Canadian Weed Science Society
Société canadienne de malherbologie

Annual Meeting
November 19 to 22, 2018

Réunion annuelle
19 au 22 novembre 2018

Marriott on the Falls
Niagara Falls, Ontario

Contents

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Thank you to our Local Arrangements Committee for 2018:

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Rory Degenhardt	Al Hamill
Allan Kaastra	Robert Nurse
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Canadian Weed Science Society

2018 Annual Meeting Agenda

Marriott on the Falls, Niagara Falls, Ontario
November 19-22, 2018

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

Monday, November 19, 2018		
Time	**Topic/Event**	**Location**
24 hours	Office/Storage	Oakes Office
8:00 am – 4:00 pm	CWSS-SCM Board Meeting	Fallsview Private Dining Room
9:00 am – 3:00 pm	Tour – Butterfly Conservatory, Niagara College, Chocolate, Winery	Hotel Lobby
3:00 – 8:00 pm	Registration	Oakes Foyer
3:00 – 8:00 pm	Posters and Exhibit Boards Setup	Oakes Foyer
4:30 – 6:00 pm	Graduate Student Meet & Greet with Board	Oakes South
6:00 – 9:00 pm	CropLife and Industry Reception	Oakes North

	Tuesday, November 20, 2018		
#	**Time**	**Topic/Event**	**Location**
	24 hours	Office/Storage	Oakes Office
	24 hours	Posters and Exhibit Boards	Oakes Foyer
	7:00 am – 5:00 pm	Registration	Oakes Foyer
	7:30 – 8:30 am	Breakfast	Oakes North
	8:45 – 9:00 am	Welcome – Page, Tardif	Oakes South
1	9:00 – 9:15 am	Development of Management Strategies for Spreading Dogbane(*Apocynum androsaemifolium* L.) in Wild Blueberry	Lyu, Hugh Q * White, Scott N
2	9:15 – 9:30 am	A mechanistic framework to explain yield loss in corn (*Zea mays* L.) caused by early season stress	Gonzalez, Hugo * Lee, Elizabeth A Lukens, Lewis Swanton, Clarence
3	9:30 – 9:45 am	Antioxidant Responses to Weed Competition in Arabidopsis and Maize	Berardi, Nicole * Swanton, Clarence Amirsadeghi, Sasan

4	9:45 – 10:00 am	Artificial Hybridization Between *Amaranthus tuberculatus* and *Amaranthus albus*	Murphy, Brent P * Chatham, Laura A Rayburn, A. Lane Tranel, Patrick
	10:00 –10:30 am	Break	Oakes Foyer
5	10:30 – 10:45 am	Characterizing ACCase resistant green foxtail and weed diversity in a long-term rotation	McLennan, Deanna J * Gulden, Robert H
6	10:45 – 11:00 am	Does oxidative stress play a role in weed competition in maize (*Zea mays* L.)?	Richer, Avery R * Amirsadeghi, Sasan Swanton, Clarence
7	11:00 – 11:15 am	Effect of Seasonal Herbicide Application Timing on Japanese knotweed (*Fallopia japonica*) Shoot Regeneration	Jollimore, Tyler D * White, Scott N Nams, Vilis Abbey, Lord
8	11:15 – 11:30 am	Exergy as a physiological crop stress measurement tool	Alzaben, Heba * Swanton, Clarence Fraser, Roydon
9	11:30 – 11:45 am	Exploring the Relationship Between the Law of Constant Final Yield and Field Bean (*Phaseolus vulgaris*) in Manitoba	Koroscil, Leanne J * Gulden, Rob
10	11:45 – 12:00 pm	Management of Annual Weeds in Isoxaflutole Resistant Soybean	Smith, Andrea * Soltani, Nader Kaastra, Allan Hooker, Dave Robinson, Darren Sikkema, Peter
	12:00 pm – 1:15 pm	Lunch	Oakes North
11	1:15 – 1:30 pm	Multiple herbicide-resistant Canada fleabane (*Conyza canadensis* (L.) Cronq.) and waterhemp (*Amaranthus tuberculatus (*Moq.) J.D. Sauer) dose response to tolpyralate and tolpyralate plus atrazine	Metzger, Brendan A * Raeder, Alan J. Hooker, Dave Robinson, Darren Sikkema, Peter
12	1:30 – 1:45 pm	Occurrence and distribution of waterhemp (*Amaranthus tuberculatus* var. *rudis*) from Ontario and Quebec resistant to herbicides spanning four modes of action and control using HPPD-inhibiting herbicides	Benoit, Lauren * Hedges, Brittany Schryver, Mike Soltani, Nader Hooker, Dave Robinson, Darren Laforest, Martin Soufaine, Brahim

			Tranel, Patrick Giacomini, Darci Sikkema, Peter
13	1:45 – 2:00 pm	Spring-sown Cereal Rye (*Secale cereale*) Response to Quizalofop	Buck, Elizabeth M * Robinson, Darren Sikkema, Peter Soltani, Nader Van Acker, Rene
14	2:00 – 2:15 pm	Effect of crops and weediness levels on soil microbial communities from a long-term field experiment in western Canada	Kamino, Leila * Gulden, Robert H
	2:15 – 2:45 pm	Break	Oakes Foyer
	2:45 – 4:30 pm	**Cereals, oilseeds and pulses**	**Oakes South (Steve Shirtliffe)**
15	2:45 – 3:00 pm	Novel Formulation of 2,4-D for Improved Compatibility, Weed Control and Reduced Drift	Dahl, Gregory K * Van Dam, David A
16	3:00 – 3:15 pm	Preplant Weed Control in Canola with Arylex^{TM} Active Herbicide (Halauxifen-methyl)	Degenhardt, Rory * Juras, Len Smith, Laura MacRae, Andrew Ward, Katherine
17	3:15 – 3:30 pm	Rolling Resistance – An Update on Kochia and Russian Thistle in Alberta	Beckie, Hugh Hall, Linda M * Martin, Elise Shirriff,, Scott W Leeson, Julia J
18	3:30 – 3:45 pm	Trifludimoxazin: a new PPO inhibitor with preemergence and postemergence activity	Oostlander, Mark * Armel, Greg Budd, Chris Drew, Lyle Bertholet, Ethan
19	3:45 – 4:00 pm	Improving Herbicide Effectiveness and Minimizing Impacts with Research, Analysis, Visualization and Demonstration	Dahl, Gregory K * Spandl, Eric P Magidow, Lillian C Annie, Makepeace D Van Dam, David A
20	4:00 – 4:15 pm	Advanced Weed Control: The Next Step in Pulse Weed Management	Reid, Andrew
21	4:15 – 4:30 pm	Characterizing Turbulent Spray Deposition from Self-Propelled Sprayers	Wolf, Tom

	OR		
	2:45 – 3:45pm	**Horticulture and Special Crops**	**Hennepin (Jichul Bae)**
22	2:45 – 3:00 pm	Evaluation of Herbicide Options for Bracken Fern Control in the Sprout Year of Wild Blueberries in New Brunswick in 2016	Graham, Gavin L *
23	3:00 – 3:15 pm	Evaluation of ALS/AHAS-inhibiting herbicides for red sorrel (*Rumex acetosella* L.) management in wild blueberry	White, Scott N *
24	3:15 – 3:30 pm	Using genetic tests to confirm herbicide resistant weeds in Ontario horticulture crops	Obeid, Kristen A * Page, Eric R Laforest, Martin Nurse, Rob E Simard, Marie-Josee
25	3:30 – 3:45 pm	Repetitive cultivation in muck soil: Effect on weed emergence and seed bank	Simard, Marie-Josee * Nurse, Rob E Laforest, Martin Obeid, Kristen A
		Networking	
	6:00 – 9:00 pm	Dine arounds with local hosts. Sign up at registration desk Meet in hotel lobby at 6:00 pm	
	7:00 – 9:00 pm	President's Dinner with Plenary Speakers	Fallsview Private Dining Room

	Wednesday, November 21, 2018		
	24 hours	Office/Storage	Oakes Office
	24 hours	Posters and Exhibit Boards	Oakes Foyer
	7:00 – 8:00 am	CWSS Board + LAC 2018/2019 meeting	Fallsview Private Dining Room
	7:00 – 8:00 am	Poster Viewing with Authors Present	Oakes Foyer
	7:00 am – 5:00 pm	Registration	Oakes Foyer
	7:30 – 8:30 am	Breakfast	Oakes North
		Plenary Session	Oakes South
	8:30 – 8:35 am	Welcome	Mike Cowbrough
26	8:35 – 9:05 am	Lessons learned from over 35 years of working with farmers	Steve Johns
27	9:05 – 9:45 am	The perpetual motion of plant interactions	Dr. Clarence Swanton
	9:45 – 10:15 am	Break	Oakes Foyer

28	10:15 – 11:00 am	Current and future use of imaging and data collection tools along with analytical techniques for crop protection	Dr. Scott Noble
29	11:00 – 11:45 am	Hyperspectral imaging to detect herbicide resistant Palmer amaranth	Dr. Maor Matzrafi
	11:45 am – 12:45 pm	Lunch	Oakes North
30	12:45 – 1:25 pm	Managing Resistance with Spray Application Technology	Dr. Tom Wolf
31	1:25 – 2:05 pm	Advances in mechanical weed control and their effectiveness at weed removal	Dr. Steve Shirtliffe
32	2:05 – 2:35 pm	All influence, No Authority: a how-to on leading and collaborating when you're not the boss	Kate Hyatt
33	2:35 – 3:05 pm	Ethics, Agriculture and the Environment	Dr. Robert Zimdahl
	3:05 – 3:30 pm	Break	Oakes Foyer
	3:30 – 4:50 pm	**Molecular Biology**	**Hennepin (Rob Nurse)**
34	3:30 – 3:50 pm	What is a weed ecologist doing in a lab? – the value of molecular approaches for understanding plant invasions	Clements, David Shaik, Razia Zhu, Xiaocheng Weston, Leslie
35	3:50 – 4:10 pm	Weed population biology: using a basic understanding of physiology and molecular biology to explore long term trends in resistance	Page, Eric * Meloche, Sydney
36	4:10 – 4:30 pm	Molecular Diagnostics and genetics of herbicide resistant weeds	Laforest, Martin * Simard, Marie-Josee Page, Eric R Nurse, Rob E Obeid, Kristen A
37	4:30 – 4:50 pm	Deciphering the evolutionary mechanisms driving the spread of glyphosate resistant *Amaranthus tuberculatus*	Kreiner, Julia
	OR		
	3:30 – 5:00 pm	**Corn, soybean and edible bean**	**Oakes South (Allan Kaastra)**

38	3:30 – 3:45 pm	Management of Glyphosate Resistant Common Waterhemp with Enlist^{TM} System in Soybean	Ashigh, Jamshid * Smith, Laura Vanhie, Michael Degenhardt, Rory
39	3:45 – 4:00 pm	Management of glyphosate resistant kochia with Enlist in E3 soys	Vanhie, Michael * Smith, Laura Degenhardt, Rory Ashigh, Jamshid MacRae, Andrew
40	4:00 – 4:15 pm	Tankmixtures of glyphosate with 2,4-D accentuates 2,4-D injury in glyphosate-resistant corn	Sikkema, Peter * Shropshire, Christy Soltani, Nader
41	4:15 – 4:45 pm	Manage resistance now, A new resistance management platform for Canada's agri-food industry	Soulard, Danielle
	5:30 – 6:30 pm	CWSS-SCM Reception	Oakes North
	6:30 – 9:30 pm	CWSS-SCM Awards Banquet	Oakes North

	Thursday, November 22, 2018		
#	**Time**	**Topic/Event**	**Location**
	24 hours	Office/Storage	Oakes Office
	7:30 am – 12:00 pm	Poster and Exhibit Boards – Take Down	Oakes Foyer
	7:30 – 8:00 am	Breakfast	Oakes North
	8:00 – 9:30 am	CWSS-SCM Annual General Meeting	Oakes North
	9:30 – 10:00 am	Break & Hotel Checkout	Oakes Foyer
		Forage, Rangeland, Forestry and Industrial Vegetation Management	**Oakes South (Lisa Jarrett)**
42	10:00 – 10:15 am	Torpedo^{TM} plus Aminopyralid for Total Vegetation Control in Industrial Land Management	Smith, Laura R * Degenhardt, Rory Juras, Len
		Weed Biology, Ecology and Invasive Species	**Oakes South (David Clements)**
43	10:15 – 10:30 am	Ecological goods and services of weeds – Denitrification and the soil microbial community	Gulden, Robert H * Tenuta, Mario
44	10:30 – 10:45 am	A patchy landscape: musings on the proliferation of kochia in 2018	Geddes, Charles M *
45	10:45 – 11:00 am	Kochia Population Genetics: Panmictic Prairie Populations	Martin, Sara L * Wei, Wei

