus Extreme weather conditions, short growing season, low crop heating units, acidic and stony soils restrict field crops and vegetable production in Newfoundland and Labrador (NL). The food production in NL is limited to only 10% of the total requirement, with the rest being imported from mainland Canada and other countries causing substantial economic and environmental burden to the end users and industry. One possible solution to enhance food production is growing of vegetables in small scale indoor vertical hydroponic system. This study aims to: 1) evaluate the performance of small-scale vertical hydroponic systems designed specifically for indoor vegetable production, 2) assess the effects of light emitting diodes (LED) and fluorescent light on the growth and yield of lettuce. Two locally fabricated vertical hydroponic systems: Christmas tree shaped design (CT), and Green-DNA shaped design (GD) were compared for lettuce production with

	commercially available deep-water culture (DW) system as the control. Result showed that total fresh biomass was significantly higher in DW system compared to CT, GD produced higher root fresh weight (RFW), root dry weight (RDW), and leaf area (LA) compared to DW and CT whereas, Chlorophyll content was significantly higher ($p<0.05$) in CT compared to GD and DW systems respectively. A similar result was observed when plants were grown under fluorescent light except for chlorophyll content, and LA that was significantly higher ($p<0.05$) in control. This suggests that GD was the best performing system across most growth and yield parameters. While comparing the effects of light, LED produced significantly higher ($p<0.05$) total fresh biomass, RFW, RDW and LA compared to the fluorescent grown plants. To authenticate feasibility of small-scale indoor vertical hydroponics systems, further growing of crop cycles with close monitoring is needed.
89	**- Lipid enhancement in Alfalfa through CRISPR/Cas9 mediated genome editing** Mohammed Musthafa Mukthar[1, 2], Dr. Hari Poudel[2], Dr. Stacy Singer[2], Dr. Guanqun (Gavin) Chen[1] [1]Department of Agricultural, Food and Nutritional Science, University of Alberta, [2]Lethbridge Research and Development Center, Agriculture and Agri-Food Canada A paucity of lipids in the vegetative tissues of forages leads to higher methane emissions primarily due to the reactions of the methanogens in the fermentation process and higher intake by ruminants. While this can be overcome through the supplementation of lipids in the ruminants' diet, this is costly and impractical. Alfalfa (*Medicago sativa* L.), is a notable forage crop in terms of nutritional quality and export value; however, it contains only 2-4% lipid content in its aboveground vegetative biomass on a dry matter basis (dry matter yield). As such, the aim of this study is to enhance total shoot lipid content (TSLC) in alfalfa by disrupting *PEROXISOMAL TRANSPORTER 1* (*PXA1*) and *SUGAR DEPENDENT 1* (*SDP1*) genes using CRISPR/Cas9-mediated genome editing. Three guide RNAs (gRNAs) were designed for both genes separately, which were then inserted into a background vector and introduced into alfalfa using *Agrobacterium tumefaciens*-mediated transformation. Gene editing frequency droplet digital PCR (GEF-ddPCR) assays and Sanger sequencing were used to confirm the existence of mutations at the target sites. *SDP1* mutants with 1 of 4 alleles mutated, and *PXA1* mutants with 2 of 4 alleles mutated, were identified in the first generation. Preliminary shoot lipid analyses indicated that *PXA1*-edited genotypes possessed a small but significant 8.9% relative increase in TSLC compared to wild-type controls. Furthermore, fatty acid compositional analyses demonstrated that *SDP1*-edited genotypes exhibited a significant increase in linoleic acid (18:2) compared to controls. The application of this gene editing method to develop new germplasm with high TSLC could contribute to a reduction in greenhouse gas emissions from ruminant production systems in the future.
90	**A novel assessment of Kernza® Intermediate Wheatgrass establishment and agronomy in Atlantic Canada.** Brittany Cole[1], Andrew Hammermeister[1], Aaron Mills[2] [1]Dalhousie University, Truro, NS, [2]Agriculture and Agri-Food Canada, Harrington, PE Recent attention has been given to perennial plants for agricultural use because of their resilience to dynamic conditions and potential contribution to climate change adaptation and mitigation. The newly adopted, deep rooting perennial intermediate wheatgrass (IWG; Thinopyrum intermedium),

	Kernza®, offers a dual-purpose forage and grain crop while demonstrating greater ecosystem services than comparable annual crops, including efficient water-use and nutrient uptake, and higher carbon sequestration capabilities. While Kernza® research has been conducted in multiple countries and climates, conclusive and replicated evidence on cultivation methods has been lacking. This study aims to assess the novel establishment of IWG in Atlantic Canada, disentangle the agronomy necessary to optimize performance, and summarize the benefits of growing IWG within local cropping systems for knowledge and technology transfer. Kernza® test plots will be established within each Maritime Province in 2022 and 2023 to identify microclimate variability in crop phasic development, biomass and yield, as well as to provide an array of growing conditions for assessing the quintessential agronomy of growing Kernza®; this includes the influence of Spring vs Fall seeding on performance, optimal plant density, and impact of intercropping with forage, commodity, and soil building crops to enhance the environment and economic benefits of IWG. A simultaneous crop rotation study will provide a more industry accessible assessment of Kernza® within local agriculture systems to initiate the social science aspect of commercial adoption. Establishing novel perennial crops in Atlantic Canada may prove essential to secure agricultural yields under projected climate conditions and for meeting Federal and Provincial emission targets.
91	**Purpose-grown biomass crops in Nova Scotia: Statistical predictive yield modeling and real-world verification** Emily Mantin[1], Laura Weir[1], Yousef Papadopoulos[2], Kevin Vessey[1] [1]Saint Mary's University, Halifax, NS, [2]Agriculture and Agri-Food Canada, Bible Hill, NS The bioeconomy of Nova Scotia could be stimulated by the increased production and utilization of biomass crops grown on marginal agricultural lands. The biomass yields of four purpose-grown biomass crops (Switchgrass, Miscanthus, coppiced Hybrid Poplar and Willow) were predicted using linear mixed-effects models created from published data from areas with similar climates to Nova Scotia. These models were validated and refined using crop yields collected from five field sites established across the Province. Two locally sourced, low-cost soil amendments (a pulp mill wood fibre residue and a liquid anaerobic digestate) and a plant biostimulant (a seaweed extract) were also applied to the crops during the establishment year to assess effects on crop establishment and early yields. This report focuses on two field sites, Bible Hill and Nappan. Four annual biomass harvests (2019 – 22) were recorded for grasses. Miscanthus biomass yield averaged 9,000 kg ha^{-1} while Switchgrass averaged 2,500 kg ha^{-1} with minimal difference between soil amendments in 2021 (two years post-establishment). Statistical yield models for Nova Scotia predicted up to 20,000 kg ha^{-1} and 10,000 kg ha^{-1} for Miscanthus and Switchgrass, respectively. Biomass yields recorded in the field are likely lower than predicted because the grasses have not yet reached their yield potential. Trees will be harvested in 2022 after one three-year cycle post-coppicing. The results suggest these crops show great potential as contributors to biomass supply in Nova Scotia. Management factors during the establishment year have also been identified as important influences on early yields of these crops.
92	**Good, you bought a drone – Now what?** Seungbum Ryu[1], Steve Shirtliffe[1], Steven Xue[1], Ian Stavness[1] [1]University of Saskatchewan, Saskatoon, SK Unmanned aerial vehicle (UAV) or remotely piloted aircraft (RPA) technology is starting to use

