Canadian Weed Science Society

Société canadienne de malherbologie

74rd Annual Meeting
November 23nd to 27th 2020

74e Réunion annuelle
23 au 27 novembre 2020

Online at:

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INTERNATIONAL YEAR OF PLANT HEALTH 2020

ANNÉE INTERNATIONALE DE LA SANTÉ DES VÉGÉTAUX 2020

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Martin Laforest	Co-chair - budget
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Eric Page	Grad student presentations
Cezarina Cora	Continuing education workshop
Greg O’Neill & Kalidas Subedi	Photo contest
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Martin Laforest (chair) Darin Fodor (May to August) Kristina Polziehn & Shuhua Liu Robert Nurse & Lydia Maheux	Internet hosting special committee
Charles Geddes	Awards Banquet
Caroline Halde	Poster session
Cezarina Cora	Media & publicity
Kristina Polziehn	Registration
William Kramer	Grad student rep
Audrey-Kim Minville	Grad student rep replacement

CWSS-SCM 2019 ANNUAL MEETING AGENDA

Note that the abstracts for the individual presentations are listed by number in the Abstract section.
Note that presentations and posters are available anytime from November 16 and after the meeting
Presentation timeslots only indicate live question periods

Monday, November 23, 2020		
Time (in Ottawa/Eastern Standard Time)	**Topic/Event**	**Host/Chair**
11:00 am - 2:00 pm	CWSS-SCM Board Meeting	François Tardif
6:00 - 7:00 pm	Graduate Student Meet and Greet with Board Members	François Tardif/William Kramer
7:00 – 8:00 pm	General meet and greet – make your own cocktail (MYOC)	Martin Laforest/Marie-Josée Simard/To be determined

Tuesday, November 24, 2020			
#	**Time**	**Topic/Event**	**Host/Chair/Speaker***
	Bottom of home page (President's welcome) and pre-recorded (LAC)	Welcoming remarks – President and LAC Announcements	François Tardif/Marie-Josée Simard & Martin Laforest
	Live Q and A timeslot	**Graduate Student Presentations (Question and Answer period)**	**Eric Page**
	1:15 -preparation		
1	1:20 - 1:30 pm	Development and evaluation of a precision herbicide applicator for real-time spot application of dichlobenil to control hair fescue in wild blueberry fields	Craig MacEachern* Travis Esau
2	1:30 - 1:40 pm	Wick weeding: An investigation into alternative weed control strategies in Atlantic potato production systems	Laura Anderson* Andrew McKenzie-Gopsill Scott White
3	1:40 - 1:50 pm	Spatiotemporal dynamics and weed seed feeding tendencies of field crickets (Grillidae) found in blueberry fields	Janelle MacKeil* Chris Cutler Scott White
4	1:50 - 2:00 pm	Optimal parameters for identification of hair fescue (*Festuca filiformis* Pourr.) and red sorrel (*Rumex acetosella* L.) in wild blueberry (*Vaccinium angustifolium* Ait.) fields using convolutional neural networks	Patrick Hennessy* Travis Esau Qamar Zaman Arnold Schumann Kenny Corscadden

5	2:00 - 2:10 pm	Can cover crops control weeds and mitigate soil water erosion during the establishment of grapevine (*Vitis vinifera* L.) in southern Quebec?	Audre-Kim Minville* Marie-Josée Simard Odile Carisse Caroline Halde
6	2:10 - 2:20 pm	Control of multiple-herbicide-resistant waterhemp (*Amaranthus tuberculatus*) in corn with postemergence herbicides	Christian Willemse* Nader Soltani David Hooker Amit Jhala Peter Sikkema
7	2:20 - 2:30 pm	Investigation of management strategies to optimize cover crop-based weed mitigation in Canadian sweet corn production.	Hayley Brackenridge* Jichul Bae Marie-Josée Simard François Tardif Kerry Bosveld Robert Nurse
8	2:30 - 2:40 pm	The importance of singlet oxygen in resource-independent competition	Nicole Berardi* Sasan Amirsadeghi Clarence Swanton
9	2:40 - 2:50 pm	Thermal remote sensing under field conditions: Weed stress example	Heba Alzaben* Roydon Fraser Clarence Swanton
10	2:50 - 3:00 pm	Biologically-effective-dose of bromoxynil, applied alone and tankmixed with metribuzin, for the control of glyphosate-resistant Canada fleabane [*Conyza canadensis* (L.) Cronq.] applied preplant in soybean	David Westerveld* David Hooker Darren Robinson Peter Sikkema
11	3:00 - 3:10 pm	The Carabid interaction network: Consequences for weed seed bio-control	Stefanie de Heij* Christian Willenborg
12	3:10 - 3:20 pm	Understanding invertebrate weed seed predation: Uncovering the major factors that drive seed selection decisions in carabid weed seed predators	Khaldoun Ali* Christian Willenborg
13	3:20 - 3:30 pm	Integration of residual herbicides with cultural and mechanical weed control provides better weed management in Faba bean (*Vicia faba* L).	Amanda Fedorchuk* Christian Willenborg Eric Johnson
14	3:30 - 3:40 pm	Assessing Herbicide Tolerance in Lentils *(Lens culinaris)* Using Hyperspectral Imagery	Brianna Zoerb* Steven Shirtliffe Eric Johnson Keshav Sighn
15	3:40 - 3:50 pm	Weed suppression using cover crop mixtures in organic field crop systems in Quebec	Stéphanie Lavergne* Anne Vanasse Marie-Noëlle Thivierge Caroline Halde

	Live Q and A timeslot. Panel	Corn, Soybean and Edible Beans	Adam Pfeffer & Laura Smith
16	4:00 - 5:00 pm	Sodium cation concentrations in Western Canada water sources and influence of sodium on glyphosate performance and interaction with AMS adjuvants	Gregory Dahl* David Van Dam Martin Carr Amanda Flipp and collaborators
	See online agenda for details	**Weed Biology, Ecology and Invasive Species**	**David Clements & Marie-Josée Simard**
17	4:00 - 5:00 pm	Kochia and wild oat intraspecific and interspecific interference	Shaun Sharpe
18	4:00 - 5:00 pm	Manipulating kochia [*Kochia scoparia* (L.) Schrad.] seed production through phenology-based weed control	Charles Geddes* Louis Molnar Robert Gulden and collaborators
19	4:00 - 5:00 pm	Preliminary investigation of cow wheat (*Melampyrum lineare*) interference with wild blueberry (*Vaccinium angustifolium* Ait)	Vanessa Deveau Scott White*
20	4:00 - 5:00 pm	Duration of weed presence influences the recovery of photosynthetic efficiency and yield in common bean (*Phaseolus vulgaris* L.)	Andrew McKenzie-Gopsill* Sasan Amirsadeghi Sherry Fillmore Clarence Swanton
	See online agenda for details	**Horticulture and special crops**	**Martin Laforest & Shuhua Liu**
21	4:00 - 5:00 pm	Clethodim suppresses hair fescue (*Festuca filiformis*) in wild blueberry (*Vaccinium angustifolium* Ait).	Scott White* Gavin Graham
22	4:00 - 5:00 pm	Evaluation of amino acid-inhibiting herbicide tank mixtures for hair fescue (*Festuca filiformis*) management in wild blueberry (*Vaccinium angustifolium* Ait).	Scott White
23	4:00 - 5:00 pm	Timing of Tribenuron Methyl and Hexazinone Treatment for Sheep Sorrel Management in Wild Blueberry	Gavin Graham
24	4:00 - 5:00 pm	Management of triazine resistant weeds in tomato	Darren Robinson* Kris McNaughton
25	4:00 - 5:00 pm	The amino acid substitution Phe255Ile in *psbA* gene confers resistance to hexazinone in hair fescue (*Festuca filiformis*) plants from lowbush blueberry (*Vaccinium angustifolium* Ait.) fields	Martin Laforest Brahim Soufiane Katherine Bisaillon Eric Page Scott White*

Wednesday, November 25, 2020			
#	**Time**	**Topic/Event**	**Host/Chair or presenter**
	Live Q and A timeslot Horaire des questions et réponses live	**Plenary Session "Weeds and invasive plants in Canada: past, present and future"** **Plénière «La dispersion des mauvaises herbes et des plantes envahissantes au Canada, d'hier à defrancoismain»**	**Host : Marie-Josée Simard & Martin Laforest**
26	11:15 - 11:30 am	Weeds and invasive plants : (very) old problem, new challenges Mauvaises herbes et plantes envahissantes : un vieux problème, de nouveaux défis	**Claude Lavoie**
27	11:30 - 11:45 am	Weed migrations and climate change Migration de mauvaises herbes et changement climatiques	**Antonio DiTommaso**
28	11:45 - 12:00 am	Using bioclimate modelling to understand pest ecology and predict pest invasions L'utilisation de la modélisation bioclimatique pour comprendre l'écologie des organismes nuisibles et prédire les invasions	**Meghan Vankosky & Owen Olfert**
	12:00 – 1h30	Lunch break	
29	1:45 - 2:00 pm	Preventing weed spread with the detection and identification of weed seeds in commodities La prévention de la dissémination des mauvaises herbes grâce à la détection et à l'identification des semences dans les denrées	**Ruojing Wang**
30	2:00 - 2:15 pm	Looking for a needle in a haystack : use of metabarcroding to find weeds and invasive species in seed lots Chercher une aiguille dans une botte de foin: l'utilisation du métabarcodage pour trouver les mauvaises herbes et plantes envahissantes dans les lots de semences	**Marie-Josée Côté**
31	2 :15- 2:30 pm	Weed Science - a view to the future La malherbologie - un regard vers l'avenir	**Clarence Swanton**
	2:30- 3:30 pm	**Poster presenters available for one-on-one meeting**	Poster presenters
	3:30-5:00 pm	**CWSS-SCM Awards Banquet**	**Charles Geddes & Breanne Tidemann**

Thursday, November 26, 2020			
#	**Time**	**Topic/Event**	**Host/Chair or presenter***
	11:00 - 12:00 am	Canadian Journal of Plant Science presentation and workshop	Josephine Sciortino Brian Beres
	12:00 - 2:00 pm	**CWSS-SCM Annual General Meeting**	François Tardif
	Live Q and A timeslot. Panel		
	See online agenda	**Cereals, Oilseeds and Pulses**	**Charles Geddes & Breanne Tidemann**
32	2:00 - 3:00 pm	Certitude®: Burndown Herbicide Prior to Seeding Canola	Britanny Hedges* Brendan Metzger Ethan Bertholet and collaborators
33	2:00 - 3:00 pm	Viability of targeting the wild oat (*Avena fatua* L.) panicle	Breanne Tidemannn* Neil Harker Eric Johnson and collaborators
34	2:00 - 3:00 pm	Novel high surfactant oil concentrate adjuvant system for use in Canada	Gregory Dahl* David Van Dam Martin Carr and collaborators
35	2:00 - 3:00 pm	Preliminary results on the performance of ammonium nonanoate as a lentil desiccant	Eric Johnson* Shaun Campbell Sydney Redekop and collaborators
36	2:00 - 3:00 pm	Rinskor active (florpyrauxifen-benzyl): Mode of action, use rates and environmental profile	Laura Smith Rory Degenhardt Len Juras Kevin Falk* Jamshid Ashigh
		Rangeland, Forestry and Industrial Weed Management	**David Ralph & Lisa Jarrett**
37	2:00 - 3:00 pm	Emerging invasive plant management issues in BC	Becky Brown* Crystal Chadburn
38	2:00 - 3:00 pm	Rinskor™ active (Florpyrauxifen-benzyl) for weed control in pastures and industrial areas	Laura Smith* Rory Degenhardt Jamshid Ashigh Kevin Falk

		Provincial Reports and Regulatory Updates	**Kirsten Obeid**
39	2:00 - 3:00 pm	How Did a Pandemic Change Weed Extension in New Brunswick?	Gavin Graham
	Live Q and A timeslot Horaire Q et R live	**Management of herbicide resistance Workshop** **Atelier sur la gestion de la résistance**	**Host: Kristen Obeid & Martin Laforest**
40	3:00 - 3:15 pm	SAgE pesticides: Health and environment to the forefront SAgE pesticides: Santé et Environnement à l'avant-plan	**Audrey Roy**
41	3:15 - 3:30 pm	Portrait and management of waterhemp (Amaranthus tuberculatus (Moq.) J.D. Sauer) in Quebec Portrait et gestion de l'amarante tuberculée (Amaranthus tuberculatus (Moq.) J.D. Sauer) au Québec.	**David Miville**
42	3:30 – 3:45 pm	Limiting the spread of multiple herbicide resistant waterhemp: A proactive management approach Limiter la propagation de l'amarante tuberculée résistante aux herbicides: Une approche de gestion proactive	**Stéphanie Mathieu**
43	3:45 – 4:00 pm	Robotic weeding for vegetable crops Le désherbage robotisé dans les légumes	**Teric Greenan**
44	4:00 – 4:15 pm	The Oz robot in sweet corn Le robot Oz dans le maïs sucré	**Maryse Leblanc & Maxime Lefebvre**
45	4:15 – 4:30 pm	Using electricity for weed control with shocking results L'utilisation de l'électricité pour un désherbage avec des résultats surprenants	**Philip Oegema**

Friday, November 27, 2020		
Time	**Topic/Event**	**Host/Chair or presenter**
11:00- am 1:00 pm	**CWSS-SCM Board Meeting**	**Marie-Josée Simard**

Poster Session

#	Title	Author(s) Presenter*
46	Minor Use Pesticides Program at the Pest Management Center of Agriculture and Agri-Food Canada	Czechura, P.*
47	Seed bank depletion in muck soil after three years without seed inputs: A case study	Simard, M.-J.*, Nurse, R.E., Laforest, M., Obeid, K.A
49	AAFC-Pest Management Centre: Successes in weed control	Liu, S.*, Kora, C
49	Mitigating herbicide resistance – incorporating integrated weed management strategies	Tidemann, B.D.*, Harker, K.N., Geddes, C.M., Blackshaw, R., Lupwayi, N., Shirtliffe, S.,Willenborg, C., Johnson, E.N., Gulden, R., Turkington, T.K., Semach, G., Mulenga, A
50	Does alloploidy increase weediness? Comparing niches of allopolyploids to their progenitors	Mata J.*, Martin S. L., Smith T.W.
51	Does crop competition impact the expression of a herbicide-resistant weed phenotype?	Geddes C.M.*, Kimmins M.T.
52	Responses to atrazine in male and female plants of common waterhemp (*Amaranthus tuberculatus*).	Gagnon, G.*, Flores-Mejia, S., Bipfubusa, M., Mathieu, S, Marcoux, A., Laforest, M., Michaud, D.
53	Portrait de la résistance des mauvaises herbes aux herbicides de 2011 à 2019 au Québec	Flores-Mejia, S.*, Marcoux, A., Miville, D.
54	Evaluation of two methods (solarisation and burial) for disposal of hand-weeded tall waterhemp (*Amaranthus tuberculatus* (Moq.) J.D. Sauer) plants	Flores-Mejia, S.*, Nguyen, M.-T., Bipfubusa, M, Fréchette, I., Mathieu, S., Faucher, Y., Duval, B., Marcoux, A., Miville, D., Leblanc, M., Dupuis, M.