			Benedict, Leshawn Sauder, Connie A Beckie, Hugh Hall, Linda M
	OR		
		Provincial Reports and Regulatory Updates	**Hennepin (Angela Gourd)**
46	10:00 – 10:15 am	Baking Soda for Weed Control	Graham, Gavin L *
47	10:15 – 10:30 am	Manitoba report	Tammy Jones
48	10:30 – 10:45 am	Ontario field crop report	Mike Cowbrough
49	10:45 – 11:00 am	Ontario horticultural crop report	Kristen Obeid
50	11:00 – 11:15 am	Saskatchewan report	Clark Brenzil
51	11:15 – 11:30 am	Nova Scotia report	Angela Gourd
52	11:30 – 11:45 am	British Columbia report	Ken Sapsford
	11:45 am – 3:00 pm	CWSS-SCM Board Meeting Lunch in room	Fallsview Private Dining Room

Poster Session

#	Title	Section	Author(s)
53	Response of winter wheat to herbicide plus fungicide plus ammonium thiosulphate tankmixes	Cereals, Oilseeds and Pulses	Soltani, Nader * Hooker, Dave Sikkema, Peter
54	Secondary seed dormancy and seedbank persistence in *Brassica carinata*	Cereals, Oilseeds and Pulses	Dueck, Rebecca * Gulden, Robert H
55	Weed management practises in annual cropping systems in the prairie provinces	Cereals, Oilseeds and Pulses	Leeson, Julia Y *
56	Herbicide evaluations for Ontario grown Quinoa	Horticulture and Special Crops	Nurse, Rob E * Cowbrough, Mike
57	Sensitivity of Dry Bean to Herbicides Applied Preplant for Glyphosate-Resistant Canada Fleabane Control in a Strip-Tillage Cropping System	Soybean, Corn, and Edible Beans	Soltani, Nader * Shropshire, Christy Sikkema, Peter
58	Tricotelydenous giant ragweed (*Ambrosia trifida* L.)	Weed Biology and Ecology / Invasive and Noxious Weeds	Page, Eric R * Meloche, Sydney Bae, Jichul Larsen, Jamie Laforest, Martin Nurse, Rob E

59	*Thesium ramosum* in North America: A collaborative Canada-U.S. weed risk assessment	Weed Biology and Ecology / Invasive and Noxious Weeds	Entwistle, Katrina * Wilson, Claire
60	Commercial formulations of glyphosate, saflufenacil, sulfentrazone, and their mixtures influence soil microbial community structure	Weed Biology and Ecology / Invasive and Noxious Weeds	Rosset, Jonathan D * Gulden, Robert H
61	Quantitative assays for *Amaranthus palmeri* and *A. tuberculatus* detection	Weed Biology and Ecology / Invasive and Noxious Weeds	Murphy, Brent P * Plewa, Dianne E Phillippi, Elizabeth Bissonnette, Suzanne M Tranel, Patrick
62	The use of cereal rye (*Secale cereale* L.) cover crops to control Canada fleabane (*Conyza canadensis* (L.) Cronq.)	Weed Biology and Ecology / Invasive and Noxious Weeds	Vanhie, Theodore R * Tardif, François Swanton, Clarence Cowbrough, Mike
63	Increasing duration of weed free period and cultural weed management practices in *Glycine max* (L.) influence weed community structure in southern Manitoba	Weed Biology and Ecology / Invasive and Noxious Weeds	Rosset, Jonathan D * Gulden, Robert H

Abstracts

1	DEVELOPMENT OF MANAGEMENT STRATEGIES FOR SPREADING DOGBANE (*APOCYNUM ANDROSAEMIFOLIUM* L.) IN WILD BLUEBERRY. Hugh Q. Lyu*, Scott N. White; Dalhousie University Faculty of Agriculture, Truro, NS ABSTRACT Wild blueberry is an important crop in Nova Scotia and weed management is an ongoing challenge in commercial wild blueberry fields. Spreading dogbane is an increasingly common creeping herbaceous perennial weeds in wild blueberry fields. Spreading dogbane is competitive, as it spreads rapidly and reduces blueberry yield and profits. The object of this study is to develop management strategies for spreading dogbane. Field experiments established in summer 2017 and 2018 to investigate 1) the most effective herbicides to control spreading dogbane 2) the best timing to control spreading dogbane. In summer spot spray experiments, dicamba, foramsulfuron and glyphosate provided the most consistent control across sites (>80% injury and reduced density by 80%-100%) in non-bearing year. However, only dicamba reduced final density by 84% in bearing year; foramsulfuron and glyphosate only controlled aboveground growth but did not kill underground structures. Summer spot spray is more effective than fall spot spray, because same herbicides used in fall spot spray experiments did not reduce dogbane density in bearing year. Dicamba is effective to control spreading dogbane. When applying dicamba at bud and flowering stages, dogbane density reduced by 77% and 93% respectively in bearing year. Results of herbicide efficiency and timing on controlling spreading dogbane should help growers to control this challenging weed species. Keywords: wild blueberry; weed management; spreading dogbane; *Apocynum androsaemifolium* L.; creeping herbaceous perennial
2	A MECHANISTIC FRAMEWORK TO EXPLAIN YIELD LOSS IN CORN (*ZEA MAYS* L.) CAUSED BY EARLY SEASON STRESS. Hugo Gonzalez*[1], Elizabeth A. Lee[1], Lewis Lukens[1], Clarence Swanton[2]; [1]University of Guelph, Guelph, ON, [2]Professor, Guelph, ON ABSTRACT Physiological stress caused by early season weed competition, drought, or intraspecific competition can result in rapid yield loss in corn (*Zea mays* L.). The mechanism by which these stresses cause yield loss is not well known. It was hypothesized that if early season physiological stress caused by abiotic or biotic variables reduces yield then the mechanism by which this occurred was the result of a reduction in kernel set, and a subsequent increase in anthesis-to-silking interval. Field trials were conducted in 2012 and 2013 at two locations (Arkell and Elora Research Stations). Treatments included an enriched far red ratio, drought and intraspecific competition (15 plants/m2). Early season stress negatively impacted kernel set and

	flowering dynamics. The reduction in kernel set was driven primarily by reductions in plant growth rates at silking. A delay in days to anthesis and silking was also observed because of a reduction plant dry matter accumulation during the early vegetative phase of corn growth. This research provides a mechanistic explanation for the rapid loss in yield that occurs in corn as a result of early season stress caused by abiotic and biotic variables.
3	ANTIOXIDANT RESPONSES TO WEED COMPETITION IN ARABIDOPSIS AND MAIZE. Nicole Berardi*[1], Clarence Swanton[2], Sasan Amirsadeghi[3]; [1]University of Guelph, Guelph, ON, [2]Professor, Guelph, ON, [3]Post Doctoral Research, Guelph, ON ABSTRACT Changes in light quality induced by the presence of neighbouring weeds is an important mechanism of plant competition effecting crop plants during the early stages of seedling development. Alteration of the light environment is recognized via changes in the red/far-red light ratio (R/FR), in which a reduction in R/FR is induced by light that is reflected upwards off weeds. Recognition of a reduced R/FR elicits physiological stress responses within the crop plant characterized by increased reactive oxygen species (ROS) production and subsequent modification of antioxidant capacity to regulate ROS levels. The resulting physiological responses due to the presence of neighbouring weeds are hypothesized to be the cause of significant yield losses during early season weed competition. To explore the associated stress and antioxidant responses to weed competition the model species, Arabidopsis and maize were studied under two light environments, a high R/FR (weed-free, FR-D) environment, and a low R/FR environment (weedy, FR-E). Results indicate that in response to the low R/FR light environment the proportion of reduced ascorbate, a potent antioxidant, was significantly decreased when compared with the weed-free light environment in both Arabidopsis and maize. Fluctuations in associated antioxidant regenerating enzymes were also observed in both species. These results demonstrate the importance of elucidating the molecular basis of weed-crop competition. Further identification of these responses and associated genes would not only provide important insights into the molecular basis of weed-crop competition, but may also provide targets for improving weed stress tolerance in crop plants.
4	ARTIFICIAL HYBRIDIZATION BETWEEN *AMARANTHUS TUBERCULATUS* AND *AMARANTHUS ALBUS*. Brent P. Murphy*, Laura A. Chatham, A. Lane Rayburn, Patrick Tranel; University of Illinois, Urbana, IL ABSTRACT Multiple species within the *Amaranthus* genus have been reported to cross pollinate, resulting in the formation of interspecific hybrids and transfer of key traits. The objective of this study was to investigate the hybridization potential between *A. tuberculatus* and *A. albus* under greenhouse conditions. Utilizing ALS resistance

	marker present within the *A. tuberculatus* population, progeny of eight *A. albus* female plants grown alongside male *A. tuberculatus plants* were screened for candidate hybrids, which were confirmed with molecular markers. Progeny from four populations of *A. tuberculatus* female plants grown with *A. albus* were screened for presence of *A. albus* diagnostic molecular markers. Infrequent unidirectional hybridization from *A. tuberculatus* (male) to *A. albus* was observed. Both sterile and dioecious, fertile hybrid plants were obtained. Flow cytometry revealed that progeny of the fertile, hybrid plants possessed greater DNA content than either parental population, suggesting chromosome doubling of at least one genome may be required for hybridization. Interestingly, seed obtained from the *A. tuberculatus* female plants were viable, yet were not the result of *A. albus* hybridization. Progeny possessed skewed gender ratios, favoring the female gender, suggesting pollen contamination was unlikely the source of most of the seed. Potential causes of this phenomenon, such as auto-pollination or apomixis, are discussed.
5	CHARACTERIZING ACCASE RESISTANT GREEN FOXTAIL AND WEED DIVERSITY IN A LONG-TERM ROTATION. Deanna J. McLennan*[1], Robert H. Gulden[2]; [1]University of Manitoba, Winnipeg, MB, [2]University of Manitoba, Winnipeg, MB ABSTRACT In 2000, the long-term Pesticide Free Production (PFP) experiment was initiated to study the effect of reduced in-crop herbicide use on weed populations, crop yield while lowering the selection pressure for herbicide-resistant weed biotypes. Two four-year crop rotations were planted, both rotations received three herbicide omission treatments; in-crop herbicides omitted from oats, omitted from oats and flax, and a control treatment, with in-crop herbicides applied to every crop. After 17 years of rotation, equivalent germinable seedbank densities exist among the herbicide omission treatments. Green foxtail densities were higher in the control treatment that received yearly herbicide applications, frequently Group 1 herbicides. All other weed species followed the opposite trend, displaying higher densities in the reduced in-crop herbicide-use treatments. Additionally, species richness and Shannon-Wiener diversity were greater in treatments with reduced in-crop herbicide use. Within treatments, competitive crops and management practices helped reduce seedbank densities for all weed species.
6	DOES OXIDATIVE STRESS PLAY A ROLE IN WEED COMPETITION IN MAIZE (*ZEA MAYS* L.)? Avery R. Richer*[1], Sasan Amirsadeghi[2], Clarence Swanton[3]; [1]University of Guelph, Guelph, ON, [2]Post Doctoral Research, Guelph, ON, [3]Professor, Guelph, ON ABSTRACT Understanding how crop plants detect neighbouring weed species and the associated changes in the molecular and physiological responses within crop plants can help explore the mechanisms of resource-independent plant competition. Plants can detect the presence of weeds through changes in light quality, specifically the

