Canadian Weed Science Society
Société canadienne de malherbologie

71st Annual Meeting
November 20th to 23rd, 2017

71e Réunion annuelle
20 au 23 novembre 2017

The Radisson
Saskatoon, Saskatchewan

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Doug Fehr—Poster contest
Aaron Gerein—Local Sponsorship
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CWSS-SCM 2017 DAILY MEETING AGENDAS

Tuesday, November 21, 2017		
Day 1		
Moderator: Eric Page		
Title	**Speaker**	**Abstract #**
President's Welcome	Linda Hall	
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Heat LQ: A new tool for pre-harvest weed management in cereals	Andrew J. Reid	21

Horticulture and Specialty Crops		
Variation among vine crops in preemergence herbicide tolerance	Darren E. Robinson	22
Weed Control in Wild Blueberry	Gavin L. Graham	23

Industrial Vegetation and Rangeland Moderator: Laurel Perrott		
Title	**Speaker**	**#**
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The influence of producer management and industrial disturbance on grassland seed banks in Alberta	Lysandra A. Pyle	25
OcTTainTM XL for Broadleaf Weed Control on Industrial and Other Non-Crop Areas of Canada.	Laura R. Smith	26
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PLENARY SESSION: REVOLUTIONIZING WEED SCIENCE WITH NEW TECHNOLOGIES

Plenary: Revolutionizing weed science with new technologies	
Moderators: Trish Meyers, Steve Shirtliffe	
Title	**Speaker**
Introduction	Steve Shirtliffe and Trish Meyers
Practical applications of Unmanned Aerial Vehicles (UAV) in site-specific weed management	Jesper Rasmussen (Department of Plant and Environmental Sciences at the University of Copenhagen)
Remote sensing in crop production	Kristina Polziehn (Axiom Agronomy Ltd.)
Bayer Digital Farming – Make Every Drop Count	Warren Bills (Bayer)
Focus on weeds, the modeling capability of ZedX in this area, and how digital tools will support growers in making weed management decision	Tracy Rowlandson (BASF)

BIOGRAPHIES AND/OR ABSTRACTS OF PLENARY SESSION SPEAKERS

Jesper Rasmussen

Dr. Jesper Rasmussen is an Associate Professor with the Department of Plant and Environmental Sciences at the University of Copenhagen in Copenhagen, Denmark. Jesper has worked with research and teaching at the university level since 1982 within a number of subjects related to arable farming with special emphasis on organic agriculture. Dr. Rasmussen is well recognized for his research on mechanical weed control. He is trained as a weed scientist but also works on conservation tillage, grasslands, and cultivars adapted to organic agriculture. In 2013, he initiated work on UAV imagery with focus on site-specific weed management and phenotyping. In 2016, his research team were able to implement pre-harvest control of perennial weeds in cereals based on maps generated from UAV images. Jesper's main approach to UAV imaging is that farmers should capture images locally and that all work operations from mission planning to the generation of the application map should be done within 3-6 minutes per hectare to make UAV imagery cost-effective.

Abstract: Practical applications of Unmanned Aerial Vehicles (UAV) in site-specific weed management. Jesper Rasmussen, University of Copenhagen, Denmark

The recent introduction of user-friendly UAVs enables new possibilities for weed mapping and site-specific weed management. Literature and practical experiences, however, are still scarce when it comes to the demonstration of benefits in commercial farming. In this presentation, all steps from flight planning and image acquisition to patch spraying are evaluated for site-specific control of Canada thistle (*Cirsium arvense*). Canada thistle is a common and highly competitive weed in Denmark, distributed in patches, sprayed with glyphosate before or after crop harvest, and controllable with mechanical methods after crop harvest. Furthermore, thistle patches are relatively stable from one year to the next, which allows the use of maps in the following year. Image acquisition with small consumer-grade UAVs is possible with a minimum of training and does not require specialists. For pre-harvest thistle mapping, the capacity is between 10 and 20 hectares per 20 minutes, which corresponds to the duration of one battery. Image pre-processing including mosaicking and geo-referencing are carried out with commercial software. Thistle detection is carried out with an in-house software, Thistle Tool, which is programmed in MaTLaB. Thistle Tool divides images into patches of around 1 m^2 and classify them into two categories: with or without thistles. More than 90 % accuracy in patch classification has been achieved under varying environmental conditions. The use of herbicide applications maps shows that sprayers with 3 m boom sections are able to target herbicides to the thistle patches with high precision. This demonstrates that UAV imagery is technically feasible in weed management and near-readily adoptable by end-users. For adoption by farmers, however, it is important that the whole workflow is developed into user-friendly procedures without too steep learning curves. Today, implementation is impeded by relatively complicated image extraction workflows, which involve multiple software packages and difficulties in loading the applications maps into the sprayers. In addition to thistle mapping, experiences with annual grass weed mapping in cereals is also presented. (Abstract # 35)

Kristina Polziehn

Kristina Polziehn from Sturgeon County, Alberta, recently named a 2017 Canadian Nuffield Scholar, holds a Master of Science Degree from University of Alberta with a background in plant science and agronomy. She is a Professional Agrologist (P.Ag.) and Certified Crop Advisor in Alberta as well as serves as a board member for the Alberta Institute of Agrologists and Canadian Weed Science Society. She is an independent agronomist with grain producers in northern Alberta. She began her company, Axiom Agronomy Ltd., in 2014 providing crop consulting, soil sampling and prescription nutrient mapping. She also serves as a dealer for AgPixel® in Alberta, assisting customers in acquiring, processing, and analyzing aerial agricultural data from unmanned aerial vehicles (UAV) and manned aircraft systems.

Warren Bills

Warren Bills has been involved in the Ag Technology space for over 10 years. Spending time in agronomy, research, sales, and agtech startups has rounded his career to bring knowledge and insight to farms and ag business. Warren is based out of Calgary, Alberta and manages Business Development for Bayer Digital Farming in Canada.

Simply put, helping agriculture evolve through its digital era is my passion. My energy and enthusiasm come through finding opportunity and building business solutions that fits cleanly into digital farming for farmers, agribusiness, and society.

His presentation title is “Bayer Digital Farming – Make Every Drop Count.”

Tracy L. Rowlandson

Tracy L. Rowlandson received a B.Sc. in Environmental Science from the University of Guelph in 2003 and a M.Sc. degree in Agricultural Meteorology from the University of Guelph in 2006. She completed her Ph.D. degree in Agricultural Meteorology in the Department of Agronomy at Iowa State University in 2011. She has worked in academia and private industry as an Agricultural Meteorologist, focusing on integrated pest management programs and satellite retrieval of soil moisture and vegetation characteristics.

Tracy is an Agricultural Meteorologist and has just been hired on the BASF/Zedex team.

CONCURRENT PLENARY BREAKOUT SESSIONS

There are two concurrent sessions for the afternoon. To accommodate all attendees in the two rooms, the coloured sticker on your name tag will indicate which session you will attend first. After the break, you will switch to the other session.

Status of Herbicide Resistance (Venice)		
Start Time	**End Time**	**Speaker**
Moderator: Clark Brenzil		
12:30	13:00	Hugh Beckie
13:00	13:30	Kelly Bennett
13:30	14:00	Breanne Tidemann
14:00	14:45	MOA & Crushed Seed Demo
14:45	15:00	Break
15:00	15:30	Hugh Beckie
15:30	16:00	Kelly Bennett
16:00	16:30	Breanne Tidemann
16:30	17:15	MOA & Crushed Seed Demo

Technology in Weed Science (Michelangelo C)		
Start Time	**End Time**	**Speaker**
Moderator: Cory Jacobs		
12:30	13:00	Tom Wolf
13:00	13:30	Cory Willness
13:30	14:00	Chris Neeser
14:00	14:45	Nozzle, Drone, and Research Demo
14:45	15:00	Break
15:00	15:30	Tom Wolf
15:30	16:00	Cory Willness
16:00	16:30	Chris Neeser
16:30	17:15	Nozzle, Drone, and Research Demo

Breanne D. Tidemann: Harvest weed seed control in Western Canada (Abstract # 36)
Kelly Bennett: Herbicide Resistance: Farmer Attitudes, Opinions & Use Patterns
Chris Neeser: Performance and cost of field scouting for weeds and diseases using imagery obtained with an Unmanned Aerial Vehicle (Abstract # 37)
Cory Willness: Soil, Water and Topography MAPS: Opportunities for Variable-rate Weed Control (Abstract # 38)

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Concurrent Sessions for Thursday

Thursday, November 23, 2017		
Corn, Soybean, and Edible Bean Moderator: Alan Kaastra		
Title	**Speaker**	**#**
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Effect of glyphosate timing, rate and tank mix partner on control of an annual ryegrass (*Lolium multiflorum*) cover crop. (presentation not given at meeting)	Darren E. Robinson	40
Precision Agriculture and the Diversity-Stability Hypothesis	Clarence J. Swanton	41
Corn, Soybean, and Edible Bean		
Control of glyphosate-resistant waterhemp in glufosinate, glyphosate/dicamba, glyphosate/2,4-D and mesotrione/glufosinate/isoxaflutole-resistant soybean	Peter H. Sikkema	42
Alternative approaches to the control of glyphosate resistant Canada fleabane. (presentation not given at meeting)	François Tardif	43
ZIDUA SC - A new herbicide for residual weed control in corn and soybean.	Mark Oostlander	44

Regulatory
Moderator: Chis Neeser

Abstracts: Gavin Graham (Abstract # 45)

Posters

#	Title	Author(s)
46	ACCASE Resistant Green Foxtail (*Setaria viridis (L.) P. Beauv*) in a Long-Term Rotation Study with Different In-Crop Herbicide Use Intensities.	Deanna J. McLennan*[1], Robert Gulden[2]; [1]University of Manitoba, Mather, MB, [2]University of Manitoba, Winnipeg, MB
47	Do soil characteristics influence weed seed mortality?	Geddes, Charles M *, Gulden, Robert, University of Manitoba.
48	Dynamics of Vegetation, Biological Soil Crusts, and Seed Banks along Pipelines in Southern Alberta's Mixedgrass Prairie.	Lysandra A. Pyle*, Edward Bork, Linda Hall; University of Alberta, Edmonton, AB
49	Evaluation of Herbicide Damage to Fababean Using UAV Imagery.	HEMA S. DUDDU*[1], Austin McGill[2], Menglu Wang[2], Eric Johnson[2], Steven J. Shirtliffe[2]; [1]UNIVERSITY OF SASKATCHEWAN, SASKATOON, SK, [2]University of Saskatchewan, Saskatoon, SK
50	Impact of Late Emerging Weeds on the Yield of Glyphosate-Resistant Soybean.	Soltani, Nader *[1], Amit, Jhala[2], Robert E. Nurse[3], Peter H. Sikkema[1], [1]University of Guelph, Ridgetown, ON, [2]University of Nebraska, [3] Agriculture and Agri-Food Canada, Harrow, ON
51	Impact of Pulse and Canola Frequency in a Crop Rotation on Weed Biomass, Weed Density and Shift in Weed Populations - Preliminary Report.	William E. May*; Agriculture and Agri-Food Canada, Indian Head, SK
52	Life-Cycle Analysis and Fitness Characteristics of Glyphosate Susceptible and Resistant Common Ragweed (*Ambrosia artemisiifolia* L.).	Jichul Bae*[1], Robert E. Nurse[2], Eric R. Page[3]; [1]Agriculture and Agri-Food Canada, Harrow, BC, [2]Agriculture Canada, Harrow, ON, [3]Agriculture and Agri-Food Canada, Harrow, ON
53	Potential Yield Loss from Weeds in Dry Beans in North America	Nader Soltani*[1], J. Anita Dille[2], Peter H. Sikkema[1]; [1]University of Guelph, Ridgetown, ON, [2]Kansas State University, Manhattan, KS
54	Residual Weed Population Shifts in Alberta – 1973 to 2017.	Julia Y. Leeson*[1], Linda Hall[2], Chris Neeser[3]; [1]Agriculture and Agri-Food Canada, Saskatoon, SK, [2]University of Alberta, Edmonton, AB, [3]Alberta Agriculture & Forestry, Brooks, AB