	widely in agricultural research fields. Daily collection of aerial image data is significant in size that most of computers' storage cannot handle the quantity of the data. Agronomic Crop Imaging lab (ACI) at the University of Saskatchewan uses Globus software system to synchronize local computer to the University and Global Institution of Good Security (GIFS) database to upload and secure the image data every 12 hours. Also, all the images uploaded to GIFS database are stitched and processed by 'PlotVision' automatically. Image data requires heavy computer power and a lot of time to process in conventional methods, but using a website 'PlotVision' can finish all the image processing job easily.
93	**Can APSIM be used to predict canola growth and yield in western Canada?** Kristina Polziehn[1], Alan Grombacher[2], Ryan Adams[3], Steve Shirtliffe[4], Linda Gorim[1] [1]University of Alberta, Edmonton, AB, [2]Nutrien Ag Solutions, Saskatoon, SK, [3]Nutrien Ag Solutions, High River, AB, [4]University of Saskatchewan, Saskatoon, SK The Agricultural Production Systems sIMulator (APSIM) is a modelling platform for cropping systems that can be used to simulate canola (Brassica napus L.) productivity under various management, climate, soil water and nutrient dynamics. APSIM was developed to simulate biophysical processes in farming systems, with the ability to evaluate the economic and ecological effects of management practices, especially under a changing climate. Crop models are an under-utilized agricultural tool in Canada for strengthening risk management on farms and quantifying the dynamics of genotype x management x environment interactions. While APSIM modeling research in canola has been performed in Australia, China, Germany and the USA, there is a lack of published research in Canada. This study aims to develop a western Canadian canola model using APSIM Next Generation (NG). Field studies conducted in 2022 and 2023 with six commercial glufosinate-tolerant spring canola varieties seeded at multiple seeding dates in two locations in northern Alberta are used to parametrize the model for phenology, yield and biomass. Additional parameterization, calibration, and validation of an ASPIM NG canola model will include detailed weather, soil, and yield data acquired through a collection of historical replicated, multi-environment experimental datasets from government, university and private companies. Building upon the model, the secondary objectives, conditional on the performance of the model are to 1) inter-compare the model with the Australian APSIM NG canola model, 2) simulate and evaluate the impact of weather variability on western Canadian canola yields, and 3) upscale the APSIM NG crop model to evaluate regional scale yield differences in western Canada. APSIM NG can be useful in the future to assess the performance of new canola varieties and farming practices on canola growth, development, and yield under different climatic risks.
94	**Evaluating Source-sink relationship in Canola germplasms** Saiam Jahan Liza[1], Karanjot Gill[1], Devin Zenchyson-Smith[1], Habibur Rahman[1], Linda Gorim[1] [1]Department of Agriculture, Food, and Nutritional Sciences, University of Alberta, Edmonton, AB Canola is the most-grown crop in the Canadian Prairies, contributing about $26.7 billion to the economic activities in Canada. According to Statistics Canada, in 2021 canola yields were 12.6 million tonnes. Canola plants grow by capturing sunlight throughout the growing season. The variability in climatic conditions in the past couple of years necessitates the selection of canola germplasm with higher photosynthetic efficiency and source-sink relationship geared towards higher yields. This study aims to evaluate the source-sink relationship and contribution of canola pods to

	photosynthesis in 170 canola lines under field conditions at the West 240 site (University of Alberta) in a lattice square design with three replications. In this project, several parameters were measured such as biomass (stem, leaf, and root dry weight) at BBCH 65, SLA (specific leaf areas) using Accupar LP 80 Ceptometer at BBCH 65, and pod chlorophyll fluorescence using a MultisepQ meter at BBCH 75, Plant height and canopy cover at BBCH 53. The yield of canola germplasms is bounded by source and sink. Higher above-ground dry matter and source-sink ratio increase the yield of the canola. Canola germplasms with larger leaf areas are higher in assimilates and photosynthetic activity. This source-sink relationship, specific leaf area, and photosynthesis in pods in several canola lines establish a relationship with the overall yield of the crop and selection of the superior germplasm. Physiological, agronomic, and quality traits can be assessed through the comparison of the traits in this research that will be used in future research.
95	**Effect of humalite for enhancing crop production and as a soil amendment for improving soil health** Sumedha Vaishnavi Nallanthighal[1], Devin Zenchyson-Smith[1], Karanjot Gill[1], Malinda Thilakarathna[1], Linda Gorim[1] [1]Department of Agriculture, Food and Nutrition Science, University of Alberta, Edmonton, AB Since 40% to 60% of applied nitrogen is lost to the environment, identifying on-farm solutions to increase nitrogen usage efficiency (NUE) is necessary given that the Canadian government plans to reduce N-fertilizer input by 30%. This research project evaluates humalite as one strategy to reduce N-fertilizer application and promote soil health in Prairies cropping systems. Humalite is a naturally occurring form of oxidized coal-like substance containing high levels of humic acid and low amount of heavy metals. The Prairie Mines and Royalty ULC, Hanna, Alberta holdings have large humalite deposits that are unique due to a higher percentage of humic acid and a lower concentration of toxic heavy metals. Humic acids are increasingly being used as soil amendments as they seem to improve soil nutrient availability, nutrient uptake, crop growth, buffer drought stress and improve crop yield and nutritional quality. This study aims to determine the optimal humalite rate and N-fertilizer application rates, relate these rates with crop yields (wheat and canola) and soil health parameters at four sites namely: (a) St Alberta (University of Alberta) (black soil) (b) Gateway Research Organization (grey soil) (c) Battle River Research Group (black soil) and (d) Chinook Applied Research Association (brown soil). Annually, humalite was applied at four rates (0, 100, 200, 400 and 800 pounds/acre) and urea at two rates (zero, recommended rate and ½ recommended rate – based on soil tests). Agronomic and soil health parameters were taken throughout the growing season. Results from the last two seasons show an increase in NUE in the treatment involving half urea recommended rate plus humalite when compared to other treatments. No significant increase in soil active carbon and respiration was observed in the first year. This project seeks to provide producers with a naturally occurring product that will have both financial and environmental benefits.
96	**Identifying superior photosynthetic traits in canola germplasm** Fernando Guerrero-Zurita[1], Karanjot Gil[1], Devin Zenchyson-Smith[1], Habibur Rahman[1], Linda Gorim[1] [1]Department of Agriculture, Food, and Nutritional Sciences, University of Alberta, Edmonton, AB Canola is the most grown crop in the Canadian Prairies, contributing about $26.7 billion to the economic activities in Canada. Most studies show that former approaches to improve yields such