Abstracts

1	**Development and evaluation of a precision herbicide applicator for real-time spot application of dichlobenil to control hair fescue in wild blueberry fields.** MacEachern, C., Esau, T. Dalhousie University, Truro, NS Wild blueberries (*Vaccinium angustifolium*) are one of the most economically important crops in Nova Scotia with a 5-year average farm gate value of $16.78 million. From a management perspective, the greatest concern within the industry is controlling Corscadden (*Festuca filiformis Pourr.*). Hair fescues have rapidly spread throughout the region from a field frequency of 7% in 2001 to 68% in 2019. One of the reasons for this rapid spread is the lack of affordable management options. Dichlobenil has been identified as a candidate to manage hair fescues however, its high cost means it is not employed by most growers. This project proposes the use of machine vision to accommodate spot application of dichlobenil for controlling hair fescue in wild blueberries. To do this, a series of cameras will be mounted onto the boom of a Valmar 1255 Twin Roller Pull Type Pneumatic Granular Applicator. The cameras will feed images to a pretrained neural network which, will determine whether there is hair fescue below the nozzle. This determination will then be used to operate a decision system which will either open or close a custom designed valve and apply dichlobenil to the positive detections. This way, dichlobenil is applied only where the fescue grass is and nowhere else. Being that hair fescue has only a 25% average field uniformity, the development of a precision spot applicator represents a potential 75% cost reduction.
2	**Wick weeding: An investigation into alternative weed control strategies in Atlantic potato production systems.** Anderson, L.[1,2], McKenzie-Gopsill, A[1], White, S.[2] [1]Agriculture and Agri-Food Canada; [2]Dalhousie University, NS. Photosystem II- (PSII) inhibitors, such as metribuzin, form the foundation of weed management in Atlantic Canadian potato production. Lamb's quarters (*Chenopodium album* L.) with PSII-inhibitor resistance have recently been confirmed across the potato producing regions of Atlantic Canada. With their rapid and upright growth habit, lamb's quarters can quickly come to over-top a potato canopy. Wick herbicide applicators offer an alternative integrated weed management (IWM) strategy whereby non-selective herbicides are selectively applied at a specified height in-season, minimizing off-target applications and damage to the crop species. Rope-wick application may provide an effective means of controlling PSII-inhibitor resistant lamb's quarters in potato production systems. The present study evaluated the use of glyphosate applied with a rope-wick applicator for control of lamb's quarters over-topping the canopy of Shepody, NorValley, and Yukon Gold potato cultivars with

	spreading, semi-erect and upright growth habits, respectively. Wicking glyphosate did not impact biomass of lamb's quarters over-topping the potato canopy, however, early rope-wick applications decreased lamb's quarters reproductive allocation by 74% compared to the untreated control. Early wick applications resulted in greater glyphosate injury to marketable potato tubers than late applications across all potato cultivars. Overall, marketable yield did not differ across treatments or cultivars. These results indicate that rope-wick applicators may provide a viable IWM strategy for disrupting resource allocation in lamb's quarters over-topping the potato canopy while maintaining marketable yields across cultivars with varying growth habits.
3	**Spatiotemporal dynamics and weed seed feeding tendencies of field crickets (Grillidae) found in blueberry fields**. MacKeil, J. Cutler, C., White, S. Dalhousie University, Truro, NS Although a range of pests can damage wild blueberries, weeds continue to be a major production challenge due to the lack of tillage and crop rotation associated with the perennial monoculture of wild blueberry production. That said, the use of pesticides introduces an additional risk which has the potential to cause significant harm to humans and environment alike if mismanaged. For this reason, there exists a need to find alternative pest control methods which ensures environmental longevity and limits negative effects to humans. Laboratory and field studies were conducted during the summer-fall season of 2019 to assess the feasibility of the field cricket (*Gryllus pennsylvanicus*) as a natural enemy of weed seeds in wild blueberry fields. Field experiments in Nova Scotia revealed field crickets were active for 15 weeks throughout wild blueberry fields, peaking in mid-August, coinciding with the seed rain of economically destructive weeds. Laboratory no-choice feeding studies revealed field crickets consumed on average, 500 hair fescue seeds, per cricket, over 120 hours. These findings suggest that post-dispersal weed seed predation by field crickets in wild blueberry fields may influence weed emergence, providing a valuable and sustainable ecological service. The results of this study coupled with insecticide toxicity assays will prove critical in the understanding of natural enemies' contributions in wild blueberry cropping systems.
4	**Optimal parameters for identification of hair fescue (*Festuca filiformis* Pourr.) and red sorrel (*Rumex acetosella* L.) in wild blueberry (*Vaccinium angustifolium* Ait.) fields using convolutional neural networks.** Hennessy P.J.[1], Esau T.J.[1], Zaman Q.U.[1], Schumann A.W.[2], Corscadden K.W.[3] [1]Department of Engineering, Faculty of Agriculture, Dalhousie University, Truro, NS; [2]Citrus Research and Education Center, University of Florida, Lake Alfred, FL, USA; [3]Centre for Technology, Environment & Design, Lethbridge College, Lethbridge, AB A major yield-limiting factor for commercial wild blueberry production are infestations of hair fescue and red sorrel. Broadcast applications of liquid

	herbicides are common for management of these weeds. The intermittent nature of the weeds provides an opportunity for increased herbicide application efficiency through spot spraying using real-time machine vision sensing. Images were collected from 58 wild blueberry fields in Nova Scotia to train convolutional neural networks (CNNs) to identify hair fescue and red sorrel. A fully randomized evaluation was performed in three wild blueberry fields in Nova Scotia to test the effects of target distance and camera selection on identification accuracy. Target distances of 0.57 m, 0.98 m, and 1.29 m were tested using a Canon T6 DSLR camera, an LG G6 smartphone, and a Logitech c920 webcam. The peak validation F_1-scores for detecting at least one target weed per image were 0.97 and 0.90 for hair fescue and red sorrel, respectively with the YOLOv3-Tiny CNN at 1280x736 resolution. Overall red sorrel detection F_1-scores varied from 0.52 to 0.67 during field testing when adjusting the CNN resolution and detection threshold. Overall hair fescue F_1-scores showed minimal changes when adjusting the same parameters, only moving between 0.80 and 0.81. Detection of hair fescue was most accurate at a target distance of 0.98 m, with F_1-scores of up to 0.97. Red sorrel detection was most accurate at a target distance of 0.57 m, with a peak F_1-score of 0.94. The Logitech c920 camera failed to detect any red sorrel targets in 19 of 27 parameter combinations used in the analysis. Deployment of a CNN for controlling spray applications on wild blueberry fields will limit herbicide use and create cost-savings for growers.
5	**Can cover crops control weeds and mitigate soil water erosion during the establishment of grapevine (*Vitis vinifera* L.) in southern Quebec?** Minville A.-K.[1], Simard M.-J.[2], Carisse O.[2], Halde C.[1] [1]Department of Plant Science, Laval University, Quebec City, QC; [2]Agriculture and Agri-Food Canada (AAFC), Saint-Jean-sur-Richelieu, QC Cover crops can contribute to improve soil health and are competitive against weeds. However, cover crops are not typically grown during grapevine establishment, especially in production systems in which vines are covered with soil for winter protection. The objective of the study was to assess the effect of interrow cover crops on weed control and soil water erosion. A three-year randomized complete block design experiment (2018-2020) was conducted in newly established grapevines (variety Vidal) in southern Quebec (AAFC research farm in Frelighsburg, QC). The interrow (3 m wide) treatments tested included 1) an annual grass mix (*Lolium multiflorum* Lam., *Avena sativa* L.), 2) a perennial grass mix (*Poa pratensis* L., *Lolium perenne* L., *Lolium multiflorum* Lam., *Festuca rubra* L.), 3) a weed-free treatment with repetitive interrow cultivation, and 4) a weedy control. A 1 m wide area under the grapevine rows was clean cultivated in all treatments and vegetated treatments were mowed a few times during the growing season. Collected data included weed density by species, plant biomass, grapevine growth and yield (in 2020), as well as soil aggregate stability (a measure of resistance to degradation by erosion). All data

	analysis was conducted with SAS University Edition (version 15.1) using proc MIXED for repeated measures. Dominant weeds included clover species (*Trifolium spp.* L.), brown knapweed (*Centaurea jacea* L.), and witch grass (*Panicum capillare* L.). Weed control was higher in the annual intercrop compared to the perennial grass mix. Compared to the cultivated interrow, soil aggregate stability was the highest under all vegetated covers, including the weedy control. Although grapevine canopy development was more important in the cultivated treatment throughout the experiment, grape yield (kilogram per vine) during the first commercial harvest was not affected by interrow treatments. These results indicate that intercropping during vineyard establishment is a sustainable weed management strategy in southern Quebec.
6	**Control of multiple-herbicide-resistant waterhemp (*Amaranthus tuberculatus*) in corn with postemergence herbicides.** Willemse C.[1], Soltani N.[1], Hooker D.[1], Jhala A.[2], Robinson D.[1], Sikkema P.[1] [1]Department of Plant Agriculture, University of Guelph Ridgetown Campus, Ridgetown, ON; [2]Department of Agronomy and Horticulture, University of Nebraska-Lincoln, Lincoln, NE Multiple-herbicide-resistant (MHR) waterhemp is becoming increasingly difficult to control due to the evolution of resistance to acetolactate synthase (ALS), photosystem II (PS II), 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) and protoporphyrinogen oxidase (PPO) inhibiting herbicides. Two field studies were conducted in Ontario in 2019 and 2020 to determine (1) MHR waterhemp control with herbicides applied early postemergence (EPOST) and (2) the interaction between 4-hydroxyphenylpyruvate dioxygenase (HPPD)-inhibiting herbicides and PS II-inhibiting herbicides applied postemergence (POST) for MHR waterhemp control. In study one, all EPOST applications provided 99% to 100% MHR waterhemp control 12 WAA at site (S) 2 and S5. At S1, S3 and S4, all EPOST herbicide applications controlled MHR waterhemp ≥ 90% 12 WAA except glyphosate + *S*-metolachlor/atrazine and glyphosate + dicamba/atrazine that provided 61% to 76% and 63% to 89% control, respectively. In study two, HPPD- and HPPD- plus PS II-inhibiting herbicides provided greater MHR waterhemp control than PS II-inhibiting herbicides at all sites. Mesotrione applied POST controlled MHR waterhemp 54% 4 WAA at S1 and S4, control increased 29%, 34% and 22% with the addition of atrazine, bromoxynil and bentazon, respectively. At S1 and S4, tolpyralate applied POST controlled MHR waterhemp 61%, control increased 20% with the addition of bromoxynil. The addition of atrazine, bromoxynil or bentazon did not increase MHR waterhemp control with topramezone. Colby's analysis indicated synergism between mesotrione and bromoxynil or bentazon and tolpyralate and bromoxynil at S1 and S4. This research concludes that herbicide tank-mixtures applied EPOST can provide full-season MHR waterhemp control. Furthermore, atrazine, bromoxynil and bentazon increased MHR waterhemp control with mesotrione and bromoxynil increased MHR waterhemp control with tolpyralate.
7	**Investigation of management strategies to optimize cover crop-based weed mitigation in Canadian sweet corn production.** Brackenridge, H.[1], Bae, J.[2], Simard, M-J.[3], Tardif, F.[1], Bosveld, K.[4], and Nurse, R.E.[4] [1]Department of Plant Agriculture, University of Guelph, Guelph, ON; [2]Agriculture and Agri-Food

	Canada (AAFC), Agassiz, BC; [3]AAFC-St. Jean-sur-Richelieu, QC; [4]AAFC-Harrow, ON Fall sown cereal rye (*Secale cereal* L.) has gained popularity as a cover crop due to its weed-suppressive capabilities. When mechanically terminated with a roller-crimper, this method of weed control makes an inexpensive enhancement to an integrative weed management program. Research has shown that early milk, occurring in mid-July, is the optimal stage for cereal rye termination via roller-crimper. However, roller-crimping at this timing would cause significant delays in cash crop planting, potentially compromising yields. Therefore, the objective of this research was to identify an earlier maturing cereal rye cultivar. Two cereal rye cultivars (early vs. standard maturity) were compared at three seeding rates (150, 300, and 600 seeds/m^2) for their effect on rye biomass, weed biomass, and marketable yield. The trial was conducted at Agassiz, BC, Harrow, ON, and St. Jean-sur-Richelieu, QC in 2019 and at Harrow and St. Jean-sur-Richelieu in 2020. Results thus far suggest that the early maturing cereal rye cultivar reaches early milk two to seven days earlier than the standard cultivar at Agassiz and Harrow. This suggests that earlier roller-crimping may be possible at these locations. Cereal rye biomass was highest in the 600 seeds/m^2 seeding rate but did not differ between cultivars. Additionally, rye biomass was weakly correlated to weed biomass after crimping, however, the strength of this relationship varied among locations and years and there was no difference in weed control between rye cultivars at each location. Marketable sweet corn yield was affected by cereal rye seeding rate but not rye cultivar. Overall, cereal rye biomass, weed biomass after roller-crimping, and marketable sweet corn yield differed among locations and years. These findings emphasize the complexity of roller-crimping cereal rye for weed mitigation and the importance of multi-site-year studies to draw regionally specific conclusions.
8	**The importance of singlet oxygen in resource-independent competition**. Berardi, N., Amirsadeghi, S., Swanton, C. Department of Plant Agriculture, University of Guelph, Guelph, ON Neighbouring weeds can influence the proportion of far-red (FR) light a plant is exposed to by reflecting unused FR light horizontally, altering light quality a plant receives. The altered light environment is detected through a decrease in the ratio of red to FR light. This form of plant interaction is considered resource-independent competition and can have detrimental effects on plant growth. Recently, FR light has been shown to enhance the production of singlet oxygen in plants. Under normal physiological conditions, singlet oxygen acts as an important signalling compound that is involved in regulating the expression of specific sets of genes and essential physiological processes. However, when singlet oxygen is produced in excess it can cause irreversible damage to proteins, lipids and DNA resulting in photoinhibition of photosynthesis and cell death. Recently, FR light has been shown to enhance the production of singlet oxygen in plants. To further explore the mechanisms surrounding resource-independent plant competition and the involvement of singlet

	oxygen, *Arabidopsis thaliana* was studied under a FR-enriched environment. Results indicate that singlet oxygen is a major reactive oxygen species involved in resource-independent competition. Our results also establish a link between singlet oxygen and the TOR kinase signalling pathway, a major regulator of plant growth and development. Further identification of these responses would provide important insights into the molecular basis of plant competition and the central role that singlet oxygen plays under these conditions.
9	**Thermal remote sensing under field conditions: Weed stress example**. Alzaben H.[1], Fraser R.[1], Swanton C.[2] [1]Department of Mechanical and Mechatronics Engineering, University of Waterloo, Waterloo, ON; [2]Department of Plant Agriculture, University of Guelph, Guelph, ON. Thermal remote sensing has many applications; as an assessment tool for urban heat islands, as an ecological indicator of ecosystem development, and as a water stress detection tool. In this study, the exergy destruction principle (EDP) was applied as a theory to explain the expected inverse relationship between surface temperature and crop stress caused by weeds. It was hypothesized that corn growing in a weed free environment will have lower surface temperature compared to corn grown in competition with weeds as predicted by the EDP. This hypothesis was tested under variable field conditions. Weed stress experiments were conducted in 2014 and 2016 at the Arkell and Woodstock Research Stations, ON in which weeds were controlled with glyphosate at the 4^{th}, 7^{th} and 10^{th} leaf tip stage of corn growth. Crop surface temperature was found to increase during the day as the rate of crop stress increase yielding a shallow, but statistically significant ($P < 0.05$) negative slope. Crop surface temperature measurements, however, were highly variable. This variability was the result of various external and weather dependent variables that affect crop surface temperature. This research is important to enhance the potential application of precision agriculture as a weed management tool.
10	**Biologically-effective-dose of bromoxynil, applied alone and tankmixed with metribuzin, for the control of glyphosate-resistant Canada fleabane [*Conyza canadensis* (L.) Cronq.] applied preplant in soybean.** Westerveld, D.B., Hooker, D.C., Robinson, D.E., Sikkema, P.H. Department of Plant Agriculture, University of Guelph, Ridgetown, ON Soybean yield loss due to weed interference in North America is estimated to be an average of 52% if no weed management tactics were utilized. Glyphosate-resistant (GR) Canada fleabane (*Conyza canadensis* (L.) Cronq.), first confirmed in Ontario in 2010, can reduce soybean yield up to 67%. Bromoxynil is a photosystem II inhibiting herbicide that is used for post-emergent control of annual broadleaf weeds primarily in monocot crops. The objective of this research is to determine the biologically-effective-dose (BED) of bromoxynil applied alone and when tankmixed with metribuzin (400 g ai ha^{-1}) applied preplant (PP) for control of GR Canada fleabane in soybean in