ABSTRACTS

1	**EVALUATION OF SPRING AND FALL HERBICIDE APPLICATIONS FOR RED SORREL (RUMEX ACETOSELLA L.) MANAGEMENT IN WILD BLUEBERRY (*VACCINIUM ANGUSTIFOLIUM* AIT.)**.. Rakesh K. Menapati*[1], Scott White[2]; [1]Masters student, Truro, NS, [2]Dalhousie University Faculty of Agriculture, Truro, NS Red sorrel is a common creeping herbaceous perennial weed in commercially managed wild blueberry fields in Nova Scotia, Canada. Flowering and seed production occurs primarily in overwintering ramet populations that establish following season-long ramet emergence from creeping roots. Fall herbicide applications may therefore reduce or prevent flowering and seed production in this species, whereasspring herbicide applications may help to suppress season long ramet emergence seedling emergence. The objectives of this researchare to i) evaluate herbicides for fall control of red sorrel ramet populations prior to overwintering, and ii) evaluate spring herbicide applications for suppression of season-long ramet emergence and seedling emergence in wild blueberry fields. Fall herbicides evaluated included propyzamide, glufosinate, dicamba, flumioxazin, flumioxazin + hexazinone, tribenuron-methyl, glyphosate, clopyralid, nicosulfuron/rimusulfuron, pyroxsulam, dichlobenil, and dicamba + diflufenzopyr. Spring herbicides included propyzamide, hexazinone, pyroxsulam, sulfentrazone, saflufenacil, glufosinate, indaziflam, hexazinone + pyroxsulam, hexazinone + saflufenacil, hexazinone + glufosinate, hexazinone + indaziflam, hexazinone + sulfentrazone, and clopyralid. Fall and spring herbicide applications were made in early November 2015 and May 2016, respectively. Fall applications of dicamba, dichlobenil, glufosinate, and tribenuron-methyl significantly reduced overwintering and flowering ramet density in the year after application, and are tentatively recommended for red sorrel management in wild blueberry. Spring herbicide applications were less effective than fall applications, though propyzamide, hexazinone + indaziflam, hexazinone + sulfentrazone, and pyroxsulam significantly reduced total non-bearing year ramet density relative to the nontreated control. Results indicate that red sorrel will most effectively be managed by fall herbicide applications in wild blueberry, and additional research is required to determine acceptable spring herbicide treatments for this weed species.
2	**EVALUATION OF CHEMICAL AND MECHANICAL CONTROL STRATEGIES FOR JAPANESE KNOTWEED (*FALLOPIA JAPONICA*).** Tyler D. Jollimore*[1], Scott White[2], Vilis Nams[1], Lord Abbey[1]; [1]Dalhousie Faculty of Agriculture, Truro, NS, [2]Dalhousie University Faculty of Agriculture, Truro, NS Japanese knotweed (*Fallopia japonica*) is an invasive species in Europe and North America that frequently occurs near roads, waterways and other frequently disturbed locations. It causes significant disruption to ecosystems by reducing plant diversity, in addition to accelerating the erosion of riverbanks and shorelines. Three experiments were conducted in Bible Hill and Antigonish, NS, Canada to evaluate chemical and mechanical management strategies. With

	the objective of reducing knotweed stem density, height and diameter in 1x1 m plots, across two growing seasons. In repeated cutting, knotweed was: left standing, cut once or cut twice during the growing season. Application method compared the effectiveness of aminopyralid (2.4 g a.e / L) and glyphosate (9.0 g a.e / L) when applied at peak height, using spot application or a herbicide injection tool. Application timing compared the effectiveness of aminopyralid and glyphosate spot applications when conducted at peak height or when knotweed is cut and herbicide is applied one month later. The application of two cuttings caused significant reductions in knotweed density, height and diameter in Bible Hill. However, in Antigonish only height and diameter were significantly reduced. In application method, spot applications of herbicides were significantly more effective in reducing stem height and density compared to injection, in Bible Hill. No significant reductions were observed in any category in Antigonish. In application timing, application of aminopyralid or glyphosate at peak height caused significant reductions in knotweed stem density, height and diameter. Aminopyralid and glyphosate were equivalent in their ability to control knotweed. The application of a cutting treatment prior to herbicide application provided no additional benefit in control. It did however reduce the height of the knotweed, making herbicide easier to apply.
3	**EVALUATION OF FLAZASULFURON FOR FESCUE GRASS (*FESTUCA SPP.*) SUPPRESSION AND CROP TOLERANCE IN WILD BLUEBERRY (*VACCINIUM AUGUSTIFOLIUM* AIT.).** Linshan Zhang*[1], Scott White[2], Kris W. Pruski[1], Randall A. Olson[1]; [1]Dalhousie University, Truro, NS, [2]Dalhousie University Faculty of Agriculture, Truro, NS A field experiment was conducted to evaluate the effect of flazasulfuron on blueberry crop safety and to determine the most suitable flazasulfuron application timing and rate to control fescue grass (*Festuca* spp.) in wild blueberry. Treatments consisted of flazasulfuron applied at 38 and 50g a.i ha^{-1} in fall of the bearing year and spring, summer, and fall of the non-bearing year. Propyzamide, terbacil and foramsulfuron were also included to evaluate flazasulfuron against currently available herbicides. Flazasulfuron can be safely used in wild blueberry fields at the rates evaluated at all indicated application timings. Spring non-bearing year flazasulfuron applications were more effective at reducing fescue grass in the non-bearing year when compared to fall bearing year flazasulfuron applications. Summer non-bearing year flazasulfuron application did not control fescue. Fall non-bearing year flazasulfuron applications reduced fescue density in the bearing year and did not cause blueberry injury, indicating potential use of this application timing to provide bearing year fescue suppression. Application rates of 38 and 50 g a.i. ha^{-1} did not significantly affect foramsulfuron efficacy, indicating that the lower rate is adequate for fescue management. Further studies are needed to determine the most optimum herbicide use patterns of flazasulfuron with other registered herbicides that could improve fescue grass management in wild blueberry.
4	**GLYPHOSATE-RESISTANT WATERHEMP (*AMARANTHUS TUBUCULATUS* VAR. *RUDIS*) CONTROL WITH SOIL APPLIED AND POST-EMERGENCE HERBICIDES IN CORN (*ZEA MAYS*).** Lauren Benoit*, Peter H. Sikkema, Darren E. Robinson, David C. Hooker; University of Guelph, Ridgetown, ON

	Waterhemp is the fourth glyphosate-resistant weed species in Ontario. Glyphosate-resistant (GR) waterhemp was first confirmed in Lambton County, Ontario in 2014; since then resistant populations have been confirmed in Essex, Chatham-Kent and Lambton counties. Multiple resistant populations to group 2, 5 and 9 herbicides have been documented in Ontario. Waterhemp is highly competitive species and if left uncontrolled can result in corn yield losses of up to 74%. The objective of this research was to evaluate 15 soil-applied and 12 post-emergence herbicides for control of waterhemp. Field studies at two different locations were completed in both 2016 and 2017. At 56 days after application (DAA) s-metolachlor/atrazine/mesotrione (2067 g.a.i. ha^{-1}) and s-metolachlor/atrazine/mesotrione/ bicyclopyrone (2025 g.a.i. ha^{-1}), applied preemergence, controlled GR waterhemp 90 and 95%, respectively. Postemergence applications, mesotrione + atrazine (100 g.a.i. ha^{-1} + 280 g.a.i. ha^{-1}) and dicamba/atrazine (1500 g.a.i. ha^{-1}), provided 93 and 88% control 56 DAA, respectively.
5	**CULTURAL WEED CONTROL IN SOYBEAN: DOES IT MATTER?** Jonathan D. Rosset*, Robert Gulden; University of Manitoba, Winnipeg, MB The Canadian Prairies are located at the northern fringe of the North American soybean (*Glycine max* (L.) Merr.) growing region. The development of short-season soybean varieties has enabled producers in Manitoba and eastern Saskatchewan to adopt the crop for primary grain production. Soybean production area in the prairie region has seen a six-fold increase over the last decade, and current production recommendations have been adopted from the warmer long-season soybean growing regions of North America. Soybean production in these areas have contributed to the selection of many herbicide-resistant (HR) weed biotypes. As part of a responsible, integrated weed management strategy, soybean production in the prairie region must adopt good agronomic practices to reduce selection pressure for HR weeds. Cultural weed management tools used to interfere with weeds and reduce selection pressure for HR weed biotypes include narrow row widths, high population densities, and competitive cultivars. This study evaluated the influence of row width (19 cm vs. 76 cm), population density (0.75, 1, and 1.5 times the recommended target density) and cultivar (erect, intermediate, and bushy) on the critical weed free period (CWFP) (i.e. the duration which a crop must be kept weed free to reach maximum yield potential) of soybean grown in the northern Great Plains region. Data from three experimental sites revealed that choosing narrow row widths or competitive cultivars can shorten the duration of the CWFP, while low population densities can lengthen the CWFP of soybean grown in the northern Great Plains region.
6	**BIOFUMIGATION AND *BRASSICA JUNCEA* COVER CROP IMPACTS ON WEED COMMUNITIES**. Maxime Lefebvre*; McGill University and IRDA, St-Bruno-de-Montarville, QC Biofumigation is an agronomic practice to control soil-borne pests and weeds mainly by releasing volatile isothiocyanates (ITCs) following *Brassica* tissues disruption. The aim of the project was to assess weed communities' response to biofumigation and interference of *Brassica juncea* cover crop. A three-year field experiment was carried out at the Research and Development Institute for the Agri-environment, St-Bruno-de-Montarville, QC, Canada. Indian

	mustard (*Brassica juncea* var. Caliente 199) was sown in the spring and in the fall, once or twice a year, compared to oat and to a control without cover crop. At the full flowering stage of mustard, weeds were identified and weed abundance and biomass were measured. In 2014, headspace gas chromatography-mass spectrometry analyses revealed that mustard tissues released 72.50 µg of allyl-ITC g^{-1}. In 2015 and 2016, quantities of ITCs released climbed up to 750.50 and 1219.50 µg of allyl-ITC g^{-1}, respectively. Weed establishment in spring cover crops was similar in all treatments in 2014. Mustard cover crops in 2015 slightly reduced weed establishment compared to oat and in 2016, reduction of weed establishment was significantly different from oat. Mustard cover crops sown in spring had greater interference than oat cover crop in 2015 and 2016 according to relative neighbor effect analyses. In spring 2016, species richness, Shannon-Weiner's and Simpson's biodiversity indexes were lower in the treatment were biofumigation was performed twice a year compared to oat. Principal coordinates analysis and permutational multivariate analysis of variance underlined significant changes in weed communities in 2016. Weed communities in the control and oat cover crop were different from those in the treatment where biofumigation was done twice. The results have shown the potential of biofumigation to reshape weed communities by its impact on weed establishment and interspecific interference, key processes of population dynamics. Biofumigation could be used efficiently and advisedly in an ecologically-based weed management system or for repression of susceptible weed species.
7	**EFFICACY OF CHEMICAL CONTROL METHODS ON GIANT HOGWEED.** Meghan Grguric*[1], Mike Cowbrough[2], François Tardif[1]; [1]University of Guelph, Guelph, ON, [2]OMAFRA, Guelph, ON Giant hogweed is a highly toxic and invasive plant that is of great concern because of its environmental, economic and public health impacts. Its persistence and ability to spread rapidly make it hard to manage. Glyphosate is an efficient broadcast herbicide for the control of this weed, but its lack of selectivity and soil persistence allow for seedlings to emerge later in the season and establish an overwintering root system. We hypothesize that residual selective herbicides exist that can provide adequate control over giant hogweed. Six trials were conducted at two locations within Ontario in May of 2016 and 2017. There were seven herbicides: Milestone (aminopyralid), Clearview (aminopyralid + metsulfuron), Sightline (aminopyralid + metsulfuron+ fluroxipyr), Lontrel (clopyralid), Garlon (triclopyr), Tordon (picloram), and Ally (metsulfuron-methyl). They were compared to Roundup (glyphosate) and Truvist (aminocyclopyrachlor +chlorsulfuron) applied as known positive controls. Data recorded were visible injury of treated plants and density of new seedlings, and grass species. Results indicate that the three following herbicides, Clearview, Garlon, and Tordon provided as good control as Roundup and Truvist while leaving the grass cover intact and reducing seedling recruitment. If spring control is missed, other late season options such as herbicide injection are necessary to prevent seed dispersal. We hypothesize that herbicides which were successful as a broadcast control against giant hogweed will also provide adequate control as an injectable. Three trials were conducted at three locations in 2017. There were three herbicides: Clearview, Garlon and Truvist. They were compared to Roundup applied as a known positive