	red (R) to far-red (FR) ratio. *Zea mays* L. was grown in a weed-free environment (R/FR~1.8) as well as a FR-enriched (FR-E) environment. The FR-E environment was generated using a biologically weedy system (R/FR~0.5). The biological weedy system generates a consistent FR-E environment without compromising incoming photosynthetic photon flux density. Plant height, and above and below ground biomass were measured at the 4th leaf tip stage. Morphological measurements showed an increased root-to-shoot ratio in plants grown in the FR-E environment, indicating a shade avoidance response. Hydrogen peroxide measurements indicated increased levels of H_2O_2 under FR-E conditions, while catalase activity remained consistent between treatments. Cell death analysis conducted in the field with 5-aminolevulinic acid show enhanced sensitivity to cell death by a singlet oxygen generating compound in plants grown in the presence of weeds. These results suggest increased production of singlet oxygen in the FR-E environment, demonstrating that oxidative stress is a fundamental early impact of neighbouring weeds on maize. Increased singlet oxygen levels regulate hydrogen peroxide level and activate stress responses that negatively impact growth and biomass production. These results further highlight the importance of early season weed control.
7	EFFECT OF SEASONAL HERBICIDE APPLICATION TIMING ON JAPANESE KNOTWEED (*FALLOPIA JAPONICA*) SHOOT REGENERATION. Tyler D. Jollimore*[1], Scott N. White[2], Vilis Nams[3], Lord Abbey[1]; [1]Dalhousie Faculty of Agriculture, Truro, NS, [2]Dalhousie University Faculty of Agriculture, Truro, NS, [3]Dalhousie Faculty of Agriculture, Halifax, NS ABSTRACT Japanese knotweed (*Fallopia japonica*) is an invasive species in Europe and North America. With riparian zones, roadsides and real estate seeing large, contiguous-area infestations. Knotweed invasions are associated with reductions in native plant diversity, accelerated soil erosion and reduction in real estate value. Two experiments were established in Antigonish and South Maitland, NS Canada; to determine the ability of four herbicides, spot applied at either: peak height (~300 cm) or fall (~last two weeks of September), to cause knotweed stem density reductions 1 YAT. 1x2 m plots were established on sites in spring of 2017. Stem density data was collected shortly before treatment. The experiment was arranged in a completely randomized design with treatments: control (no herbicide), imazapyr (12.0 g a.e. L water^{-1}), aminopyralid (4.8 g a.e. L water^{-1}), glyphosate (9.0 g a.e. L water^{-1}) or aminocyclopyrachlor (0.395 g a.i. L water^{-1} with 2.5 mL Activate+ L water^{-1}). Sprays were conducted using a CO_2 pressurized sprayer with an air induction nozzle, until all leaf surfaces were wet. Data was analyzed in Minitab18™ using ANOVA to determine significant effect ($P < 0.05$). Tukey's test was used to determine significantly different means ($P < 0.05$). Imazapyr and glyphosate saw significant density reductions 1 YAT when applied at peak height and fall. Aminopyralid caused significant density

	reductions but only when applied in the fall. Aminocyclopyrachlor did not achieve density reductions in either timing. This indicates that peak height and the fall can be useful herbicide application windows for knotweed. Allowing for flexibility in management strategies.
8	EXERGY AS A PHYSIOLOGICAL CROP STRESS MEASUREMENT TOOL. Heba Alzaben*[1], Reece Lawrence[2], Roydon Fraser[3], Clarence Swanton[4]; [1]Graduate PhD student, Waterloo, ON, [2]University of Toronto, Toronto, ON, [3]Professor, Waterloo, ON, [4]Professor, Guelph, ON ABSTRACT Energy has both magnitude and quality. Exergy is the quality of energy available to do work. It is also measure of the distance from the equilibrium state. According to the exergy destruction principle, a plant will develop in a manner to maximize the amount of work available within a given environment for the purpose of structural organization, function and stress recovery. It was hypothesized if corn plants experienced physiological stress caused by weed competition or insufficient rate of nitrogen then leaf surface temperatures will increase compared to non-stressed corn plants. Nitrogen experiments were conducted in 2016 and 2017 on a long term nitrogen trials at the Elora Research Station, ON, utilizing six different rates of nitrogen. Weed stress experiments were conducted in 2014 and 2016 at the Arkell and Woodstock Research Stations, ON in which weeds were controlled with glyphosate at the 4^{th}, 7^{th} and 10^{th} leaf tip stage of corn growth. Leaf surface temperature was collected using a research thermal camera. Whorl temperatures were measured using a type T thermocouple attached to a temperature recorder for continues measurements. An inverse relationship was observed between surface temperature and increasing stress caused by insufficient rate of nitrogen or weed competition. The exergy destruction principle provided a theory from which thermal remote sensing can be applied through the use of surface temperature measurements to detect physiological stress in crop plants caused by abiotic and biotic variables.
9	EXPLORING THE RELATIONSHIP BETWEEN THE LAW OF CONSTANT FINAL YIELD AND FIELD BEAN (*PHASEOLUS VULGARIS*) IN MANITOBA. Leanne J. Koroscil*[1], Robert H. Gulden[2]; [1]University of Manitoba, Winnipeg, MB, [2]University of Manitoba, Winnipeg, MB ABSTRACT Crop spatial arrangement is comprised of row spacing and plant density and influences crop productivity and interference with weeds. Local and current research in this area is scarce and older recommendations may be outdated. Manitoba is one of the provinces with the largest field bean (*Phaseolus vulgaris*) acreage in Canada, therefore updated recommendations from relevant local research to optimize yields and control weed populations using plant spatial arrangement would be of great

	benefit to Manitoban bean producers. The Law of Constant Final Yield states that plant biomass increases in proportion to plant density, then plateaus and remains constant beyond a certain density. Recent research in field beans by Laura Schmidt (unpublished) has shown that as planting row width decreases, the field bean yield-density relationship increasingly does not conform to the Law of Constant Final Yield. The objectives of this research are to explore the underlying reasons behind these observations with a field study based at the Ian Morrison Research Farm in Carman, MB. Two varieties of navy bean with different growth habits (Envoy (Type I) and T9905 (Type II)) were used. Plant spatial arrangement and density were altered by varying inter-row plant distance from 10 cm to 20 cm to 40 cm while spacing between the rows remained the same (20 cm). The experimental design was a two-way factorial randomized complete block design. Preliminary results will be discussed.
10	MANAGEMENT OF ANNUAL WEEDS IN ISOXAFLUTOLE RESISTANT SOYBEAN. Andrea Smith*[1], Nader Soltani[1], Allan Kaastra[2], Dave Hooker[1], Darren Robinson[1], Peter Sikkema[1]; [1]University of Guelph, Ridgetown, ON, [2]Bayer CropScience, Guelph, ON ABSTRACT Transgenic crops, with herbicide resistance traits, are being developed to provide innovative weed control options. Soybean with a transgene that confers resistance to the Group 27 herbicide, isoxaflutole, is currently under development and will provide a novel herbicide mode-of-action for use in soybean. Ten field experiments were conducted over a two-year period (2017, 2018) on five unique soil types, using isoxaflutole-resistant soybean, to evaluate the efficacy of isoxaflutole + metribuzin applied preemergence (PRE). Isoxaflutole + metribuzin was applied at 52.5 + 210, 79 + 315 and 105 + 420g ai ha^{-1}, representing the low, medium and high rates, respectively. These treatments were applied alone and followed by glyphosate (900 g ae ha^{-1}), applied postemergence (POST), when weed escapes from isoxaflutole + metribuzin, applied PRE, were 7.5 cm tall. Control of lamb's quarters, and common ragweed differed between locations. Lower control occurred at locations which received lower amounts of cumulative rainfall between the PRE and POST applications. Control of all other species did not differ among locations. Isoxaflutole + metribuzin, applied PRE, controlled broadleaf weeds 25 to 69, 49 to 86, and 71 to 95% and controlled annual grasses 85 to 97, 75 to 99, and 86 to 100% with the low, medium and high rates, respectively. Isoxaflutole + metribuzin, applied PRE, followed by glyphosate, applied POST, controlled all weeds 98 to 100%. This study concludes that there was higher levels of weed control as the rate of isoxaflutole+ metribuzin was increased, and that the two-pass weed control program of isoxaflutole + metribuzin, applied PRE followed by glyphosate, applied POST, provides excellent annual grass and broadleaf weed control in isoxaflutole-resistant soybean.
11	MULTIPLE HERBICIDE-RESISTANT CANADA FLEABANE (CONYZA CANADENSIS (L.) CRONQ.) AND WATERHEMP (AMARANTHUS TUBERCULATUS (MOQ.) J.D. SAUER) DOSE RESPONSE TO TOLPYRALATE AND TOLPYRALATE PLUS ATRAZINE. Brendan A.

	Metzger*[1], Alan J. Raeder[2], Dave Hooker[1], Darren Robinson[1], Peter Sikkema[1]; [1]University of Guelph, Ridgetown, ON, [2]ISK Biosciences, Concord, OH ABSTRACT Tolpyralate, a recently commercialized herbicide, inhibits the 4-hydroxyphenyl-pyruvate dioxygenase (HPPD) enzyme in susceptible plants. Applied postemergence (POST), alone or in tank-mixtures with atrazine, tolpyralate provides control of several annual grass and broadleaf weed species in corn. Multiple-resistant (MR) Canada fleabane (Groups 2 and 9), and MR waterhemp (Groups 2, 5, 9 and 14), are an evolving weed management challenge in Ontario. Field studies to examine tolpyralate dose response in these species, and compare to commercial standard herbicides were conducted in Ontario in 2017/2018 at four locations with populations of MR Canada fleabane, and at three locations with infestations of MR waterhemp. Treatments included six rates of tolpyralate from 3.75-120 g ai ha-1 applied alone or with atrazine in a 1:33.3 tank-mix ratio. Commercial standards included dicamba/atrazine (1500 g ai ha-1) and bromoxynil + atrazine (280 + 1500 g ai ha-1) for control of MR Canada fleabane, and dicamba/atrazine (1500 g ai ha-1) and mesotrione + atrazine (100 + 280 g ai ha¬-1) for control of MR waterhemp. At 8 WAA, tolpyralate + atrazine at 22.3 + 742 g ai ha-1, applied POST, controlled MR Canada fleabane ≥95%, and was similar to both industry standards applied at label rates; however, no dose of tolpyralate alone provided >95% control. At 8 WAA, tolpyralate + atrazine at 57 + 1901 g ai ha-1, applied POST, controlled MR waterhemp ≥95%, and was similar to both industry standards when applied at label rates, while tolpyralate alone did not provide 95% control. Overall, these studies conclude that tolpyralate + atrazine provides excellent control of MR Canada fleabane and MR waterhemp, and is an effective herbicide option for in-season management of these species in corn.
12	OCCURRENCE AND DISTRIBUTION OF WATERHEMP (AMARANTHUS TUBERCULATUS VAR. RUDIS) FROM ONTARIO AND QUEBEC RESISTANT TO HERBICIDES SPANNING FOUR MODES OF ACTION AND CONTROL USING HPPD-INHIBITING HERBICIDES. Lauren Benoit*[1], Brittany Hedges[2], Mike Schryver[2], Nader Soltani[2], Dave Hooker[2], Darren Robinson[2], Martin Laforest[3], Brahim Soufaine[4], Patrick Tranel[5], Darci Giacomini[5], Peter Sikkema[2]; [1]University of Guelph, Kirkton, ON, [2]University of Guelph, Ridgetown, ON, [3]Agriculture and Agri-Food Canada, St-Jean-sur-Richelieu, QC, [4]Universite du Quebec a Trois-Rivieres, Trois-Rivieres, QC, [5]University of Illinois, Urbana, IL ABSTRACT Waterhemp (*Amaranthus tuberculatus*) is a competitive and highly-prolific summer annual weed. Waterhemp populations resistant to up to three herbicide modes of action, 2, 5, and 9, were recorded at 58 locations in Ontario as of 2016. In 2017 and 2018 research was conducted to identify additional herbicide resistant waterhemp locations in Eastern Canada. 23 new locations were identified through random and