	Ontario. Five field experiments were conducted over a two-year period (2019-2020) to determine the dose of bromoxynil +/- metribuzin that provided 50, 80 and 95% GR Canada fleabane control. At 8 weeks after application (WAA) bromoxynil at 98 and 277 g ai ha^{-1} controlled GR Canada fleabane 50 and 80%, respectively. When tankmixed with metribuzin, bromoxynil at 10, 25, and 54 g ai ha^{-1} controlled GR Canada fleabane 50, 80, and 95%, respectively. No soybean injury was observed. At 8 WAA, bromoxynil + metribuzin (280 + 400 g ai ha^{-1}) controlled GR Canada fleabane 97% similar to the industry standards of saflufenacil + metribuzin and glyphosate/dicamba + saflufenacil at 99 and 100% control, respectively. This is the first study that evaluated the utilization of bromoxynil for GR Canada fleabane control prior to seeding soybean; results show that bromoxynil + metribuzin applied PP provides excellent GR Canada fleabane control.
11	**The Carabid interaction network: Consequences for weed seed bio-control.** de Heij, S.E., Willenborg, C.J. Department of Plant Sciences, University of Saskatchewan, Saskatoon, SK Carabid beetles (Coleoptera: Carabidae) have been found to be important bio-control agents in crop fields by lowering both pest insects and weed populations. Recently, their role as weed seed consumers has especially seen as surge in interest. Carabids have been found to consume a variety of weed seeds, spatially correlate with weeds, and reduce weed seed bank entry. However, the results of carabid weed seed bio-control studies are highly variable and a correlation between the activity-density of carabids and weed seed reduction is not always found. I will discuss some of the results of our large field study on carabid weed seed control in conventional crop fields in Saskatchewan. Furthermore, I will discuss some of the concepts discussed in our published paper 'Connected Carabids', for which the inspiration came from the variability in our own field results. 'Connected Carabids' is a synthesis/review paper in which the direct and indirect network interaction which can influence carabid feeding and foraging behavior (and thus their bio-control potential) are discussed. The notion behind it is that greater understanding of carabids' interaction network will aid in explaining field results. But more importantly, that this can aid in the design of agricultural landscapes and management types which benefit from optimal natural bio-control.
12	**Understanding invertebrate weed seed predation: Uncovering the major factors that drive seed selection decisions in carabid weed seed predators.** Ali, K., Willenborg, C. University of Saskatchewan, Saskatoon, SK Field studies have shown that carabid beetles can remove upwards of 65-90% of specific weed seeds shed in agricultural fields each year. Such data do not explain how and why carabid predators go after weed seeds, however. It remains to be proven that weed seed predation by carabids is a genuine

	ecological interaction driven by certain ecological forces that power predation dynamics, and bring about natural regulation of weed populations. To fill into this knowledge gap, we adopted a mechanistic approach to study weed seed predation ecology. Laboratory studies were carried out using different carabid species and three species of brassicaceous weeds as a model system. With this approach, we were able to produce clear and solid evidence that olfactory receptors inform seed predation decisions in the model system under study. Other senses like taste and vision did not play significant roles in seed selection. Also, we were able to isolate and identify the nature of the olfactory (chemical) cues that drive seed predation interactions. Here, we found that weed seed-coat volatile chemicals in terms of long-chain alkanes and esters account for the species-specific differences between the three weed species. However, seed chemistry per se failed to predict which seed types (i.e. species) predators would prefer in some cases. In this regard, seed-predator mass ratio scaling was found to be a more accurate predictor of seed preference by carabid predators. In effect, when the predator is able to crush seeds of different types with almost equal efficiency, seeds that are of superior chemical quality would be selected more preferably for consumption. By contrast, when different weed types show significant differences in their coat hardness, predators would select the seed type that is easier to crush and handle regardless of the chemical quality of that chosen seed type.
13	**Integration of residual herbicides with cultural and mechanical weed control provides better weed management in Faba bean (*Vicia faba* L.).** Fedorchuk, A., Willenborg C., Johnson, E. Department of Plant Science, University of Saskatchewan, Saskatoon, SK Field experiments were conducted in 2017-2019 with four pre-emergent herbicide treatments displaying different lengths of residual activity including; glyphosate (no residual activity), glyphosate+saflufenacil (low), glyphosate+flumioxazin (medium) and glyphohsate+pyroxasulfone+sulfentrazone (high). Additionally, three levels of integration of cultural and mechanical weed management strategies were utilized, and named as low (45 seeds m^{-2}, late seeding, 24 cm row spacing, no mechanical weeding), medium (45 seeds m^{-2}, early seeding, 12 cm row spacing, no mechanical weeding) and high (90 seeds m^{-2}, early seeding, 12 cm row spacing, mechanical weeding) replicated four times and arranged as a Sudoku design. Weed biomass was found to be significantly lower in three out of four site years. Weed seed yields were reduced amongst several treatment combinations in this study. Notably, no combination of pre-emergent herbicide decreased weed seed yield when low integration practices were used. When medium integration practices were used, the addition of any of the residual herbicides caused weed seed yields to decrease from 324 kg ha^{-1} in the glyphosate control treatment to 60, 107, and 71 kg ha^{-1} with saflufenacil, flumioxazin, and pyroxasulfone+sulfentrazone additions, respectively. Faba

	bean yield was not affected by the herbicide applications but did significantly increase by the increasing level of integration. The low integration treatment yielded 1001 kg ha^{-1} and was significantly less than the medium integration treatment at 2314 kg ha^{-1}, and the high integration treatment at 2691 kg ha^{-1}. By increasing the level of integration within the crop, the faba bean is able to create a dense canopy earlier in the season. This allows the faba beans to out compete weeds for sunlight, water, and nutrients, therefore reducing weed pressures, and improving weed management.
14	**Assessing Herbicide Tolerance in Lentils *(Lens culinaris)* Using Hyperspectral Imagery.** Zoerb, B., Shirtliffe, S., Johnson, E., Singh, K. Department of Plant Sciences, University of Saskatchewan, Saskatoon, SK Weed control is of great importance in the successful management of lentil due to its poor competitive ability and short stature. With a lack of effective herbicides and an increase in herbicide resistant weeds; weed control is becoming even more challenging to lentil producers. Field ratings to assess herbicide safety and phytotoxicity in crops can be a tedious process. The objective of this research is to determine if phenotyping crop phytotoxicity is possible through the use of UAV imagery. A two-factor randomized complete block design was conducted at two locations in Saskatchewan, Canada in 2019. The factors tested included lentil variety (CDC Greenstar, CDC Maxim, CDC Impala and CDC Improve) and herbicide rates- including the recommended dose and up to ten times the recommended dose of both saflufenacil and metribuzin herbicides. Unmanned aerial vehicle hyperspectral imagery was captured 6, 16 and 23 days after the application of metribuzin. Increasing herbicide dose decreased both field measures of above-ground biomass and plant stand counts. The greatest spectral variation in reflectance was present for metribuzin versus the saflufenacil herbicide. The spectra were noted to differ especially in the green peak, red-edge, and near infrared regions. Further work will be done in graphing the hyperspectral data from 2019, as well as 2020, to determine if an appropriate vegetative index can be produced to classify different levels of herbicide tolerance. The end goal of this work is to contribute to improving herbicide screening technology with the end goal of being able to assess crop phytotoxicity autonomously via computer algorithms.
15	**Weed suppression using cover crop mixtures in organic field crop systems in Quebec.** Lavergne, S.[1], Vanasse, A.[1], Thivierge, M.-N.[2], Halde, C.[1] [1]Département de phytologie, Université Laval, Quebec City, QC; [2]Agriculture and Agri-Food Canada, Quebec Research and Development Centre, Quebec, QC. Weeds are one of the main yield-limiting factors in organic corn production. In eastern Canada, organic field crop producers have a rising interest in using cover crop (CC) mixtures instead of pure stands to maximize ecosystem services. However, few studies have attempted to determine weed suppression from these multi-species CC mixtures (especially over six species). A two-year field experiment was conducted at Laval University Agronomic Research Station (2017–2018; 2018–2019) and on an organic commercial farm (2017–2018). The experimental design was a split-plot with four blocks. The CC treatment (Year 1) was the main plot factor, comparing a weedy control without

	CC, a pure stand of field pea, and mixtures of 2, 6 and 12 species. The corn organic fertilization (Year 2) was the subplot factor (0 or 120 kg N ha^{-1}). In Year 1, among all site-years, pure stand of field pea provided the highest aboveground biomass (2.6 Mg ha^{-1}), followed by the 2-species mixture (2.3 Mg ha^{-1}) and both multi-species CC mixtures (means of 1.8 Mg ha^{-1}). Field pea was the dominant species in every CC mixture. Weed biomass was inversely related to aboveground biomass of CC (Pearson correlation coefficient of -0.54) and was influenced by the two-way interaction between CC treatments and site-years. Therefore, using multi-species CC mixtures decreased weed biomass only at Laval University Agronomic Research Station in the fall of 2018. In organic corn (Year 2), weed biomass was not affected by CC treatments and was slightly greater in fertilized than in unfertilized treatments. Moreover, corn yield was highest in the pure stand of field pea and the mixtures of 2-species and 12-species. Corn yield increased by 10% with poultry manure application irrespective of the CC treatments. In our study, poor soil nitrogen availability rather than weed competition limited organic corn yield.
16	**Sodium cation concentrations in Western Canada water sources and influence of sodium on glyphosate performance and interaction with AMS adjuvants.** Dahl, G.K.[1], Van Dam, D.A.[2], Carr, M.M.[2], Flipp, A.[1], Hennemann, L.J.[1], Skelton, J.J.[1],[1]Winfield United; [2]Winfield United Canada. Water quality testing was conducted from 2018 through 2020 in Canada. The water quality reports used coefficients from research at North Dakota State University to recommend the amount of ammonium sulfate, AMS, needed to be to overcome antagonism of glyphosate from cations. The AMS amounts recommended were adequate to overcome the antagonism. Many water quality reports indicated the samples contained more than 500 ppm sodium. Many of the samples did not contain high levels of calcium or magnesium and were not considered hard. Studies were conducted to determine the influence of sodium cation concentration on glyphosate. Spray water samples were made using distilled water and various amounts of sodium chloride. The target waters were to be distilled water, 125 ppm sodium, 250 ppm sodium, 500 ppm sodium and 1000 ppm sodium. Glyphosate was sprayed at 434 g ae ha^{-1} with a hand boom with AIXR 110015 flat fan nozzles at 100 liters per hectare. Each of the glyphosate plus water samples were sprayed with no adjuvant, 34% AMS at 2.5% v/v or an adjuvant which contains a nonionic surfactant plus 34% liquid AMS at 2.5% v/v. Control of velvetleaf (*Abutilon theophrasti Medik*) and common lambsquarters (*Chenopodium album L.*) was decreased as sodium cation concentration increased when no adjuvant was present. The nonionic surfactant plus AMS adjuvant and the AMS adjuvant increased velvetleaf control when distilled water was used compared to glyphosate alone. Both nonionic surfactant plus AMS adjuvant and the AMS adjuvant were able to

	prevent the reduction in velvetleaf control as sodium concentration increased. The nonionic surfactant plus AMS adjuvant increased common lambsquarters control when distilled water was used compared to glyphosate alone or with just AMS. The nonionic surfactant plus AMS adjuvant was able to reduce or prevent the reduction in common lambsquarters control as sodium concentration increased.
17	**Kochia and wild oat intraspecific and interspecific interference.** Sharpe, S. Agriculture and Agri-Food Canada, Saskatoon, SK. Wild oat (*Avena fatua*) and kochia (*Kochia scoparia*) are troublesome and invasive weeds in the Canadian Prairies. Wild oat is a long-standing threat to crop production and is widely distributed across annual cropping systems while kochia is more densely located in the southern regions of the Prairie provinces and expanding northward. The evolution of Group 2, 4, and 9 herbicide resistant kochia is a concerning development which may facilitate further escape from conventional integrated pest management strategies. The study objective was to evaluate competition dynamics between kochia and wild oat within the context of kochia introductions into wild oat infested fields. Greenhouse experiments were established in Saskatoon, SK in 2019. Treatments included varying planting densities for kochia and wild oat using ratios of 1:1, 2:1, 1:2, and 2:2, with single species controls. After 3 months of wild oat competition, kochia biomass was reduced by approximately 70%. Wild oat was primarily impacted by intraspecific interference (approximately 50% biomass reduction), but an instance of similar interference was observed in one experimental run with 2 kochia plants. Should kochia's range further expand northward, it is not likely to easily displace wild oat though impacts of allelopathy should further be considered. Additional study is required to consider how crop competition dynamics impact interference between these two weeds.
18	**Manipulating kochia [*Kochia scoparia* (L.) Schrad.] seed production through phenology-based weed control.** Geddes, C.M.[1], Molnar L.J.[1], Gulden, R.H.[2], Johnson, E.N.[3], Mulenga, A.[4], and Willenborg, C.J.[3] [1]Agriculture and Agri-Food Canada (AAFC), Lethbridge, AB; [2]Department of Plant Science, University of Manitoba, Winnipeg, MB; [3]Department of Plant Sciences, University of Saskatchewan, Saskatoon, SK; [4]AAFC, Scott, SK The growing abundance of herbicide-resistant weeds world-wide calls for new innovations in the way we think about and implement integrated weed management (IWM) programs. The efficacy of any weed control tool is dependent on the timing of implementation. Understanding the timing of weed life cycle events (phenology) can improve the efficiency of weed control passes by informing farmers of the optimal timing for weed control efforts; yet weed phenology remains largely understudied. The philosophy of weed control is