	control. Treatments were applied in late June to flowering plants at three rates. Data recorded was visible injury of treated plants. None of the treatments tested were as efficient as Roundup for herbicide injection control.
8	**CONTROL OF GLYPHOSATE-RESISTANT WATERHEMP (AMARANTHUS TUBERCULATUS VAR. RUDIS) IN ONTARIO WITH THE ROUNDUP READY 2 XTEND CROP SYSTEM**. Brittany Hedges*, Peter H. Sikkema, Darren E. Robinson, David C. Hooker; University of Guelph, Ridgetown, ON Waterhemp is a small-seeded broadleaf weed, which emerges throughout the growing season. Glyphosate resistant (GR) waterhemp was discovered in Ontario in 2014. If left uncontrolled, yield decreases of up to 73% have been observed. Dicamba and glyphosate-resistant soybean (Roundup Ready 2 Xtend soybean) allow for dicamba to be applied pre-plant, pre-emergent (PRE) and/or post-emergent (POST). The objective of this study was to determine the control of GR waterhemp in dicamba-resistant soybean with more than one herbicide mode of action applied PRE or in a two-pass system (PRE fb POST), with glyphosate/dicamba (Roundup Xtend) applied POST. At 56 days after application (DAA), glyphosate/dicamba (1800 g ae ha^{-1}), pyroxasulfone (150 g ai ha^{-1}), s-metolachlor/metribuzin (1943 g ai ha^{-1}), pyroxasulfone/sulfentrazone (300 g ai ha^{-1}), and flumioxazin/pyroxasulfone (240 g ai ha^{-1}) controlled GR waterhemp 44, 80, 87, 91 and 96%, respectively. The addition of glyphosate/dicamba to pyroxasulfone, s-metolachlor/metribuzin, pyroxasulfone/sulfentrazone and flumioxazin/pyroxasulfone PRE controlled GR waterhemp 84, 89, 91 and 92%, respectively. In a two-pass program, pyroxasulfone, s-metolachlor/metribuzin, pyroxasulfone/sulfentrazone and flumioxazin/pyroxasulfone PRE controlled GR waterhemp 68, 80, 77 and 84%, respectively. The same PRE herbicides, followed by glyphosate/dicamba (1800 g ae ha^{-1}) POST, improved control of GR waterhemp to 93, 99, 98 and 99%, respectively. In conclusion, the addition of glyphosate/dicamba pyroxasulfone, s-metolachlor/metribuzin and pyroxasulfone/sulfentrazone applied PRE, resulted in a small increase in GR waterhemp control. Additionally, a two-pass program of an effective soil applied herbicide followed by glyphosate/dicamba POST controlled GR waterhemp >85%.
9	**WEED MANAGEMENT IN ORGANIC PULSES: THE INTEGRATED APPROACH.** Oleksandr Alba*; Saskatoon, SK Weed management is one of the biggest challenges for organic producers worldwide. Organic producers tend to rely heavily on mechanical weed control (MWC) and cultural methods as they are the only option for weed control in organic systems. Currently, there are sufficient recommendations for use of mechanical weed control tools such as rotary hoe (RH), harrow (H), inter-row cultivation (IT) separately. Additionally, there have been several studies examining the cultural weed control practice of increased crop seeding rate. However, these mechanical and cultural weed control methods have not been directly compared or tested in combination. The study was conducted during the 2016 – 2017 field seasons at three locations: Kernen Crop Research Farm, Goodale Research Farm near Saskatoon and producers land at Hunter, SK.

	Mechanical weed control with rotary hoe, flex tine harrow and steerable inter-row cultivator was applied as single, paired and multiple combination treatments in field pea and lentil grown under recommended conventional and organic seeding rates for Western Canada. Both MWC treatments and choice of organic seeding rate exhibited significant weed biomass suppression in comparison with untreated control in both field pea and lentil. Single MWC application with RH, H and IT cultivation resulted in insufficient weed control in both crops when compared to paired and multiple MWC combinations. Lentil yield increased 40% after two passes with RH in combination with single inter-row cultivation. In field pea all MWC treatments had relatively similar yield increase ranging from 39% to 50%, except IT cultivation where yield was just 35% higher than in untreated check. Yield response to organic seeding rate was 13% and 23% higher in field pea and lentil respectively when compared to conventional rate.
10	**CONQUERING LINURON RESISTANT PIGWEED IN CARROTS.** Tessa J. de Boer*, Clarence J. Swanton; University of Guelph, Guelph, ON Linuron resistant pigweed (*Amaranthus spp*.) is becoming an increasingly difficult weed for growers to control as there are few herbicides registered for use on carrots. If left uncontrolled, a 92-100% yield loss could occur. The objective of this research was to test the effectiveness of herbicides not yet registered for use on carrots and to test alternative timings of herbicides already registered to create a comprehensive weed control program for carrot growers. A field trial composed of 14 treatments was carried out at two locations in the Holland Marsh, Ontario over the 2016 and 2017 growing seasons. Injury and weed control was rated at approximately 7, 14, 21, and 56 days after crop emergence. During the 2016 season, all treatments provided excellent weed control with 3 out of the 14 treatments reducing yield. Fomesafen applied PRE is suspect of the yield reduction. During the 2017 season, which had significantly more rainfall than the 2016 season, treatments that included pethoxamid or carfentrazone applied PRE severely reduced carrot emergence when compared to the control. However, weed control was good for many of the treatments. Wick weeding was also assessed as a potential tool for carrot growers to use until new herbicides become available. In both 2016 and 2017 trials were established on a stand of weeds in the absence of crop to assess the effectiveness of one or two passes of glyphosate or dicamba. In addition, in 2017 a trial was established in a grower's carrot field near Grand Bend, Ontario. The grower was satisfied with the control wick weeding provided and would utilize this tool again. Both the experimental field trials and results from the grower trial proved the effectiveness of wick weeding.
11	**BIOLOGICALLY-EFFECTIVE DOSE OF TOLPYRALATE APPLIED POST-EMERGENCE FOR ANNUAL WEED CONTROL IN CORN (*ZEA MAYS* (L.)).** Brendan Metzger*[1], Alan Raeder[2], David C. Hooker[1], Darren E. Robinson[1], Peter H. Sikkema[1]; [1]University of Guelph, Ridgetown, ON, [2]ISK Biosciences, Cleveland, OH Tolpyralate is a 4-hydroxyphenyl-pyruvate dioxygenase (HPPD)-inhibiting herbicide under evaluation for post-emergence (POST) weed management in corn. A total of six field studies were conducted in Ontario over a three-year period (2015, 2016 and 2017), to determine the

	biologically-effective dose of tolpyralate for the control of seven annual weed species. Tolpyralate was applied POST alone at rates ranging from 3.75-120 g a.i. ha^{-1} or tank-mixed at a 1:33.3 ratio with atrazine at rates ranging from 125-4000 g ai ha^{-1}. Two industry standards, mesotrione plus atrazine and topramezone plus atrazine were included for comparison purposes. Regression analysis was conducted to determine the predicted tolpyralate, and tolpyralate + atrazine doses required to achieve >90% control of each species 8 weeks after application. The required rate of tolpyralate [g ai ha^{-1}] for 90% control is presented in parenthesis for the following species: velvetleaf (*Abutilon theophrasti* (Medik.)) [<3.75], common ragweed (*Ambrosia artemisiifolia* (L.)) [7.3], common lambsquarters (*Chenopodium album* (L.)) [5.6], green/redroot pigweed (*Amaranthus powellii* (S.) Wats.)/(*Amaranthus retroflexus* (L.)) [8.5], and green foxtail (*Setaria viridis* (L.) Beauv.) [15.5], wild mustard (*Sinapis arvensis* (L.)) [>120] and ladysthumb (*Polygonum persicaria* (L.)) [>120]. The required rate of tolpyralate plus atrazine [g a.i. ha^{-1}] for 90% control is presented in parenthesis for the following species: velvetleaf [<3.75 + <125], common lambsquarters [<3.75 + <125], common ragweed [6 + 194], green/redroot pigweed [6.1 + 198], wild mustard [7.6 + 245], green foxtail [11.7 + 377] and ladysthumb [13.5 + 436]. Based on these studies, tolpyralate + atrazine, applied POST, at the proposed label rate range of 30-40 + 500-1000 g a.i. ha^{-1} provides excellent broad-spectrum weed control in corn.
12	**PRE-EMERGENT HERBICIDE TOLERANCE IN SPRING-SOWN WINTER RYE**. Elizabeth M. Buck*[1], Darren E. Robinson[1], Peter H. Sikkema[1], Rene Van Acker[2], Nader Soltani[1]; [1]University of Guelph, Ridgetown, ON, [2]University of Guelph, Guelph, ON Cereal winter rye maintained vegetatively within a cash crop to form a living mulch can suppress inter-row broadleaf weeds when intersown in vegetable systems. Concerns regarding cereal rye's ability to suppress grass weeds and performance potential when co-establishing with dicotyledonous weeds makes pre-emergent herbicide use desirable. Spring sown winter cereal rye tolerance to s-metolachlor (600 & 1200 g ai/ha), EPTC (1700 & 3400 g ai/ha), dimethenamid-p (272 & 544 g ai/ha), and pendimethalin (540 & 1080 g ai/ha) was examined in Ridgetown, ON using a four-replicate RCBD over four site-years. No herbicide treatment significantly affected rye stand 1 week after emergence (WAE), ground cover 4 WAE, and height 4 WAE. Dimethenamid-p 272 g ai/ha produced significantly less rye biomass than pendimethalin 1080 g ai/ha, but neither differed from the untreated control. A trial-treatment interaction significantly affected rye ground cover 2 WAE; dimethenamid-p 272 g ai/ha in site-year 1 differed from pendimethalin 1080 g ai/ha in site-year 2 and s-metolachlor 1200 g ai/ha in site-year 4. These results indicate that spring-sown winter rye may be tolerant to commonly used vegetable pre-emergent herbicides, though this work should be repeated in wetter conditions and with higher rates.
13	**EVALUATION OF SEQUENTIAL MESOTRIONE APPLICATIONS AND HERBICIDE SPOT APPLICATIONS FOR GOLDENROD (*SOLIDAGO* SPP.) MANAGEMENT IN WILD BLUEBERRY.** Muhammad Hammad Farooq*[1], Scott White[2], Qamar Zaman[3], Nathan S. Boyd[4]; [1]Student, Truro, NS, [2]Dalhousie University Faculty of Agriculture, Truro, NS, [3]Dalhousie university, Truro, NS, [4]University of Florida, Wimauma, FL

