Provincial Report to the CWSS/SMC
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Legislation

Weed Control Act, R.S.O. 1990, c. W.5 https://www.ontario.ca/laws/statute/90w05

Ontario Schedule of Noxious Weeds (effective January 1, 2015)
http://www.omafra.gov.on.ca/english/crops/facts/noxious_weeds.htm

A poster of Ontario's 25 noxious weeds has been created. For a PDF copy of this poster, please contact kristen.obeid@ontario.ca

Minor Use

Cranberry	rimsulfuron	Prism	Labelled weeds	AAFC-PMC	February 2023
Horseradish	dimethenamid-p	Frontier Max	Labelled weeds	OMAFRA	February 2023
Dry Bulb onions on muck	bromoxynil	Pardner	Labelled Weeds	MAPAQ	March 2023
Shallots on muck	bromoxynil	Pardner	Labelled Weeds	MAPAQ	March 2023
Green Onions on muck	bromoxynil	Pardner	Labelled Weeds	MAPAQ	March 2023
Leeks	bromoxynil	Pardner	Labelled Weeds	AAFC-PMC	March 2023
Flax	topramezone	Armezon	Labelled Weeds	AAFC-PMC	October 2023

New Extension Material – Publication 75 now in a searchable database

The Ministry of Agriculture, Food and Rural Affairs (OMAFRA) has transformed the way crop protection information is provided to better serve clients through an online digital application called the Ontario Crop Protection Hub.

The Ontario Crop Protection Hub is now available and ready to access the latest crop protection information: https://cropprotectionhub.omafra.gov.on.ca

The Ontario Crop Protection Hub is…

- accessible through any device (tablet, computer, smart phone),
- allows you to customize and find information based on your specific business needs, and
- replacing PDF and print crop protection publications, which can quickly become out of date.

There is a feedback form link at the top of the webpage and available here:
https://cropprotectionhub.omafra.gov.on.ca/contact

Questions? Contact the Agricultural Information Contact Centre by email at ag.info.omafra@ontario.ca or phone 1-877-424-1300

The Ontario Herbicide Resistant Weed Database and mapping tool can also be found on the weed page on the Ontario Crop Protection Hub: https://cropprotectionhub.omafra.gov.on.ca/weed-control

Current Herbicide Resistant Weeds in Ontario

Weed	WSSA Group	Weed	WSSA Group
barnyard grass	5	mustard, wild	5
Canada fleabane	2, 9, 22	nightshade, Eastern black	2, 22
carrot, wild	4	peppergrass, field	22
cocklebur	2	pigweed, green	2, 4, 5, 14
crabgrass, large	1	pigweed, redroot	2, 5, 6, 14, 27
foxtail, green	2	pigweed, smooth	6
foxtail, giant	2	ragweed, common	2, 5, 9, 14
foxtail, yellow	5	ragweed, giant	2, 5, 9
goosefoot, late-flowering	5	ryegrass, Italian	9
groundsel, common	5	waterhemp	2, 5, 9, 14, 27
lamb's-quarters	5	witchgrass	5

22 resistant weed species, with the common trend of more species with multiple resistance

Herbicide Resistant Weed Testing

Completed by Turnkey Genomics: www.turnkeygenomics.ca

Project partners include: AAFC, AAFC-PMC, BASF, Bayer CropScience Inc., FMC Canada, FVGO, MAPAQ, OAG, OFVGA, OPVG and Syngenta Canada Inc.

Significant Results in 2023

- A total of 117 fields were tested through this project in 2023. 61 fields in Ontario, 55 fields in Manitoba and 1 field in Prince Edward Island.
- Of the 61 fields in Ontario 55 tested positive for resistant weeds or 90% and 41/55 fields had 2-way or 3-way resistant weed populations.
- Five-way resistant waterhemp to herbicide groups 2, 5, 9, 14 and 27 has been confirmed in 8 counties in Ontario - Chatham-Kent, Essex, Elgin, Lambton, Middlesex, Northumberland and Stormont, Dundas & Glengarry.
- Waterhemp has been confirmed in 18 counties in Ontario (Brant, Bruce, Chatham-Kent, Dufferin, Elgin, Essex, Haldimand, Huron, Lambton, Leeds and Grenville United Counties, Middlesex, Niagara, Norfolk, Northumberland, Ottawa, Stormont, Dundas and Glengarry, Wellington and Wentworth). No new counties were found this season.
- Over the course of this study, multiple resistant waterhemp has been confirmed in asparagus, corn, peppers, soybeans, sweet corn, wheat and white beans in Ontario. Wheat is new in 2023.
- In 2023, 100% of waterhemp confirmations were G14 resistant compared to 67% G9 resistant.
- Multiple resistant pigweed species (green pigweed and redroot pigweed) are commonly found in many horticulture crops for example: G2/G5 in pumpkins, potatoes, strawberries, sunflowers and tomatoes and G5/G14 in carrots.
- 33% of all pigweed spp. samples were multiple resistant to G5/G14 herbicides. All samples came from carrot fields.