	changing in response to growing resistance issues, and in addition to reducing yield losses, another main objective of weed management is to reduce the number of weed seeds returned to the soil seed bank. IWM programs are in need of tools that target and manipulate weed seed production. Kochia (*Kochia scoparia* (L.) Schrad.] is among the worst agricultural weed problems in the southern Canadian prairies due to multiple herbicide resistance and unique biological traits allowing this weed to thrive when exposed to abiotic stresses like heat, drought, or salinity. Limiting kochia seed production is an important goal for IWM because kochia exhibits relatively short seed bank longevity (1-2 years). Limiting kochia seed production for two consecutive years could cause rapid population decline. A field experiment was conducted to determine the impact of pre- or post-harvest herbicide (glyphosate + saflufenacil) application at six different harvest dates on kochia seed production before and after harvest. Preliminary results from two experiments in Lethbridge, Alberta in 2018 suggest that kochia seed production can be minimized by tailoring the timing of harvest around late August (about 2000-2200 GDD), resulting in minimal seed production before harvest and on regrowth following harvest. Pre-harvest herbicide treatment can extend this "critical period for weed seed control" later, while post-harvest herbicide treatment can extend this window earlier during the growing season.
19	**Preliminary investigation of cow wheat (*Melampyrum lineare*) interference with wild blueberry (*Vaccinium angustifolium* Ait).** Deveau, V.[1], and White, S.N.[1]. [1]Department of Plant, Food, and Environmental Sciences, Dalhousie University Faculty of Agriculture, Truro, NS. Cow wheat (*Melampyrum lineare*) is a common annual root hemi-parasitic plant in lowbush blueberry fields in Nova Scotia. Plants of the genus *Melampyrum* form parasitic haustorial connections with many different host species, including wild blueberry (*Vaccinium angustifolium* Ait). Potential effects of cow wheat interference with wild blueberry growth and development, however, have not been investigated. The objective of this research was to conduct an observational field study to determine the effect of cow wheat presence or absence on wild blueberry stem density, stem height, stem diameter, stem biomass, and number of berries per stem. The experiment was conducted in 10 bearing year wild blueberry fields in Nova Scotia in August 2020. Treatments consisted of 1) absence of cow wheat and 2) presence of cow wheat. The experiment was arranged as a completely randomized design with 10 replications of each treatment in each field. Each replication consisted of a 0.5 by 0.5m quadrat placed in a patch of blueberries containing blueberry plants only (treatment 1) or blueberry plants and cow wheat (treatment 2). With the exception of wild blueberry stem height and stem density at one site, presence or absence of cow wheat had a significant effect on all lowbush blueberry response variables measured ($P \leq 0.0180$). Lowbush blueberry stem density, stem height, stem diameter, stem biomass, and berries per stem were 13-57%, 15-50%, 7-30%, 43-69%, and 29-77% lower, respectively, in quadrats with cow wheat relative to quadrats without cow wheat. There was also a significant negative correlation between cow wheat density and wild blueberry stem height ($P = 0.0188$), stem diameter ($P = 0.0022$), and stem biomass ($P = 0.0097$). Results suggest

	cow wheat interferes with wild blueberry and support grower observations of reduced wild blueberry growth and yield in fields with high cow wheat populations.
20	**Duration of weed presence influences the recovery of photosynthetic efficiency and yield in common bean (*Phaseolus vulgaris* L.)** Andrew G. McKenzie-Gopsill[1*], Sasan Amirsadeghi[2], Sherry Fillmore[3], Clarence J. Swanton[2] [1]Charlottetown Research and Development Centre, Agriculture and Agri-Food Canada, Charlottetown, PE; [2]Department of Plant Agriculture, University of Guelph, Guelph, ON; [3]Kentville Research and Development Centre, Agriculture and Agri-Food Canada, Kentville, NS Photosynthetic responses of common bean (*Phaselous vulgaris* L.) to increasing durations of weed-free and weedy environments were investigated using a critical period for weed control study under field conditions. The presence of weeds induced the shade avoidance response and was accompanied by a reduced red to far-red ratio (R/Fr) of reflected light supporting previous assertions it is an important signal regulating crop-weed interactions. Despite increases in stomatal conductance and leaf intercellular [CO_2] with increasing duration of weed presence, CO_2 assimilation and photosynthetic efficiency continually declined. This coincided with reduced Calvin cycle capacity suggesting induction of biochemical rather than stomatal limitations on photosynthesis. Weed removal prior to reproductive stages resulted in maintenance of high photosynthetic capacity. When weed presence extended to reproductive stages and beyond the critical period for weed control, however, CO_2 assimilation and photosynthetic efficiency never recovered. Yield was highly correlated with photosynthetic efficiency and in a similar manner, declined with increasing durations of weed presence through reduced seeds per plant. We conclude that the lasting consequence of weed competition is impairment of photosynthesis, which may provide an important mechanism to explain yield loss.
21	**Clethodim suppresses hair fescue (*Festuca filiformis*) in wild blueberry (*Vaccinium angustifolium* Ait).** White, S.N.[1] and Graham, G.[2] [1]Department of Plant, Food, and Environmental Sciences, Dalhousie University Faculty of Agriculture, Truro, NS; [2]New Brunswick Department of Agriculture, Aquaculture, and Fisheries, Fredericton, NB Hair fescue is a tuft-forming perennial grass of concern in lowbush blueberry as tufts form dense sods that reduce lowbush blueberry yield and inhibit harvest. Although generally tolerant to ACCase-inhibiting herbicides, injury to some *Festuca* spp. following clethodim applications has been reported. ACCase-inhibiting herbicides are important for non-bearing and bearing year perennial grass management in lowbush blueberry but have not been extensively evaluated for hair fescue management. The objectives of this research were to 1) determine the relative efficacy of foramsulfuron, fluazifop-p-butyl,

	sethoxydim, and clethodim on hair fescue, and 2) determine if foramsulfuron tank mixtures with fluazifop-p-butyl, sethoxydim, and clethodim improve hair fescue suppression. None of the herbicides evaluated caused unacceptable injury to lowbush blueberry. Foramsulfuron (35 g a.i. ha^{-1}) reduced hair fescue total tuft density, flowering tuft density, and flowering tuft inflorescence number. Fluazifop-p-butyl (250 g a.i. ha^{-1}) and sethoxydim (495 g a.i. ha^{-1}) caused variable levels of visual injury to hair fescue and did not reduce total tuft density, flowering tuft density, or flowering tuft inflorescence number. Clethodim (91 g a.i. ha^{-1}), however, caused >50% visual injury to hair fescue and reduced hair fescue total tuft density, flowering tuft density, and flowering tuft inflorescence number. Fluazifop-p-butyl and sethoxydim tank mixtures with foramsulfuron did not increase hair fescue suppression relative to foramsulfuron alone. A foramsulfuron + clethodim tank mixture provided equivalent hair fescue suppression as either herbicide applied alone. Foramsulfuron and clethodim should therefore be used in rotation rather than tank mixture to manage hair fescue in lowbush blueberry.
22	**Evaluation of amino acid-inhibiting herbicide tank mixtures for hair fescue (*Festuca filiformis*) management in wild blueberry (*Vaccinium angustifolium* Ait).** White, S.N.[1]. [1]Department of Plant, Food, and Environmental Sciences, Dalhousie University Faculty of Agriculture, Truro, NS Hair fescue is a tuft-forming perennial grass that reduces lowbush blueberry yield. The currently registered amino acid-inhibiting herbicides foramsulfuron and nicosulfuron+rimsulfuron (ALS/AHAS-inhibitors), glufosinate (glutamine synthesis-inhibitor), and glyphosate (EPSP synthase-inhibitor) exhibit variable efficacy on hair fescue when applied alone. Tank mixtures of herbicides with complimentary modes of action, however, can improve weed control but have not been evaluated for hair fescue management in wild blueberry. The objective of this research was to determine the main and interactive effects of ALS/AHAS-inhibiting herbicides and the complimentary mode of action herbicides glufosinate and glyphosate on hair fescue. The experiment was a 4 by 3 factorial arrangement of ALS/AHAS-inhibiting herbicide (none, foramsulfuron, nicosulfuron+rimsulfuron, flazasulfuron) and complimentary mode of action tank mixture (none, glufosinate, glyphosate) arranged in a randomized complete block design with 4 blocks and was conducted in spring of the non-bearing year in 2 wild blueberry fields in 2019. Spring non-bearing year foramsulfuron, nicosulfuron+rimsulfuron, glufosinate, and glyphosate applications alone did not consistently reduce hair fescue total tuft density, flowering tuft density, or flowering tuft inflorescence number. Flazasulfuron applications, however, reduced hair fescue total tuft density, flowering tuft density, and flowering tuft inflorescence number at each site. Foramsulfuron tank mixtures with glufosinate and glyphosate did not consistently improve hair fescue suppression. Nicosulfuron+rimsulfuron tank mixtures with glufosinate and glyphosate, however, consistently reduced flowering tuft density and flowering tuft inflorescence number. Similarly, the flazasulfuron+glufosinate tank mixture reduced total tuft density, flowering tuft density, and flowering tuft inflorescence number at each site and the flazasulfuron+glyphosate tank mixture reduced flowering tuft density and flowering tuft inflorescence number at each site. Nicosulfuron+rimsulfuron and flazasulfuron tank mixtures with glufosinate or

	glyphosate may therefore contribute to hair fescue management in wild blueberry and reduce the likelihood of selecting for ALS/AHAS-inhibiting herbicide resistant hair fescue biotypes.
23	**Timing of Tribenuron Methyl and Hexazinone Treatment for Sheep Sorrel Management in Wild Blueberry.** Graham, G.L. New Brunswick Department of Agriculture, Aquaculture and Fisheries (NBDAAF), Fredericton, NB Sheep sorrel (*Rumex acetosella*) is an annual or short-lived perennial weed that has been noted in blueberry production for many years and is traditionally found in areas of low fertility. Recently, growers have reported heavier than normal sheep sorrel populations, and they suspect resistance to hexazinone is the reason. Tribenuron methyl has shown promise for sheep sorrel control, although there is a wide application window and a risk of crop injury or reduced weed control if applied at an incorrect timing. In the fall of 2018, a trial was established near Chipman, New Brunswick in an established wild blueberry field following crop harvest. The trial design was a factorial design as a randomized complete block consisting of twelve treatments and four replicates. The main trial factor was hexazinone rate, either 0 or 1920 g ai/ha, applied on May 9, 2019. The secondary factor, tribenuron methyl timing, consisted of tribenuron methyl (30 g ai/ha plus 0.2% v/v Agral 90) applied at six distinct timings: None; Early Fall – Before pruning September 21, 2018; Late Fall – November 8, 2018 after pruning; Early spring – May 2, 2019; Pre-emergent – May 9, 2019 or Post-emergent – after blueberry emergence on May 28, 2019. The only significant factor for crop injury was the tribenuron timing treatment. The post-emergent treatment caused the highest level of crop injury and was significant over the entire trial period. Hexazinone rate was a significant factor for sheep sorrel control over all rating periods, with a 10-20% increase when adding hexazinone over no hexazinone treatments. Adding tribenuron significantly improved sheep sorrel control for every rating period and there was no difference between application timings. The interaction term, significant over the trial period, followed the trends of the single factors. Sheep sorrel populations were low in the trial area, and this trial should be replicated under higher populations. The addition of this pest to the current label for tribenuron methyl would be a significant improvement for the wild blueberry industry.
24	**Management of triazine resistant weeds in tomato**. Robinson, D, McNaughton, K. University of Guelph, Guelph, ON. The management of triazine-resistant weeds, including common lambquarters (*Chenopodium album* L.) and redroot pigweed (*Amaranthus retroflexus* L.) were investigated in tomato (*Solanum lycopersicum* L.). Field trials were conducted over a five-year period at two locations (for a total of 10 location-years) in Ontario to study the effect of pre-plant incorporated treatments of sulfentrazone (100 or 200 g ai ha^{-1}), s-metolachlor (1200 or 2400 g ai ha^{-1}), and metribuzin (250 or 500 g ai ha^{-1}) on transplanted processing tomato.

	Treatments were applied individually, and in all possible combinations as tank mixtures. Additionally, tomato tolerance was evaluated under weed-free conditions. The tank-mixture of sulfentrazone + s-metolachlor gave greater than 85% control of *Amaranthus retroflexus* and *Solanum ptycanthum*, but only 70-76% control of *Abutilon theophrasti*, *Ambrosia artemisiifolia* and *Chenopodium album*. The combination of sulfentrazone + s-metolachlor + metribuzin provided excellent control of triazine-resistant common lambsquarters and redroot pigweed. Under weed-free conditions, injury was observed in two of the ten location-years. Stunting, leaf distortion and leaf discolouration were observed in treatments containing sulfentrazone at locations where CEC levels were below 8 meq $100g^{-1}$ soil and less than 1% organic matter. At the remaining eight location-years, there was no visual injury or reduction in plant dry weight, time to first flower or marketable yield of transplanted tomato in any treatments relative to the hand-weed, untreated controls. Sulfentrazone is registered for use prior to transplanting tomato in the province of Ontario; however, its use is not recommended in soil types with low cationic exchange capacity where soil organic matter is less than 2%.
25	**The amino acid substitution Phe255Ile in *psbA* gene confers resistance to hexazinone in hair fescue (*Festuca filiformis*) plants from lowbush blueberry (*Vaccinium angustifolium* Ait.) fields.** Martin Laforest, M.[1], Soufiane, B.[1], Bisaillon, K.[1], Page, E.R.[2] and White, S.N.[3]. [1]Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu Research and Development Center, Saint-Jean-sur-Richelieu, QC; [2]Agriculture and Agri-Food Canada, Harrow Research and Development Center, Harrow, ON; [4]Department of Plant, Food, and Environmental Sciences, Dalhousie University Faculty of Agriculture, Truro, NS Cultivation of lowbush blueberry, an important crop in the eastern part of North America, is unique as it is done over the course of two consecutive growing seasons. Pest management, and in particular weed management, is impacted by the biennial cultural practice. The choice of methods to control weeds is limited and such a system relies heavily on herbicides for weed management. Availability of unique herbicide active ingredients for weed management is limited, and ones that are available are repeatedly used and the risk of developing resistance is acute. *Festuca filiformis*, a perennial grass weed, has evolved resistance to hexazinone, a frequently used photosystem II inhibitor in lowbush blueberry production. We show that substitution of phenylalanine to isoleucine at position 255 is responsible for a decreased sensitivity to the active ingredient by a factor of 13.8. Early diagnosis of resistance based on the detection of the mutation will inform growers to use alternative control methods and thus help to increase the sustainability of the cropping system