	has breeding for genetically improved cultivars and implementing cultural practices are at saturation. Therefore, to further increase canola yields, breeders need to incorporate alternate strategies such as increasing photosynthetic efficiency (PE). The goal of this study is to evaluate photosynthetic parameters such as chlorophyll fluorescence, stomatal conductance, and photochemical efficiency in different canola germplasm to identify those with superior PE. Field trials were conducted in a Lattice Square design with three replications at the West 240 site, University of Alberta in 2021 (project is on-going) involving 170 accessions of canola (two check accessions included). PE parameters were measured at BBCH 65 stage and include: quantum yield of photosystem II (PSII), non-photochemical quenching (NPQ), and photochemical efficiency (ΦPSII). Other measurements include gas exchange parameters such as sub-stomatal CO_2 concentration (C_i), stomatal conductance (g_s), transpiration (E), and vapor pressure deficit (VPD). Other physiological parameters such as leaf area index (LAI), chlorophyll concentration (Chl_{SPAD}), leaf shape, and yield (Y) were also measured. Accessions with the best response will be identified using a principal component analysis followed by cluster analysis. Data from the first two years of the experiment are still being processed and there is a preliminary strong correlation between photosystem II-related variables with seed yield. This study will provide both canola breeders and producers with information on canola germplasm with superior PE and how that relates to yield.
97	**A data-driven technique for early detection of emerging herbicide resistance in farm fields via spatiotemporal dynamics** Greg Stewart[1], Devin Kirk[1], Charles Geddes[2] [1]Geco Engineering, [2]Agriculture and Agri-Food Canada, Lethbridge Research and Development Centre The different spatiotemporal dynamics of herbicide-resistant and -susceptible biotypes of weed populations permits their identification in fields. An algorithmic technique has been developed that combines the information obtained in maps of in-field weed locations with models of spatiotemporal dynamics of weed reproduction, enabling the detection of areas in the field that show evidence of herbicide resistance. In a commercial setting, weed maps may be obtained through computer vision systems deployed in unmanned aerial vehicles or in optical spot spray systems. If resistance is detected while still only existing in a small patch, it enables a weed control strategy to contain and eliminate the resistant biotype before it spreads and becomes a larger problem that requires additional management. The impact of this detection-and-containment strategy was evaluated in the context of a simulation over a wide range of different weed situations (including selfing/outcrossing, short/long-distance pollination and/or seed dispersal, dominant/semidominant resistance, spread/no spread by the harvester, and other variables). For all situations, the simulated detect-and-contain strategy maintained the frequency of resistant biotypes and the overall weed density at a low level, while a traditional weed control strategy led to exponential growth in both parameters. Initial results from commercial farm fields in Canada will also be presented. Together, these results suggest that this data-driven technique can exploit differences in weed spatiotemporal dynamics for both resistance detection and weed management.
98	**Utilizing digital imaging technology to characterize herbicide symptomology** Keshav Singh[1], Charles Geddes[1], Eric Johnson[2], Breanne Tidemann[3], Steve Shirtliffe[2], Hongquan

Wang[1], Austin Jaster[1], Jennifer Zuidhof[3], Kelly Turkington[3]

[1]Agriculture and Agri-Food Canada (AAFC), Lethbridge, AB, [2]University of Saskatchewan, Saskatoon, SK, [3]Agriculture and Agri-Food Canada (AAFC), Lacombe, AB

Herbicide use in agriculture has increased in recent decades. While many herbicides improve the efficiency and efficacy of weed control, the sustainability of many current options are threatened by herbicide-resistant weeds, potential environmental impacts, and public scrutiny. Reinvestment from crop protection companies into herbicide discovery warrants improved methods to assess their impact on crop and weed species. Visual efficacy and phytotoxicity ratings are the standard method used to evaluate weed control and crop injury in response to herbicide treatment. However, these ratings require extensive training and experience and can be highly subjective when performed by multiple assessors. Therefore, a more efficient, consistent, and non-invasive way to evaluate herbicide performance is required. High-throughput digital imaging is a promising tool to measure plant response to herbicide treatment. By offering an indication of plant health in real time, plant reflectance is also valuable for informing site-specific herbicide treatment. Two proximal sensors (GreenSeeker NDVI and hyperspectral) along with aerial imagery were utilized to evaluate the response of two model species, tame oat [Avena sativa; model for wild oat (Avena fatua)] and oriental mustard [Brassica juncea; model for wild mustard (Sinapis arvensis)], to herbicides targeting different modes of action. The initial experiments reported here were performed near Lethbridge, AB in 2022. The imagery data were collected alongside visual ratings for control plots (baseline) and at 3, 7, 10 and 14 days after treatment. Indices such as Normalized Difference Vegetation Index (NDVI), Chlorophyll Vegetation Index, and Optimized Soil Adjusted Vegetation Index were used to assess variation in response to herbicide treatment. The NDVI correlated with visual ratings (R^2 ≈0.65–0.94), suggesting that it holds potential to improve upon current methods for assessing plant response to herbicide treatment. Given further development, digital imaging could improve the efficiency and consistency of future herbicide assessments.

99 **The economic threshold for glyphosate-resistant kochia (Bassia scoparia) in canola**

Charles Geddes[1], Teandra Ostendorf[1], Robert Gulden[2], Prabhath Lokuruge[3]

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Kochia [Bassia scoparia (L.) A.J. Scott] is a troublesome tumbleweed that is capable of causing significant crop yield losses. In recent years, glyphosate-resistant (GR) kochia has increased rapidly throughout the southern Canadian prairies. GR kochia can be problematic particularly in GR crops such as canola, soybean or corn, and in conservation tillage systems. New canola cultivars with stacked resistance to glyphosate and glufosinate may offer growers an opportunity to manage kochia plants that survive glyphosate by following up with a rescue application of glufosinate. However, rapid growth of kochia requires these decisions to be made quickly and efficiently. New lower seeding rate recommendations for hybrid canola may also cause greater vulnerability to weed interference. The objectives of this research were to determine (a) the economic and action thresholds for GR kochia in canola, and (b) how canola seeding rates impact these thresholds. Three field experiments were conducted in 2022 near Lethbridge, AB (rain-fed and irrigated), and Scott, SK. No differences in canola yield were observed in the Lethbridge rain-fed experiment due to large variability in emergence caused by delayed spring precipitation. Seeding canola at 160

	seeds m^{-2} increased yield by 14% compared with 80 seeds m^{-2} among weedy and weed-free treatments in the Lethbridge irrigated experiment, but not in Scott, SK. The action threshold for GR kochia in canola, equivalent to the density of kochia resulting in 5% yield loss, was 9.1 and 327.5 kochia plants m^{-2} when canola was seeded at 80 and 160 plants m^{-2}, respectively, in the Lethbridge irrigated experiment. At Scott, SK, however, these thresholds were 50.2 and 29.4 plants m^{-2}, respectively. Repetition of this work in 2023 will help elucidate further the economic impact of GR kochia in canola, and whether a reduction in canola seeding rates could result in greater vulnerability to weed interference.
100	**Alberta survey of herbicide-resistant kochia (Bassia scoparia) in 2021** Charles Geddes[1], Mattea Pittman[1], Linda Hall[2], Keith Topinka[2], Julia Leeson[3], Shaun Sharpe[3], Hugh Beckie[3] [1]Agriculture and Agri-Food Canada (AAFC), Lethbridge, AB, [2]University of Alberta, Edmonton, AB, [3]Agriculture and Agri-Food Canada (AAFC), Saskatoon, SK Kochia [Bassia scoparia (L.) A.J. Scott] is a problematic summer-annual tumbleweed capable of causing significant crop yield losses in the western Great Plains region of North America. The impact of kochia on prairie farmlands continues to grow in the presence of unfettered selection for herbicide resistance combined with efficient seed- and pollen-mediated gene flow. Kochia populations in the Canadian prairies have been documented with resistance to up to three herbicide sites of action. Recent surveys in this region found acetolactate synthase (ALS) inhibitor resistance in all of the kochia populations tested, while resistance to glyphosate and synthetic auxins continues to increase across the prairie provinces. Monitoring of herbicide resistance is important to understand the extent of the problem, and to inform integrated weed management strategies. A randomized-stratified survey of 319 sites in Alberta was conducted to determine the incidence and frequency of resistance to glyphosate, fluroxypyr, and dicamba among kochia populations in 2021. Overall, 314 of the 319 sites had enough viable seed for resistance diagnostics. Glyphosate-resistant kochia was documented in 78% of the populations, while 44% were fluroxypyr-resistant and 28% were dicamba-resistant. This represents an increase from 50%, 13% and 18% of kochia populations exhibiting resistance to glyphosate, fluroxypyr, and dicamba, respectively, during the previous Alberta survey in 2017. Triple-resistant kochia populations, resistant to ALS inhibitors, glyphosate, and at least one synthetic auxin, increased from 16% of the sites in 2017 to 45% in 2021. However, auxinic herbicide resistance among kochia populations overlapped only partly, with 30% resistant to fluroxypyr but not dicamba, 14% resistant to dicamba but not fluroxypyr, and 14% resistant to both synthetic auxins. The current study documents the continued increase in kochia populations resistant to glyphosate, fluroxypyr, and dicamba in Alberta, and suggests an immediate need for further implementation of integrated management.
101	**Saskatchewan survey of herbicide-resistant weeds in 2019 and 2020** Charles Geddes[1], Mattea Pittman[1], Shaun Sharpe[2], Julia Leeson[2] [1]Agriculture and Agri-Food Canada (AAFC), Lethbridge, AB, [2]Agriculture and Agri-Food Canada (AAFC), Saskatoon, AB Canada is home to the third-largest number of unique herbicide-resistant (HR) weed biotypes (weed species by herbicide site of action combination), surpassed only by the United States and Australia. HR weeds infest over half of the fields under annual crop production in the Canadian