	Goldenrods are the most common creeping herbaceous perennial weeds in wild blueberry fields in Atlantic Canada and reproduce through seeds extensive underground rhizomes. Currently, goldenrods found to be the most abundant in wild blueberry cropping due to lack of management plans, their rapid spread and limited control options. Field studies were therefore conducted in commercial wild blueberry fields in 2016 and 2017 to evaluate the efficacy of sequential mesotrione applications and herbicide spot applications on goldenrods control. Mesotrione application timings were at 30 cm shoot height followed by a sequential mesotrione application at 7, 14, 21, and 28 days after initial application (DAIA). Postemergence spot applications of glyphosate, dicamba, dicamba plus diflufenzopyr, triclopyr, glufosinate, foramsulfuron, mesotrione, clopyralid, tribenuron methyl, flazasulfuron and bicyclopyrone were applied at the floral bud stage. Preliminary results indicated that broadcast application of mesotrione at 144 g a.i ha^{-1} in 200 L ha^{-1} water followed by sequential mesotrione application at 14 and 21 DAIA provided >95% control of goldenrod shoots. Postemergence spot applications of bicyclopyrone, clopyralid, and dicamba caused 80 to 90% goldenrod shoot injury, but <70% of treated plants died. In contrast, spot applications of glyphosate, glufosinate, mesotrione, and flazasulfuron provided complete control of treated goldenrod shoots.
14	**RESIDUAL EFFECTS OF S-METOLACHLOR TANK MIXES ON ANNUAL RYE GRASS AND RED CLOVER INTERSEEDED INTO 4-5 LEAF CORN.** Sydney M. Wardell*, Peter H. Sikkema, Darren E. Robinson; University of Guelph, Ridgetown, ON Cover crops such as annual rye grass (*Lolium multiflorum* Lam.) and red clover (*Trifolium pretense* L.) may be interseeded into corn (*Zea mays* L.) for soil improvement, erosion control and weed suppression. However, this practice has the potential to reduce corn yield, and some corn herbicides may have adverse effects on the cover crops. The study objective is to examine the residual effects of preemergent s-metolachlor tank mixes on cover crop growth, the competitiveness with emerging weeds of red clover and annual rye grass interseeded into 4-5 leaf corn, and corn yield. Two field studies were conducted in 2016 and 2017 at the University of Guelph Ridgetown Campus over two sites with differing soil types. Red clover exhibited 92% to 99% visible injury over all herbicide treatments, and annual rye grass visible injury was 77% to 95%. Monocot and dicot weed counts and biomass were significantly lower in the herbicide treatments than the herbicide-free control; our preliminary findings indicate that weed suppression may be primarily due to herbicide treatments. Grain corn yields ranged from 10.8 to 11.6 t ha-1 and were not affected by the cover crops or herbicide treatments evaluated in 2016.
15	**SASKATCHEWAN WEED SURVEY OF HERBICIDE-RESISTANT WEEDS IN 2014-15.** Hugh J. Beckie*, Julia Y. Leeson; Agriculture and Agri-Food Canada, Saskatoon, SK A weed resistance survey was conducted in 400 randomly selected fields in Saskatchewan in 2014 and 2015. Samples of 18 weed species were screened in pot assays in the greenhouse using Group 1 or Group 2 herbicides (tier-1 screening). Overall 57% (227/400) of surveyed

	fields had a herbicide-resistant (HR) weed biotype, compared with 31% of fields in 2009 and 10% of fields in 2003. Of 301 fields where wild oat (*Avena fatua* L.) was collected, 65% had an HR population (49% of the 400 surveyed fields). Group 1-HR wild oat was confirmed in 59% of fields where the weed was sampled (45% of all 400 surveyed fields). Group 2-HR wild oat was found in 32% of fields sampled (21% of all surveyed fields). Group 1+2-HR wild oat was confirmed in 25% of fields where wild oat was sampled (16% of all surveyed fields). Of 104 fields where green foxtail (*Setaria viridis* L.P. Beauv.) seeds were collected, 31% had an HR population. Group 1-HR green foxtail was found in 17% of fields, with Group 2-HR green foxtail in 15% of fields. This is the first survey in Saskatchewan to document Group 2 resistance in this weed. Six broadleaf weed species had Group 2-HR populations: 25% of fields with wild mustard (*Sinapis arvensis* L.), 23% with shepherd's-purse (*Capsella bursa-pastoris* (L.) Medik.), 20% with chickweed (*Stellaria media* (L.) Vill.), 20% with cleavers (*Galium* spp.), 14% with stinkweed (*Thlaspi arvense* L.), and 10% with redroot pigweed (*Amaranthus retroflexus* L.). This is the first survey in Saskatchewan to document redroot pigweed, shepherd's-purse and stinkweed populations with Group 2 resistance. Based on this survey, it is estimated that 4.8 million ha in Saskatchewan are infested with HR weeds, in a total field area of 8.7 million ha. The additional cost to manage HR weeds in Saskatchewan is estimated at $258 million annually.
16	**CREATING A RESISTANCE MANAGEMENT PLATFORM FOR CANADA'S AGRI-FOOD INDUSTRY CROPLIFE CANADA.** Maria Trainer, Carol Hannam, CropLife. Crop protection products – including herbicides, insecticides and fungicides – are vital tools used by growers to protect their crops. While crop protection products have allowed growers to effectively and economically control weeds, insects and diseases, certain patterns of use have rendered these products less effective. CropLife Canada recognizes the importance of ensuring that existing crop protection technologies are viable long into the future. As such, CropLife Canada has formed a Resistance Management Committee with the intent to develop a resistance management strategy in Canada which ensures product longevity while promoting proactive resistance management practices. From an industry perspective, the goal of CropLife Canada's Resistance Management Committee is to increase awareness of pest resistance while providing a reliable source of information for farmers, retailers and other stakeholders. In order to assist in the development of such resources, CropLife Canada has engaged Synthesis Agri-Food Network to conduct a scan of current resistance management practices, attitudes and awareness, beginning with a survey of Certified Crop Advisors across Canada and the Ordre des agronomes du Québec. In addition to presenting the results from the Certified Crop Advisor survey, CropLife Canada and Synthesis Agri-Food Network will discuss existing resistance management resources and the direction of future research.
17	**MANAGING WEED SEED PRODUCTION IN LENTIL AND WHEAT WITH ABOVE- AND IN-CANOPY CLIPPING.** Lena D. Syrovy*[1], Breanne D. Tidemann[2], Neil Harker[3], Steven J. Shirtliffe[1];

	[1]University of Saskatchewan, Saskatoon, SK, [2]Agriculture and Agri-food Canada, Lacombe, AB, [3]Agriculture and Agri-Food Canada, Lacombe, AB New weed control techniques are needed to improve weed control efficacy and reduce herbicide reliance in western Canadian field cropping systems. While chaff collection or pulverization can be effective in reducing weed seed dispersal, these techniques require a large percentage of weed seeds to be retained on plants at harvest, and can still result in large crop yield losses due to crop-weed competition during the growing season. Weed clipping is an in-crop technique that can be used either above the crop or selectively within the crop canopy, which may reduce weed seed production as well as competition between crop and weeds. To test this hypothesis a field study was conducted in Saskatoon, SK, and Lacombe, AB, in 2017 testing the effect of timing, frequency, and height of clipping on weed seed production and crop yield in a tall crop, wheat, and a short crop, lentil. Preliminary results from the 2017 season will be presented. The project will continue in Saskatoon and Lacombe in 2018.
18	**UTILITY OF ARYLEX™ ACTIVE HERBICIDES FOR CONTROL OF EMERGING WEED THREATS IN CANADIAN CEREAL CROPS.** Rory Degenhardt*[1], Jamshid Ashigh[2], Len T. Juras[3], Laura R. Smith[4], Andrew W. MacRae[4]; [1]Dow AgroSciences, Edmonton, AB, [2]Dow AgroSciences, London, ON, [3]Dow AgroSciences, Saskatoon, SK, [4]Dow AgroSciences, Winnipeg, MB Arylex™ active (halauxifen-methyl) is a synthetic auxin herbicide from the new arylpicolinate chemical family that has now been developed into four commercial herbicide products, Pixxaro™, Paradigm™, Rexade™ and Cirpreme™, for use in Canadian cereal crops. By pairing Arylex with other active ingredients, these herbicide products provide multiple mechanisms of action, with complementary, or in many cases overlapping, activity against a broad spectrum of annual, winter annual and perennial weeds. Between 2010 and 2017, Dow AgroSciences evaluated Arylex-containing herbicide products in small plot field research trials conducted across Canada for control of emerging weed threats, including field horsetail (*Equisetum arvense*), American dragonhead (*Dracocephalum parviflorum*), field violet (*Viola arvensis*), nightshade (*Solanum spp*.), field bindweed (*Convolvulus arvensis*), and barnyard grass (*Echinochloa crusgalli*). All of these weeds have shown increasing abundance in recent weed surveys, and for most there is very little information available to producers on herbicide control options. Arylex-containing herbicide products showed strong activity against these weeds, ranging from suppression to high-level control depending on the weed and the product. These Arylex-containing herbicides will provide Canadian farmers with new tools to control weeds such as field horsetail, American dragonhead, field violet, nightshade species, field bindweed and barnyard grass in their cereal crops. ™ Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow.
19	**FLUROXYPYR-BASED CONTROL OF KOCHIA FROM 1990-2014 IN WESTERN CANADA - PROVIDING CONTEXT TO HERBICIDE RESISTANCE DEVELOPMENT**. Len T. Juras*[1], Rory Degenhardt[2], Andrew W. MacRae[3], Jamshi Ashigh[4], Laura R. Smith[3]; [1]Dow AgroSciences, Saskatoon, SK, [2]Dow AgroSciences, Edmonton, AB, [3]Dow AgroSciences, Winnipeg, MB, [4]Dow AgroSciences, London, ON

	Commercial product launches of fluroxypyr-based products occurred in 1997 in Canada and 1999 in the USA. A comprehensive analysis of the Dow AgroSciences fluroxypyr historical research database from the Northern Great Plains and Western Canada during 1990 to 2014 was conducted to determine the expected control and variability in control of kochia by fluroxypyr applied alone at various rates in field situations and to determine the field GR-80. The second objective was to determine if a change or shift in the control of kochia by fluroxypyr applied alone occurred over time, comparing the 1990-1994 trial results to the 2010-2014 trial results. The fluroxypyr labelled rate (105 g ae/ha) for control of kochia averaged 84% control (visual ratings) four to six weeks after application (WAA) across all locations and years. The calculated GR-80 for fluroxypyr applied to control kochia was determined to be 80.6 g ae/ha. Although a fluroxypyr-resistant kochia biotype was first reported in the USA (Montana) in 1994, a summary of fluroxypyr field data (4-6 WAA) conducted with the most common rates did not show a significant change in levels of kochia control between the time periods 1990-1994 and 2010-2014. Given the documented rate of spread of Group 2 and Group 9 resistant kochia across the Northern Great Plains and Western Canada, the data suggest different interactions are at play in the evolution of fluroxypyr resistance in kochia.
20	**AN ADJUVANT SYSTEM TO IMPROVE HERBICIDE DEPOSITION, CANOPY PENETRATION AND REDUCE OFF TARGET LOSSES.** Gregory K. Dahl*[1], Raymond L. Pigati[2], Joe V. Gednalske[1], Lillian C. Magidow[1], Andrea C. Clark[1], Eric P. Spandl[2], David A. Van Dam[2]; [1]Winfield United, River Falls, WI, [2]Winfield United, Shoreview, MN A crop-based adjuvant has been developed that improved herbicide deposition, canopy penetration and reduced spray drift. The adjuvant was derived from vegetable oil. It has reduced the amount of fine spray particles without creating large droplets or thickening the spray mixture. The adjuvant has been shown to have this effect with many nozzle types, sizes and spray mixtures. Fluorescent dye was added to spray mixtures to illustrate the differences in canopy penetration when the deposition adjuvant was added or not added to the spray mixtures. Pictures taken of plants sprayed a mixture containing the fluorescent dye showed coverage farther down in the canopy than when the adjuvant was not used. Spray mixtures were sprayed aerially to compare and analyze the deposition, swath displacement and off target movement. The study was conducted with an Air Tractor 502A with a spray boom with 36 CP 11 TT nozzles that operated at 276 kilopascals. The treatments were applied at 18.7 or 46.8 liters per hectare at 241 kilometers per hour per hour with a boom height of 3 meters. The airplane sprayed lengthwise on a grass runway surrounded by soybeans. Collectors were placed perpendicular to the flight path across the pattern. These were interspaced at 3 meter intervals including upwind, under the flight path and downwind. Kromocote cards were placed on collectors to evaluate deposition. Wind movement was perpendicular to the direction of the