26	**Mauvaises herbes et plantes envahissantes : vieux problèmes, nouveaux défis.** Lavoie, C. École supérieure d'aménagement du territoire et de développement régional, Université Laval, Québec, QC. La relecture d'un vieil ouvrage publié en 1906 (*Mauvaises herbes du Canada* par George Clark et James Fletcher) et la publication d'un nouveau livre sur le sujet en 2019 (*50 plantes envahissantes : protéger la nature et l'agriculture* par Claude Lavoie) permet de revisiter le problème des plantes nuisibles et de comprendre quels sont les changements qui sont survenus depuis plus d'un siècle. Les deux livres traitent du même nombre d'espèces (50), mais n'en partagent pas beaucoup (11), outre quelques plantes très communes comme le chénopode blanc (*Chenopodium album* L.) ou le chiendent (*Elytrigia repens* (L.) Desv. *ex* B.D. Jacks). Certaines plantes abordées en 2019 n'étaient pas encore introduites au Canada en 1906. Cela dit, les différences entre les deux ouvrages s'expliquent autrement : les définitions de plantes nuisibles ne sont plus les mêmes – on insistait beaucoup, en 1906, sur l'utilité et l'apparence des plantes – et, surtout, le paysage agricole a depuis beaucoup changé. Les corridors routiers, structures de dissémination par excellence des mauvaises herbes, sont bien plus abondants de nos jours qu'au début du 20e siècle. L'émergence de la culture du maïs, et particulièrement celle du soya, ont favorisé tout un cortège de plantes qui, jusqu'à la fin des années 1980, ne figuraient guère parmi les envahisseurs nuisibles. C'est notamment le cas de la grande herbe à poux (*Ambrosia trifida* L.) qui est en voie de devenir, du moins dans le Midwest américain, la principale plante nuisible des cultures de soya, une plante qui résiste mal à la compétition d'un envahisseur d'aussi grande taille. En définitive, une telle relecture est utile pour mieux cibler les efforts de lutte dans un contexte climatique en perpétuel changement. **Weeds and invasive plants: old problems, new challenges.** Lavoie, C. École supérieure d'aménagement du territoire et de développement régional, Université Laval, Québec, QC. The rereading of an old book published in 1906 (*Farm Weeds of Canada* by George Clark and James Fletcher) and the publication of a new book on the same subject in 2019 (*50 plantes envahissantes: protéger la nature et l'agriculture*) allows us to revisit the invasive plant problem and understand the changes that have occurred over more than a century. Although both books treat the same number of species (50), there is little overlap (11), apart from several very common plants such as common lamb's-quarters (*Chenopodium album* L.) or quack grass (*Elytrigia repens* (L.) Desv. *ex* B.D. Jacks). Certain plants discussed in 2019 had not yet been introduced to Canada in 1906. This being said, the differences between these two works can be explained otherwise: the definitions of noxious plants are no longer the same – in 1906, much emphasis was placed on the usefulness and appearance of plants – and, most importantly, the agricultural landscape has since changed drastically. Roadways, weed

	dissemination structures par excellence, are much more abundant nowadays than at the start of the 20th century. The emergence of corn, and particularly of soybean cultivation, fostered an assemblage of plants which, until the late 1980s, were not considered noxious invaders. This is notably the case for giant ragweed (*Ambrosia trifida* L.), which is becoming, at least in the American Midwest, the main pest of soybean crops, a plant with poor resistance to such a tall invader. Ultimately, this rereading will help to better target control efforts in a context of a constantly changing climate.
27	**Weed migrations and climate change: Staying at the forefront.** DiTommaso, A. Section of Crop and Soil Sciences, School of Integrative Plant Science, Cornell University, Ithaca, NY, USA Invasive species are often seen as harbingers of climate change because of their potential to cause economic and environmental change in the process of expanding their ranges. During the last decade, research has focused on how climatic factors are likely to impact the growth, reproduction, and performance of agronomic weeds and invasive plant species of natural areas. Research has also focused on predicting the potential distributions of invasive species based on their climatic and habitat suitability. However, we know relatively less about how biotic interactions and climate change may affect invasive species, especially at range margins. This knowledge can improve our overall understanding of genetic and ecological factors that restrict local adaptation and hence the abundance and distribution of potentially invasive species into new regions. I will provide an overview of how climate change may be impacting the growth and reproduction of invasive plant species. From current projects, I will also illustrate how this information can help us better understand the potential for invasive species to expand their range into novel regions. **Migration de mauvaises herbes et changement climatiques : Demeurer à l'avant-garde.** DiTommaso, A. Section of Crop and Soil Sciences, School of Integrative Plant Science, Cornell University, Ithaca, NY, USA Les espèces envahissantes sont souvent considérées comme des indicateurs avant-coureurs de changements climatiques puisqu'elles peuvent potentiellement engendrer des perturbations économiques et environnementales lors de l'expansion de leur aire de répartition. Durant la dernière décennie, les travaux de recherche ont principalement tenter d'évaluer l'effet des facteurs climatiques sur la croissance, la reproduction et la performance des espèces de mauvaises herbes agricoles et de plantes envahissantes de milieux naturels. Les travaux ont aussi cibler la prédiction de la distribution potentielle des espèces envahissantes selon leur besoins climatiques et les habitats disponibles. Toutefois, nous connaissons relativement moins de choses sur les effets des interaction biotiques et des changements climatiques sur les espèces envahissantes, particulièrement aux limites de leur aire de distribution. Cette

	connaissance peut améliorer notre compréhension globale des facteurs génétiques et écologiques qui limitent l'adaptation locale et ainsi l'abondance et la distribution d'espèces potentiellement envahissantes dans de nouvelles régions. Je vais exposer sommairement comment les changements climatiques peuvent potentiellement modifier la croissance et la reproduction d'espèces de plantes envahissantes. Je vais aussi illustrer comment cette information peut nous aider à comprendre comment les espèces envahissantes peuvent étendre leur aire de distribution dans de nouvelles régions.
28	**Using bioclimate modelling to understand pest ecology and predict pest invasions.** Vankosky, M.A.[1], Weiss, R.M[1], Geddes, C.[2], Olfert, O.[1] [1]Agriculture and Agri-Food Canada, Saskatoon Research and Development Centre, Saskatoon SK; [2]Agriculture and Agri-Food Canada, Lethbridge Research and Development Centre, Lethbridge, AB Agricultural pests pose annual challenges to farmers across Canada. Important pests include species of insects, weeds, and plant pathogens that may be native, adventive, migratory, or invasive to Canada. The threat of invasive pests to Canadian agriculture continues to increase, due to the expansion of global trade and climate change (which affects their distribution and abundance). Invasive pests can decrease crop yield and can result in barriers to trade. Bioclimate models are important tools that can be used to inform farmers, agronomists, and other agricultural stakeholders about risks associated with agricultural pests. There are two primary types of bioclimate models: 1) distribution models (i.e., bioclimatic niche envelope models) that use pest biology and climatic conditions to predict the establishment, distribution, and abundance of pests, and 2) phenology models that predict the annual development and abundance of pests, in relation to the crop plant, natural enemies, and weather conditions. Thus, bioclimate models can be used to predict risk between growing seasons, within growing seasons, and changes to risk over time associated with climate change. Bioclimate models can provide farmers, agronomists, policy makers, and scientists with important information to mitigate the impact of invasive and native pest species by making timely pest management decisions to protect against yield losses. Here, we provide an overview of the development, use, benefits, and challenges associated with bioclimate models on the Canadian Prairies. **L'utilisation de la modélisation bioclimatique pour comprendre l'écologie des organismes nuisibles et prédire les invasions.** Vankosky, M.A.[1], Weiss, R.M[1], Geddes, C.[2], Olfert, O.[1] [1]Agriculture and Agri-Food Canada, Saskatoon Research and Development Centre, Saskatoon SK; [2]Agriculture and Agri-Food Canada, Lethbridge Research and Development Centre, Lethbridge, AB Les ennemis des cultures sont une source annuelle de défis pour les producteurs à travers le Canada. Les ravageurs importants incluent des espèces d'insectes,

	de mauvaises herbes et des pathogènes de plantes qui peuvent être indigènes, adventives, migratrices ou envahissantes au Canada. La menace que pose les espèces nuisibles envahissantes envers l'agriculture canadienne augmente continuellement en raison de l'augmentation du commerce mondial et des changements climatiques (qui modifient leur distribution et leur abondance). Les espèces nuisibles envahissantes peuvent réduire les rendements des cultures et peuvent générer des barrières commerciales. Les modèles bioclimatiques sont des outils importants qui peuvent être utilisés pour informer les producteurs, les agronomes et les intervenants du milieu agricole à propos des risques associés aux ravageurs agricoles. Il y a deux principaux types de modèles : 1) les modèles de distribution (i.e. modèles de niche bioclimatique) qui utilisent des information sur la biologie des ravageurs et les conditions climatiques pour prévoir l'établissement, la distribution et l'abondance des ravageurs et 2) les modèles phénologiques qui prédisent le développement annuel et l'abondance des ravageurs et relation avec la culture, les ennemis naturels et les conditions météorologiques. Ainsi, les modèles bioclimatiques peuvent prédire les risques interannuels, intra-annuels et ceux temporels associés aux changements climatiques. Les modèles bioclimatiques peuvent fournir aux producteurs, agronomes, décideurs politiques et scientifiques des informations importantes pour réduire l'impact des espèces nuisibles envahissantes et indigènes en prenant des décisions opportunes concernant la gestions des ennemis des cultures afin de protéger les rendements. Ici, nous présentons un aperçu de développement, de l'utilisation, des bénéfices et des défis associés aux modèles bioclimatiques dans les prairies canadiennes.
29	**Preventing weed spread with the detection and identification of weed seeds in agricultural commodities.** Wang, R., Canadian Food Inspection Agency, Seed Science and Technology Section, Saskatoon Laboratory, Saskatoon, SK. Seeds are the agent for long-distance dispersal of invasive plants and noxious weeds into new areas. Human activities, especially trade, facilitate the spread of noxious weeds to the areas that are far beyond the weed biological dispersal range. The plant protection regulations and quarantine requirements are currently recognized measures preventing weeds from spreading. Prevention is the most cost-effective measure for controlling weeds, mitigating large economic losses and environmental harm. Therefore, weed seed detection and identification are required in trading agricultural commodities, such as seeds, grains, packing materials, and feed, using seed or phytosanitary certifications. Weed seed detection and identification are also essential to support regulatory monitoring, surveillance, and enforcement by regulatory bodies such as the CFIA. Seed identification, or identifying plant species with seeds, is a specialized diagnostic test currently performed by specialized professionals and experts, with limited tools to assist and declined taxonomic expertise to support. With the increasing awareness of the prevention of weeds and testing demands in Canadian import and export, the CFIA is exploring advanced technologies

for testing applications. The CFIA led the digital tool development to help commercial testing laboratories and collaborated internationally for knowledge sharing with a digital platform. It contains the "Seed Identification Guide", a peer-reviewed virtual publication, online learning tools, and standard protocols for authors and users. The digital resources are used daily by end users and analysts in training from 50 countries. The developed information and image database will also build the foundations for the future application of artificial intelligence (AI). Research conducted in collaboration with computer scientists also explored computer vision and its potential applications. The proof of concept study demonstrated that computer vision achieved a high recognition rate greater than 97% in distinguishing close-related species using digital images of their seeds.

Preventing weed spread with the detection and identification of weed seeds in agricultural commodities. Wang, R., Canadian Food Inspection Agency, Seed Science and Technology Section, Saskatoon Laboratory, Saskatoon, SK.

Les semences sont des agents de dispersion des plantes envahissantes et des mauvaises herbes nuisibles sur de longue distances dans de nouvelles zones. Les activités humaines, particulièrement les échanges commerciaux, facilitent la dispersion des mauvaises herbes nuisibles jusqu'à des régions qui sont bien en dehors de la zone de dispersion biologique de la mauvaises herbe. Les réglementations sur la protection des végétaux et les exigences en matière de quarantaine sont actuellement des mesures reconnues qui limitent la dispersion des mauvaises herbes. La prévention est le moyen le plus économique permettant de lutter contre les mauvaises herbes, réduire les pertes économiques importantes et les dommages à l'environnement. Ainsi, la détection et l'identification des semences de mauvaises herbes lors de l'échange de produits agricoles tels que les semences, les grains, les emballages et la moulée, en utilisant les certifications de semences ou phytosanitaires. La détection et l'identification des semences de mauvaises herbes sont aussi essentielles pour appuyer le suivi, le contrôle et l'application de la règlementation par les organismes règlementaires tels que l'ACIA. L'indentification des semences, ou l'identification des espèces de plantes avec les semences, est un test diagnostic spécialisé présentement réalisé par des professionnels et des experts spécialisés avec un nombre limité d'outils et un support taxonomique en déclin. Avec l'augmentation de la sensibilisation à la prévention des mauvaises herbes et les demandes de tests dans les importations et les exportations canadiennes. L'ACIA se penche sur des technologies de pointe pour l'application de tests. L'ACIA a dirigé le développement d'outils numériques pour aider les laboratoires commerciaux qui effectuent les tests d'identification et a collaboré à l'international pour échanger avec une plateforme numérique. Elle contient le « Guide d'identification des semences », une publication virtuelle révisée par les pairs, des outils d'apprentissage en ligne, et des protocoles standardisés pour les auteurs et les utilisateurs. Les ressources numériques sont utilisées à tous les

	jours par les utilisateurs finaux et les analystes en apprentissage provenant de 50 pays. L'information acquise ainsi que la banque d'images vont permettre l'application future d'intelligence artificielle (IA). Des travaux de recherche effectués en collaboration avec des chercheurs en informatique ont aussi évaluer la faisabilité, et les applications potentielles, de la vision par ordinateur. Une étude de validation de concept a démontré que la vision par ordinateur a permis de différencier des espèces proches parentes, à l'aide d'images numériques des semences, avec un taux de reconnaissance de plus de 97%.
30	**Looking for a needle in a haystack: use of metabarcoding to find weeds and invasive species in seed lots.** Côté M.-J.[1], Jones S.K.[2], Colville A.[1], Kyte S.[1], Wurm N.[2], Chmara J.[1], Duceppe M.-O.[1] [1]Ottawa Laboratory (Fallowfield), Canadian Food Inspection Agency (CFIA), Ottawa, ON; [2]Seed Science & Technology, CFIA, Saskatoon, SK To import seeds into Canada, the seed lot must be free of prohibited noxious weeds, therefore, marketplace monitoring seed samples are taken and tested along with the non-compliant import samples for seed purity. Currently, seed purity testing is performed by manually searching the seed sample for contaminating seeds which are then analysed morphologically for species identification. The process can be lengthy due to the number of seeds in the samples and identification by seed analyst experts can be limited to the genus or family level due to the lack of distinctive morphological characteristics. Therefore, metabarcoding was evaluated as a complementary method for the detection and identification of weed species contaminating crop seed lots. Thus, a workflow using the High-Throughput Sequencing technology (HTS) as well as bioinformatics pipelines for data analysis were developed to detect and identify weed seeds as well as other crop seeds contaminating different seed samples using DNA barcode markers. The workflow was first evaluated on screenings sieved from wheat, barley and flax grain or common seed samples. After analysis against a set of weed species DNA barcode references, positives corresponding to seeds of known weed species that were present in the screenings were successfully detected. Then screenings were put back into the original seed or grain sample (2,500 wheat seed samples) and processed through the same metabarcoding workflow. Again after analysis, positives corresponding to weed seeds of known species that were present in the screenings could be still detected even back into the wheat seed sample. Therefore, metabarcoding can successfully help seed analysts in the detection and identification of weeds in crop seed lot samples. However, more validation work will need to take place in order to investigate further the limitations of the method and to gage its best possible application. **Chercher une aiguille dans une botte de foin: l'utilisation du métabarcodage pour trouver les mauvaises herbes et plantes envahissantes dans les lots de semences**. Côté M.-J.[1], Jones S.K.[2], Colville

	A.[1], Kyte S.[1], Wurm N.[2], Chmara J.[1], Duceppe M.-O.[1] [1]Ottawa Laboratory (Fallowfield), Agence Canadienne d'Inspection des Aliments (ACIA), Ottawa, ON; [2]Seed Science & Technology, ACIA, Saskatoon, SK Pour importer des semences au Canada, les lots doivent être libre de semences nuisibles interdites, ainsi, des échantillons de semences sont prélevés lors d'activité de surveillance des marchés et leur pureté est évaluée en parallèle avec des échantillons importés non-conformes. Présentement, les évaluations de pureté des semences sont faites par un tri manuel des semences hétérogènes qui sont identifiées à l'aide d'analyses morphologiques. Le processus peut être long puisque le nombre de semences dans les échantillons peut être élevé et l'identification par des experts en analyses de semences peut se limiter au genre ou à la famille s'ils n'y a pas de caractéristiques morphologiques distinctes. Ainsi, le codage à barres de l'ADN (metabarcoding) a été évalué en tant que méthode complémentaire pour la détection et l'identification de mauvaises herbes dans les lot de semences de cultures. Un processus utilisant une technologie de Séquençage à Haut Débit (SHD) et des plateformes bioinformatiques permettant l'analyse des données a été développé pour repérer et identifier les graines de mauvaises herbes ainsi que les semences d'autres cultures en utilisant des marqueurs d'ADN par codages à barres. Le processus a été initialement testé sur des criblures de semences ou de grains de blé, d'avoine et de lin. Une évaluation de criblures qui contenaient des graines de mauvaises herbes connues, avec des marqueurs d'ADN par codages à barres de ces espèces a permis de détecter la présence des espèces de mauvaises herbes. Alors, ces criblures ont été remises dans l'échantillon original de semences ou de grain (2 500 échantillons de semences de blé) et passés dans le même procédé. Encore une fois, après analyse, les échantillons qui contenaient des espèces de mauvaises herbes connues pouvaient être détectés. Ainsi, le codage à barres de l'ADN (metabarcoding) peut aider les évaluateurs de lots de semences dans la détection et l'identification de mauvaises herbes dans les échantillons de lots de semences de cultures. Toutefois, des travaux de validation additionnels seront nécessaires afin d'évaluer les limites de la méthode et de jauger quelle serait sa meilleure utilisation.
31	**Weed Science- a view to the future.** Swanton, C.J. Department of Plant Agriculture, University of Guelph, Guelph, ON Mark Twain once said, "If you want to change the future, you must change what you are doing in the present". Weed science has never been more important as we face global challenges of producing abundant safe food, while confronting climate change and the degradation of natural and agricultural ecosystems. In this presentation, I hope to encourage weed scientist to think beyond their own sphere of research and consider new research and educational priorities for the future. I will discuss questions related to emerging technologies of new chemistry, precision agriculture, and big data management.