	directed field scouting, 22 in Ontario and 1 in Quebec. Seed was collected at all locations. Seed was germinated and waterhemp plants were tested in a greenhouse for resistance to four herbicides: imazethapyr (75 g a.i. ha^{-1}), atrazine (1000 g a.i. ha^{-1}), glyphosate (900 g ae ha^{-1}), and lactofen (110 g a.i. ha^{-1}). The 10 locations that were identified in 2018 were not included in the greenhouse work. Of the 23 samples collected in 2016-17: 100% conferred resistance to imazethapyr, 88% to atrazine, 84% to glyphosate and 43% to lactofen. 43% of the populations conferred resistance to all four herbicides. This is the first report of a weed resistant to group 14 herbicides in Eastern Canada. Field studies were conducted in 2017 and 2018 to determine the relative efficacy of group 27 herbicides plus atrazine applied PRE and POST for controlling multiple resistant waterhemp in corn. 12 weeks after application (WAA), mesotrione + atrazine and isoxaflutole + atrazine, applied preemeergence, controlled waterhemp 87 and 90%, respectively. 12 WAA, tolpyralate + atrazine and tembotrione + atrazine, applied postemergence, controlled waterhemp 97 and 98%, respectively.
13	SPRING-SOWN CEREAL RYE (*SECALE CEREALE)* RESPONSE TO QUIZALOFOP. Elizabeth M. Buck*[1], Darren Robinson[2], Peter Sikkema[2], Nader Soltani[2], Rene Van Acker[3]; [1]Cornell University, Buffalo, NY, [2]University of Guelph, Ridgetown, ON, [3]University of Guelph, Guelph, ON ABSTRACT Cereal winter rye cover crops (*Secale cereal* L.) can effectively suppress broadleaf weeds. When intersown as living mulch in vegetable crops, cereal rye can also suppress crop yield. An effective method to limit the competitiveness of cereal rye towards crops would increase the viability of living mulch production systems. Cereal rye tolerance to quizalofop-p-ethyl applied postemergence was examined in Ridgetown, ON. Four factorial trials consisting of seven quizalofop-p-ethyl micro-rates (0 to 18 g ai ha^{-1}) applied once when rye had 1 to 2 tillers, or one or two weeks after the tillering began were conducted over two summers. The biologically effective rate required to obtain one-half of the observed response for rye weight at harvest differed among application timings. Application timing influenced the effect to which quizalofop-p-ethyl prevented snap bean yield loss. The successful use of rye, with or without quizalofop-P-ethyl application, to suppress weeds was inconsistent. Results indicate that quizalofop-p-ethyl acts upon rye by reducing stand density and not by stunting, and that the rate necessary to achieve the desired level of rye suppression is influenced by rye stage at application. Use of quizalofop-p-ethyl to suppress cereal rye may not be practical without good weed control during rye establishment.
14	EFFECT OF CROPS AND WEEDINESS LEVELS ON SOIL MICROBIAL COMMUNITIES FROM A LONG-TERM FIELD EXPERIMENT IN WESTERN CANADA. Leila Kamino*[1], Robert H. Gulden[2]; [1]University of Manitoba, Winnipeg, MB, [2]University of Manitoba, Winnipeg, MB

	ABSTRACT In addition to abiotic properties of the soil, plant species and community composition greatly shape the microbial community structure and functions in the soil. Specific carbon and energy sources released through plant exudates and litter are readily mineralized by soil microbes resulting to the selection of unique species-specific microbial communities. The extensive use of monoculture stands in modern agroecosystems is highly associated with loss of plant diversity with weedy plants being the dominant sources of plant diversity. However, there is a dearth of information on how crop species grown in rotation and with different weed densities influence the dynamics of the soil microbial communities. Therefore, the objectives of this study were to determine how the soil microbial communities are influenced by different crop species grown in rotation with differing weediness levels over the growing season. Research was initiated at the Ian N. Morrison Research Farm located in Carman, Manitoba in a fully phased long-term field study. The study consists of an annual crop rotation, with three levels of selective in-crop herbicide applications and two controls (fallow and prairie) arranged as a RCBD with three replicates. Using illumina sequencing targeting the 16S rRNA gene, a total 27 phyla groups were detected with *Proteobacteria* and *Acidobacteria* dominating in all the bulk soils groups. Crop species and weediness levels has a significant influence on the bacterial community of the bulk soil over the growing season. At most sampling dates the fallow and prairie clustered differently from each other and also from all other crop treatments on the PCA ordination plots. Weediness level was important at shaping the bacterial community in most treatments, but the effect was more pronounced in wheat treatments at the mid-vegetative stages. The results from this study indicate that plant species and agronomic practices that shifts the dynamics of weed communities and weed seedbank are important forces that shape the community composition of soil microbes. Because soil microbes perform important ecosystem functions, understanding how their diversity and dynamics shifts with agronomic practices is needful in order to foster ecologically sustainable methods.
15	NOVEL FORMULATION OF 2,4-D FOR IMPROVED COMPATIBILITY, WEED CONTROL AND REDUCED DRIFT.. Gregory K. Dahl*[1], David A. Van Dam[2]; [1]University of Wisconsin, River Falls, River Falls, WI, [2]Winfield United, Arden Hills, MN ABSTRACT AGH 09008 is a novel 2,4-D acid type herbicide formulation. AGH 09008 is marketed by WinField® United. as Rugged® herbicide. AGH 09008 contains 2,4-D acid at 3.49 pounds per gallon or 418 grams per liter. Typical use rates are 0.5 to 2 pints per acre. Broadleaf weed control with AGH 09008 was more similar to that obtained from 2,4-D esters than that from 2,4-D dimethyl amine. Generally, 2,4-D esters provided similar or greater weed control than AGH 09008 and AGH 09008 provided greater weed control than 2,4-D dimethyl amine. The compatibility and performance of AGH 09008 with K-salt glyphosate herbicides was similar to that of 2,4-D esters and better than

	2,4-D dimethyl amine. AGH 09008 performed well when UAN was the spray carrier. AGH 09008 was more compatible than 2,4-D dimethyl amine in mixtures with other herbicides, fertilizers and other tank mix products. AGH 09008 caused no injury to soybeans when applied seven or more days prior to planting. Tomatoes showed significant growth regulator type injury when placed in volatility testing chambers with 2,4-D ester formulations. The appearance of tomatoes tested with AGH 09008 and 2,4-D amine were similar to that of tomatoes that were in not exposed to 2,4-D.
16	PREPLANT WEED CONTROL IN CANOLA WITH ARYLEX™ ACTIVE HERBICIDE (HALAUXIFEN-METHYL). Rory Degenhardt*[1], Len Juras[2], Laura Smith[3], Andrew MacRae[4], Katherine Ward[5]; [1]Corteva Agriscience, Edmonton, AB, [2]Corteva Agriscience, Saskatoon, AB, [3]Corteva Agriscience, Winnipeg, MB, [4]Corteva Agriscience, Auburn, NY, [5]Corteva Agriscience, Morden, MB ABSTRACT Canola (*Brassica napus*) is the primary cash crop grown in rotation in Western Canada, but has few options for preplant weed control. Arylex™ active herbicide (halauxifen-methyl) is a Group 4 herbicide active ingredient (arylpicolinate family) currently registered exclusively for control of broadleaf weeds in cereal crops in either preplant or post-emergence applications. Between 2015 and 2018, a pre-formulated combination of Arylex and carfentrazone-ethyl, a protoporphyrinogen oxidase inhibitor (Group 14 mode of action), was evaluated for efficacy and crop safety in preplant applications to canola trials located across Western Canada. A spring application of Arylex plus carfentrazone-ethyl (5.24 + 9.76 g ae/ha) in tank-mix with glyphosate at 450 g ae/ha provided superior control of emerged glyphosate-resistant volunteer canola, wild buckwheat (*Polygonum convolvulus*), overwintered false cleavers (*Galium spurium*), flixweed (*Descurainia Sophia)*, narrow-leaved hawk's-beard (*Crepis tectorum*) and dandelion (*Taraxacum officinale*), compared to glyphosate alone at 450 to 675 g ae/ha. Weed control was also found to be consistent whether the herbicide treatment was applied at water volumes of 50 L/ha or 100 L/ha. At both the proposed application rate (5.24 + 9.76 g ae/ha) and twice the proposed application rate, Arylex plus carfentrazone-ethyl was safe to spring-seeded canola. The preformulated mixture of Arylex plus carfentrazone-ethyl will be a useful tool for canola growers looking for superior weed control and a multi-mode of action herbicide product to prevent the spread of, and selection for, glyphosate-resistant weeds. ™Trademark of Dow AgroSciences, DuPont or Pioneer, or their affiliated companies or their respective owners.
17	ROLLING RESISTANCE – AN UPDATE ON KOCHIA AND RUSSIAN THISTLE IN ALBERTA. Hugh Beckie[1], Linda M. Hall*[2], Elise Martin[2], Scott W. Shirriff,[3], Julia J. Leeson[3]; [1]Australian Herbicide Resistance Initiative (AHRI), School of Agriculture and Environment, University of Western Australia, Perth, Australia, [2]University of Alberta,

	Edmonton, AB, [3]Saskatoon Research and Development Centre, Agriculture and Agri-Food Canada, Saskatoon, SK ABSTRACT A weed survey was conducted in southern Alberta in 2017 in 305 randomly predetermined sites across 16 counties/MDs to determine the distribution and abundance of acetolactate synthase (ALS) inhibitor and glyphosate resistance in Russian thistle and ALS inhibitor, glyphosate and dicamba resistance in kochia. Of 45 Russian thistle populations tested, 31 (69%) were ALS inhibitor-resistant. No populations exhibited resistance to glyphosate. Of the 305 kochia populations tested, 100% were resistant to ALS inhibitors. Glyphosate and dicamba resistance was identified in 40 and 8% of kochia plants and, in 10% of the populations, individuals were resistant to all three herbicides. The incidence of kochia resistance is much greater than that found in the previous survey in 2012. **Correspondence author:** Linda Hall (email: lmhall@ualberta.ca).
18	TRIFLUDIMOXAZIN: A NEW PPO INHIBITOR WITH PRE AND POST EMERGENCE ACTIVITY. Mark Oostlander*[1], Greg Armel[2], Chris Budd[3], Lyle Drew[4], Ethan Bertholet[5]; [1]BASF Canada, Lethbridge, AB, [2]BASF Corporation, Research Triangle Park, NC, [3]BASF Canada, Mississauga, ON, [4]BASF Canada, Regina, SK, [5]BASF Canada, Saskatoon, SK ABSTRACT Trifludimoxazin [1,5-dimethyl-6-thioxo-3-(2,2,7-trifluoro-3,4-dihydro-3-oxo-4-prop-2-ynyl-2H-1,4-benzoxazin-6-yl)-1,3,5-triazinane-2,4-dione] is a new inhibitor of protoporphyrinogen IX oxidase (PPO or Protox). This is the first PPO inhibitor containing a triazinone heterocycle. Trifludimoxazin is very active when applied PRE or POST on dicot/broadleaf weeds including PPO resistant Amaranthus biotypes which are not controlled by currently registered PPO inhibitors like the diphenylether herbicides (e.g., fomesafen, lactofen, etc.), sulfentrazone, or flumioxazin. Trifludimoxazin has also demonstrated activity on key monocot/grass weeds including Lolium spp. The combination of trifludimoxazin plus saflufenacil improved the burndown and spectrum of weed control over solo trifludimoxazin and solo saflufenacil and therefore will be a key mix partner for commercial development in the pre-seed burndown use segment in Canada. Trifludimoxazin is expected to receive registration in key countries for use in multiple crops and by the early - middle part of the next decade. Given its unique ability to control several resistant weed biotypes, trifludimoxazin will be an important tool for future PPO herbicide tolerant crops.
19	IMPROVING HERBICIDE EFFECTIVENESS AND MINIMIZING IMPACTS WITH RESEARCH, ANALYSIS, VISUALIZATION AND DEMONSTRATION. Gregory K. Dahl*[1], Eric P. Spandl[2], Lillian C. Magidow[3], Makepeace D. Annie[2], David A. Van Dam[2]; [1]University of