	Prairies, and the number of unique HR weeds and area which they infest is growing. Systematic surveys of HR weeds in the prairie provinces have been conducted using similar methodology since the early-2000s, providing a comprehensive database that may be used to understand their spatial and temporal dynamics at a landscape-scale. The previous 2014–2017 round of prairie surveys found HR weeds in 59%, 57%, and 68% of annual-cropped fields in Alberta, Saskatchewan, and Manitoba, respectively. HR weeds costed prairie farmers an estimated $530 million annually in reduced crop yields and quality, and increased costs of weed control. In continuation of this monitoring system, a randomized-stratified pre-harvest survey of 419 fields in Saskatchewan was conducted to determine the status of HR weeds in 2019 and 2020. Priority was given to testing with acetyl-CoA carboxylase (ACCase)- and acetolactate synthase (ALS)-inhibiting herbicides. ACCase inhibitor resistance was documented in wild oat, green foxtail, and yellow foxtail, while ALS inhibitor resistance was documented in wild oat, kochia, sow thistle species, wild mustard, stinkweed, redroot pigweed, false cleavers, shepherd's purse, pale smartweed, lamb's quarters, hemp nettle, and chickweed. The area with HR weeds present before crop harvest in Saskatchewan increased from 4.8 million ha (8.7 million ha field area) in 2014/2015 to 6.2 million ha (11.5 million ha field area) in 2019/2020. These results suggest that 72% of Saskatchewan fields under annual crop production had at least one HR weed biotype present. Based on previous grower estimates, HR weeds cost Saskatchewan farmers about $430 million annually
102	**Survey of Glyphosate- and Dicamba-Resistant Kochia in Saskatchewan** Shaun Sharpe[1], Julia Leeson[1], Charles Geddes[2], Hugh Beckie[1], Christian Willenborg[3] [1]Agriculture and Agri-Food Canada (AAFC), Saskatoon, SK, [2]Agriculture and Agri-Food Canada (AAFC), Lethbridge, AB, [3]University of Saskatchewan, Saskatoon, SK Kochia [Bassia scoparia (L.) A.J. Scott] is an halophytic, invasive tumbleweed and a troublesome weed for Western Canadian agronomy. Kochia has evolved resistance to several herbicide modes of action including Group 2 (several), Group 4 (dicamba, fluroxypyr), and Group 9 (glyphosate) with multiple-resistant biotypes present in Saskatchewan. Previous surveillance activities for Saskatchewan in 2011/2012 identified the presence of glyphosate-resistant kochia in nine municipalities. The study objective was to determine the current occurrence of glyphosate-, and dicamba-resistant kochia at 300 sites within central and southern Saskatchewan. A post-harvest stratified-random survey was conducted in the fall of 2019 with site selection stratified by proportional cultivated land area per ecodistrict. A composite sample were gathered from twelve plants at each location. Seed was threshed and screened in the greenhouse with glyphosate (900 g ae ha^{-1}) and dicamba (280 g ae ha^{-1}). Screening occurred in cycles between October 28, 2020 to September 30, 2022 in a greenhouse in Saskatoon, SK. Of the screened populations, 87% demonstrated some degree of glyphosate resistance (n=275) while 45% demonstrated some degree of dicamba resistance (n=255) with 103 populations demonstrating resistance to both herbicides. For glyphosate resistance, 22% demonstrated a high level of resistance (>60% survival), 86% demonstrated moderate glyphosate resistance (21 to 60% survival), and 33% demonstrate low level resistance (1 to 20% survival). For dicamba-resistant kochia, only 1 population (0.4%) demonstrated high resistance while 1% demonstrated moderate resistance and 44% low level resistance. Substantial increases in glyphosate-resistant kochia populations were detected across the agronomic production region of central and southern Saskatchewan. Adoption of integrated kochia patch management strategies and monitoring ditches and field margins is advisable. Good herbicide stewardship practices including applying chemistry at proper staging, using full label

	rates, and rotating modes of action will be critical to mitigate ongoing resistance evolution.
103	**Attempting to Reduce Viable Wild Oat (Avena fatua) Seed Set at Jointing or Panicle Emergence** Breanne Tidemann[1], Colleen Wyering[2] [1]Agriculture and Agri-Food Canada, [2]Central Alberta Co-op Herbicide resistant wild oat are a significant pest in western Canada, requiring novel methods of control, such as management of seedbank inputs. Attempts to use harvest weed seed control to limit seedbank inputs are unlikely to be successful due to early seed shed, requiring research into alternative strategies. A preliminary pot study was conducted in 2021 at Lacombe, AB to investigate the potential for chemical applications at jointing and panicle emergence growth stages to reduce production of viable wild oat seed. A number of auxin-mimic herbicides were tested, in addition to glyphosate and two plant growth regulators. Wild oat was seeded into pots, arranged in a randomized complete block design, and grown in an open air crossing shelter. Chemicals were applied at jointing (~6 leaf with visible nodes), and full panicle emergence using a handboom with 100L/ha water volume. Plants grew to maturity with seed collection bags placed over the panicles post-anthesis to prevent loss or mixing of seeds between treatments. Plants were harvested at maturity, threshed, and seed production and seed viability measured. A generalized linear mixed model ANOVA was conducted in Proc Glimmix in SAS 9.4 on seeds produced, seed viability, and overall viable seed production. Application timing did not significantly alter the production of wild oat seed. Viable seed production was reduced by applications of glyphosate, quinclorac, trinexapac, and a mixture of dicamba and diflufenzopyr. Glyphosate, trinexapac, and dicamba mixed with diflufenzopyr reduced seed production when applied at jointing, while glyphosate also reduced seed production when applied at panicle emergence. Glyphosate, quinclorac, and dicamba mixed with diflufenzopyr significantly reduced wild oat seed viability, regardless of application timing. Thus, while both quinclorac and trinexapac applications reduced viable seed production, the former affected primarily seed viability while the latter affected the number of seeds produced. Results indicate that late season chemical applications may be used to prevent production of viable seeds, providing an alternative management time-point in the lifecycle if suitable chemicals can be identified.
104	**Residual Weed Population Shifts in Manitoba – 1978 to 2022** Julia Leeson[1], Kim Brown-Livingston[2], Shane Hladun[1] [1]Agriculture and Agri-food Canada, [2]Manitoba Agriculture In 2022, a total of 704 fields of canola, spring wheat, soybean, oat, corn, barley, field pea, pinto bean and sunflower were surveyed in Manitoba. These fields were selected using a stratified random sampling procedure based on ecodistricts. In each field, weeds were counted in 20 quadrats (50 by 50 cm) in late summer. Weed data are summarized using a relative abundance index based on frequency, field uniformity and density. The results from the 2022 survey are compared to results from surveys of 659 fields in 2016, 631 fields in 2002, 452 fields in 1997, 501 fields in 1986 and 1424 fields in 1978-1981. The lowest median weed density and the highest percent of weed-free quadrats was recorded in 2022. Green foxtail (*Setaria viridis* (L.) P. Beauv.) was the most abundant weed in each survey. Wild buckwheat (*Fallopia convolvulus* (L.) Á. Löve) ranked second in 2022 and 2016. Five other species have been ranked amongst the top 20 species in each survey: lamb's-quarters (*Chenopodium* spp.), redroot pigweed (*Amaranthus retroflexus* L.),