	How can a better understanding of plant-to-plant interactions and stress physiology contribute to better weed management in the future? How do we ensure that sound science informs policy decisions? This presentation is a starting point based on shared values. Creativity and innovation will always be central, to the advancement of weed science in the future. **La malherbologie- un regard vers l'avenir.** Swanton, C.J. Department of Plant Agriculture, University of Guelph, Guelph, ON Mark Twain a déjà dit: «Si vous voulez changer le future, vous devez changer ce que vous faites dans le présent». La malherbologie n'a jamais été plus importante puisque nous devons relever le défi planétaire qui consiste à produire des denrées alimentaires sécuritaires en abondance tout en étant confrontés aux changements climatiques et à la dégradation des écosystèmes naturels et agricoles. Durant cette présentation j'espère encourager les malherbologistes à penser en dehors de leur sphère de recherche et envisager de nouvelles avenues de recherche et de nouvelles priorités en matière d'éducation pour l'avenir. Je vais discuter de questions reliées aux nouvelles technologies dans le domaine de la chimie, l'agriculture de précision et la gestion de grandes bases de données. Comment une meilleure compréhension des interactions plante-plante et e la réponse physiologique au stress peut améliorer la gestion des mauvaises herbes dans l'avenir? Comment pouvons-nous nous assurer que les décisions politiques soient basées sur une science raisonnée. Cette présentation est un point de départ basé sur des valeurs communes. Dans l'avenir, la créativité et l'innovation seront toujours au cœur des progrès de la malherbologie.
32	**Certitude®: Burndown Herbicide Prior to Seeding Canola.** Hedges, B. K.[1], Metzger, B.[2], Bertholet, E.[3], Wood, M.[4], Reid, A.[5] [1]BASF, Lethbridge, AB.; [2]BASF, Winkler, MB.; [3]BASF, Saskatoon, SK.; [4]BASF, Regina, SK; [5]BASF, Calgary, AB Pre-seed burndown herbicides allow growers to control weeds prior to seeding; reducing the density of weeds prior to an in-crop application and providing an environment with less competition for the emerging crop. Glyphosate is the most commonly used pre-seed burndown herbicide, however, glyphosate-resistant weeds are becoming more prevalent across western Canada. Volunteer canola and glyphosate-resistant kochia has become an increasing issue for canola growers in western Canada. Controlling volunteer canola, reduces the presence of seedling disease and competition for resources. Currently submitted for registration is a tank-mix called Certitude®. Certitude is a tank-mix of topramezone and bromoxynil that can be applied prior to seeding canola for burndown weed control of emerged weeds such as volunteer canola and kochia. Tolerance and efficacy trials were established in western Canada to determine canola tolerance and weed control when Certitude® was applied pre-seed to

	canola. Key weed species in the efficacy trials were volunteer canola (*Brassica napus*) and kochia (*Kochia scoparia*). Efficacy treatments were applied when volunteer canola was cotyledon to 6 leaf and kochia was up to 10 cm in height. At 14 to 21 days after treatment (DAT), Certitude® provided 88% control of volunteer canola and 85% control of kochia. Canola tolerance was 2.2% with the 2X rate of Certitude® at 10 to 23 DAT. No canola tolerance concerns were observed with Certitude®. Excellent control of volunteer canola and kochia was observed with Certitude®.
33	**Viability of targeting the wild oat (*Avena fatua* L.) panicle.** Tidemann, B.D.[1], Harker, K.N.[1], Johnson, E.N.[2], Shirtliffe, S.[2], Willenborg, C.[2], Michielsen, L.[1], Reid, P.[1], Sroka, E.[1], Zuidhof, J.[1] [1]Agriculture and Agri-Food Canada, Lacombe, AB; [2]Department of Plant Sciences, University of Saskatchewan, Saskatoon, SK Increased frequency of herbicide resistance in wild oat has amplified the need for alternative management strategies. Two studies were conducted to investigate the viability of targeting the wild oat panicle. The first was conducted in Lacombe, AB from 2015-2017 comparing hand clipping of the panicle, to removal by a cutter bar, and a selective crop-topping treatment in wheat. All treatments were applied either when most of the panicles were emerged, at initiation of seed shed, or at both timings. Wild oat dockage and viability were measured in the first year, and wild oat population, biomass and seedbank measure in a subsequent canola year. A second study, conducted at both Lacombe and Saskatoon, SK from 2015-2017 investigated weekly clippings of the panicle in lentils and wheat using a cutter bar from panicle emergence to initiation of seed shed on subsequent wild oat densities in canola. Preliminary results from the first study suggest that the selective crop topping treatment was the most effective panicle targeting method, and early implementation of any of the treatments tended to be more effective than late treatments. Preliminary results of the second study found no consistent, measureable impact of panicle removal timing. Based on the first study this is likely due to the smaller scale impact of only clipping in a single year, particularly in a weed species with a dormant seed bank. However, these studies indicate an opportunity to target the wild oat panicle with alternative management strategies, particularly those that can be translocated or conducted throughout the entire wild oat plant.
34	**Novel high surfactant oil concentrate adjuvant system for use in Canada**. Dahl, GK[1], Van Dam, D.A.[2], Carr, M.M.[2], Hennemann, L.J.[1], Skelton, J.J.[1], Flipp, A.[1] [1]Winfield United; [2]Winfield United Canada The performance of certain herbicides can be increased with the use of oil-based adjuvants. Lipophilic herbicides are being used in tank mixtures with hydrophilic herbicides such as glyphosate or glufosinate. Many oil adjuvants

	have been demonstrated to be antagonistic to weed control with glyphosate. High Surfactant Oil Concentrates, HSOC, are a new class of adjuvants. HSOC adjuvants contain a minimum of 25% w/w surfactant in a minimum of 50% w/w oil. The new adjuvant is a high surfactant oil concentrate where the oil used is methylated seed oil. The new adjuvant was designed with an emulsifier system and other components that can enhance and do not antagonize glyphosate performance. The new HSOC adjuvant was compared to other adjuvant systems with several lipophilic herbicides alone or in tank mixtures with glyphosate or glufosinate. Herbicides plus the new HSOC adjuvant provided weed control better than or equal to that provided by the adjuvant systems currently used with those herbicides.
35	**Preliminary results on the performance of ammonium nonanoate as a lentil desiccant.** Johnson, E.[1], Campbell, S.[1], Redekop, S.[1], Singh, K.D.[1], Shirtlffe, S.[1] [1]University of Saskatchewan, Saskatoon, SK There is a growing need to evaluate alternative harvest aid herbicides for pulse crops such as lentil. Many marketers are prohibiting the use of harvest aids in response to growing consumer concerns about pesticide residues, with glyphosate being the primary target of public scrutiny. Organic acids have been evaluated in the past but they tend to require high concentrations for efficacious crop dry down, resulting in high cost. Ammonium nonanoate, sold under the trade name Axxe® herbicide, has been recently registered in Canada for pre-seed burndown, spot application or shielded inter-row application in field crops, pastures, and non-crop areas. It is registered as a harvest aid in cotton, potatoes, and some other root, tuber, and bulb vegetables in the United States. Rates of 20 to 33 % v/v are recommended for potato desiccation depending on foliage density. A two-year study evaluating ammonium nanonoate for lentil desiccation was conducted at the University of Saskatchewan in 2019 and 2020. Concentrations of 20 and 33% v/v were compared with glyphosate (900 g ai ha^{-1}), glufosinate (400 g ai ha^{-1}), diquat (296 g ai ha^{-1}), saflufenacil (50 g ai ha^{-1}), and a saflufenacil / glyphosate tank-mix (25 / 900 g ai ha^{-1}). Carrier volume application was 200 l ha^{-1}. The ammonium nonanoate treatments produced symptoms within 2 to 3 hours of application. Visual ratings indicate that the ammonium nonanoate treatments reached 90% drydown within 2 to 3 days after application; whereas, the other treatments required > 7 days to achieve a comparable level of visual drydown. There were minimal benefits from increasing the ammonium nonanoate rate from 20 to 33% v/v. Preliminary results from 2019 indicate that "desiccation response scores" obtained by hyperspectral imagery correlated with visual ratings, and could provide an objective measurement of desiccant efficacy. Ammonium nonanoate exhibits potential as a lentil harvest aid; however, it is not cost effective at the rates evaluated in this study. Lower application rates than 20% v/v may be possible due to the high efficacy observed at this rate.

36	**Rinskor active (florpyrauxifen-benzyl): Mode of action, use rates and environmental profile.** Falk, K., Smith, L., Degenhardt, R., Juras, L., Ashigh, J. Corteva Agriscience™, Calgary, AB Rinskor™ active is a new herbicide active ingredient from Corteva Agriscience™ with a differentiated site of action, offering effective post-emergence control of certain broadleaf, grass and sedge weeds, including agronomically important hard to control herbicide-resistant species. It is the second member of a unique synthetic auxin chemotype, the arylpicolinates (Group 4). Rinskor™ is unique because it binds preferentially to different auxin receptors as compared to other synthetic auxins. Characteristics of Rinskor™ make it a valuable tool and excellent fit for use in integrated weed management (IWM) programs. Rinskor™ is potent, at low use rates, against susceptible species, it provides broad-spectrum weed control, performs well under a broad range of environmental conditions, and it breaks down rapidly in the environment providing it a favourable environmental fate, toxicology and ecotoxicology profile. ™ Trademark of Dow AgroSciences, DuPont or Pioneer, and their affiliated companies or their respective owners.
37	**Emerging invasive plant management issues in BC**. Brown, B., Chadburn, C. Invasive Plant Program, British Columbia Ministry of Forests, Lands Natural Resource Operations and Rural Development, Nanaimo, BC A discussion of emerging issues as they relate to the British Columbia Early Detection Rapid Response Program for invasive plants. The issues of early detection, pathway interception, physical containment, accessing new herbicides, and treatments on or adjacent to private lands will be discussed in the context of feature terrestrial and aquatic species, such as Flowering rush (*Butomus umbellatus* L.), European common reed (*Phragmites australis* (Cav.) Trin. ex Steud), North Africa grass (*Ventenata dubia* (Leers) Coss. & Durieu), and Shiny geranium (*Geranium lucidum* L.).
38	**Rinskor™ active (Florpyrauxifen-benzyl) for weed control in pastures and industrial areas.** Smith, L., Degenhardt, R., Juras, L., Falk, K., Ashigh, J. Corteva Agriscience, Calgary, AB Rinskor™ active (florpyrauxifen-benzyl) is a novel a Group 4 herbicide in the arylpicolinate family. Rinskor active is a unique herbicide that provides effective control of broadleaf weeds, while also controlling several sedge and grass species. Two formulations (WG (647.7 g ae/kg) and SC (86.4 g ae/L)) have been developed combining Rinskor with aminopyralid (a Group 4 herbicide) for use in industrial areas and pastures. Research trials were conducted between 2018 and 2020, to test efficacy of these formulations on weeds including: wild parsnip (*Pastinaca sativa*), wild carrot (*Daucus carota*),

	common caraway (*Carum carvi*) and Canada thistle (*Cirsium arvense*). Results determined that Rinskor controls wild parsnip, wild carrot and wild caraway and the addition of aminopyralid did not negatively impact the level of control. Rinskor alone did not provide control of Canada thistle, but when combined with aminopyralid control was over 85%. Combining these two actives provides a robust solution for controlling problematic and noxious weeds in industrial areas and pastures. ™ Trademark of Dow AgroSciences, DuPont or Pioneer, and their affiliated companies or their respective owners.
39	**How Did a Pandemic Change Weed Extension in New Brunswick?** Graham, G.L. New Brunswick Department of Agriculture, Aquaculture and Fisheries (NBDAAF), Fredericton, NB The COVID-19 pandemic has changed all aspects of our day to day activities and weed extension work is no different. As a province, New Brunswick had relatively low case numbers and started the move towards 'New Normal' at a faster pace than other regions. The impacts of these changes and the hindsight lessons learned will be discussed, through the lens of the return to weed extension work in New Brunswick.
40	**SAgE pesticides : Santé et Environnement à l'avant-plan.** Roy, A., Centre de Référence en Agriculture et Agroalimentaire du Québec (CRAAQ), Québec, QC SAgE pesticides est un site Web diffusant de l'information sur les risques pour la santé et l'environnement des usages agricoles des pesticides au Québec. Il a pour objectif de permettre une gestion rationnelle et sécuritaire des pesticides dans les entreprises agricoles. Il est un outil d'aide à la décision conçu pour permettre aux producteurs et aux conseillers agricoles de faire un choix éclairé parmi les produits de protection des cultures homologués au Québec. Les risques sont basés sur l'indicateur de risque des pesticides du Québec (IRPeQ) et sont divisés selon le volet santé et environnement. Cet outil résulte de la comparaison d'indicateurs de risque des pesticides mentionnés dans la littérature scientifique. La sélection et la définition des critères de l'indicateur sont le fruit d'une collaboration étroite entre le ministère de l'Agriculture, des Pêcheries et de l'Alimentation (MAPAQ), le ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC) et l'Institut national de santé publique du Québec (INSPQ). Les risques sont définis à l'aide de résultats chiffrés et de symboles de risque. Plusieurs outils complémentaires sont disponibles sur le site. On consulte SAgE pesticides au : sagepesticides.qc.ca. **SAgE pesticides: Health and environment to the forefront.** Roy, A., Centre de Référence en Agriculture et Agroalimentaire du Québec (CRAAQ), Québec, QC