	Wisconsin, River Falls, River Falls, WI, [2]Winfield United, Arden Hills, MN, [3]Winfield United, River Falls, WI ABSTRACT Winfield® United, a Land O' Lakes company and its Legacy companies have worked for a long time to improve the effectiveness of herbicide applications and minimize off-target issues. Several herbicides, adjuvant products and application methods have been developed and brought to market. Field testing has been a strong part of the research program to evaluate product performance. Winfield United recently opened an Innovation Center in River Falls, Wisconsin. The Innovation Center greatly increased the ability of Winfield United to build and test new herbicide and adjuvant formulations. Spray droplet analysis is conducted in an industry leading wind tunnel and testing facility. Potential spray mixtures are evaluated for the risk of loss due to particle drift. Greenhouse facilities and growth chambers grow plants for testing, and help evaluate the influence of environmental conditions. Winfield United also has a new spray booth. This spray booth can be used to apply spray mixtures with multiple nozzles at field speeds up to 18 miles per hour. Spray collection methods can be used and different imaging technology can be used to observe droplets behavior and interaction with leaves. Other instruments and methods that determine how droplets behave on different waxy or hairy leaf surfaces. Winfield United is involved in Precision Agricultural Technology, GPS mapping and forecasting tools to improve decision making and weed control results. SUSTAIN™ is a new program which is used to improve sustainability and reduce the impact of agriculture and its practices on the environment.
20	ADVANCED WEED CONTROL: THE NEXT STEP IN PULSE WEED MANAGEMENT. Andrew Reid,
21	CHARACTERIZING TURBULENT SPRAY DEPOSITION FROM SELF-PROPELLED SPRAYERS. Tom Wolf*[1], Brian Caldwell[1], Hubert Landry[2]; [1]Agrimetrix Research & Training, Saskatoon, SK, [2]PAMI, Humboldt, SK ABSTRACT Deposit uniformity is a cornerstone of good spray application. Variable deposition can result in uneven weed control or crop damage, and results in a waste of resources. Spray patterns are commonly evaluated by nozzle manufacturers or during sprayer inspections, using patternators that collect spray from a stationary boom. However, commercial application practices experience boom movement (sway and yaw), effects from travel speed and wind, and mechanical air turbulence from the sprayer unit itself that may move droplets. Trials were conducted in Saskatchewan to characterize spray deposit amounts and uniformity from high-clearance sprayers travelling between 13 and 32 km/h and boom heights ranging from 20 to 160 cm above target. Collectors were 11.25 cm x 1.25 cm plastic drinking straws spaced 25 cm apart in three 1-m sections under the

	boom, or 2-mm diameter plastic line that spanned a 36 m wide boom. Results showed that deposits on plastic straws depended on both boom height and travel speed, but generally achieved coefficient of variation (CV) values of 16% or better when the boom was set at least 80 cm above target. Boom height deviated by an average of 17% from the intended height due to boom sway, but this deviation also depended on travel speed and was frequently >50%. On string collectors spanning the entire width of the boom, deposits were more variable, with an average CV of 27% when measured at 30 cm intervals. Deposits from an ASABE Extremely Coarse spray were less variable than those from a Medium spray. Deposits along the sprayer path (where string was placed perpendicular to the boom) were less variable than those along the spray boom, with CVs of 17 to 22% depending on the location of the sampler string under the boom. These results show that traditional patternation results under-estimate the variability of sprays that occur in commercial practice, and improvement in spray deposit characteristics will complement efforts to maintain low use rates and delay the onset of some forms of herbicide resistance.
22	EVALUATION OF HERBICIDE OPTIONS FOR BRACKEN FERN CONTROL IN THE SPROUT YEAR OF WILD BLUEBERRIES IN NEW BRUNSWICK IN 2016. Gavin L. Graham*; NBDAAF, Fredericton, NB ABSTRACT Bracken fern (*Pteridium aquilinum*) is a perennial species which is common in newly cleared wild blueberry fields. A trial was established in the spring of 2016 in a field near Halcomb, New Brunswick to evaluate broadcast herbicide options for control of this weed. No injury resulted from a mesotrione or foramsulfuron treatment. There was significant injury to blueberries following tribenuron methyl application, but plants did recover before the end of the sprout year. Bracken fern was suppressed following foramsulfuron applications, with the early application having the highest level of control. Mesotrione treatments had a higher level of weed control early after application, but control also declined as the trial progressed through the sprout year. The highest mesotrione alone ratings occurred when applied to fronds that were fully unfolded, although there was no significant difference between mesotrione application timings within the crop year. Tribenuron methyl had a low level of activity after application, but improved as the sprout year progressed and was increased to control in the crop year. There was no bracken fern control benefit to following foramsulfuron with mesotrione but using mesotrione twice did significantly increase weed control. Two applications of mesotrione in the sprout year significantly improved bracken fern control in the crop year, as compared to one application of mesotrione alone, with no difference between the application timings evaluated in this trial. The registration of two applications of mesotrione could improve the management of bracken fern in wild blueberry production in New Brunswick and provides bracken fern control similar to the commercial standard, tribenuron methyl.

23	EVALUATION OF ALS/AHAS-INHIBITING HERBICIDES FOR RED SORREL (RUMEX ACETOSELLA L.) MANAGEMENT IN WILD BLUEBERRY. Scott N. White*; Dalhousie University Faculty of Agriculture, Truro, NS ABSTRACT Red sorrel is the most common weed species in wild blueberry fields in Nova Scotia, Canada. Recent herbicide screening research identified tribenuron-methyl as a promising herbicide for red sorrel management in wild blueberry, though comparison with other ALS/AHAS-inhibiting herbicides is lacking. The objective of this research was to evaluate currently registered, and promising new, ALS/AHAS-inhibiting herbicides for red sorrel management in wild blueberry. Herbicides were applied in spring of the non-bearing year, fall of the non-bearing year, and fall of the bearing year following pruning, with each application timing evaluated in a separate experiment. Experiments were arranged in a randomized complete block design with 5 blocks and 2m X 4m or 2m X 6m plot size. Treatments consisted of 1) nontreated control, 2) tribenuron-methyl (30g a.i. ha-1), 3) foramsulfuron (35 g a.i. ha-1), 4) nicosulfuron+rimsulfuron (13g a.i. ha-1 + 13g a.i. ha-1), 5) flazasulfuron (50g a.i. ha-1), 6) pyroxsulam (15g a.i. ha-1), and 7) halosulfuron (37g a.i. ha-1). Tribenuron-methyl and flazasulfuron were the most effective treatments evaluated across all three application timings. Spring non-bearing year tribenuron-methyl applications reduced red sorrel total ramet density, flowering ramet density, and seedling density by 84%, 99%, and 93%, respectively. Spring non-bearing year flazasulfuron applications tended to reduce total ramet density and also reduced flowering ramet and seedling density, indicating potential for this herbicide to contribute to red sorrel management in wild blueberry. Similarly, fall non-bearing year and fall bearing year tribenuron-methyl and flazasulfuron applications reduced spring ramet density by 57% to 58% and 92% to 94%, respectively. ALS/AHAS-inhibiting herbicides can contribute to red sorrel management in wild blueberry, and future research should focus on refining tribenuron-methyl and flazasulfuron use for this weed species.
24	USING GENETIC TESTS TO CONFIRM HERBICIDE RESISTANT WEEDS IN ONTARIO HORTICULTURE CROPS. Kristen A. Obeid*[1], Eric R. Page[2], Martin Laforest[3], Rob E. Nurse[2], Marie-Josee Simard[4]; [1]OMAFRA, Harrow, ON, [2]Agriculture and Agri-Food Canada, Harrow, ON, [3]Agriculture and Agri-Food Canada, St-Jean-sur-Richelieu, QC, [4]AAFC, Saint-Jean-sur-Richelieu, QC ABSTRACT Using genetic tests to confirm herbicide resistant weeds in Ontario horticulture crops Obeid, K.A., Page, E.R., Laforest, M., Nurse, R.E., and Simard, M.J. Several surveys were conducted to test suspected herbicide resistant weeds in Ontario horticulture crops. As a pilot project, genetic tests for group 2 resistant pigweed species, group 2 resistant common ragweed, and group 5 resistant lamb's-quarters were completed by Ministère de l'Agriculture, de Pêcheries et de

	l'Alimentation du Québec (MAPAQ) diagnostic lab in Quebec City, Quebec. Genetic tests for group 1 resistant large crabgrass and group 9 resistant Canada fleabane were completed by Dr. Eric Page's lab at Agriculture and Agri-Food Canada in Harrow Ontario. Overall, 82% of the samples submitted to the MAPAQ diagnostic lab tested positive and 7% of the large crabgrass and 50% of the Canada fleabane samples tested positive for herbicide resistance using molecular markers.
25	REPETITIVE CULTIVATION IN MUCK SOIL: EFFECT ON WEED EMERGENCE AND SEED BANK. Marie-Josee Simard*[1], Rob E. Nurse[2], Martin Laforest[3], Kristen A. Obeid[4]; [1]AAFC, Saint-Jean-sur-Richelieu, QC, [2]Agriculture and Agri-Food Canada, Harrow, ON, [3]Agriculture and AgriFood Canada, St-jean-sur-Richelieu, QC, [4]OMAFRA, Harrow, ON ABSTRACT Repetitive cultivation is often used to control weeds in crops such as lettuce. Cultivation is also essential in organic crops for which there is an increasing demand. Cultivation can increase weed emergence and increase or decrease seed persistence. A series of four repetitive cultivations has been shown to lower the weed seedbank by 15% in a sandy loam. However, few studies have quantified this effect in muck soils. This study evaluates the effect of two and four repetitive cultivations on weed emergence and the weed seedbank in muck soil. Cultivation treatments (0, 2 and 4 cultivations using a rototiller) were done in lettuce plots set in a completely randomized bloc design at the AAFC research farm in Ste-Clotilde-de-Châteauguay, Qc in 2017 and 2018. Weeds were counted by species in 50 × 50 cm quadrats (same location every year). Seeds of two weed species (*Ambrosia artemisiifolia* and *Amaranthus retroflexus*) were sown in the quadrats at the beginning of the experiment. Soil samples were also collected before the beginning of the experiment and after each growing season and disposed in the greenhouse to evaluate the seedbank. Results show cultivation modified emergence patterns. Results indicate the total seedbank was not significantly reduced after the first year.
26	Lessons learned from over 35 years of working with farmers. Steve Johns
27	The perpetual motion of plant interactions. Dr. Clarence Swanton
28	Current and future use of imaging and data collection tools along with analytical techniques for crop protection. Dr. Scott Noble
29	Hyperspectral imaging to detect herbicide resistant Palmer amaranth. Dr. Maor Matzrafi
30	MANAGING RESISTANCE WITH SPRAY APPLICATION TECHNOLOGY. Tom Wolf*; Agrimetrix Research & Training, Saskatoon, SK ABSTRACT It has been reported that the repeated use of sublethal herbicide doses can accelerate the development of resistant weed populations for outcrossing species such as rigid ryegrass (*Lolium rigidum*), palmer amaranth (*Amaranthus palmeri*), waterhemp (*Amaranthus tuberculatus*), and kochia (*Kochia scoparia*). Herbicide dose