	flight path. Each mixture was sprayed 4 times. Cards were collected between each pass. Videos of each pass with the airplane were made with a digital video camera. The mixtures applied included water and rhodamine dye at 250 milliliters per 100 liters. Certain adjuvants were included in the tank mixes and compared. The swath of the water treatment moved downwind and drifted notably as demonstrated both by video and on collection cards. The deposition adjuvant reduced the swath displacement and downwind drift as demonstrated by both the videos and the collection cards.
21	**HEAT LQ: A NEW TOOL FOR PRE-HARVEST WEED MANAGEMENT IN CEREALS.** Andrew J. Reid*; BASF Canada, Lethbridge, AB
22	**VARIATION AMONG VINE CROPS IN PREEMERGENCE HERBICIDE TOLERANCE.** Darren E. Robinson*, Kristen McNaughton; University of Guelph, Ridgetown, ON Variation among vine crops in preemergence herbicide tolerance.
23	**WEED CONTROL IN WILD BLUEBERRY**. Gavin L. Graham*; NBDAAF, Fredericton, NB Hawkweeds (*Hieracium* spp.) are becoming locally problematic in wild blueberry production, due to their low growth habit and low pH requirement. Multiple species and hybrids are present in production. Previous trial experience has shown a layered herbicide program can help manage these species. Due to simplicity and cost concerns, growers prefer a single pass, pre-emergent herbicide program. A trial was established in the F-block region of Northeastern New Brunswick to evaluate terbacil rate and tank mix partner effects on hawkweed control in wild blueberry production. A factorial design was used. The main factor was terbacil rate, either 0, 1200 or 2000 g ai/ha. The sub-factor was tank mix partner, either glufosinate (750 g ai/ha), clopyralid (151 g ai/ha), flazasulfuron (50 g ai/ha plus 0.25% v/v Agral 90) or no tank mix partner. Treatments were applied on May 18, 2017 to emerged hawkweed rosettes but before blueberry emergence. Terbacil rates were significantly different on the final 4 sprout year ratings, with higher suppression from higher rates. Clopyralid was the most effective tank mix by the end of the sprout year. Early control from glufosinate declined as the trial progressed. Flazasulfuron was not effective on the hawkweed species in the trial. Tank mixing may improve control, especially for glufosinate treatments. As terbacil is an expensive treatment, growers need to weigh the benefit of increased control with the additional costs. No pre-emergent treatment offered complete hawkweed control by the end of the sprout year, so additional trial work is warranted to evaluate fall herbicides and layering terbacil, glufosinate and clopyralid treatments.
24	**EVALUATION OF FLORASULAM, AND FLORASULAM TANK MIXTURES, IN WESTERN CANADA ALFALFA**. Andrew W. MacRae*[1], Len T. Juras[2], Rory Degenhardt[3], Laura R. Smith[4], Jamshid Ashigh[5]; [1]Dow Agrosciences LLC, Winnipeg, MB, [2]Dow AgroSciences, Saskatoon, SK, [3]Dow AgroSciences, Edmonton, AB, [4]Dow AgroSciences, Winnipeg, MB, [5]Dow AgroSciences, London, ON

	Florasulam (PrePass™ FLEX herbicide) is a Group 2 herbicide registered for use in pre-seed applications for spring wheat (including durum), spring barley, winter wheat, and tame oats in Western Canada. When used pre-plant florasulam is applied in combination with glyphosate (Group 9) and or Group 4 herbicides to provide multiple modes of action to broaden weed control spectrum. Late fall or early spring application of florasulam may provide control of difficult weeds, such as dandelion (*Taraxacum officinale*), that adversely impact alfalfa production in Western Canada. Studies were conducted in Western Canada to determine the optimum application timing in established alfalfa that minimized crop injury of florasulam alone or in combination with Group 4 herbicides. When applied alone, late fall applications of florasulam (after two hard frosts) resulted in the best crop tolerance on established alfalfa. Early spring applications (prior to initial spring alfalfa re-growth) to established alfalfa resulted in slightly greater injury initially, compared to late fall applications. However the crop quickly recovered and minimal injury was observed 4 to 6 weeks after application. Florasulam tank mixes applied after spring green-up were also evaluated. A tank mix of florasulam and MCPB+MCPA resulted in comparable crop injury to the MCPB+MCPA treatment applied alone. ™ Trademark of The Dow Chemical Company (“Dow”) or an affiliated company of Dow.
25	**THE INFLUENCE OF PRODUCER MANAGEMENT AND INDUSTRIAL DISTURBANCE ON GRASSLAND SEED BANKS IN ALBERTA.** Lysandra A. Pyle*, Edward Bork, Linda Hall; University of Alberta, Edmonton, AB Grassland seed banks are shaped through a multitude of disturbances that affect the aboveground species composition, reproductive output of flowering plants, and soil cover. Disturbances such as cultivation, fire, and pipeline installation can also have a legacy effect on seed bank composition. We will be describing germinable seed bank composition under disturbance regimes in north central Alberta’s Central Parkland and Dry Mixedwood natural subregions under divergent management regimes and the legacy of pipeline disturbance Mixedgrass prairie. In north central Alberta 102 pastures were sampled and land use history and current management was identified through producer interviews. Management factors with the potential to affect seed bank formation such as grazing systems, timing of grazing, livestock types, pasture seed mixtures, cultivation, pasture age, herbicide use, etc. were observed. Plant community composition and the corresponding rangeland health score was also assessed. In south eastern Alberta’s Mixedgrass prairie aspects of pipeline construction (age, width, and distance from the disturbance) were related to seed bank, plant community, and biological soil crust (lichens, mosses, spike-mosses, etc.) composition. Dynamics between these community layers, invasive species, and the role of ground cover components such as soil crusts will be discussed.
26	**OCTTAIN™ XL FOR BROADLEAF WEED CONTROL ON INDUSTRIAL AND OTHER NON-CROP AREAS OF CANADA.** Laura R. Smith*; Ashigh, J., Degenhardt, R.F., Juras, L.T., and MacRae, A.W. Dow AgroSciences Canada Inc., Calgary, AB. OcTTain™ XL herbicide, a combination of fluroxypyr-meptyl (90 g ae/L) plus 2,4-D ester (360 g ae/L), has recently been registered by Dow AgroSciences for use in rangeland, permanent

	pasture, industrial and other non-crop areas of Canada at a rate range of 720 to 1395 g ae/ha. OcTTain XL has been a proven broadleaf weed solution in cereal crops at a use rate of 495 g ae/ha, since its initial registration in 2011. Small plot research trials were conducted over several years in the northern USA and Canada to test OcTTain XL for the control of kochia (*Kochia scoparia* (L.)), specifically investigating the maximum weed size that is effectively controlled with the non-crop labelled rates. OcTTain XL at 1395 g ae/ha provided acceptable control of kochia up to 50 cm in height, while the 720 g ae/ha rate provided suppression of kochia up to 50 cm in height. Expansion of the OcTTain XL label to allow use on rangeland, permanent pasture and non-crop areas provides farmers and land managers with an additional option for the control of hard-to-kill broadleaf weeds, including kochia biotypes resistant to Group 2 and 9 herbicides, up to 50 cm in size. ™ Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow.
27	**HERBICIDE AND N FERTILIZATION CONTROL OF YELLOW TOADFLAX (*LINARIA VULGARIS*) AND HOARY ALYSSUM (*BERTEROA INCANA*) IN PERENNIAL FORAGE SYSTEMS**. Laurel A. Perrott*; Lakeland College, Vermilion, AB Yellow toadflax (*Linaria vulgaris*) and hoary alyssum (*Berteroa incana*) are noxious and prohibited noxious weeds, respectively, that reduce forage production. Selective herbicide control options for toadflax in perennial forage systems are limited and no selective herbicides are registered for hoary alyssum control in perennial forages. In 2017, pasture field experiments at five east and central Alberta locations tested the efficacy of four existing selective herbicides (aminocyclopyrachlor [ACPC] + metsulfuron; aminopyralid + 2,4-D + metsulfuron; dicamba + didflufenzopyr; picloram [toadflax only], and aminopyralid + 2,4-D [hoary alyssum only]); herbicide application timing (pre- and post-toadflax bloom); and N fertilization (0 or 100 kg ha^{-1} urease inhibitor treated N) on natural yellow toadflax and hoary alyssum populations in three factor (toadflax) and two factor (hoary alyssum) RCB designs. Visual control ratings (14, 28, and 56 days after application [DAA]) and population reduction were used to quantify weed control. Picloram was the only herbicide to achieve acceptable yellow toadflax control (82% visual control across sites when applied post-bloom) at the 56DAA rating. Post-bloom timing achieved 63% greater toadflax control than pre-bloom timing across sites and treatments, although application timing did not adequately improve the efficacy of the other herbicides on toadflax. Toadflax herbicide control was improved slightly by N fertilization when competitive forage populations were present, while control was reduced when forage populations were thin and non-competitive. All herbicides tested achieved adequate to excellent (85-100%) hoary alyssum control. Herbicide label expansions of these products will provide hoary alyssum management options to western Canadian forage producers. Post-bloom herbicide timing provides superior toadflax control, however, selective herbicide options for yellow toadflax in perennial forage systems remain limited.
28	**DO WEEDS ALTER SOYBEAN ADAPTIVE PLASTICITY TO SUBSEQUENT DROUGHT STRESS?** Andrew G. McKenzie-Gopsill*[1], Lewis Lukens[2], Elizabeth Lee[2], Clarence J. Swanton[2]; [1]Agriculture and Agri-Food Canada, Charlottetown, PE, [2]University of Guelph, Guelph, ON

	Phenotypic plasticity in response to stress may limit plastic responses to subsequent stresses. This may result in a maladapted phenotype, thereby limiting further expression of plasticity to subsequent stress. It was hypothesised that exposure of soybean (Glycine max (L.) Merr.) to far-red-enriched (FRE) light reflected from neighbouring weeds would reduce plasticity to subsequent drought stress. Soybean seedlings were grown in a field fertigation system and exposed to a simulated delay in early-season weed control followed by one or two drought stresses. In contrast to control plants, stem elongation induced by FRE light was maintained under drought stress. Stem elongation, however, did not result in a cost to fitness. In addition, no further interactions were found between FRE light and drought. Total biomass plant^{-1} was reduced by drought stress, which also altered biomass allocation between shoots and roots. Vegetative plasticity in response to drought, however, did not recover total biomass and resulted in a rapid, linear decline in seeds plant^{-1}. Reproductive plasticity in response to drought maintained seed weight despite losses in seeds plant^{-1}. These results demonstrate that the frequency, type and severity of stress influences the ability of soybean to express adaptive vegetative and reproductive plasticity such that delays in early-season weed control may not result in a maladapted phenotype to subsequent drought stress.
29	**INVESTIGATING MECHANISMS OF GLYPHOSATE RESISTANCE IN COMMON RAGWEED (*AMBROSIA ARTEMISIIFOLIA*).** Holly P. Byker*[1], Peter H. Sikkema[2], Nader Soltani[2], Darren E. Robinson[2]; [1]University of Guelph, RIDGETOWN, ON, [2]University of Guelph, Ridgetown, ON Common ragweed (Ambrosia artemisiifolia) was the third glyphosate-resistant weed reported in Ontario. Herbicide resistance mechanisms can be divided into two broad categories: target-site resistance (mutations in the target enzyme or gene amplification) and non-target-site resistance (reduced absorption, translocation or enhanced metabolism). This research seeks to investigate known mechanisms of glyphosate-resistance by comparing the Ontario glyphosate-resistant common ragweed biotype to an Ontario susceptible biotype through the following experiments: DNA sequencing of glyphosate's target site, looking for gene amplification using qPCR, tracking absorption/translocation using 14C-labelled glyphosate, and the evaluation of differences in breakdown metabolites using HPLC. Understanding the mechanism and inheritance of resistance will provide further insight into glyphosate's mode of action and aid in tracking the spread of resistant populations.
30	**ACETYL-COA CARBOXYLASE GENE AMPLIFICATION IN HERBICIDE RESISTANT CRABGRASS (*DIGITARIA SANGUINALIS*).** Martin Laforest*[1], Brahim Soufiane[2], Marie-Josee Simard[3], Kristen Obeid[4], Eric R. Page[5], Robert E. Nurse[6]; [1]Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, QC, [2]Agriculture and Agrifood Canada, St-Jean-sur-Richelieu, QC, [3]Agriculture and Agri-Food Canada, Saint-jean-sur-Richelieu, QC, [4]Ontario Ministry of Agriculture, Food and Rural Affairs, Harrow, ON, [5]Agriculture and Agri-Food Canada, Harrow, ON, [6]Agriculture Canada, Harrow, ON In 2011, Southern Ontario growers reported a lack of large crabgrass (*Digitaria sanguinalis*) control. In 2015, crabgrass seeds were collected from an onion field at Leamington, ON and tested positive for resistance to Acetyl-CoA Carboxylase (ACCase, WSSA group 1) inhibitors (up