- All common ragweed samples were multiple resistant. With 50% resistant to G2/G5 and 50% resistant to G2/G5/G14 herbicides. The common ragweed samples came from corn (2), IP beans (4), soybeans (11) and white beans (1).
- Three-way resistant common ragweed to herbicide groups 2, 5 and 14 has been confirmed in Bruce, Lambton and Prescott and Russell counties.
- Continued documentation of Canada fleabane resistant to G9 in apples, blueberries, carrots, grapes, onions, pumpkins and strawberries.
- Amaranthus species identification showed that waterhemp is often confused with green pigweed and tumble pigweed.

Canadian Plant Health Council – Weeds Surveillance Community of Practice (WSCP)
Co-Chairs Kristen Obeid and Sandra Flores-Mejia

- The WSCP is a multi-partner working group created in 2018 to strengthen Canada's plant health system as a part of the Canadian Plant Health Council
- The goal is coordination of activities to support monitoring and surveillance of weed species across Canada to inform weed management.
- The work is advanced by experts from federal, provincial and territorial governments, industry associations, academia and other organizations involved in plant health.
- *Amaranthus* spp. have been chosen as an initial focus as they are an important threat to Canadian agriculture due to high competitiveness and resistance to multiple herbicide groups.

Accomplishments to date:

1. Harmonized Surveillance Protocol for Waterhemp and other Amaranthus Species
2. Waterhemp Questionnaire

Both resources are available through *AgriReseau* and *FieldCropNews* which are updated annually

3. Poster developed on the National Surveillance of Waterhemp
4. Poster developed on the Available Genetic Testing for Herbicide Resistant Weeds across Canada
5. Poster developed on Palmer amaranth
6. Palmer amaranth Pest ID

Future collaborations will include working with Crop Life Canada and the Manage Resistance Now platform.

Robotic Weeding Trials (AgRobotics Working Group, OMAFRA, University of Guelph and Haggerty Creek AgRobotics Company)
Several weeding robots promise to provide reduced soil compaction, a lower carbon footprint, reduced inputs (seed, herbicide, etc.), less labour requirements, scalable mechanical weeding, and ease of use. However, questions about their practicality and return on investment remain. To test these claims, experiments and demonstrations continued in 2023.

Robotics Technologies Tested:

1. **FarmDroid** https://farmdroid.dk

- Solar-charged batteries
- 24-hours autonomous operation (sleep mode when batteries are low)
- Seeder, and inter- and intra-row mechanical weeder
- Geo-tags each seed planted

2. **Naïo Orio** https://www.naio-technologies.com
- Rechargeable lithium batteries
- Autonomous tool carrier robot
- Up to 10 hours of autonomous operation
- Inter-row guidance and mechanical weeding
- RTK-GPS guidance

3. **Nexus Goat** https://nexusrobotics.ca
- Electric hybrid motor
- 24-hour autonomous operation
- Machine vision inter- and intra-row mechanical weed removal
- Recognizes the crop and picks out everything that is not the crop

4. **Naïo Ted** https://www.naio-technologies.com
- For grapes/vineyards, potential for trellised fruit
- First in Ontario June 2023
- Autonomous 100% electric vehicle – up to 10 hours
- 10 acres/day
- Inter- and intra-row weeder
- Hilling and De-hilling
- Vine hedger
- Yield estimation

5. **Carbon Robotics LaserWeeder ™**
- Sub-millimeter accuracy
- 30 x 150 w CO2 10.6 m lasers with tracking cameras
- 9 x LED bedtop lighting bars & 12 x Hi-Res predict cameras
- 40+ crop AI deep learning models, precision computer vision softward
- Liftable weeding implement with 20 ft coverage width
- Pulls behind row tractors with 3-point hitch
- 60-84" adjustable row spacing
- Front-mounted PTO-driven generator
  Overall dimensions 240 " W x 117" L x 106" H

Results

FarmDroid FD20

Research Trial
- Single row – 3.4 cm apart in-row
- Cluster - groups of 3 onions, 12cm apart
- Conventional – double row, 5 cm apart
- All rows were 40 cm apart

Single row and clusters had significantly more large and jumbo onions than conventional. Clusters also allow for intra-row weeding.