	reaching the weeds can be sub-lethal for to a number of reasons, including poor nozzle patternation (linked to spray pressure, boom height, and boom sway), lack of canopy penetration by the spray, or spray movement due to wind. Recent research has shown that spray displacement due to sprayer-induced turbulence can also reduce herbicide dose. Most of these examples refer to one-time, possibly random occurrences of sublethal dosing. Repeated, year-after-year dose reduction at the same location may occur due to topographical features such as uneven terrain, causing recurring suboptimal boom height. Effective boom levelling technologies are required to minimize these effects. Of particular importance are land features requiring a sprayer turn. Any turn will cause the outer boom regions to travel faster than the tractor unit, causing under-dosing. This effect is more pronounced with tighter turns and wider boom widths, and can result in a loss of dose of over 50%. This presentation will report on new research that documents spray deposit uniformity for a number of these examples, and identifies strategies for minimizing this problem. The roles of pulse-width modulation and optical spot spraying will be discussed as a possible tools to address herbicide under-dosing.
31	Advances in mechanical weed control and their effectiveness at weed removal. Dr. Steve Shirtliffe
32	All influence, No Authority: a how-to on leading and collaborating when you're not the boss. Kate Hyatt
33	Ethics, Agriculture and the Environment. Dr. Robert Zimdahl
34	WHAT IS A WEED ECOLOGIST DOING IN A LAB? – THE VALUE OF MOLECULAR APPROACHES FOR UNDERSTANDING PLANT INVASIONS. David R. Clements*[1], Razia Shaik[2], Xiaocheng Zhu[2], Leslie A. Weston[2]; [1]Trinity Western University, Langley, BC, [2]Charles Sturt University, Wagga Wagga, Australia ABSTRACT Weed ecologists are increasingly turning to molecular techniques to help understand plantinvasion and dispersal. Invasive plant species seldom represent a uniform, static entity as a monotype. It is difficult to evaluate ecotypic differences by simply observing phenotypes in the field or even using common garden experimentation. Historical records of plant invasions are sometimes vague, and there are many possibilities for the interplay between evolution within a taxa prior to and post introduction. We illustrate the value of utilizing advanced molecular techniques to understand invasion ecology using case studies – specifically the cucurbit melon (Cucurbitaceae) and *Echium* spp. (Boraginaceae) invasions in Australia and the pantropical invasion of the vine, *Mikania micrantha* (Asteraceae). These cases illustrate the importance of evaluation of the role of introduction history. Some species (e.g., *M. micrantha*, *Cucumis myriocarpus* and *C. lanatus*) turn out to be much more uniform genetically in their invaded range than their native range. The management implications for these existing invasions are clear – genetically uniform populations may be more easily managed, particularly if considering biocontrol

	strategies. More generally, if new invasions can be contained by rapid response, it might be possible to avoid the Pandora's box resulting from the introduction of multiple genotypes.
35	WEED POPULATION BIOLOGY: USING A BASIC UNDERSTANDING OF PHYSIOLOGY AND MOLECULAR BIOLOGY TO EXPLORE LONG TERM TRENDS IN RESISTANCE. Eric R. Page*, Sydney Meloche; Agriculture and Agri-Food Canada, Harrow, ON ABSTRACT Herbicide resistance research is often myopic. Following the initial description of a resistant biotype, its location and the molecular mechanism conferring resistance, questions around the long term persistence of the resistance trait are rarely addressed. Take Canada fleabane for example, the glyphosate resistant biotype of this species is currently a ubiquitous sight in crop fields across southern Ontario, yet the first herbicide to which Ontario fleabane populations became resistant was paraquat back in 1993. Although the frequency and abundance of this biotype never reached the levels currently observed for glyphsoate resistant fleabane, at its peak in the late 1990's the paraquat resistant biotype made up over 90% of the fleabane population on the grounds of the Harrow Research and Development Centre. As the use of paraquat waned and glyphosate's accelerated, the paraquat resistant biotype was effectively managed into a non-issue. The purpose of this research was to determine, 25 years on, what proportion of the Canada fleabane population on the Harrow Research and Development Centre are currently paraquat or glyphoate resistant and to examine how management practices influence the persistence of herbicide resistant traits following the removal or reduction of the selection pressure.
36	MOLECULAR DIAGNOSTICS AND GENETICS OF HERBICIDE RESISTANT WEEDS. Martin Laforest*[1], Marie-Josee Simard[2], Eric R. Page[3], Rob E. Nurse[3], Kristen A. Obeid[4]; [1]Agriculture and Agri-Food Canada, St-Jean-sur-Richelieu, QC, [2]AAFC, Saint-Jean-sur-Richelieu, QC, [3]Agriculture and Agri-Food Canada, Harrow, ON, [4]OMAFRA, Harrow, ON ABSTRACT For decades now, herbicide use has put pressure on weeds that have evolved resistance. Many researchers have focused on these resistant weed species to better understand the mechanisms of resistance, distribution and behavior in various conditions. New methods for the rapid detection of herbicide resistant cases have resulted from this work. However, much remains to be done as many mechanisms of resistance are still elusive. Weed science is on the verge of transitioning into the post-genomics era as more and more efforts are geared toward the sequencing of complete genomes. This new knowledge will provide new tools to better understand the biology of herbicide resistance but also poses new challenges and may require the adoption of new technologies.

37	DECIPHERING THE EVOLUTIONARY MECHANISMS DRIVING THE SPREAD OF GLYPHOSATE RESISTANT *AMARANTHUS TUBERCULATUS*. Julia M. Kreiner*; University of Toronto, Toronto, ON ABSTRACT
38	MANAGEMENT OF GLYPHOSATE RESISTANT COMMON WATERHEMP (*AMARANTHUS RUDIS*) WITH THE ENLIST™ SYSTEM IN SOYBEAN. Jamshid Ashigh*[1], Laura Smith[2], Michael Vanhie[3]; [1]Corteva Agriscience, London, ON, [2]Corteva Agriscience, Winnipeg, MB, [3]Corteva Agriscience, Thamesford, ON ABSTRACT The evolution of common waterhemp resistance to herbicide Groups 2, 5, 9 and 14 has reduced the number of effective herbicide options for the management of this troublesome weed in agricultural production systems of Ontario. The extended emergence period of common waterhemp during the growing season, warrants the need to evaluate herbicide programs that provide season-long control of this weed. With the Enlist™ system, 2,4-D, a group 4 herbicide, can be used for control of waterhemp and other broadleaf weeds. A three year study from 2016 to 2018 was conducted in several locations across southern Ontario to determine the robustness of the Enlist system for control of glyphosate-resistant common waterhemp in soybean. Acceptable season-long control (≥90%) of glyphosate-resistant common waterhemp was achieved across all years with a two-pass weed control system consisting of an application of a preemergence herbicide followed by a postemergence application of Enlist Duo™, a pre-mix of 2,4-D choline and glyphosate. *™ ® Trademark of Dow AgroSciences, DuPont or Pioneer, and their affiliated companies or their respective owners*.
39	MANAGEMENT OF GLYPHOSATE RESISTANT KOCHIA WITH ENLIST IN E3 SOYS. Michael Vanhie*[1], Laura Smith[2], Rory Degenhardt[3], Jamshid Ashigh[4], Andrew MacRae[5]; [1]Corteva Agriscience, Thamesford, ON, [2]Corteva Agriscience, Winnipeg, MB, [3]Corteva Agriscience, Edmonton, AB, [4]Corteva Agriscience, London, ON, [5]Corteva Agriscience, Auburn, NY ABSTRACT Management of Glyphosate-Resistant Kochia (*Bassia scoparia*) and other common Western Canada broadleaf weeds with Enlist™ System in Soybean. Michael Vanhie, Laura Smith, Jamshid Ashigh, and Andrew MacRae; Corteva Agriscience™, Agriculture Division of DowDuPont™, Calgary, AB Enlist E3™ soybeans contain herbicide resistant traits that offer growers more tools when combatting glyphosate-resistant and other broadleaf weeds common to the soybean growing regions of Western Canada. The Enlist E3 technology confers tolerance to 2,4-D, glyphosate, and glufosinate. Enlist Duo™ herbicide, a new

	proprietary low volatile formulation of 2,4-D choline and glyphosate, has been developed for use on Enlist E3 soybean. Experiments were established in Western Canada from 2014 to 2018, to evaluate control of redroot pigweed (*Amaranthus retroflexus*), wild buckwheat (*Polygonum convolvulus*) and glyphosate-resistant kochia (*Bassia scoparia* formally *Kochia scoparia*) and volunteer canola (*Brassica napus*) with two applications of Enlist Duo™ or with 2,4-D choline plus glufosinate applied to Enlist E3 soybean. Two applications of Enlist Duo provided 88% control of kochia, while the tank-mix of 2,4-D choline plus glufosinate was slightly better, at 94%. Control of wild buckwheat, pigweed and glyphosate-resistant volunteer canola were similar between Enlist Duo and 2,4-D plus glufosinate treatments, exceeding 85% control. Enlist E3 soybean offers Western Canada soybean growers new herbicide options to control many of the common yield reducing weeds, including weeds resistant to glyphosate. ™Trademark of the Dow Chemical Company ("Dow") or an affiliated company of Dow. Enlist E3 soybeans jointly developed by Dow AgroSciences LLC and MS Technologies.
40	TANKMIXTURE OF GLYPHOSATE WITH 2,4-D ACCENTUATES 2,4-D INJURY IN GLYPHOSATE-RESISTANT CORN. Peter Sikkema*, Christy Shropshire, Nader Soltani; University of Guelph, Ridgetown, ON ABSTRACT Six field trials were conducted at Ridgetown, Ontario over a two-year period (2015 and 2016) to determine the tolerance of two corn hybrids to 2,4-D (560 and 1120 g ai ha^{-1}) and glyphosate (1800 g ae ha^{-1}) applied alone or in combination at V1, V3 or V5. In DeKalb DKC52-61 corn, 2,4-D caused as much as 24, 16, 11 and 11% visible injury at 1 WAT, 2 WAT, 4 WA-C and 8 WA-C, respectively. Plant stand was not affected, but plant height decreased 5 cm at 560 g ai ha^{-1} and 7% at 1120 g ai ha^{-1}. As the application timing was delayed from V1 to V5, there was a trend to increase injury at both 2,4-D rates. Corn yield decreased 8% with 2,4-D applied at 560 g ai ha^{-1} and 12% at 1120 g ai ha^{-1}. In Pioneer P0094AM corn, 2,4-D caused as much as 16, 9, 7 and 7% visible injury at 1 WAT, 2 WAT, 4 WA-C and 89 WA-C, respectively. Plant height was not affected, but goosenecking and brace root malformation were increased as the rate of 2,4-D was increased. There was generally no difference between glyphosate rates (1800 vs 0 g ae ha^{-1}) at V1 corn stage but visible injury, goosenecking and brace root malformation at other application timings was as much as 15, 3 and 19% greater when 2,4-D was applied in a tankmixture with glyphosate, respectively. Yield was reduced 12% when 2,4-D (1120 g ai ha^{-1}) was applied with glyphosate in the tankmixture.
41	MANAGE RESISTANCE NOW, A RESISTANCE MANAGEMENT PLATFORM FOR CANADA'S AGRI-FOOD INDUSTRY. Danielle Soulard*; CropLife Canada, Ottawa, ON

	ABSTRACT
42	TORPEDO™ PLUS AMINOPYRALID FOR TOTAL VEGETATION CONTROL IN INDUSTRIAL LAND MANAGEMENT. Laura R. Smith*[1], Rory Degenhardt[2], Len Juras[3]; [1]Corteva Agriscience, Winnipeg, MB, [2]Corteva Agriscience, Edmonton, AB, [3]Corteva Agriscience, Saskatoon, AB ABSTRACT Torpedo, a pre-formulated wettable granule by Valent Canada Inc., combines pyroxasulfone (42.5% w/w) and flumioxazin (33.5% w/w) for the control of various problematic weed species in non-cropped areas. Experiments were established in Manitoba, Saskatchewan and Alberta, from 2016 to 2018, to determine the weed control benefits obtained when combining Torpedo with ClearView™ herbicide (aminopyralid at 52.5% w/w and metsulfuron at 9.45% w/w). Torpedo was applied at rates from 160-440 g ai/ha, ClearView™ at 105 g ai/ha, and all treatments were sprayed with glyphosate at 1920 g ae/ha, targeting kochia (*Bassia scoparia* formally *Kochia scoparia*), common dandelion (*Taraxacum officinale*), narrow leaf-hawksbeard (*Crepis tectorum*), witchgrass (*Panicum capillare*) and foxtail barley (*Hordeum jubatum*). The tank-mix of Torpedo and ClearView™ provided equivalent or greater control of all weed species compared to the products applied alone. The ClearView plus Torpedo tank-mix contains four active ingredients and four herbicide modes of actions (Group 2, 4, 14 and 15), providing a robust system to control both grass and broadleaf weed species and offering applicators more options for herbicide resistance management in non-cropped, fallow or industrial areas where total vegetation control is the goal. ™ Trademark of Dow AgroSciences, DuPont or Pioneer, or their affiliated companies or their respective owners.
43	ECOLOGICAL GOODS AND SERVICES OF WEEDS; DENITRIFICATION AND THE SOIL MICROBIAL COMMUNITY. Robert H. Gulden*[1], Mario Tenuta[2]; [1]University of Manitoba, Winnipeg, MB, [2]University of Manitoba, Winnipeg, MB ABSTRACT Plants exert direct and indirect species-specific effects on the soil microbial community which can affect soil function. Little is known about the degree of this phenomenon among common weeds and crops. To test this, a greenhouse study was initiated that focussed on the effect of chickweed, green foxtail and wheat on denitrification and aspects of the soil microbial community. All species were grown alone and as the two crop/weed combinations and at the end of the study, denitrification, aspects of the soil microbial community and plant biomass were determined. Despite relatively low biomass production, chickweed grown alone resulted in remarkable reductions in microbial biomass carbon and nitrogen causing a 2-fold elevation in microbial C:N ratio compared to the unplanted control. While not