	to 4X the labelled herbicide rate) although none of the target site mutations previously known to confer resistance were detected in the ACCase gene sequence. In order to determine gene differential expression that could explain herbicide resistance, we compared wildtype and resistant biotypes mRNAs using RNASeq. The RNASeq results were confirmed by Reverse-Transcriptase Quantitative PCR (qRT-PCR) and both indicate an increase in the level of expression of the ACCase gene in resistant biotypes. The number of transcripts was 3.4 to 9.3 times higher in the resistant biotype compared to the susceptible population. We pushed our analysis further and we tried to explain the higher level of ACCase gene expression since the high variability of ACCase transcript levels in the resistant plants could be indicative of a genomic architecture promoting higher expression. Quantitative PCR (qPCR) analyses confirmed ACCase gene duplication that there are five to seven times more copies in the resistant biotype compare to the susceptible biotype. A qPCR assay was developed that could serve as a diagnostic tool when ACCase inhibitor resistance is suspected for large crabgrass.
31	**THE CASE OF A GLYPHOSATE RESISTANCE TRANSGENE IN WEEDY *BRASSICA RAPA*: TEN YEARS LATER.** Marie-Josee Simard*[1], Martin Laforest[2], Marie-Edith Cuerrier[3]; [1]Agriculture and Agri-Food Canada, Saint-jean-sur-Richelieu, QC, [2]Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, QC, [3]Centre de recherche sur les grains (CÉROM) inc., St-Mathieu-de-Beloeil, QC Bird rape mustard (*Brassica rapa*) is a weed reported in the province of Québec since 1908. It is a close relative of the most widely grown species of canola, *B. napus*. Almost all of the canola grown in Québec is transgenic, glyphosate or glufosinate resistant. Crop-weed hybrids have been observed in 2001 in locations where the crop is grown and the weed was present. In 2005, the introgression of the transgene that confers glyphosate resistance was detected in a *B. rapa* plant located in one of the hybrid swarms identified in 2001 (near St-Henri, QC). In 2015, unidentified mustard plants growing in a glyphosate resistant corn field located near Victoriaville, less than 130 km southeast of St-Henri, survived a glyphosate application. The field history was recorded and seeds from this population were grown in the greenhouse at the CEROM research station located in Saint-Mathieu-de-Beloeil and at the AAFC Saint-Jean-sur-Richelieu research station. At the CEROM, seedlings were sprayed with 900 and 1800 g ae ha^{-1} of glyphosate. At the AAFC station, plants were grown to maturity to identify the mustard at the species level using morphological characteristics and generate leaf and seed material. Leaf samples were tested for the presence of the transgene and species-specific markers while seeds were tested for fatty acid and glucosinolate content. In 2017, leaf and seed material from unidentified mustard plants growing in two other glyphosate resistant fields (corn and soybean) located in the same area (near Victoriaville) was also sent for identification and genetic testing. All observations and tests indicate the glyphosate resistant mustards are bird rape populations that have the transgenic construct.
32	**POTENTIAL FOR GLYPHOSATE RESISTANCE IN BOHEMIAN KNOTWEED (*FALLOPIA X BOHEMICA*).** Matthew G. Strelau[1], David R. Clements*[2], Micaela Janse van Rensburg[1], Michael J. Bogress[1]; [1]Trinity Western University, Langley, BC, [2]Trinity Western University, Langley, BC

	Japanese knotweed, *Fallopia japonica*, is an East Asian perennial herb transported to North America approximately 100 years ago. The vigorous rhizome structure and extremely rapid growth has presented a difficult invasive issue creating significant property damage and impacts on local biodiversity. Being male-sterile in North America, the weed has generally only reproduced asexually but is often able to spread through anthropogenic soil transport. Through hybridization with the congeneric *Fallopia sachalinensis*, the offspring (*Fallopia* x *bohemica*) can produce viable seeds resulting in potential for long distance dispersal. The most widely applied herbicide for the control of knotweed is glyphosate. Due to heterosis and long-distance dispersal in this hybrid knotweed, there is potential for the development of herbicide resistance. Our study examined resistance and/or tolerance attributes in Bohemian knotweed. Rhizome fragments were collected from two populations of Bohemian knotweed in British Columbia's Fraser Valley, one with no record of glyphosate applications and a second that had been repeatedly sprayed with glyphosate in previous years. The fragments were propagated in soil to the 4-leaf stage and sprayed with glyphosate in a dose-response test. The populations were sprayed with 0X, 0.125X, 0.25X, 0.5X, 1X, 2X, and 4X the recommended dose (3560 g a.i. ha $^{-1}$). The response was measured using dry-weight as an assessment of biomass for each specimen. ANOVA failed to detect differences in a dose response between populations. A comparison of standard error among treatments showed a high degree of variance, negatively impacting the log-logistic analysis, i.e. failing to identify resistance or tolerance in knotweed for these particular populations. Comparison between populations did show a pronounced difference, with the previously sprayed population exhibiting consistently lower dry weight than the unsprayed population across various glyphosate doses. However, this difference in dry weight may be attributed to the difference in fresh weight means between the two populations. Populations may respond differently to glyphosate due to a combination of prior herbicide spray-history and genetic variation. Variation after transforming the data logarithmically and normalizing to a linear regression dose-response curve was too high. There was no difference in EC_{50} (P = 0.3030; F = 1.067); the EC_{50} is the same for both populations. Although this study failed to provide evidence of resistant traits in the particular populations of Bohemian knotweed in British Columbia tested, persistent usage of glyphosate may select for tolerant and resistant mechanisms. More diverse control methods, utilizing a variety of chemical treatments, mechanical removal, or biological control, must be considered when managing knotweed.
33	**SEED BANK PERSISTENCE, GERMINATION AND EARLY GROWTH OF GLYPHOSATE-RESISTANT KOCHIA.** Hugh J. Beckie*[1], Robert Blackshaw[2], Julia Y. Leeson[1], Phillip Stahlman[3], Todd Gaines[4], Eric Johnson[5]; [1]Agriculture and Agri-Food Canada, Saskatoon, SK, [2]Agriculture and Agri-Food Canada, Lethbridge, AB, [3]Kansas State University, Hays, KS, [4]Colorado State University, Fort Collins, CO, [5]University of Saskatchewan, Saskatoon, SK This study describes the seed bank persistence of glyphosate-resistant (GR) kochia at two sites in western Canada and examines if GR kochia from western Canada and mid-western United States differ from their susceptible counterparts in seed germination and early growth characteristics at low temperature regimes using a thermogradient plate. Site or depth of seed burial (surface, 2.5 cm, 10 cm) in the soil did not affect seed viability over time; time to 50 and

	90% loss of viability averaged 210 and 232 days, respectively. GR kochia generally germinated later and had lower cumulative germination than glyphosate-susceptible (GS) kochia from Saskatchewan and Kansas, but not Colorado. Similarly, time to 10% first leaf of GS kochia from Saskatchewan and Kansas tended to be sooner than that of GR kochia, with a greater percentage of GS vs. GR seedlings of populations from all regions having attained first leaf by the end of the experiment. The short seed bank longevity and delayed and reduced germination and time to first leaf of GR kochia may potentially be exploited to maximize management efficiency.
34	**LIFE AFTER GRAD SCHOOL - PATHWAYS TO PROSPERITY IN THE ACADEMY.** Christian J. Willenborg*; University of Saskatchewan, Saskatoon, SK Four (or more) years ago you enrolled in a PhD, with the intention of becoming an academic. Now, you are nearing the defense and it's time to find a job. This presentation will attempt to provide advice on becoming a prepared candidate. We will explore important areas of the CV, including what matters and what doesn't. We will discuss the job interview itself and finally, preparing for life in the academy as a young professor.
35	**PRACTICAL APPLICATIONS OF UNMANNED AERIAL VEHICLES (UAV) IN SITE-SPECIFIC WEED MANAGEMENT.** Jesper Rasmussen, University of Copenhagen, Denmark The recent introduction of user-friendly UAVs enables new possibilities for weed mapping and site-specific weed management. Literature and practical experiences, however, are still scarce when it comes to the demonstration of benefits in commercial farming. In this presentation, all steps from flight planning and image acquisition to patch spraying are evaluated for site-specific control of Canada thistle (*Cirsium arvense*). Canada thistle is a common and highly competitive weed in Denmark, distributed in patches, sprayed with glyphosate before or after crop harvest, and controllable with mechanical methods after crop harvest. Furthermore, thistle patches are relatively stable from one year to the next, which allows the use of maps in the following year. Image acquisition with small consumer-grade UAVs is possible with a minimum of training and does not require specialists. For pre-harvest thistle mapping, the capacity is between 10 and 20 hectares per 20 minutes, which corresponds to the duration of one battery. Image pre-processing including mosaicking and geo-referencing are carried out with commercial software. Thistle detection is carried out with an in-house software, Thistle Tool, which is programmed in MaTLaB. Thistle Tool divides images into patches of around 1 m^2 and classify them into two categories: with or without thistles. More than 90 % accuracy in patch classification has been achieved under varying environmental conditions. The use of herbicide applications maps shows that sprayers with 3 m boom sections are able to target herbicides to the thistle patches with high precision. This demonstrates that UAV imagery is technically feasible in weed management and near-readily adoptable by end-users. For adoption by farmers, however, it is important that the whole workflow is developed into user-friendly procedures without too steep learning curves. Today, implementation is impeded by relatively complicated image extraction workflows, which involve multiple software packages

	and difficulties in loading the applications maps into the sprayers. In addition to thistle mapping, experiences with annual grass weed mapping in cereals is also presented.
36	**HARVEST WEED SEED CONTROL IN WESTERN CANADA**. Breanne D. Tidemann*; Agriculture and Agri-food Canada, Lacombe, AB Harvest weed seed control (HWSC) is a new paradigm of weed control that aims to control those weed seeds remaining on the plant at the time of harvest, preventing their redistribution throughout the field. Efficacy of HWSC is limited by the retention of weed seeds on the plant until the time of harvest, and production of seeds at a collectable height in the crop canopy. Potential weeds to target with HWSC methods in western Canada will be identified. In addition, results of stationary threshing experiments with the Harrington Seed Destructor, one method of HWSC, will be presented indicating high efficacy on those weeds that are introduced into the machine. Lessons learned from the first field season of testing the Harrington Seed Destructor in the field will also be presented. Final thoughts on the potential for HWSC in western Canada will be given with time for discussion and questions.
37	**PERFORMANCE AND COST OF FIELD SCOUTING FOR WEEDS AND DISEASES USING IMAGERY OBTAINED WITH AN UNMANNED AERIAL VEHICLE.** Chris Neeser[1], Michael Harding[1], Naser El-Sheimy[2], Jan Zalud3 and Joe Chomistek, [1]Alberta Agriculture and Forestry, [2]University of Calgary, [3]JZ Aerial Inc Unmanned Aerial Vehicles (UAVs), also known as drones, are increasingly being marketed to farmers and crop consultants as a must have new tool. The promise is that knowledge gained by looking at fields from a bird's eye perspective will enable farmers to better understand yield limiting factors and to take corrective measures where needed. We designed this study with the objectives to examine the value of aerial images captured from a UAV for the purpose of scouting for weeds and diseases in a variety of crops. For each of six crops at two locations, a set of three images (early mid and late season) were taken at 180 m above ground level at a resolution that covered a 6 cm by 6 cm area on the ground for each pixel in the image. This is considered high resolution aerial imagery. However, for the purpose of early season weed scouting we found that this resolution is too coarse to detect the presence of small weeds, which is critical for optimal weed control recommendations. Further testing on much higher resolution images showed that weed density information could be extracted by locating and removing crop rows from the images and then calculating weed density from pixels covering vegetation in the remaining inter-row space. This suggested that it should be possible to use current UAV technology to generate weed density maps without the need to first produce extremely high resolution images of entire fields. Nevertheless the 6 cm per pixel resolution was more than adequate to locate patches that could potentially be associated with disease. We were able to readily detect areas of missing or senescent plants that were less than one square meter in size. Such areas could be identified visually or by the use of segmentation algorithms, but the latter was much more effective in situations where numerous small patches were present throughout the crop canopy. In these cases, the algorithm was able to quickly identify thousands of such areas and eliminate the ones that did