	wild oats (*Avena fatua* L.), Canada thistle (*Cirsium arvense* (L.) Scop.) and pale smartweed (*Persicaria lapathifolia* (L.) Delarbre). Volunteer canola (*Brassica napus* L.) ranked third in 2022 for the first time. Foxtail barley (*Hordeum jubatum* L.) had the largest increase in rank, reaching the top 20 in 2022. Golden dock (*Rumex fueginus* Phil.) and green pigweed (*Amaranthus powellii* S. Watson) also appeared in the top 20 in 2022. Yellow foxtail (*Setaria pumila* (Poir.) Roem. & Schult.), kochia (*Bassia scoparia* (L.) A. J. Scott), and biennial wormwood (*Artemisia biennis* Willd.) also ranked as high or higher in 2022 than previous surveys. Spiny annual sow-thistle (*Sonchus asper* (L.) Hill) and broad-leaved plantain (*Plantago major* L.) have increased since the initial surveys, but declined in 2022 in comparison to 2016.
105	**When using glyphosate plus dicamba, 2,4-D, halauxifen or pyraflufen/2,4-D for glyphosate-resistant horseweed control in soybean, which third mix partner is better, saflufenacil or metribuzin?** Meghan Dilliott[1], Nader Soltani[1], Christy Shropshire[1], Peter Sikkema[1] [1]University of Guelph, Ridgetown, ON Glyphosate-resistant (GR) horseweed (Erigeron canadensis L.) interference in soybean can reduce yield by up to 93%. Glyphosate plus dicamba, 2,4-D ester, halauxifen-methyl, or pyraflufen-ethyl/2,4-D applied preplant (PP) provide variable GR horseweed control in soybean. The objective of the study was to determine if the addition of saflufenacil or metribuzin to glyphosate plus dicamba, 2,4-D ester, halauxifen-methyl, or pyraflufen-ethyl/2,4-D will improve the level and consistency of GR horseweed control. Four trials were conducted over the 2020 and 2021 field seasons in fields with GR horseweed populations. Glyphosate plus dicamba, 2,4-D ester, halauxifen-methyl, or pyraflufen-ethyl/2,4-D controlled GR horseweed 96, 77, 71, and 52%, respectively at 8 weeks after application (WAA). When saflufenacil or metribuzin was added to glyphosate plus dicamba or 2,4-D ester, GR horseweed control did not improve at 8 WAA. When saflufenacil or metribuzin was added to glyphosate plus halauxifen-methyl, GR horseweed control improved by 27 and 25%, respectively 8 at WAA. When saflufenacil or metribuzin was added to glyphosate plus pyraflufen-ethyl/2,4-D, GR horseweed control was improved by 47 and 37%, respectively at 8 WAA. The consistency of GR horseweed control was improved when saflufenacil or metribuzin was added to glyphosate plus dicamba, 2,4-D ester, halauxifen-methyl, or pyraflufen-ethyl/2,4-D compared to each herbicide applied alone. Synergism was observed when metribuzin was added to glyphosate plus halauxifen-methyl and when saflufenacil or metribuzin was added to glyphosate plus pyraflufen-ethyl/2,4-D at 8 WAA. Though GR horseweed control was improved with the addition of saflufenacil or metribuzin to glyphosate plus halauxifen-methyl or pyraflufen-ethyl/2,4-D, all treatments including saflufenacil resulted in the highest level and most consistent control.
106	**- Interactions between HPPD inhibiting and reactive oxygen species generating herbicides for the control of annual weed species in corn** John Fluttert[1], Nader Soltani[1], Peter Sikkema[1] [1]University of Guelph, Ridgetown, ON The complementary modes of action of 4-hydroxyphenylpyruvate dioxygenase (HPPD)- and photosystem II (PSII)-inhibitors have been credited for the synergistic weed control improvement of several species. Recent research discovered that reactive oxygen species (ROS) generation and

subsequent lipid peroxidation is the cause of cell death by the glutamine synthetase-inhibitor glufosinate. Therefore, a basis for synergy exists between glufosinate and HPPD-inhibitors, but the interaction has not been well reported. Four field experiments were conducted in Ontario, Canada in 2020 and 2021 to determine the interaction between HPPD-inhibiting (mesotrione and tolpyralate) and ROS-generating (atrazine, bromoxynil, bentazon, and glufosinate) herbicides on annual weed species control in corn. The ROS-generators were synergistic with the HPPD-inhibitors for the control of velvetleaf (Abutilon theophrasti Medik.), except for tolpyralate + glufosinate which was additive 8 weeks after application (WAA). Tank-mixes of HPPD-inhibitors plus ROS-generators were synergistic for the control of common ragweed (Ambrosia artemisiifolia L.) except for tolpyralate + glufosinate which was antagonistic 8 WAA. Tolpyralate + glufosinate was antagonistic for the control of barnyardgrass [Echinochloa crus-galli (L.) P. Beauv.] and Setaria spp. 8 WAA. Common lambsquarters (Chenopodium album L.) control 8 WAA was synergistic with mesotrione plus atrazine, bromoxynil, or glufosinate and with tolpyralate plus bromoxynil or bentazon. Herbicide tank-mixes were generally additive for the control of wild mustard (Sinapis arvensis L.) 8 WAA except for the synergistic tank-mixes of tolpyralate plus atrazine or bromoxynil. Results from this study demonstrate that co-application of ROS-generators with mesotrione or tolpyralate controlled all broadleaf weed species >90% at 8 WAA with the exceptions of common ragweed and common lambsquarters control with tolpyralate + glufosinate. Mesotrione plus PSII-inhibitors controlled barnyardgrass and Setaria spp. 48-68 percentage points less than tolpyralate plus the respective PSII-inhibitor at 8 WAA; however, mesotrione + glufosinate and tolpyralate + glufosinate controlled the grass weed species similarly.