	significantly different, lower nirK abundance was observed in this treatment as well. Compared to the unplanted control, the effects of wheat were intermediate and green foxtail treatments often did not vary from the unplanted control. Root biomass and soil moisture content alone did not explain the changes in denitrification and soil microbial community caused by chickweed, clearly indicating species-specific effects on soil function by this species.
44	A PATCHY LANDSCAPE: MUSINGS ON THE PROLIFERATION OF KOCHIA IN 2018. Charles M. Geddes*; Research Scientist, Lethbridge, AB ABSTRACT Kochia thrived in many areas of the prairie landscape this summer (2018), following the "perfect storm" of dry conditions in 2017 followed by variable weather in spring and summer 2018. Kochia populations inhabited many low-lying areas, in part due to saline tolerance, delayed germination, and reduced interference from less-tolerant crops. In other fields, kochia populations existed also outside of low-lying areas, suggesting patch expansion into regions of the field where the crop is more competitive. Undoubtedly, herbicide-resistance has contributed to increased abundance of kochia in western Canada; however, herbicide-resistance is not the only reason this weed thrives in prairie landscapes. This presentation will highlight how kochia biology has contributed to the recent proliferation of this weed in western Canada, and will include a brief summary of past and present research on kochia biology, herbicide-resistance, and management. This presentation aims to stimulate discussion to help guide the future direction of kochia research in Canada.
45	KOCHIA POPULATION GENETICS: PANMICTIC PRAIRIE POPULATIONS. Sara L. Martin*[1], Wei Wei[2], Leshawn Benedict[3], Connie A. Sauder[3], Hugh Beckie[4], Linda M. Hall[5]; [1]Agriculture and Agri-Food Canada, Ottawa, ON, [2]State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, Chinese Academy of Sciences, Beijing, China, Beijing, Peoples Republic, [3]AAFC, Ottawa, ON, [4]Australian Herbicide Resistance Initiative (AHRI), School of Agriculture and Environment, University of Western Australia,, Perth, Australia, [5]University of Alberta, Edmonton, AB ABSTRACT Kochia has successfully evolved resistances to four different herbicide modes of action. These resistances appear to spread quickly through kochia populations and could result in genetic bottlenecks, reduced standing genetic variation, and a reduced ability of populations to adapt further. Here we used double digest restriction enzyme associated sequencing to determine the level of gene flow among kochia populations, their levels of genetic diversity, and whether selection for glyphosate resistance resulting from an increase in copy number for the gene encoding the 5-enolpyruvylshikimate-3-phosphate synthase enzyme is associated with a reduction in genetic variation. We determined that populations from the Canadian Prairies show little to no genetic differentiation (F_{ST} = 0.01) and no correlation between genetic and

	geographic distance (r^2 = -0. 02 p = 0.56) indicating that there is high gene flow among populations and no population structure. There is some evidence that kochia populations are somewhat genetically depauperate in comparison to other weed species, but genetic diversity did not differ between populations and individuals with high or low 5-enolpyruvylshikimate-3-phosphate synthase copy number. While kochia is expected to be predominately outcrossing, the inbreeding coefficients suggest there are 23% fewer heterozygotes in these populations than expected, indicating that self-pollination rates may range up to 59%. We conclude any alleles for herbicide resistance will be able to spread quickly through the species' populations and that the spread of these alleles appears unlikely to reduce the overall genetic variation of these populations. However, given this level of gene flow among populations, populations are unlikely to adapt to local conditions or form ecotypes without extremely strong selection pressure.
46	BAKING SODA FOR WEED CONTROL. Gavin L. Graham*; NBDAAF, Fredericton, NB ABSTRACT Two trials were established in 2018, in separate production systems, to evaluate the use of sodium bicarbonate for weed control. One trial evaluated herbicide applications to dormant cranberry to control tree moss (*Climacium dendroides*). All treatments would be safe for use in cranberry production, if applied under the application conditions of this trial. Moss control was variable over the trial area. Sulfentrazone and to a lesser extent sodium carbonate peroxyhydrate were largely ineffective for the control of the moss species in this trial. Sodium bicarbonate treatments had a rate effect on the first and final three rating dates, where the higher rate provided significantly higher moss control. The high rate of sodium bicarbonate and flumioxazin were statistically similar by the end of the trial period, both providing adequate season long control of moss. The second trial evaluated liverwort (*Marchantia polymorpha*) control in nursery production of black spruce. All application methods would result in commercially acceptable crop injury over the rating period of this experiment. The high rate of sodium bicarbonate or the dusting treatment resulted in a commercially acceptable level of liverwort control over all rating periods. The lower rate offered a level of suppression by the end of the trial, with no different in application timings. Sodium carbonate peroxyhydrate suppressed liverwort, although the final level of weed control would not be commercially acceptable. Within both production systems, the feasibility of high water volumes used to apply the sodium bicarbonate and the registration path for a sodium bicarbonate product would need to be evaluated further. Sodium carbonate peroxyhydrate application rates were 5-40 times lower than the sodium bicarbonate treatments and were applied at a lower water volume, so future work should evaluate equivalent application conditions. Based on these limited trials, there is potential to explore a registration of sodium bicarbonate for moss and/or liverwort control.

47	MANITOBA REPORT. Tammy Jones.
48	ONTARIO FIELD CROP REPORT. Mike Cowbrough.
49	ONTARIO HORTICULTURAL CROP REPORT. Kristen Obeid.
50	SASKATCHEWAN REPORT. Clark Brenzil.
51	NOVA SCOTIA REPORT. Angela Gourd.
52	BRITISH COLUMBIA REPORT. Ken Sapsford.
53	RESPONSE OF WINTER WHEAT TO HERBICIDE PLUS FUNGICIDE PLUS AMMONIUM THIOSULPHATE TANKMIXES . Nader Soltani*, Dave Hooker, Peter Sikkema; University of Guelph, Ridgetown, ON ABSTRACT Co-application of herbicides with fungicides and foliar fertilizers can reduce application costs and increase input efficiency in winter wheat production. A study was conducted at six field sites near Exeter and Ridgetown, ON over a three-year period (2014, 2015 and 2016) to determine the effect of ammonium thiosulphate (ATS), various fungicides (azoxystrobin/propiconazole, trifloxystrobin/prothioconazole, or pyraclostrobin/metconazole), and various herbicides (bromoxynil/MCPA, thifensulfuron/tribenuron+MCPA, pyrasulfotole/bromoxynil, or 2,4-D/dichlorprop) applied alone and in tankmix combinations on winter wheat crop injury and grain yield. The treatments were applied using Hypro ULD120-02 flat-fan nozzles around Zadoks Growth Stage 30. The herbicides and fungicides caused <0.6% leaf injury when ATS was not added to the tankmix. When averaged across fungicides in ATS tankmixes, leaf injury 1 week after treatment application (WAA) was 3.5 to 3.7% with thifensulfuron/tribenuron and dichlorprop-P/2,4-D herbicides and 5.1 to 5.8% injury with bromoxynil/MCPA and thifensulfuron/tribenuron herbicides. On the three field sites with the highest leaf injury, a fungicide-ATS tankmix increased injury to 4.5% averaged across fungicides, and to 4.3% with a herbicide-ATS tankmix averaged across herbicides. Three-way tankmixes of herbicide-fungicide-ATS caused the highest injury (7.1%). Despite significant crop injury 1 WAA with some tankmixes, there was no evidence that grain yields were adversely affected. This study shows that the co-application of a three-way tankmix of ATS with fungicides (azoxystrobin/propiconazole, trifloxystrobin/prothioconazole, or pyraclostrobin/metconazole) and herbicides (bromoxynil/MCPA, thifensulfuron/tribenuron+MCPA, pyrasulfotole/bromoxynil, or dichlorprop-P/2,4-D) has the potential to cause considerable injury in winter wheat under some environmental conditions in Ontario, but the effect seems transient with no grain yield reductions detected.
54	SECONDARY SEED DORMANCY AND SEEDBANK PERSISTENCE IN *BRASSICA CARINATA*. Rebecca Dueck*[1], Robert H. Gulden[2]; [1]University of Manitoba, Winnipeg, MB, [2]University of Manitoba, Winnipeg, MB ABSTRACT

	Ethiopian mustard (*Brassica carinata*) is being developed into a specialty oil crop to produce biofuel. Among the *Brassica* crops, persistence of crop seed lost at harvest which lead to volunteer populations in subsequent years is well established. The degree to which this happens in *Brassica carinata*, however is not known. Laboratory and field experiments were established to investigate secondary seed dormancy and seedbank persistence. A number of *Brassica carinata* lines were compared to one *Brassica napus* and one *Brassica juncea* line. The lab experiments showed that *B. carinata* seed can be easily induced into secondary seed dormancy using the standard protocol developed for *B. napus*. Differences in the potential for *B. carinata* to be induced into secondary seed dormancy were observed among the genotypes examined. However, while differences in seedbank persistence were observed among some *B. carinata* lines at some sampling dates in the field study, seedbank decline slopes did not differ among the *B. carinata* lines. Seedbank persistence and decline slopes in *B. carinata* were similar to those observed in *B. juncea* and were significantly lower than those in the *B. napus* line. The potential for *Brassica carinata* to form persisting volunteer populations appears to be low.
55	WEED MANAGEMENT PRACTISES IN ANNUAL CROPPING SYSTEMS IN THE PRAIRIE PROVINCES. Julia Y. Leeson*; Agriculture and Agri-Food Canada, Saskatoon, SK ABSTRACT Producers in the Prairie Provinces have been advised to adopt various weed management practises to delay the development and spread of herbicide resistant weed biotypes. This poster documents the use of chemical, physical and cultural weed control practises in Alberta, Saskatchewan and Manitoba. The poster is based on preliminary analysis of data from management questionnaires completed by participants in the provincial weed surveys conducted in Saskatchewan in 2014 and 2015, Manitoba in 2016 and Alberta in 2017 (685, 106, and 306 responses, respectively). Based on the data presented, there is opportunity to increase understanding and adoption of weed management practises with the potential to delay the development and spread of herbicide resistant weed biotypes.
56	HERBICIDE EVALUATIONS FOR ONTARIO GROWN QUINOA. Rob E. Nurse*[1], Mike Cowbrough[2]; [1]Agriculture and Agri-Food Canada, Harrow, ON, [2]OMAFRA, Guelph, ON ABSTRACT Quinoa (*Chenopodium quinoa*), a potential new specialty crop for some Canadian growing regions, currently has no registered herbicides available to manage competitive weeds. Growers will require herbicide registrations that provide selective control of common lambsquarters (*Chenopodium album*) while having low phytotoxicity on quinoa. The first of two studies was conducted at Guelph and Harrow, ON in 2015 and 2016. This study evaluated the phytotoxic effects of eight herbicides at proposed 1x and 2x overlap doses for each herbicide. Of the eight herbicides evaluated only two of the herbicides (s-metolachlor and pendimethalin)