	SAgE pesticides is a web site that presents information on health and environmental risks of pesticide use in Québec. Its objective is to allow a rational and safe management of pesticides on farms. It’s a decision support tool designed to help farmers and extension specialists make an informed decision when selecting among the crop protection products registered in Québec. Risks are based on a risk indicator value (named IRPeQ) and separated into heath and environment components. This tool is based the comparison of risk indicators mentioned in scientific literature. The selection and definition of criteria used to generate the risk indicator values was the product of a close collaboration between the provincial ministries of agriculture (MAPAQ), environment and climate change (MELCC) and public health (INSPQ). The risks are presented in numerical formats and are accompanied by symbols. Additional useful tools are also available on the web site. To consult the web site (in French) go to: sagepesticides.qc.ca.
41	**Portrait et gestion de l’amarante tuberculée (*Amaranthus tuberculatus* (Moq.) J.D. Sauer) au Québec.** Miville, D. Laboratoire d’expertise et de diagnostic en phytoprotection, Direction de la phytoprotection, Ministère de l’agriculture, des pêcheries et de l’alimentation du Québec, Québec, QC Découverte pour la première fois au Québec en 2017, l’amarante tuberculée (AT) est déjà reconnue comme la mauvaise herbe la plus difficile à gérer dans la province. Les acteurs du monde agricole québécois apprennent depuis à la reconnaitre et à la gérer adéquatement. Le nombre de nouvelles populations augmente d’année en année, et ce, dans plusieurs régions du Québec. Laissant croire qu’elle était présente sur le territoire québécois bien avant 2017, mais qu’elle passait inaperçue. Dans plusieurs cas, les champs sont déjà fortement infestés et l’AT y est résistante à plus d’un groupe d’herbicides. Elle semble aussi fortement mobile entre les entreprises situées autour d’un foyer d’infestation. Les producteurs québécois ont besoin d’aide pour faire face à cet ennemi méconnu et extrêmement envahissant. Le Québec s’est donc outillé pour lui faire face et a mis en place le Plan d’intervention phytosanitaire pour lutter contre l’amarante tuberculée. Ce plan a pour objectif de déployer tous les moyens nécessaires afin de limiter, voire d’empêcher l’apparition de nouveaux foyers d’infestation d’AT sur le territoire québécois et d’assurer le contrôle de ceux ayant été détectés sur les entreprises agricoles. Les objectifs spécifiques sont : 1. Offrir un encadrement agronomique à tout producteur agricole concerné par la présence de l’AT sur son entreprise, et ce, dans toutes les régions agricoles du Québec; 2. Éviter la prolifération de l’AT, où qu’elle puisse se trouver; 3. Diffuser massivement les renseignements nécessaires au contrôle de l’AT; 4. Bonifier l’état des connaissances sur l’AT afin d’en améliorer la gestion sur le territoire québécois. **Portrait and management of waterhemp (*Amaranthus tuberculatus* (Moq.) J.D. Sauer) in Quebec.** Miville, D. Laboratoire d’expertise et de diagnostic en phytoprotection, Direction de la phytoprotection, Ministère de l’agriculture, des pêcheries et de l’alimentation du Québec, Québec, QC

	Discovered for the first time in Quebec in 2017, waterhemp is already recognized as the most difficult weed to manage in the province. Since then, Quebec agricultural stakeholders are learning to recognize it and manage it properly. The number of new waterhemp populations is increasing year after year, in many regions. Suggesting that it was present, but unnoticed, well before 2017. In many cases, fields are already heavily infested and waterhemp is resistant to more than one group of herbicides. It also appears to be highly mobile between growers located around an infested area. Quebec growers need help to deal with this unknown and extremely invasive enemy. Quebec has therefore decided to address the problem and implement a Phytosanitary action plan against waterhemp. The objective of this plan is to deploy all the necessary resources to limit, or even prevent, the appearance of new waterhemp infestations in the province of Quebec and ensure the control of those that have been detected. The specific objectives are: 1. To provide agronomic support to any grower concerned by the presence waterhemp on his farm, in any agronomic region in the province; 2. Avoid the proliferation of waterhemp, wherever it may be; 3. Massively disseminate information needed to control waterhemp; 4. Improve the state of knowledge on waterhemp in order to enhance its management in Quebec
42	**Limiter la propagation de l'amarante tuberculée (*Amaranthus tuberculatus* (Moq.) J. D. Sauer) résistante aux herbicides: Une approche de gestion proactive.** Mathieu, S.[1], Faucher, Y.[2], Duval, B.[3], Miville, D.[4], Comtois, S.[5], Lapierre, M.C.[6] [1]Ministère de l'agriculture, des pêcheries et de l'alimentation du Québec (MAPAQ), St-Jean-sur-Richelieu, QC; [2]MAPAQ, Saint-Hyacinthe, QC; [3] MAPAQ, Nicolet, QC; [4] Laboratoire d'expertise et de diagnostic en phytoprotection (LEDP-MAPAQ), Québec, QC; [5] Groupe Pleine Terre, Napierville, QC; [6]Coordination des services-conseils, Longueuil, QC Le premier cas d'amarante tuberculée au Québec a été trouvé à l'automne 2017 dans un champ de soya situé au sud-ouest de Montréal en Montérégie. Une stratégie basée sur le dépistage et l'arrachage des plants d'amarante tuberculée a rapidement été mise en place pour éviter la propagation de la plante sur la ferme. Depuis 2017, 28 autres cas ont été répertoriés dans la province soit 1 en 2018, 7 en 2019 et 20 en 2020 pour un total de 736 hectares touchés. Nous suggérons aux producteurs aux prises avec la mauvaise herbe de mettre en place une approche de gestion intégrée puisque la plante développe facilement de la résistance aux herbicides. Cette stratégie est adaptée à la réalité de chaque entreprise, basée sur le dépistage, la rotation des cultures, l'arrachage et sur toutes autres méthodes culturales possibles sur la ferme. L'utilisation d'herbicides fait souvent partie des solutions, le choix reposant sur des critères tels que leur efficacité en fonction des résistances ainsi que les risques pour la santé et l'environnement. Depuis 2017, plusieurs actions ont été réalisées sur les fermes afin de lutter contre l'amarante tuberculée. La plante a été arrachée sur 22 entreprises pour une superficie de 375 ha. En raison d'une trop forte

infestation, trois entreprises ont dû détruire une section ou la totalité de leur champ, pour un total de 11 ha de culture. Nos observations nous ont permis de constater que l'utilisation des herbicides flumioxazine/métribuzine/imazéthapyr (en mélange) de même que le pyroxasulfone jumelé à de l'arrachage ont permis de bien contrôler l'amarante tuberculée dans la culture du soya. Dans la culture du maïs, les herbicides s-métolachlore/bicyclopyrone/ atrazine/mésotrione, de même que s-métolachlore/bicyclopyrone/mésotrione ont donné de bons résultats. La pratique du sarclage mécanique a été réalisée sur 60 hectares mais pour des raisons techniques n'a pas donné de résultat concluants. Les suivis réalisés nous ont démontré que l'arrachage en début d'infestation, permet de diminuer la pression de l'amarante tuberculée dans les champs. Également, nous notons l'absence d'amarante tuberculée après 3 saisons de production d'une prairie de luzerne-mil dans un champ qui était fortement infesté en 2017.

Limiting the spread of multiple herbicide-resistant waterhemp (*Amaranthus tuberculatus* (Moq.) J. D. Sauer): A proactive management approach. Mathieu, S.[1], Faucher, Y.[2], Duval, B.[3], Miville, D.[4], Comtois, S.[5], Lapierre, M.C.[6] [1]Ministère de l'agriculture, des pêcheries et de l'alimentation du Québec (MAPAQ), St-Jean-sur-Richelieu, QC; [2]MAPAQ, Saint-Hyacinthe, QC; [3]MAPAQ, Nicolet, QC; [4]Laboratoire d'expertise et de diagnostic en phytoprotection (LEDP-MAPAQ), Québec; QC. [5]Groupe Pleine Terre, Napierville, QC; [6]Coordination des services-conseils, Longueuil, QC

The first case of waterhemp in Québec was found in the fall of 2017 in a soybean field located southwest of Montreal in the Montérégie region. A strategy based on waterhemp scouting and hand removal was quickly put in place to prevent the spread of the plant on the farm. Since 2017, 28 other cases have been reported in the province, 1 in 2018, 7 in 2019 and 20 in 2020 for a total of 736 hectares affected. We recommend growers adopt an integrated management approach because the plant easily develops herbicides resistance. This strategy is adapted to the reality of each farm, based on scouting, crop rotation, hand removal, and all other possible cultural practices on the farm. The use of herbicides is often part of the solution. They are chosen based on criteria such as efficacy (taking into account the herbicide resistance(s) of the populations) and risks to human health and the environment. Since 2017, several actions have been taken on farms to control waterhemp. Waterhemp was hand pulled on 22 farms for a total area of 375 ha. Due to a major infestation, 3 farms had to destroy part or all of their field, for a total of 11 ha. Our observations have indicated that the use of flumioxazine/metribuzine/imazethapyr (tank mix) herbicides as well as pyroxasulfone combined with hand pulling has allowed growers to properly control waterhemp in soybean. In corn fields, the herbicides s-metolachlore/ bicyclopyrone/atrazine/mesotrione, as well as metolachlore/ bicyclopyrone/mesotrione gave good results. Sixty hectares have been mechanically weeded but, for technical reasons, it generated inconclusive

	results on waterhamp control. The subsequent monitoring of populations indicates that hand pulling at the beginning of the infestation reduces waterhemp presence in the fields. Also, we noticed that waterhemp was absent from a heavily infested field (in 2017) after 3 years of alfalfa-timothy production.
43	**Robotic weeding for vegetable crops.** Greenan, T. Nexus Robotics, NS Labour is becoming more expensive and difficult to acquire, especially during the pandemic. Nexus Robotics is addressing this problem by designing a robot that mimics human labour. The current robot named "La Chèvre" (The Goat), is able to pull weeds out of vegetable crops. The advantage to this method is that the robot is able to remove weeds that are very close to the crop, without damaging the crop. **Le désherbage robotisé dans les légumes.** Greenan, T. Nexus Robotics, NS La main-d'œuvre devient plus en plus onéreuse et plus difficile à trouver, surtout pendant la pandémie. Nexus Robotics s'attaque à ce problème en concevant un robot qui imite le travail humain. Le robot actuel, appelé « La Chèvre » (« The Goat »), est capable d'arracher les mauvaises herbes des cultures maraîchères. L'avantage de cette méthode est que le robot est capable d'enlever les mauvaises herbes qui sont très proches de la culture, sans endommager celle-ci.
44	**Le robot OZ dans le maïs sucré.** Leblanc, M.L., Lefebvre, M. Plateforme d'innovation en agriculture biologique, Institut de recherche et de développement en agroenvironnement, Saint-Bruno-de-Montarville, QC La robotisation du désherbage des cultures maraîchères est une nouvelle stratégie de lutte contre les mauvaises herbes qui a fait récemment son apparition au Québec. L'évaluation de la performance du robot Oz de la compagnie française Naïo technologies fait l'objet d'une étude triennale qui a débuté en 2020 en contexte d'agriculture biologique. Le robot sera testé sur trois cultures : le maïs sucré, l'oignon espagnol et le haricot. L'essai a porté cette année sur le maïs sucré avec trois types d'outils : la herse étrille, les doigts de binage et des outils de renchaussage. La performance du robot a été comparée à trois autres moyens pour désherber, soit manuellement, avec une houe maraîchère ou avec un tracteur. Au premier désherbage, la herse étrille passée par le robot a réprimé près de 50% des mauvaises herbes sur le rang, une répression 15% plus élevée que celle passée par le tracteur et 37% supérieure au passage de la herse manuelle. Lors du deuxième désherbage du robot avec les doigts, le pourcentage de répression des mauvaises herbes sur le rang était semblable à celui de la houe maraîchère et du tracteur avec une répression de 40%. Au dernier passage du robot avec les brosses de buttage, la répression sur

	le rang était similaire à celle de la houe maraîchère et du tracteur avec 87% de répression des mauvaises herbes. Entre les rangs, l'efficacité du robot a été équivalente à celle du tracteur avec un pourcentage de répression variant entre 70 et 91%. Bien que le robot fût plus lent que le tracteur et la houe maraîchère, il a été 2 à 2,4 fois plus rapide que le désherbage manuel. Les méthodes de désherbage n'ont pas eu d'effet sur le rendement du maïs. La performance du robot pourrait être améliorée en augmentant sa vitesse. **The OZ robot in sweet corn.** Leblanc, M.L., Lefebvre, M. Plateforme d'innovation en agriculture biologique, Institut de recherche et de développement en agroenvironnement, Saint-Bruno-de-Montarville, QC Using robots in horticultural crops is a new weeding strategy in Québec. The evaluation of the efficacy of the OZ robot (developed by the French company Naïo technologies) in organic crops is part of a three-year project that started in 2020. The robot will be tested in three crops: sweet corn, Spanish onions and green beans. This year, three tools were evaluated in sweet corn: the flextine harrow, the finger weeder and tools used for hilling (brushes, hilling hoe, wheel hoe furrower and disks). The efficacy of the robot was compared to the hand hoe, wheel hoe, or tool carrier tractor. During the first weeding, the tine harrow passed by the robot controlled 50% of the weed on the row, 15% more than the one pulled by the tractor and 37% more than the hand tine harrow. During the second weeding using the finger weeder, the robot controlled 40% of the weeds on the row, a figure similar to the wheel hoe and tool carrier tractor. During the last weeding using hilling tools, weed control on rows with the robot was similar to the control obtained using the wheel hoe or tractor at 87%. In inter-rows, the weeding efficacy of the robot was equivalent to that of the tractor with a percent control between 70 and 91%. Although the robot was slower than the tractor and wheel hoe, it was 2 to 2.4 times faster than the hand hoe. The weeding methods tested had no effect on corn yields. The performance of the robot could be improved by increasing its speed.
45	**Using electricity for weed control with shocking results.** Oegema, P. Organic producer, St. Thomas, ON Using high voltage electricity is showing to be an effective control measure on most broadleaf and grass weeds. Used in standing crops like soybeans or edible beans, the Weed zapper can effectively kill weeds down to the root system, leaving only dry matter above the surface. This reduces staining in food grade beans, and increases harvest efficiency. Depending on the timing of application the Zapper can also prevent noxious weeds reaching the seed set stage. As weed size and maturity increases, efficacy can decrease; and multiple passes may be required for complete destruction of the weed. This presentation will provide an explanation of the machine itself, as well as provide examples of its use in the field.