107 **Palmer Amaranth and spring canola competition: projecting the impact of America's worst weed on Canadian agriculture**

Francine Ballantyne[1], Dr. Rene Van Acker[1], Dr. Francois Tardiff[1], Peter Smith[1]

[1]University of Guelph

Palmer Amaranth is considered one of the worst agricultural weeds in the United States, and was found in southern Manitoba in 2021. There is limited research into the interactions between spring canola, a crop much more prevalent in Canada, and Palmer Amaranth. Previous literature indicates that members of the Brassicaceae produce glucosinolates which are known to suppress the growth of pigweeds including Palmer Amaranth. Palmer Amaranth is also said to exhibit allelopathy. Our question was how does Palmer Amaranth competition impact vegetative growth and yield in spring canola? Also, can canola affect Palmer Amaranth development? We hypothesize that Palmer Amaranth may have a negative effect on canola vegetative and reproductive biomass, and that canola will also reduce final biomass in Palmer Amaranth. In the spring and summer of 2022, 3 concurrent greenhouse experiments in pots were conducted in the crop science facility at Guelph University. 2 experiments observed soybean or canola and Palmer Amaranth (Kansas or Arizona biotype) interactions. 1 experiment observed Redroot Pigweed or Palmer Amaranth with canola. Initial visual observations during the experiments indicated that the biomass of both of Palmer Amaranth and Redroot Pigweed was reduced in the presence of spring canola, and soybean vegetative biomass was less in Palmer Amaranth treatments. Spring canola appeared to have greater reproductive and vegetative biomass when growing with Palmer Amaranth or Redroot Pigweed than with itself. Further experiments are planned to investigate possible allelopathic interactions between spring canola and Palmer Amaranth.

108	**Establishing fall cover crops in Atlantic Canada** Andrew Mckenzie-Gopsill[1], Aaron Mills[1] [1]Agriculture and Agri-Food Canada Cover crops are increasingly being incorporated in to Atlantic Canadian rotations to combat declines in soil health associated with potato production. Successful establishment of a fall-seeded cover crop can provide producers a mechanism to cover the soil and reduce soil erosion prior to a potato crop or be left in the field and harvested to provide an alternative revenue stream. Due to the long cool growing season, however, there is limited opportunity to establish a cover crop following harvest often resulting in the soil left bare throughout the winter. In the present study we sought to identify cover crops suitable for fall planting by comparing spring and vernal species and if the inclusion of winter pea to each species would improve agronomic characteristics across four growing seasons. Vernal species consistently produced greater biomass in the spring than spring species and spring ground cover increased with increasing biomass. Winter pea did not improve winter survival or biomass production of any cover crop and compromised the ability to harvest vernal species. The addition of winter pea to all cover crops, however, improved the likelihood of achieving >75% spring ground cover. Soil incorporation of living vernal species in the spring negatively impacted potato yield compared to spring species. Our results suggest that vernal species and winter pea are candidate fall-seeded cover crops prior to potatoes in Atlantic Canada.
109	**Available Genetic Testing Enables Early Detection and Mitigation of Herbicide-Resistant Weeds** Martin Laforest[1], Marie-Josée Simard[1], Robert Nurse[2], Eric Page[2], Charles Geddes[3], Kristen Obeid[4], Amélie Picard[5], David Miville[5], Chris Grainger[6], Cezrina Kora[7] [1] Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, QC, [2] Agriculture and Agri-Food Canada, Harrow, ON, [3] Agriculture and Agri-Food Canada, Lethbridge, AB, [4] Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), Harrow, ON, [5] Laboratoire d'expertise et de diagnostic en phytoprotection (LEDP-MAPAQ), Québec, QC, [6] Harvest Genomics, Guelph, ON, [7] Agriculture and Agri-Food Canada (AAFC), Ottawa, ON Three out of five Canadian growers are affected by herbicide-resistant (HR) weeds and estimates show a cost to Western Canadian producers of $530 million annually in terms of increased herbicide use and decreased yield and quality. Genetic tests allow suspected HR weeds to be tested quickly with results back to growers within 1-2 weeks (sometimes within 2 days depending on test and lab capacity), allowing changes to management programs in-season. A collaborative network involving federal, provincial and private stakeholders is continuously improving a growing list of genetic tests to better serve the sector for in season management to prevent the spread of HR weeds. Application of genetic tests has broaden to several regions (Maritimes, Ontario, Prairies and Quebec) from the first tests performed in 2015 on group 2 resistant common ragweed. There are currently tests for 14 weed species (amaranths, lamb's quarter, large crabgrass, fleabane, common chickweed, ragweeds, eastern black nightshade, giant foxtail, pigweeds, Brassica spp., Italian ryegrass) covering resistance to several herbicide groups (1, 2, 5, 9, and 14). These tests

	support information based weed management decisions at the field level. The most recent results of the use and impacts of the genetic tests are presented.
110	**Activation of a singlet oxygen signaling pathway by competition cues in Arabidopsis thaliana** Nicole Berardi[1], Sasan Amirsadeghi[1], Clarence Swanton[1] [1]University of Guelph, Guelph, ON Oxidative stress responses of Arabidopsis to low red (R) to far-red (FR) signals (R:FR ≈ 0.3), generated by a biological weedy and an artificial source of FR light, were compared with a weed-free control (R:FR ≈1.4). In the low R:FR treatments, induction of the shade avoidance responses coincided with increased singlet oxygen ($^1O_2$) production and decreased levels of superoxide and superoxide dismutase activity. Although the increase of $^1O_2$ was not due to protochlorophyllide accumulation and did not result in cell death, treatments with the $^1O_2$ generator 5-aminolevulinic acid increased sensitivity to cell death. Transcriptome responses minimally resembled those reported in four Arabidopsis $^1O_2$ generating systems such that only a few genes (6 out of 1931) were consistently up-regulated supporting the specificity of $^1O_2$ signaling. Moreover, suppressors of jasmonate accumulation including the $^1O_2$-responsive amidohydrolase ILL6 and the sulfotransferase ST2a, which is involved in the prioritization of elongation growth versus defense, were consistently up-regulated. Our data support a model in which photoreceptors link low R:FR light cues to the JA signaling pathway. Repression of bioactive JAs via the amidohydrolase ILL6 and sulfotransferase ST2a may promote shade avoidance (versus defense) and $^1O_2$ acclimation (versus cell death) responses to competition cues.
111	**Harmonized surveillance of common waterhemp (Amaranthus tuberculatus (Moq.) J.D. Sauer) as a model of national collaboration** Sandra Flores-Mejia[1], Kristen Obeid[2], Jaimie Schnell[3], Amélie Picard[4], Cezarina Kora[5] [1]Centre de recherche sur les grains, inc. (CÉROM), Saint-Mathieu-de-Beloeil, QC, [2]Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), Harrow, ON, [3]Canadian Food Inspection Agency (CFIA), Ottawa, ON, [4]Laboratoire d'expertise et de diagnostic en phytoprotection (LEDP-MAPAQ), Québec, QC, [5]Agriculture and Agri-Food Canada (AAFC), Ottawa, ON. The Canadian Plant Health Council was launched in 2018 with the goal to implement the Plant Health Strategy for Canada through improving coordination of plant health surveillance and enhance response to pest threats across Canada. Different working groups were formed under the Council focussing on three key pillars: biosecurity, emergency response and surveillance. The surveillance group has established three Communities of Practice (CP) targeting specific pest topics (diseases, insects, and weeds) to enhance coordination in plant pest surveillance and monitoring. Established with participation of experts from federal and provincial governments and institutions, as well as grower representatives, these CPs facilitate collaboration, information sharing and harmonization of surveillance and monitoring protocols across the country. The Weeds Surveillance Community of Practice (WSCP) chose to focus on Amaranthus species, primarily common waterhemp (Amaranthus tuberculatus (Moq.) J.D. Sauer) and Palmer's amaranth (A. palmeri S. Watson), as they pose a significant threat to Canadian agricultural production. Both species are very competitive and resistant to multiple herbicide groups, making their control quite challenging. At this time, only common waterhemp has been found in