	were within a margin of crop safety that was considered acceptable. To better test how application timing affected crop safety a second trial was established at Harrow, ON in 2017 and 2018. S-metolachlor and pendimethalin were applied at 4 different timings: pre-emergence, cotyledon, 2 to 4 leaf, and 6 to 8 leaf stages of the crop. Results demonstrated that s-metolachlor had a good margin of crop safety at all application timings, while pendimethalin was only acceptable when applied at the 6 to 8 leaf stage.
57	SENSITIVITY OF DRY BEAN TO HERBICIDES APPLIED PREPLANT FOR GLYPHOSATE-RESISTANT CANADA FLEABANE CONTROL IN A STRIP-TILLAGE CROPPING SYSTEM. Nader Soltani*, Christy Shropshire, Peter Sikkema; University of Guelph, Ridgetown, ON ABSTRACT During 2016 and 2017, four field experiments were conducted at Huron Research Station in Exeter, Ontario to evaluate the sensitivity of dry beans, grown under a strip-tillage cropping system, to potential herbicides for the control of glyphosate-resistant (GR) horseweed. At 8 WAE, saflufenacil, metribuzin, saflufenacil + metribuzin, 2,4-D ester, flumetsulam, cloransulam-methyl, and chlorimuron-ethyl caused 13 to 32%, 8 to 52%, 32 to 53%, 5 to 7%, 13 to 21%, 16 to 29%, and 23 to 43% visible injury in dry beans evaluated, respectively. Saflufenacil decreased biomass per meter row 65% in kidney bean and 80% in white bean; metribuzin decreased biomass 82% in kidney bean and 50% in white bean; saflufenacil + metribuzin decreased biomass 88% in kidney bean, 68% in small red bean and 80% in white bean; and chlorimuron-ethyl decreased biomass 40% in white bean. There was no decrease in dry bean biomass per meter row with the other herbicides evaluated. Metribuzin and saflufenacil + metribuzin reduced kidney bean seed yield 72 and 76%, respectively. Saflufenacil + metribuzin, flumetsulam, cloransulam-methyl and chlorimuron-ethyl reduced small red bean seed yield 39, 27, 30, and 54%, respectively. Saflufenacil, metribuzin, saflufenacil + metribuzin, flumetsulam, cloransulam-methyl, and chlorimuron-ethyl reduced seed yield of white bean 52, 32, 62, 33, 42, and 62%, respectively. There was no decrease in dry bean yield with the other herbicides evaluated. Among herbicides evaluated, 2,4-D ester caused the least crop injury with no effect in dry bean seed yield.
58	TRICOTYLEDENOUS GIANT RAGWEED (*AMBROSIA TRIFIDA* L.). Eric R. Page*[1], Sydney Meloche[1], Jichul Bae[2], Jamie Larsen[3], Martin Laforest[4], Rob E. Nurse[1]; [1]Agriculture and Agri-Food Canada, Harrow, ON, [2]Agriculture and Agri-Food Canada, Agassiz, ON, [3]Agriculture and Agri-Food Canada, Harrow, ON, [4]Agriculture and Agri-Food Canada, St-Jean-sur-Richelieu, QC ABSTRACT Giant ragweed (*Ambrosia trifida* L.) is an annual monocarpic weed species that is native to North America. As a seedling, giant ragweed's most notable characteristic

	are its palmately lobed leaves that are initially oppositely arranged but frequently become alternate further up the main stem at later stages of development. While giant ragweed leaves most often have 3-5 lobes, there is a great deal of phenotypic plasticity that results in leaves with any number of lobes ranging from 0-5. Similarly, giant ragweed is most often classified as a dicotyledenous species, however as reported herein, there is also plasticity in cotyledon number and a tricotyledenous individual has been observed. The objective of the following communication is to describe and provide evidence for this unique phenotype and to discuss possible mechanisms underlying its phenology and physiology.
59	*THESIUM RAMOSUM* IN NORTH AMERICA: A COLLABORATIVE CANADA-U.S. WEED RISK ASSESSMENT. Katrina Entwistle*[1], Claire Wilson[2]; [1]Canadian Food Inspection Agency, Ottawa, ON, [2]Canadian Food Inspection Agency, Wolfville, NS ABSTRACT *Thesium ramosum* is a herbaceous, hemiparasitic plant with a wide host range. It is native to southeastern Europe and central Asia, where it grows in a variety of habitats such as parks, conservation areas, roadsides, trails, railways, and crop fields. The plant has been introduced outside of its natural range in Europe, and in North America where it was first reported in the U.S. in 1943 and Canada in 2001. In Canada, *Thesium ramosum* was discovered in Fish Creek Provincial Park in Calgary, Alberta and has since spread to hundreds of sites within the park, as well as surrounding areas. Its dispersal mechanisms are not known but possibilities include long-range transport as a contaminant of seed, grain, hay, or straw, or possibly in association with soil, foot, or vehicular traffic. Results of a collaborative Canada-U.S. weed risk assessment, using a predictive risk model developed by Koop et al. (2012), indicated that *Thesium ramosum* falls in the "minor invader" or "evaluate further" category, and is characterized as "high risk" after application of a secondary screening. There was considerable uncertainty associated with its establishment, spread, and impact potential in North America as information was lacking on many biological traits and impacts in its introduced range. A geographic analysis indicated that *Thesium ramosum* has the potential to establish in about 22.9% of Canada and 75.1% of the United States based on its current global range. Areas at risk in Canada include southern and central portions of most provinces, and all of the Maritimes. Given its "high risk" score, and geographic potential, *Thesium ramosum* has the potential to threaten native plant communities. Detector dogs have been used in survey efforts in Canada and research on control methods such as herbicide applications and hand-pulling is ongoing.
60	COMMERCIAL FORMULATIONS OF GLYPHOSATE, SAFLUFENACIL, SULFENTRAZONE, AND THEIR MIXTURES INFLUENCE SOIL MICROBIAL COMMUNITY STRUCTURE. Jonathan D. Rosset*[1], Robert H. Gulden[2]; [1]University of Manitoba, Winnipeg, MB, [2]University of Manitoba, Winnipeg, MB

	ABSTRACT Herbicides are important weed management tools and are applied either to aboveground plant growth or directly to the soil. In Canada, pre-applied herbicides are becoming more popular, and generally are applied directly to the soil. Off-target effects from these herbicides may be of environmental concern if they alter ecosystem functions provided by the soil microbial community. Yet, there is limited knowledge of how these herbicides interact with or influence the soil microbial community once applied to the soil. A microcosm experiment was designed to examine how certain commercial formulations of glyphosate, saflufenacil, sulfentrazone, and their mixtures influenced the soil microbial community structure. Carbon dioxide, nitrous oxide, and methane gaseous emission were collected from sealed microcosms 24 hours after herbicide treatments. Microcosms applied with sulfentrazone-containing treatments emitted the most carbon dioxide, followed by saflufenacil-containing treatments. Differences in methane and nitrous oxide emissions among treatments were negligible. At 2 and 10 days after application, microbial DNA was extracted from microcosms and the 5 and 7 most prominent soil fungal and bacterial phyla were quantified using real-time qPCR. The soil microbial community structure was influenced by time and herbicide treatments. Within the microbial community, time and herbicide treatment influenced bacterial community structure while fungal community structure varied only over time. The greatest influence on the bacterial community 2 days after application were observed from the saflufenacil treatments whereas the effects of glyphosate, alone and in mixtures, were more pronounced 10 days after application. Bacteroides, firmicutes, and α-proteobacteria were strongly associated with treatments 2 days after application. β-and γ-proteobacteria were more closely associated with glyphosate mixtures across both sampling times. Results from this exploratory work offers evidence of differential responses within the structure of the soil microbial community after herbicide application over time. Future investigations could examine additional soil function or isolate the effects of active ingredient versus commercial formulation on the observed effects.
61	QUANTITATIVE ASSAYS FOR *AMARANTHUS PALMERI* AND *A. TUBERCULATUS* DETECTION. Brent P. Murphy*, Dianne E. Plewa, Elizabeth Phillippi, Suzanne M. Bissonnette, Patrick Tranel; University of Illinois, Urbana, IL ABSTRACT The *Amaranthus* genus consists of as many as 70 species, including at least 10 common weedy species in the Great Plains region. Each species possesses a unique geographical range and the maintenance of this isolation is preferable to limit the spread of highly competitive species. Escapes of species beyond their native range has occurred within the *Amaranthus* genus, as observed with the 2016 introduction of *Amaranthus palmeri* into Iowa. Screening seed lots for weed-seed contaminants is necessary to minimize the probability that similar introductions occur in the future.

	The objective of this work is to develop high-throughput and quantitative molecular protocols for rapid identification of targeted *Amaranthus* spp. within mixed-seed samples. Markers were developed for the key weeds *A. palmeri* and *A. tuberculatus*. The markers were validated across a diverse collection of 12 *Amaranthus* spp., and used to construct a quantitative PCR (qPCR) assay. A high-efficiency, reliable seed DNA extraction procedure was developed and validated for 100-seed samples. When combined with the developed qPCR assay, the seed DNA extraction method allowed consistent detection of a single target seed in a pool of 100 total *Amaranthus* spp. seeds. The utilization of the developed protocol for targeted *Amaranthus* spp. detection in mixed seed lot samples are discussed.
62	THE USE OF CEREAL RYE (*SECALE CEREALE* L.) COVER CROPS TO CONTROL CANADA FLEABANE (*CONYZA CANADENSIS* (L.) CRONQ.). Theodore R. Vanhie*[1], François Tardif[1], Clarence Swanton[2], Mike Cowbrough[3]; [1]University of Guelph, Guelph, ON, [2]Professor, Guelph, ON, [3]OMAFRA, Guelph, ON ABSTRACT Canada fleabane is a concern among North American farmers, especially for no-till soybean producers. This is due to the development of fleabane populations with resistance to multiple herbicides, including glyphosate. Without tillage, the control of fleabane has utilized, almost exclusively, applications of glyphosate. The development of glyphosate-resistant populations in fields imposes severe management challenges, as other options are limited. This has forced producers to examine alternative approaches to control this weed. Observations made in recent years strongly suggest that rye might have a suppressive effect on fleabane that goes beyond a simple shading effect. This study's purpose is to examine this phenomenon further, and establish how rye cover crops can be incorporated with other weed management strategies, such as tillage and herbicides, to better control this weed across various field crops. Furthermore, the proposed research will try to understand the mechanism behind rye's suppressive effect, with the assumption that it is based on allelopathy. Two field trials have been conducted from Fall 2017 to Summer 2018. These trials had rye cover crops planted in the fall and spring and incorporated no-till and tillage treatments. One trial included the use of alternative cereal cover crops, whereas the other trial integrated herbicide treatments. The data acquired so far suggests that fall planted rye can reduce the emergence of fleabane and inhibit the growth of emerged plants in the subsequent season. These results are encouraging as it demonstrates that rye cover crops as a viable option to control fleabane in field crops.
63	INCREASING DURATION OF WEED FREE PERIOD AND CULTURAL WEED MANAGEMENT PRACTICES IN SOYBEAN [*GLYCINE MAX* (L.) MERR.] INFLUENCE THE WEED COMMUNITY STRUCTURE IN SOUTHERN MANITOBA. Jonathan D. Rosset*[1], Robert H. Gulden[2]; [1]University of Manitoba, Winnipeg, MB, [2]University of Manitoba, Winnipeg, MB

ABSTRACT

Cultural weed management strategies aim to increase a crop's competitive ability against weeds, yet little is known about how they influence the structure of the weed community. Individual field experiments were designed to test the effects of soybean row spacing, density, and cultivar on the end of the critical weed free period. Beginning at planting, treatments were kept weed-free for increasing time intervals after which the natural weed community was allowed to recruit and interfere with the crop for the remainder of the growing season. Weed community structure was determined by collecting aboveground biomass of each weed species at the R5 soybean development stage. The effects of increasing duration of weed-free period and cultural weed management practices on the weed community structure were determined using principal component analysis. Cultural weed management effects on the weed community were most pronounced when weeds were allowed to recruit immediately after soybeans were planted (weedy control) and progressively decreased as the weed-free duration increased. The soybean development stage at which the weed community structure converged (i.e. was no longer affected by cultural weed management) differed among the cultural techniques and site-years. For example, in the row spacing experiment, the weed community structure in narrow-row soybeans resembled that of the weed-free treatment one development stage sooner than in the wide-row treatments. On the other hand, in both the soybean density and cultivar studies, the weed community structure converged and resembled that of the weed-free control at the same soybean developmental stage in all treatments. Overall, cultural weed management treatments had a greater effect on the weed community structure in 2016 than in 2017, perhaps due to below average precipitation during the 2017 growing season. Increased competition from narrow-row and mid- and high-density appeared to shift the weed community towards species that have earlier recruitment periodicities. In conclusion, the time of weed management had the greatest effect on the weed community structure, but this was modified by cultural weed management techniques.

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