	not meet the specified criteria. Our results support the use of UAV acquired aerial imagery as a new tool to assist with the detection of diseases, especially during the early stages of an infestation. The cost of adding UAV aerial images to a field scouting program is however quite significant. If entirely contracted it could increase crop scouting costs from $4.00 per acre to $40.00 per acre with images taken 12 times during the season. On the other hand if imagery is supplied by a farm owned and operated UAV, the cost could be much lower, which we estimated at $11.50 per acre for cost recovery.
38	**SOIL, WATER AND TOPOGRAPHY MAPS: OPPORTUNITIES FOR VARIABLE-RATE WEED CONTROL.** Cory Willness, CCA, PAg, CAC, CropPro Consulting Current technology can be used to apply variable rate inputs targeting improved weed control. Pre-emergent herbicides, targeted soil properties, and optimization of plant stands will be discussed.
39	**A NEW ADJUVANT SYSTEM FOR USE IN DICAMBA TOLERANT SOYBEANS.** Gregory K. Dahl*[1], Raymond L. Pigati[2], Lillian C. Magidow[1], Andrea C. Clark[1], Ryan J. Edwards[1], Eric P. Spandl[2], Joe V. Gednalske[1], David A. Van Dam[2]; [1]Winfield United, River Falls, WI, [2]Winfield United, Shoreview, MN AG16098 adjuvant is a patent-pending technology specifically designed for ultra and extra coarse nozzles, for use with the new dicamba herbicide chemistries. This adjuvant system has been formulated to reduce driftable fines when using the new dicamba formulations alone or in combination with glyphosate. AG16098 was listed as a DRA on both the Monsanto and BASF web sites. Dicamba plus AG16098 and improved weed control compared to dicamba alone. Dicamba plus glyphosate plus AG16098 improved weed control compared to dicamba plus glyphosate alone. Improved weed control was attributed to better deposition and less loss to off-target movement. Off-target dicamba movement has been shown to be reduced when drift reducing adjuvants are added to spray mixtures. A field study was conducted on non-dicamba tolerant soybeans with a commercial field sprayer using TTI 11004 nozzles. The study was conducted during hot windy conditions. All the treatments included glyphosate plus a new dicamba technology product and a non-ammonium sulfate water conditioning adjuvant. One of the treatments did not include any drift reducing adjuvant. AG16098 was included in several of the treatments. Data were collected downwind using repeated horizontal transects, water sensitive spray deposition cards and spectral images from a fixed wing drone. Where AG16098 was not included in the treatment dicamba symptomology was observed more than 60 meters downwind. Where AG16098 was added to the treatment dicamba symptomology was not observed more than 20 meters downwind.

40	**EFFECT OF GLYPHOSATE TIMING, RATE AND TANK MIX PARTNER ON CONTROL OF AN ANNUAL RYEGRASS (*LOLIUM MULTIFLORUM*) COVER CROP.** Darren E. Robinson*, Peter H. Sikkema; University of Guelph, Ridgetown, ON
41	**PRECISION AGRICULTURE AND THE DIVERSITY-STABILITY HYPOTHESIS**. Clarence J. Swanton*, Virginia Capmourteres, Madhur Anand, Justin Adams, Aaron Berg; University of Guelph, Guelph, ON The benefit of precision agriculture must be defined both in terms of profitability as well as environmental enhancement. Maintaining biodiversity within the landscape is central to the protection of ecosystem services. In this presentation, I will explore the diversity-stability hypothesis and illustrate how precision agriculture can play a pivotal role in identifying opportunities to enhance biodiversity within our agricultural production system.
42	**CONTROL OF GLYPHOSATE-RESISTANT WATERHEMP IN GLUFOSINATE, GLYPHOSATE/DICAMBA, GLYPHOSATE/2,4-D AND MESOTRIONE/GLUFOSINATE/ISOXAFLUTOLE-RESISTANT SOYBEAN**. Peter H. Sikkema*[1], Mike G. Schryver[2], Nader Soltani[1]; [1]University of Guelph, Ridgetown, ON, [2]University of Guelph Ridgetown Campus, Guelph, ON Glyphosate-resistant (GR) waterhemp (*Amaranthus tuberculatus var. rudis*) (WH) was first confirmed in Lambton County, Ontario, Canada in 2014 and has now been documented in 3 southwestern Ontario counties. This small-seeded, summer annual, broadleaf weed has an extended emergence pattern, has high genetic diversity, is a prolific seed producer, and is very competitive. In Ontario, WH interference has been documented to reduce soybean yield by 73%. The focus of this research was to determine strategies for its control in Roundup Ready, Liberty Link, Enlist and HPPD-resistant soybean. In Roundup Ready soybean, at 84 days after application (DAA), a sequential application of pyroxasulfone/sulfentrazone or s-metolachlor/metribuzin PRE followed by acifluorfen or fomesafen POST provided 88-100% control of GR waterhemp. In Liberty Link soybean, at 84 DAA, a sequential application of pyroxasulfone/flumioxazin, pyroxasulfone/sulfentrazone or s-metolachlor/metribuzin PRE followed by glufosinate POST provided 97-99% control of GR waterhemp. In Enlist soybean, at 84 DAA, a sequential application of pyroxasulfone/flumioxazin, pyroxasulfone/sulfentrazone or s-metolachlor/metribuzin PRE followed by glufosinate POST provided 99% control of GR waterhemp. In HPPD resistant soybean, at 84 DAA, a sequential application of mesotrione + metribuzin or isoxaflutole + metribuzin PRE followed by fomesafen POST provided 90 and 98% control of GR waterhemp, respectively. This research indicates that the use of alternate HR soybean cultivars provides possible weed management solutions for the control of GR waterhemp in soybean.
43	**ALTERNATIVE APPROACHES TO THE CONTROL OF GLYPHOSATE RESISTANT CANADA FLEABANE.** François Tardif*[1], Mike Cowbrough[2], Clarence J. Swanton[1], Peter J. Smith[1]; [1]University of Guelph, Guelph, ON, [2]OMAFRA, Guelph, ON

44	**ZIDUA SC - A new herbicide for residual weed control in corn and soybean.** Chris Budd[1], Mark Oostlander*[2], Nikki Burton[3]; [1]BASF Canada, Guelph, ON, [2]BASF, Lethbridge, AB, [3]BASF Canada, Lethbridge, AB
45	**NEW BRUNSWICK UPDATE.** Gavin L. Graham*; NBDAAF, Fredericton, NB **Wild Blueberry Weed Management Under a Low Price Situation.** Wild blueberry production occurs on managed stands of wild fruit in Eastern North America. Weed control is a challenge based on the unique production practices. Recent low commodity prices have left growers questioning current weed control programs. A series of trials were established in three main production areas in New Brunswick in 2017. Field locations represented standard field history in the respective regions, being historical blueberry fields (Southwest), agricultural fields transitioned to wild blueberry production (Southeast) and new production areas from cleared forest (Northeast). Sixteen different sprout year herbicide programs, suggested by growers, were implemented to determine the weed control differences. Weeds were variable between the trial areas. Hexazinone, the base weed control program, performed better in newly established fields. Some tank mixes gave equivalent control to the high rate of hexazinone, dependent on the weed spectrum present. Pre-emergent followed by post-emergent programs, especially when containing hexazinone, were more expensive but offered improved weed control. Post-emergent only programs were a higher weed control risk, but offered adequate weed control in all regions. No single post-emergent treatment consistently controlled all weeds with all regions. Using multiple timings and modes of action provided resistance management benefits, at a higher price. Ultimately, the highest weed control treatments were site specific, but all regions could have equivalent weed control to hexazinone programs with an equivalent or lower cost.
46	**ACCASE RESISTANT GREEN FOXTAIL (*SETARIA VIRIDIS (L.) P. BEAUV*) IN A LONG-TERM ROTATION STUDY WITH DIFFERENT IN-CROP HERBICIDE USE INTENSITIES.** Deanna J. McLennan*[1], Robert Gulden[2]; [1]University of Manitoba, Mather, MB, [2]University of Manitoba, Winnipeg, MB In 2000, the University of Manitoba established the Pesticide Free Production (PFP) experiment at Carman, Manitoba (Schoofs et al. 2005). The objective was to reduce the selection pressure for herbicide resistant weeds in a zero--tillage production system through reduced in-crop herbicide-use. Two fully-phased, crop rotations were established, one annual rotation (Flax--Oat-- Canola--Wheat), and an annual/perennial rotation (Flax--Oat--Alfalfa--Alfalfa). Both rotations were repeated three times in each block with each repeat subjected to a different level of in--crop herbicide use intensity. The control treatment allowed in--crop pesticides in all crops in the rotation (Control). The first PFP treatment (PFP Oats) omitted in--crop pesticide use during the oat crop, the second PFP treatment (PFP Oats & Flax) omitted herbicide use in both the flax and oat crops. These treatments imposed different selection pressure on weeds (Table 1). In the spring of 2009, the weed seedbank was sampled and evaluated. Based on germinated seedling densities, *Setaria* species (*S. viridis* L., *S. glauca* L.,

	Echniochloa crus-gali L.) were dominant, accounting for 53.1% of total weed density. Other dominant weed species included redroot pigweed (*Amaranthus retroflexus* L.), yellow wood sorrel (*Oxalis stricta* L.) and species belonging to the *Brassica* family (Gulden et al. 2011). Weed seedbank densities were lowest in the control treatments (5,000 seeds m^{-2}) and increased to on average over 10,000 seeds m^{-2} in the PFP Oats & Flax treatments. In the annual rotation, weed seedbank densities were greatest after flax and similar in all other crops. In the rotation including alfalfa, seedbank densities were similar in all crops with the exception those following second year alfalfa which had lower seedbank densities. For several years, visual observations after in-crop herbicide applications have indicated that some green foxtail plants were no longer sensitive to ACCase inhibitor (Group 1) herbicides which are used frequently to manage grassy weeds in this study. In this study, we characterized the nature of this biotype and its prevalence in the seedbank.
47	**Do soil characteristics influence weed seed mortality?** Geddes, Charles M *, Gulden, Robert, University of Manitoba. Introducion and Objectives: In the seedbank, seed dormancy and quiescence promote temporal dispersal of viable weed seeds, allowing for successful seedling recruitment from a single cohort over many years 1. The seedbank is the source from which weed populations are dispersed over timescales. Certain soils result in greater weed seed mortality 2. However, the characteristics that comprise a weed seed-suppressive soil, and how these characteristics could be managed, remain unclear. Understanding which soil characteristics are associated with weed seed mortality could elucidate novel tactics for weed management at the source of temporal dispersal, thereby facilitating management of weed populations. The objectives of this study were to (a) determine the effect of soil texture on survival of canola (Brassica napus L.) seed in the soil seedbank and (b) establish associations among soil and microclimate characteristics and survival of canola seeds in field soils.
48	**DYNAMICS OF VEGETATION, BIOLOGICAL SOIL CRUSTS, AND SEED BANKS ALONG PIPELINES IN SOUTHERN ALBERTA'S MIXEDGRASS PRAIRIE.** Lysandra A. Pyle*, Edward Bork, Linda Hall; University of Alberta, Edmonton, AB Oil and gas infrastructure negatively impacts ecosystem function, increases habitat fragmentation, increases susceptibility to invasive species, and has been linked to decreases in biologically fixed carbon, productivity, and grazing capacity. In the Northern Great Plains, disturbed sites can exhibit dominance by seeded cool season grasses, native ruderals, and volunteer alien species, many of which rely on the seed bank for dispersal and persistence (i.e. *Agropyron cristatum*, *Melilotus* spp., etc.). Biological soil crusts (BSCs) are functionally important in grasslands for stabilizing the soil, fixing nitrogen, increasing available phosphorus, retaining soil moisture, and regulating both seed bank formation and seedling recruitment; however, BSCs are sensitive to disturbance and recover slowly. Further, invasive species like *Melilotus* are deleterious to grasslands by altering soil microsites and vegetation structure