	Manitoba, Ontario and Quebec. Coordinating surveillance efforts across provinces has provided early detection of common waterhemp which is key to the implementation of successful management strategies. This undertaking will also help with the identification and early detection of Palmer amaranth. Currently, the WSCP has 27 members from 14 various institutions across Canada. The group has published a harmonized protocol for monitoring Amaranthus species, featuring genetic tests available to detect herbicide resistance, relevant resources, as well as contact information for reporting suspected cases. The group has created a common repository for literature regarding these species, and examined different data collection and sharing methods. The WSCP forum allows sharing of information regarding weed management and provides opportunities to develop collaborative projects.
112	**The genome of Wild Mustard (Sinapis arvensis)** Sara Martin[1], Tracey James[1], Liz Sears[1] [1]Agriculture and Agri-Food Canada (AAFC), Ottawa, ON Wild mustard (Rhamphospermum arvense (L.) Andrz. ex Besser syn. Sinapis arvensis L.) is a common weed on the Canadian Prairies with a long seed bank. Our work has previously shown that the species is sexually compatible with the emerging oilseed Brassica carinata. Here we produce a chromosome level draft of wild mustard's genome as a stepping stone to determining which regions of the genomes are shared between the wild mustard and B. carinata and to examine which regions of B. carinata have been integrated and retained within the genomes of advanced generation hybrids with DNA contents similar to wild mustard. We see high levels of synteny between wild mustard and related Brassica species, indicating a large scope for transfer of transgenes.
113	**The importance of species selection in cover crop mixture design** Andrew Mckenzie-Gopsill[1], Aaron Mills[1] [1]Agriculture and Agri-Food Canada Cover crops are increasingly being included in crop rotations as a mechanism to promote diversity and provide agroecosystem services including weed suppression. Recently, cover crop mixtures have increased in popularity in an attempt to provide a greater diversity in ecological services as compared to monocultures. Several recent studies, however, have failed to detect a positive effect of cover crop diversity on biomass production or weed suppression. Here we assessed biomass productivity and weed suppression in 19 cover crops seeded as monocultures and 19 mixtures of varying species composition and functional richness (2- and 3-species mixtures) of full-season cover crops in Atlantic Canada. Cover crop biomass production and weed suppression varied by species identity, functional diversity, and species richness. As cover crop biomass increased regardless of diversity, weed biomass declined. Highly productive forbs and grasses provided the greatest weed suppression in monoculture. In line with previous observations, mixtures were on average not more productive nor weed suppressive than the most productive monocultures. We observed that the inclusion of the highly productive species buckwheat and sorghum-sudangrass in a mixture increased stand evenness, productivity, weed suppression and spatiotemporal stability.

	Taken together our results suggest that effects of diversity on mixture productivity and weed suppression are species specific. This further demonstrates the importance of species selection in cover crop mixture design.

Joint BMC/CSA Biomass Symposium

BMS#1	**Mr. Manolis Karampinis,** Business Development and Membership Director, Bioenergy Europe **Title:** Bioenergy in the EU framework: updates on statistics, policy framework and exploitation models **Synopsis**: Bioenergy provides around 57.4% of the European renewable energy supply and 11% of the total energy supply, being therefore a key component to decarbonisation efforts, energy security and sustainable development. In this presentation, the main market segments for bioenergy in the European context will be presented with a focus on applications for solid biomass fuels. Examples of bioenergy exploitation models in the national and regional settings or in industrial and other applications will be provided. Finally, an update on major policy developments related to the establishment of sustainability criteria for bioenergy will be presented.
BMS#2	**Dr. Michael Casler,** University of Wisconsin (Professor Emeritus) **Title**: Development of Sustainable Biomass Crops **Synopsis**: Development of improved and sustainable energy crops is a key component for restoring economic momentum of a bio-based energy economy. Perennially and low energy inputs are two key elements of developing biomass production systems that are both environmentally and economically sustainable. Some of the most common species for these systems are: poplar, willow, switchgrass, and miscanthus. Following a brief introduction to these four species, the talk will focus on switchgrass, demonstrating the potential for improving its production potential through agronomy, breeding, genetics, and genomics.
BMS#3	**Dr. Charles Xu**, Western University **Title:** Conversion of greenhouse/agricultural wastes into hydroponic bio- polyurethane (BPU) foams and their biodegradability **Synopsis:** The exploration of effective utilization of greenhouse wastes is a profound challenge for greenhouses. Herein, a hydrothermal treatment approach was demonstrated by co-liquefaction of greenhouse wastes with agricultural residue in a mixed solvent of water and ethanol in the presence of a base catalyst, to convert greenhouse wastes and corn stalk into bio-oil/bio-polyol at a very high yield of 57.2%, accompanied by a very low yield of solid residue. This bio-oil (hydroxyl number: 305 mg KOH/g) was successfully used as bio-polyol to substitute up to 50% petroleum-based polyol for the preparation of bio- polyurethane (BPU) foams. The biodegradability of the BPU foams was also studied by incubation with Dyella sp. for a period of 8 weeks. The weight loss, FTIR spectra, TGA results, and SEM images of foam samples were collected and analyzed. Results showed that BPU foams exhibited much better biodegradability than that of the petroleum-based PU foam.
BMS#4	**Dr. Ajay Dalai,** University of Saskatchewan **Title:** Insights on Biomass Pelletization as Sustainable and Clean Fuel Source and Biochar Production for Soil Improvements and Carbon Capture **Synopsis:** Our research on hydrothermal and thermochemical pretreatment of agricultural biomass using steam explosion and microwave torrefaction to depolymerize lignin that acts as a

	binder for biopellets will be presented. Further, we have evaluated the effects of process operating conditions (pelletization, torrefaction and gasification) on the treated products followed by a comprehensive physicochemical characterization of treated precursors and the resulting biopellets. We will also present the research on the optimization of the conversion of food waste to produce biochar and activated carbon through slow pyrolysis as well as physical and chemical activation. Characterization of bio-oil, biochar and activated carbon as well as application of activated carbon for adsorption of model environmental pollutants and in soil amendment for crop improvement will also be presented.
BMS#5	**Dr. Animesh Dutta**, University of Guelph **Title:** Valorization of agri-food residues and wastes: A closed-loop circular economy concept to address climate change, biogas production, wastewater management, and soil health **Synopsis:** Waste is a resource, and it is just waiting for an opportunity is the central theme of this research. In this research we propose three approaches for agri-food waste valorization. Firstly, we propose a hybrid thermochemical and biochemical approach to produce biocoal, biomethane and biofertilizer from corn residue (CR) using the concept of circular economy. In this approach, CR is first pretreated in hydrothermal carbonization (HTC) process to produce biocoal. HTC process water, a co-product of HTC processing underwent fast digestion under anaerobic conditions to produce biomethane and biofertilizer. Secondly, we produce activated carbons from Corn Fibre, a co-products ethanol production using three procedures, including direct KOH activation, HTC followed by KOH activation, and $FeCl_3$ catalyzed HTC followed by KOH activation. Finally, we propose an innovative approach of combining two thermochemical conversion methods, HTC and slow pyrolysis, for converting biomass into suitable biocarbon for the iron-making process.
BMS#6	**Dr. Edmund Mupondwa,** Science and Technology Branch, Agriculture and Agri- Food Canada (Adjunct Professor: Department of Chemical and Biological Engineering, University of Saskatchewan) **Title:** Biomass supply chains: Challenges and Opportunities in enabling the development of a sustainable circular economy biorefinery **Synopsis:** Biomass represents an important feedstock source for the development of a competitive and sustainable circular economy biorefinery due its adaptability, renewability, and minimal environmental impacts. In this regard, a biomass supply chain is a crucial element in development and sustainable integration of biomass feedstocks into Canada's biorefinery concept and circular economy. In this research, we provide a multi-dimensional analysis of Canada's agri-based biomass supply chain including: a) requirements for scaling up agri-based feedstock production and sustainable procurement in diverse rural agroecological regions of Canada, taking into account feedstock diversity and heterogeneous pretreatment and conversion pathways; b) technoeconomic business models for the commercialization of biomass for the biorefinery, including: (i) economic integration of key participants in this supply chain, including indigenous communities; (ii) significant cost reductions needed at all levels (farm-to- biorefinery) in order to optimize agri-based feedstocks (residues and dedicated bioenergy crops) for the bio-based circular economy.
BMS#7	**Dr. Don Smith**, McGill University **Title:** Development of Biologicals as Low Input, Sustainable Production Practices for Fuel and