	L'utilisation de l'électricité pour un désherbage avec des résultats surprenants. Oegema, P. Producteur biologique, St. Thomas, ON L'utilisation de l'électricité à haute tension peut être un moyen efficace de lutte contre les mauvaises herbes à feuilles larges et les graminées. Utilisée dans des cultures sur pied comme le soya et les haricots, le Weed Zapper peut détruire efficacement les mauvaises herbes jusque dans leur système racinaire, ne laissant que de la matière sèche à la surface. Ceci réduit les taches sur les fèves destinés à la consommation humaine et augmente l'efficacité de la récolte. Selon le stade des mauvaises herbes, le passage du Weed Zapper peut aussi prévenir la formation de graines par les mauvaises herbes nuisibles. L'efficacité peut diminuer plus les mauvaises herbes atteignent des stades avancés et des tailles plus grandes, nécessitant plusieurs passages pour détruire complètement la mauvaise herbe. Cette présentation montrera le fonctionnement de la machine ainsi que des exemples d'application au champ.
46	**Minor Use Pesticides Program at the Pest Management Center of Agriculture and Agri-Food Canada.** Czechura,P. Pest Management Centre, Agriculture and Agri-Food Canada (AAFC), Ottawa, ON The Minor Use Pesticides Program (MUPP) was launched in 2002 in order to increase Canadian grower competitiveness in a global market by improving access to new and effective crop protection tools and technologies. The MUPP works with growers, the provinces, industry and other stakeholders to identify annual crop/pest needs and match them with potential pest management products. Using regulatory guidelines, the Pest Management (PMC) team generates value and residue data required for the registration of the new minor use. The generated data is submitted to Pest Management Regulatory Agency for review and minor use registration.
47	**Seed bank depletion in muck soil after three years without seed inputs: A case study.** Simard, M.-J[1]., Nurse, R.E.[2], Laforest, M[1]., Obeid, K.A[3]. [1]Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu research and development centre, QC; [2]Agriculture and Agri-Food Canada, Harrow research and development centre, ON; [3]OMAFRA, Harrow, ON Repetitive cultivation is often used to control weeds in crops such as lettuce. Cultivation can increase weed emergence and increase or decrease seed persistence. A series of four repetitive cultivations has been shown to lower the weed seed bank by 15% in a sandy loam. However, few studies have quantified this effect in muck soils. This study evaluates the effect of two and four repetitive cultivations on weed emergence and the weed seed bank in muck soil. Cultivation treatments (0, 2 and 4 cultivations using a rototiller) were done in lettuce plots set in a completely randomized bloc design at the AAFC research

	farm in Ste-Clotilde-de-Châteauguay, QC in 2017, 2018 and 2019. Weeds were counted by species in 50 × 50 cm quadrats. Soil samples were collected before and after each growing season and seed bank viability was evaluated by counting emergence in a greenhouse before and after a chilling period. Repeated measures MANOVA analyses were performed. Results show rototilling modified emergence patterns but had no effect on viable seed banks. After three years without seed inputs the viable seed bank was reduced by about 50% (regardless of the cultivation treatment) for many species but not for the very abundant common purslane (*Portulaca oleracea*).
48	**AAFC-Pest Management Centre: Successes in Weed Control.** Liu, S., Kora, C. Agriculture and Agri-Food Canada, Pest Management Centre, Ottawa, ON The Minor Use Pesticides (MUP) and Pesticide Risk Reduction (PRR) teams of Agriculture of Agri-Food Canada's Pest Management Centre (PMC) work together to improve grower access to new pesticide uses and integrated pest management options for grower-identified pest issues. Collaborating with grower groups, provincial specialists, public sector researchers, academia and industry stakeholders the PMC has contributed to meeting the needs of Canadian growers for viable pest management options over the past 16 years. The MUP team, based on data generated through field and greenhouse trials conducted at seven AAFC's Research and Development Centers across Canada, submits a number of minor use regulatory submissions to Health Canada's Pest Management Regulatory Agency and therefore enabling new herbicide registrations every year. The PRR team delivers non-conventional control solutions including biological, cultural and physical approaches as well as decision support tools. Through numerous research and development projects supported to address weed issues, the PRR team has contributed new information, tools and alternative control practices, and has provided regulatory support for a number of bioherbicides, thus enabling integrated weed management. This poster highlights examples of successful weed management solutions delivered to growers by both teams.
49	**Mitigating herbicide resistance – incorporating integrated weed management strategies.** Tidemann, B.D.[1], Harker, K.N.[1], Geddes, C.M.[2], Blackshaw, R.[2], Lupwayi, N.[2], Shirtliffe, S.[3],Willenborg, C.[3], Johnson, E.N.[3], Gulden, R.[4], Turkington, T.K.[1], Semach, G.[5], Mulenga, A.[6] [1]Agriculture and Agri-Food Canada, Lacombe, AB; [2]Agriculture and Agri-food Canada, Lethbridge, AB; [3]Department of Plant Sciences, University of Saskatchewan, Saskatoon, SK; [4]Department of Plant Science, University of Manitoba, Winnipeg, MB; [5]Agriculture and Agri-Food Canada, Beaverlodge, AB; [6]Agriculture and Agri-Food Canada, Scott, SK A five year study was conducted from 2016-2020 at Lacombe, Lethbridge and Beaverlodge, AB, Scott and Saskatoon, SK and Carman, MB. We compared a traditional canola-wheat rotation with full herbicide applications to rotations

	that involved increased seeding rates, chaff collection, diversified cropping systems, and removal of herbicide applications. All locations seeded wild oat (*Avena fatua*) and wild buckwheat (*Fallopia convolvulus* (L.) Á. Löve) along with a number of other key species important to each region. The project began and ended with each treatment seeded the same (2x wheat, no herbicides). The three interim years (2017-2019) are when the treatments differed. A preliminary generalized linear mixed model ANOVA was conducted in Proc Glimmix in SAS on wild oat and wild buckwheat densities, and crop, grass weed and broadleaf weed biomass using a lognormal distribution based on AICc model selection. Wild oat was best managed in rotations utilizing perennial forages, 2 years of silage combined with a winter cereal, and treatments with full herbicide applications. Treatment impacts on wild buckwheat densities were minimal. Crop biomass reductions were reported in treatments that didn't include herbicide application with the exception of silage barley, fall rye and canola at increased seeding rates with chaff collection. Grass and broadleaf weed biomass was highly variable by site and treatment, however in some cases broadleaf biomass may have been reduced by grass weed competition rather than treatment. Results are indicating that combined integrated weed management strategies may not deliver weed control levels equivalent to herbicide applications, particularly with high weed populations.
50	**Does alloploidy increase weediness? Comparing niches of allopolyploids to their progenitors.** Mata J.[1], Martin S. L.[2], Smith T.W.[2] [1] University of Toronto, Scarborough, ON; [2]Agriculture and Agri-Food Canada (AAFC), Ottawa, ON Understanding the factors that determine a species' geographical and environmental range is important for conservation and management practices. This study compares the niche of allopolyploids to their parental species to determine whether allopolyploidization is one of those factors and as a result, increases the weediness of plant species. It is widely believed that polyploidization leads to geographic ranges that are larger and cover more extreme conditions due to an increased capacity for genetic diversity which provides more potential for adaptation. However, there is limited data supporting this idea. Thus, to investigate this hypothesis using many species, we selected allopolyploids that exist as only one ploidy level, have at least one known diploid parental species, and have at least 50 records in the GBIF database. We combine the GBIF records with climate data to quantify the geographic, environmental, and suitability (i.e., Maxent models) distribution of each allopolyploid species and its diploid progenitors. Our preliminary results produce an approximately 90% climatic range overlap and 50% geographical range overlap when comparing allopolyploids to their diploid parents. Additionally, allopolyploids have an 11% mean climatic expansion where they exist without their progenitors. However, the range area of the allopolyploids is only larger than their parental species 63% of the time. These results suggest that allopolyploids show slight increases in their environmental distribution and

	a greater shift in their geographic space, but do not necessarily have larger ranges. In the future, we are going to include Maxent species distribution models to further compare related species. Also, further analysis needs to be done with more species to have a greater sample size and it will be tested whether there is a significant difference between the variables for the allopolyploids and their progenitors.
51	**Does crop competition impact the expression of a herbicide-resistant weed phenotype?** Geddes C.M., Kimmins M.T. Agriculture and Agri-Food Canada, Lethbridge, AB Canada is home to the third-largest number of unique herbicide-resistant weed biotypes surpassed only by the United States and Australia. Almost half of these biotypes are present in the Canadian prairies, and result in increased weed control measures which cost prairie farmers an estimated $528 Million annually. Dose-response experiments remain the standard method for documenting and characterizing herbicide-resistant weeds because they allow researchers to identify resistance even when the mechanism remains unknown. While dose-response experiments are useful for identifying herbicide resistance, results do not apply directly to field crop scenarios because these experiments fail to account for interspecific plant competition. Could crop competition ameliorate the phenotypic expression of herbicide resistance in a weed population confirmed resistant during a typical dose-response experiment? A controlled-environment experiment was conducted to determine the impact of wheat plant density on the expression of a fluroxypyr-resistant kochia [*Kochia scoparia* (L.) Schrad.] phenotype when exposed to multiple doses of fluroxypyr. Three kochia populations characterized previously (one resistant, one susceptible, and one with reduced sensitivity) were exposed to seven doses of fluroxypyr (0, 17.5, 35, 70, 140, 280, and 540 g ae ha^{-1}) in combination with four wheat plant densities (0, 200, 400, and 600 plants m^{-2}). The fluroxypyr dose required to decrease kochia plant survival by 50% (LD50) decreased linearly from 258 to 103 g ae ha^{-1} as wheat density increased from 0 to 600 plants m^{-2}. A similar response was observed for visible control four weeks after application (ED50 decreased from 114 to 65 g ae ha^{-1}). When compared with the susceptible kochia control absent of wheat, increasing wheat density reduced the LD50 resistance factor (R/S ratio) from 10.8 to 4.3. These results suggest that greater interspecific competition as a result of increased wheat plant density can partially revert the expression of a fluroxypyr-resistant kochia phenotype.
52	**Responses to atrazine in male and female plants of common waterhemp (*Amaranthus tuberculatus*).** Gagnon, G.[1], Flores-Mejia, S.[2], Bipfubusa, M.[2], Mathieu, S.[3], Marcoux, A.[4], Laforest, M.[5], Michaud, D.[1]. [1]Université Laval, Québec, QC; [2]Centre de recherche sur les grains, inc. (CÉROM), Saint-Mathieu-de-Beloeil, QC; [3]Ministère de l'Agriculture, des Pêcheries et de

	l'Alimentation (MAPAQ). Saint-Jean-sur-Richelieu, QC; [4]Laboratoire d'expertise et de diagnostic en phytoprotection. (LEDP-MAPAQ), Québec, QC; [5]Agriculture et Agroalimentaire Canada, Centre de Recherche et de Développement de Saint-Jean-sur-Richelieu, Saint-Jean-sur-Richelieu, QC Common waterhemp is a newly problematic weed for crops in Quebec province. Knowledge of its physiology and biology is necessary to improve our strategies to control its spread. The purpose of this study was to evaluate the response of common waterhemp gender to different doses of atrazine. The trial was conducted with plants grown from cuttings from mother plants of known gender. Three cuttings were taken from each plant and divided per group of treatment: cuttings treated with the label rate of atrazine (1488 g a.i. ha^{-1}), those treated with twice the label rate of atrazine (2976 g a.i. ha^{-1}) and untreated cuttings (0 g a.i. ha^{-1}). Four weeks after the application, the dry biomass of each cutting from each group was measured and injury percentage was evaluated. Males and females of common waterhemp had differential responses to atrazine. At the label rate of atrazine, males were more affected than females because their biomass was reduced by 40.9% meanwhile female's biomass was reduced by 16%. At twice the normal rate, males and females were stressed equally with respectively 63.5% and 61.4% biomass reduction. Regarding the injury percentage at the normal rate of atrazine, it is not different between non treated plants for males with respective values of 15.8% and 19.7%., but for the females it was different (24.6% vs 28.5%). At twice the label rate, females were visually much more affected than the males with an injury percentage of 61.1% comparatively to 30.8%.
53	**Portrait de la résistance des mauvaises herbes aux herbicides de 2011 à 2019 au Québec** Flores-Mejia, S.[1], Marcoux, A.[2], Miville, D.[2] [1] Centre de recherche sur les grains, inc. (CÉROM), Saint-Mathieu-de-Beloeil, QC; [2] Laboratoire d'expertise et de diagnostic en phytoprotection (LEDP-MAPAQ), Québec, QC La détection de la résistance au Québec est offerte à l'ensemble des producteurs agricoles depuis 2011 par le Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ), en collaboration avec différents partenaires, au fil des années. Entre 2011 et 2014, le test classique de résistance (pulvérisation des plantules à l'aide d'un banc d'essai) était la méthode privilégiée pour évaluer les différents échantillons soupçonnés d'être résistants. Depuis 2018, la méthode de détection moléculaire de la résistance (technologie sous licence d'Agriculture et Agroalimentaire Canada) a été incluse dans l'offre de services : elle représente la majorité des tests réalisés depuis 2018 (86,1 %). Depuis 2011, 464 échantillons soupçonnés de résistance ont été reçus et 607 tests (combinaison échantillon et matière active) ont été réalisés. À ce jour, 293 échantillons (48,3 %) testés ont été classés comme résistants. Les groupes d'herbicides pour lesquels de la résistance a été confirmée sont : 2 (65,9 %), 9

	(19,5 %), 5 (5,5 %), 7 (3,1 %), 5 et 7 (résistance multiple, 3,1 %), 1 (2,0 %), 14 (1,0 %), 6 (0,7 %), et 10 (0,3 %). La résistance a été détectée chez quatorze espèces de mauvaises herbes, dont la petite herbe à poux (*Ambrosia artemisiifolia* L.) qui représente 46,7 % des cas confirmés. Les cas de résistance ont été repérés dans treize régions administratives du Québec, principalement dans la Montérégie (50,5 %), le Centre-du-Québec (20,1 %) et Lanaudière (13,7 %). La majorité des populations résistantes ont été collectées dans le soya (51,0 %), le maïs (10,5 %) et le blé (7,8 %).
54	**Evaluation of two methods (solarisation and burial) for disposal of hand-weeded tall waterhemp (*Amaranthus tuberculatus* (Moq.) J.D. Sauer) plants.** Flores-Mejia, S.[1], Nguyen, M.-T.[1], Bipfubusa, M.[1], Fréchette, I.[1], Mathieu, S.[2], Faucher, Y.[3], Duval, B. [4], Marcoux, A.[5], Miville, D.[5], Leblanc, M.[6], Dupuis, M.[7] [1] Centre de recherche sur les grains, inc. (CÉROM), Saint-Mathieu-de-Beloeil, QC; [2]Ministère de l'Agriculture, des Pêcheries et de l'Alimentation (MAPAQ). Saint-Jean-sur-Richelieu, QC; [3] MAPAQ. Saint-Hyacinthe, QC; [4] MAPAQ. Nicolet, QC; [5] Laboratoire d'expertise et de diagnostic en phytoprotection. (LEDP-MAPAQ), Québec, QC; [6] Institut de recherche et de développement en agroenvironnement (IRDA). Saint-Bruno-de-Montarville, QC; [7] Coordination services-conseils (CSC). Longueuil, QC Tall waterhemp was first discovered in the province of Québec in 2017. Most populations in the province are detected late in the season, when chemical or mechanical control is no longer an option. In order to minimise the increase of the seed bank, hand weeding has been the most common method of control, at least for the first year of the discovery. However, disposing of the residues is problematic: if left in the field, plants are capable of re-rooting and producing viable seeds, albeit in small quantities and burning the weeded plants is not possible due to provincial laws. Our preliminary research has shown that tall waterhemp can survive several weeks inside garbage bags and still produce viable seeds. The present study tested the two remaining options: solarisation and burial. Solarisation involves collecting residues in garbage bags and expose them to the sun for several weeks before disposing of them at a landfill. We tested the time (2, 4, 6 or 8 weeks) that would be necessary to effectively kill the tall waterhemp (seeds, small plants and adult plants) by solarisation and burial. The effect of burial depth was also examined at 0, 5, 10, 15 and 20 cm. Our results show that solarisation for up to 8 weeks is not an effective method for control of tall waterhemp: small plants and stems remain capable of re-rooting; seeds were capable of germinating inside the garbage bags. Additionally, germination rate was higher for the solarised seeds than for the non-solarised treatment. Buried plants ($\geq$5cm depth) started decomposing after 2 weeks, while plants left on the surface, were capable of re-rooting. Burial seems to be a promising method of disposal of small and adult plants.

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