	resulting in shading and changes to moisture and nutrient availability. A relationship between soil crusts and seed banks has been acknowledged in the literature, particularly in deserts; however, there is limited research exploring these relationships in Mixedgrass Prairie, especially divergent management and disturbance regimes. Our objectives are to quantify the impact of pipeline disturbance (i.e. time of installation, pipeline width, distance from disturbance, etc.) on plant communities, seed banks, and BSCs. Foliar and soil crust cover will be related to seed bank formation. We sampled 18 pipelines in SE Alberta at the University of Alberta Mattheis Research Ranch. Germinable seed bank was recorded in the greenhouse over 1 year. Community data was analysed in R using multivariate techniques like NMDS and PerMANOVA.
49	**EVALUATION OF HERBICIDE DAMAGE TO FABABEAN USING UAV IMAGERY. HEMA S. DUDDU***[1], Austin McGill[2], Menglu Wang[2], Eric Johnson[2], Steven J. Shirtliffe[2]; [1]UNIVERSITY OF SASKATCHEWAN, SASKATOON, SK, [2]University of Saskatchewan, Saskatoon, SK
50	**IMPACT OF LATE EMERGING WEEDS ON THE YIELD OF GLYPHOSATE-RESISTANT SOYBEAN**. Soltani, Nader *[1], Amit, Jhala[2], Robert E. Nurse[3], Peter H. Sikkema[1], [1]University of Guelph, Ridgetown, ON, [2]University of Nebraska, [3] Agriculture and Agri-Food Canada, Harrow, ON. A study consisting of thirteen field experiments was conducted during 2014 to 2016 in southwestern Ontario and southcentral Nebraska to determine the effect of late emerging weeds on yield of glyphosate-resistant soybean. Soybean was maintained weed-free with glyphosate (900 g ae ha-1) up to VC (cotyledon), V1 (first trifoliate), V2 (second trifoliate), V3 (third trifoliate), V4 (fourth trifoliate), and R1 (beginning of flowering) growth stage after which weeds were allowed to naturally infest soybean. At 6 weeks after the last glyphosate application (WAA), total weed biomass was reduced 63, 90, 98, 100, 100, and 100% at Exeter; 12, 77, 94, 95, 97, and 100% at Harrow; 28, 100, 100, 100, 100, and 100% at Clay Center, Nebraska; and 58, 87, 94, 98, 97, and 99% at Ridgetown when soybean was maintained weed free up to VC, V1, V2, V3, V4, and R1 growth stage, respectively. The critical weed-free period for 1, 2.5, 5, and 10% yield loss in soybean was VC to V1, VC to V1, VC to V1 and VE to VC growth stages at Exeter; V2-V3, V1-V2, V1-V2 and VC-V1 growth stage at Harrow; V4-R1, V2-V3, V2-V3 and V1-V2 growth stage at Nebraska; and V3-V4, V1-V2,VC-V1 and VC-V1 growth stage at Ridgetown, respectively. For weeds evaluated, there was a minimal reduction in weed biomass (5% or less) when soybean was maintained weed-free beyond the V3 soybean growth stage. Results shows that soybean must be maintained weed free up to the V3 growth stage for optimum yield. Weeds emerging after the V3 soybean growth stage did not influence the yield of glyphosate-resistant soybean.
51	**IMPACT OF PULSE AND CANOLA FREQUENCY IN A CROP ROTATION ON WEED BIOMASS, WEED DENSITY AND SHIFT IN WEED POPULATIONS - PRELIMINARY REPORT.** William E. May*; Agriculture and Agri-Food Canada, Indian Head, SK In 2012 a rotation study was initiated at Indian Head, SK that varied in the number of pulse crops and canola in the rotation. There are six rotations, 1) Wheat-Canola-Oat-Pea; 2) Wheat-Pea-Oat-Pea; 3) Wheat-Pea-Canola-Pea; 4) Wheat-Pea-Lentil-Pea; 5) Wheat-Lentil-Oat-Pea;

	6) Wheat-Canola-Pea-Canola; Dominant weed species were recorded along with grass weed biomass and broadleaf weed biomass. The study has just completed its third year of the 2nd cycle of the rotation. In this study we will report on the effect of pulse and canola frequency in the rotation on changes in weed biomass, weed density and change in weed species during the study.
52	**LIFE-CYCLE ANALYSIS AND FITNESS CHARACTERISTICS OF GLYPHOSATE SUSCEPTIBLE AND RESISTANT COMMON RAGWEED (*AMBROSIA ARTEMISIIFOLIA* L.).** Jichul Bae*[1], Robert E. Nurse[2], Eric R. Page[3]; [1]Agriculture and Agri-Food Canada, Harrow, BC, [2]Agriculture Canada, Harrow, ON, [3]Agriculture and Agri-Food Canada, Harrow, ON Evaluating fitness differences between herbicide-susceptible and resistant weed biotypes helps identify life cycle weaknesses. Targeting these weaknesses has the potential to improve resistance management. In order to properly evaluate potential fitness penalties associated with an herbicide resistant trait, it is important to control for genetic background. Backcrossing helps to ensure that any differences identified during the assessment are related to the resistance trait rather than differences in genetic background. A greenhouse study was conducted three times to evaluate potential fitness penalties associated with glyphosate-resistance in common ragweed (*Ambrosia artemisiifolia* L.). Genetic background was controlled by backcrossing of a parental resistant (PR) with a parental susceptible (PS) biotype, such that the second backcrossed generation (BC_2) had 87.5% genetic similarity with the PS. We then compared the germinability, growth, flowering time and fecundity of the PS and BC_2 lines. Results indicate that time to 50% germination of BC_2 seed was delayed by an average of 3 days relative to the PS; however, total germination at 21d was not different between the lines. Time to first flowering in the BC_2 was accelerated relative to the PS by an average of 10 days and, at physiological maturity, BC_2 plants were 23% shorter and accumulated 32% less aboveground biomass than PS plants. These differences, however, did not result in a reduction in fecundity, as measured by seed number and 100-seed weight at physiological maturity. We attribute the observed differences between the PS and BC_2 generations to the remaining PR genetics present in the BC_2 generation. While it is clear that there is no measurable fitness penalty associated with glyphosate resistance in common ragweed, the fact that the resistance trait was selected for in a biotype with delayed germination, reduced height and accelerated flowering may have important implications for the spread of the resistance trait through pollen mediated gene flow or for potential control strategies focused on reducing seed production.
53	**POTENTIAL YIELD LOSS FROM WEEDS IN DRY BEANS IN NORTH AMERICA.** Nader Soltani*[1], J. Anita Dille[2], Peter H. Sikkema[1]; [1]University of Guelph, Ridgetown, ON, [2]Kansas State University, Manhattan, KS Earlier Weed Science Society of America (WSSA) Weed Loss Committee reports by Chandler et al. (1984) and Bridges (1992), provided a summary of crop yield losses throughout various North American regions if weeds were left uncontrolled. This manuscript is a report from the current WSSA Weed Loss Committee on potential crop yield losses due to weeds in dry bean

	based on data collected from various regions of the United States and Canada. Dry bean yield loss estimates were made by comparing dry bean yield in the weedy control with plots that had >95% weed control from research studies conducted in dry bean growing regions of the United States and Canada over a 10 year period (2007 to 2016). Results from these field studies showed that dry bean growers in Idaho, Michigan, Montana, Nebraska, North Dakota, South Dakota, Wyoming, Ontario and Manitoba would potentially lose an average of 50, 31, 36, 59, 94, 31, 71, 56, and 71% of their dry bean yield which equates to a monetary loss of US$36, 40, 6, 56, 421, 2, 18, 44 and 44 million, respectively, if they use their best agronomic practices without any weed management tactics. Based on 2016 census data, at an average yield loss of 71.4% for North America, dry bean production in the United States and Canada would be reduced by 941,000 and 184,000 MT out of their total production of 1,318,000 and 258,000 MT valued at approximately US$622 and US$100 million, respectively, to uncontrolled weeds. This study documents the dramatic yield and monetary losses in dry beans due to weed interference and the importance of continued funding for weed management research to minimize dry bean yield losses.
54	**RESIDUAL WEED POPULATION SHIFTS IN ALBERTA – 1973 TO 2017.** Julia Y. Leeson*[1], Linda Hall[2], Chris Neeser[3]; [1]Agriculture and Agri-Food Canada, Saskatoon, SK, [2]University of Alberta, Edmonton, AB, [3]Alberta Agriculture & Forestry, Brooks, AB The comparison of the relative abundance of weeds in Alberta in 2017 with results from previous provincial surveys enables the identification of recent shifts in species ranks, density and relative abundance. In 2017, a total of 1236 fields of canola, spring wheat, durum, barley, oat, peas and lentil were surveyed. These fields were selected using a stratified random sampling procedure based on ecodistricts. In each field, weeds were counted in 20 quadrats (50 by 50 cm) in late summer. Weed data are summarized using a relative abundance index based on frequency, field uniformity and density. Chickweed (*Stellaria media* (L.) Vill.) was the most abundant weed, wild buckwheat (*Fallopia convolvulus* (L.) Á.Löve) ranked second, lamb's-quarters (*Chenopodium* spp.) ranked third and wild oats (*Avena fatua* L.) ranked fourth. The results from the 2017 survey are compared to results from surveys of 1333 fields in 2009-2010, 1153 fields in 2001, 684 fields in 1997, 1086 fields in 1987-1989 and 3109 fields in 1973-1977. Sixteen species have been ranked amongst the top 25 most abundant species in each survey. Twelve species have declined more than ten ranks since the 1970s. Nine of these species continued to decline in 2017: bluebur (*Lappula squarrosa* (Retz.) Dumort.), Tartary buckwheat (*Fagopyrum tataricum* (L.) Gaertn.), cow cockle (*Vaccaria hispanica* (Mill.) Rauschert), flixweed (*Descurainia sophia* (L.) Webb ex Prantl), redroot pigweed (*Amaranthus retroflexus* L.), corn spurry (*Spergula arvensis* L.), stinkweed (*Thlaspi arvense* L), common groundsel (*Senecio vulgaris* L.) and perennial sow-thistle (*Sonchus arvensis* L.). Russian thistle (*Salsola tragus* L.), wild mustard (*Sinapis arvensis* L.) and pale smartweed (*Persicaria lapathifolia* (L.) Delarbre) declined in the 2009-2010 survey, but did not decrease any further in the 2017 survey. Foxtail barley (*Hordeum jubatum* L.) has increased the most since the 1970s and appeared in the top twenty-five for the first time in 2017. Wheat (*Triticum* spp.) and stork's bill (*Erodium cicutarium* (L.) L'Hér. ex Aiton) have also steadily increased since the 1970s. Other species with their highest relative abundance recorded in 2017 include

	chickweed, lamb's-quarters, canola/rapeseed (*Brassica napus* L.), kochia (*Bassia scoparia* (L.) A.J.Scott) and barley (*Hordeum vulgare* L.). False cleavers (*Galium spurium L*.), spiny annual sow-thistle (*Sonchus asper* (L.) Hill), low cudweed (*Gnaphalium uliginosum* L.) have also increased since the 1970s, but did not increase since 2010. Overall the total weed density has steadily decreased in each survey in Alberta since the 1970s.

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