Commercial Trial
- Single row – 3.4 cm apart in-row

- Seeded at 225 m/hr, with 4 seeding units
- Rows were 40 cm apart
- Ran 24 hrs/day, only stopping for seed
- Seeded 7-acre field in 4 days

The FD20 seeded ~14x slower than conventional, but there are ways to increase seeding speed, such as using 8 seeding units or seeding in clusters rather than a single row, similar to how onion transplants are grown in the region. The FD20 was effective at removing small weeds and some thistle, but the grower continued to hand-weed the field. Next year, the tooling will be adapted to be more effective at removing thistle and working in high organic matter soils.

Naïo Orio

The Orio worked in carrots and beets grown in both organic and mineral soils. A camera-guided hitch made by Tillet & Hague allowed the robot to be used with a traditional cultivator. The hitch was effective at following the rows, which were not planted with the use of GPS.
A band sprayer was also designed and built to be used with the Orio. The sprayer had two 55-gallon tanks and was controlled by a Raven Industries field computer. The robot effectively applied fungicide, liquid fertilizer, insecticides and selective herbicides to the crops, while a non-selective herbicide could be applied simultaneously between the rows. Next year, the Orio will manage carrots and beets after seeding until harvest without the use of a tractor. A seeding unit may also be implemented.

Nexus Goat

The Nexus Goat had a successful winter in lettuce crops in Arizona. Therefore, the team decided to trial this robot in a commercial leaf lettuce and spinach field in 2023. Over the season the robot became trained on the crops and was successful in removing 80% of the weeds. The grower cooperator was pleased with the Goats' performance. There was a lot less down time due to mechanical issues compared to the 2022 field season, where this robot was trialed in onions and carrots.

Naïo Ted

The Naïo Ted robot arrived in Ontario in June and started working in a vineyard in Niagara. The growers were pleased with its performance in hilling, de-hilling and cultivation. Electric mowers were also installed on the robot to mow between the rows at the same time the robot cultivates beside the vines. Next year the robot will be tested on its vine-hedging capabilities, yield estimation and UV-C technology will be installed to test against powdery and downy mildew and small insects (mites and aphids).

There are 33 Ted robots working in France, Germany, Spain and Italy. These robots are also used as tourist attractions.

Carbon Robotics LaserWeeder ™

Demonstrations of the LaserWeeder ™ occurred over the summer. The organic carrot producer that purchased the unit is cautiously optimistic on its value as an integrated weed management tool and did have their best organic carrot crop ever. The key challenges for this technology in Ontario production systems is the $2 million cost of one unit and the annual $50,000 technology fee. The company is pursuing credit options, funding opportunities and equipment sharing between Ontario and Southern U.S. growers to provide options for Ontario growers.

The LaserWeeder ™ has sub-millimeter accuracy and does an excellent job killing small weeds. As more units are used around the world the A.I. capabilities continually increase to recognize more and more weed species.

Conclusions

- AgRobotic technology has drastically improved just in the past year, with new models and tooling options available to growers.
- There is still room for improvement to optimize these technologies for Ontario production.
- Future work will focus on enhancing tooling, reliability and modelling to de-risk these technologies for growers and to provide feedback to manufacturers.

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Challenges/Research Needs

1. Herbicide resistance in horticulture production systems in Ontario is expanding. As we continue to survey various cropping systems, more and more cases of herbicide resistant species are discovered. The newest trend is species resistant to multiple modes of action, which is making control very difficult in horticulture crops where there are species resistant to Group 1, 2, 5, 9, 14 and 27 herbicides. The majority of herbicides for postemergence control in horticulture crops are from herbicide Groups 1, 2, 5 and 14. These multiple resistant species severely limit the control options producers have. The increased spread of Groups 2, 5, 9, 14 and 27 resistant waterhemp into various production systems is very concerning (asparagus, peppers, corn, soybeans, sweet corn IP beans, wheat and white beans).
2. There is a lack of post-emergence herbicides in fruit and vegetable crops to control resistant weeds when they occur in these cropping systems. Therefore, new registrations through the minor use system and further promotion of Integrated Weed Management (IWM) strategies including robots is imperative.
3. Continued occurrence of off-target movement of auxin herbicides onto highly sensitive horticulture crops such as: grapes, tomatoes, apples, peaches, and non-GMO/IP soybeans/beans. Watch for the OFA Spray Drift Awareness Campaign.