	Residue/Food Production **Synopsis**: Biomass crops could produce about 25 Mt of biomass per year within Canada and food crop residues on the order of 48 Mt. Research is needed to attain this productivity in the face of ever-more-frequent climate change stress conditions (largely drought and high temperature). Our research focuses on understanding the potential role of plant-associated microbes in enhancing crop stress tolerance and yield. Potentially beneficial microbial strains are tested on biomass crops (such as switchgrass) and residues of food crops (corn and potato). We have isolated new strains that help plants tolerate abiotic stresses associated with climate change; there has already been laboratory and field testing. We are also evaluating an industrial-partner-supplied set of flavonoid biostimulants; this too shows substantial promise, and now is being commercialized. Fieldwork with corn and potato has shown crop residue yield increases and also food yield increases as high as 20%.
BMS#8	**Dr. Annie Claessens,** Agriculture and Agri-Food Canada **Title:** Improving switchgrass for the biomass industry **Synopsis:** Breeding strategies to increase yield (lowland x upland crosses), establishment (seed size), quality (lower leaf stem ratio), and persistence (freezing tolerance, disease resistance).
BMS#9	**Dr. Yousef Papadopoulos,** Agriculture and Agri-Food Canada **Title:** Adaptability of Miscanthus cultivars across Canada **Synopsis**: Canada's clean technology strategy recognizes the vital link between climate-smart agriculture and the biomass-to-clean technology value chain. Canada's agriculture and agri-food sector has the potential to supply perennial grass based feedstock crops. Desirable traits for Miscanthus giganteus (Miscanthus) include high biomass yield potential, adaptability to marginal soil and perennial growth habit. Based on long term evaluation trials, productive and currently available cultivars for northern latitudes have been identified. However, cultivar performance is not always consistent across diverse locations. While recent research studies across Canada have identified persistent cultivars there is limited information on the broad adaptations of these currently available cultivars, how management practices affect biomass yield, nutrient/energy composition, nutrient removal/depletion from the ecosystem and crop profitability. In this presentation we will report research to date assessing the performance of currently available Miscanthus cultivars in diverse locations across Canada and identify gaps which may impact the effective utilization of this species in biomass cropping systems.
BMS#10	**Dr. Raju Soolanayakanahally,** Agriculture and Agri-Food Canada **Title**: Bridging agriculture and the environment using bioenergy crops **Synopsis**: The development and evaluation of new poplar and willow feedstocks for bioenergy opportunities, carbon sequestration and for environmental services.
BMS#11	**Dr. J. Kevin Vessey**, Saint Mary's University **Title**: Annual and perennial biomass crop production potential on marginal lands **Synopsis**: A brief overview of BMC Projects 6 and 7 that are investigating the yield potential of hybrid sorghum, switchgrass, Miscanthus, coppiced willow, and coppiced hybrid-poplar on marginal lands with biological inputs.
BMS#12	**Dr. Xue Li,** Saskatoon Research and Development Centre, Science and Technology Branch,

	AAFC **Title**: Feedstock quality and impact on bioenergy production from four dedicated biomass crops (miscanthus, switchgrass, willow, and poplar). **Synopsis**: Miscanthus, switchgrass, willow, and poplar are important perennial grasses under development as dedicated bioenergy crops in Canada. The chemical composition of bioenergy crops has significant impact on biofuel yield and quality. Structural and soluble carbohydrate content, lignin, moisture, and ash are typical lignocellulosic biomass quality attributes of interest to a biorefinery. This paper quantifies biomass quality (fibre, digestibility, ash, lignin, and carbohydrate content) for the four dedicated lignocellulosic bioenergy crops. Impact on biofuel yield and quality is evaluated.
BMS#13	**Dr. Shahab Sokhansanj,** University of British Columbia **Title:** Pretreatment of crop residue to improve its utilization and logistical properties **Synopsis:** The research is aimed at increasing the durability of agri-pellets to a level in par with the durability of wood pellets. To enhance the natural binding of the straw, batches of raw biomass was exposed to steam or the biomass was blended with hot water. All treatments took place in sealed enclosures. A severity factor was developed to represent the combined process variables including moisture, temperature, and treatment time in a single number. The pellets made from treated and untreated biomass were tested for durability, hardness, density, and moisture sorption properties. We have observed that the pellet durability tends to increase with severity factor between 0.5 to 4 follows, then drop in durability for severity factor between 4 to 8. Treatment of biomass in hot water was found to reduce ash contents. Overall, this study has explored a relatively wide range of hydrothermal treatment conditions, which includes low to high biomass moisture content, treatment temperature, and treatment time.
BMS#14	**Dr. Duncan Cree,** University of Saskatchewan **Title:** Select Pretreatment Options for Agricultural Biomass for Thermochemical or Biochemical Conversion **Synopsis:** In this presentation, we give examples of switchgrass and oat straw subjected to fungal pretreatment and microwave-assisted torrefaction, respectively. Tests were conducted to determine any changes in morphology and chemical composition of switchgrass due to the fungal pretreatment. The pretreated switchgrass was subjected to pelletization and enzymatic saccharification to determine the impact of fungal pretreatment. Oat straw was subjected to microwave-assisted torrefaction. Torrefaction produces both the solid fuel and the volatile stream known as torgas. The torgas comprises of condensable liquids, known as tor-liquid and non-condensable gases. The condensable liquid is rich in organic acids, ketones, furfural, and levoglucosan, which could be potentially transformed into high-value chemicals and other commercially viable products.
BMS#15	**Dr. Edmundo Mupondwa**, Saskatoon Research and Development Centre, Science and Technology Branch, AAFC **Title:** Integrated technoeconomic analysis and life cycle assessment (LCA) of four dedicated biomass crops (miscanthus, switchgrass, willow, and poplar) for the production of bioenergy and bioproducts. **Synopsis:** This paper presents an integrated technoeconomic analysis and life cycle assessment

	(LCA) of four dedicated biomass crops (miscanthus, switchgrass, willow, and poplar) for the production of pellets, power, and biofuels based on two lignocellulosic biomass conversion pathways (bioconversion and thermoconversion). The analysis includes logistics pertaining to multiple feedstock supply chains, bioenergy crop production, harvest, storage, transportation, densification, pretreatment, and adoption pathways in rural and Northern Communities.
BMS#16	**Dr. Warren Mabee,** Queen's University **Title:** Circular bioeconomies: the role of policy in informing sustainable biomass use **Synopsis**: The bioeconomy is particularly well suited to adopt circular aspects to improve sustainability and increase overall impacts. There are a number of barriers to implementing a truly circular bioeconomy, however, some of which are found in current policies. This talk addresses these challenges by examining a series of barriers and describing policy changes that might be applied.

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