Manitoba survey of herbicide-resistant weeds in 2022

Canada

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Introduction and Objectives

Herbicide-resistant (HR) weeds are a growing concern for farmers worldwide[1], and Manitoba is no exception. The percentage of annual-cropped fields occupied by HR weeds in Manitoba increased from 32% in 2002[2] to 48% in 2008[3] to 68% in 2016[4]. The most-recent Manitoba survey (2016) estimated that HR weeds cost Manitoba farmers about $73 million annually in reduced crop yields and quality and increased weed control expenses[4]. Continued monitoring of the occurrence, distribution and impact of HR weeds is essential to understand how best to mitigate and manage this increasing threat to cropping systems. **The objective of this study was to determine the occurrence, distribution, and impact of HR weeds in Manitoba in 2022**, with particular focus on tier 1 acetyl-CoA carboxylase (ACCase) and acetolactate synthase (ALS)-inhibiting herbicides.

Materials and Methods

- Randomized-stratified pre-harvest survey conducted in mid- to late-August of 2022.
- 155 randomly-selected ¼ sections (65 ha) (**Fig. 1**) stratified based on cultivated area within each ecodistrict and seeded area of each crop (**Table 1**).
- Mature weed seeds collected from uncontrolled visible weed patches, and the patch area estimated.
- Seeded in 24×24×5 cm flats with soilless medium and watered daily in the greenhouse.
- 16 hr photoperiod with 20/18°C temperature and 230 µmol m^{-2} s^{-1} supplemental light.
- Tested with tier 1 ACCase- and ALS-inhibiting (Groups 1 & 2) herbicides (**Table 2**)[2-4].
- Herbicides applied at the 2–4 leaf stage using a moving-nozzle cabinet sprayer (TeeJet® 8002VS nozzle; 275 kPa; 200 L ha^{-1} solution; 2.4 km hr^{-1}).
- Plants characterized as resistant (no injury; injury with new growth) or susceptible (dead; nearly dead) 3 wk after treatment relative to resistant and susceptible controls[5].
- Maps of resistance occurrence developed using QGIS v. 3.22.2[6].

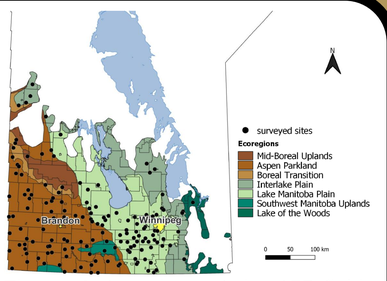

Figure 1. Locations of the 155 fields included in the 2022 survey of herbicide-resistant weeds in Manitoba.

Table 1. Field allocation by crop and ecoregion.

Crop	Aspen Parkland[a]	Boreal Transition[b]	Lake Manitoba Plain	Interlake Plain[c]	All areas	% of all areas
	no. of fields					%
Canola	22	7	18	4	51	33
Wheat	25	1	18	5	49	31
Soybean	7	0	13	0	20	13
Oat	10	0	4	0	14	9
Barley	5	0	1	1	7	5
Corn	1	0	4	2	7	5
Field pea	3	0	1	0	4	3
Pinto bean	0	0	2	0	2	1
Sunflower	0	0	1	0	1	<1
Sub-total	73	8	62	12	155	100
% of total	47	5	40	8	100	100

[a]Includes SW MB Uplands; [b]Includes Mid-Boreal Uplands; [c]Includes Lake of the Woods

Table 2. Herbicides used for resistance diagnostics.

Herbicide common name	Herbicide trade name	Rate (g ai/ae ha^{-1})
Fenoxaprop	Puma® Advance[1]	60 & 150
Quizalofop	Assure® II[2,a]	48 & 70
Tralkoxydim	Liquid Achieve™ SC[3,b]	200 & 400
Clethodim	Centurion®[4,c]	90
Imazamox	Solo® ADV[4]	35
Imazethapyr	Pursuit® 240[4,d]	75
Imazapyr	Arsenal® PowerLine[4,d]	72
Thifensulfuron + Tribenuron	Refine® SG[5,d]	15(10+5)
Chlorsulfuron	Telar® XP[1,d]	22 & 89
Glyphosate	Roundup WeatherMAX®[1]	900

Company name: [1]Bayer CropScience Inc.; [2]AMVAC Chemical Corp.; [3]Corteva Agriscience; [4]BASF Canada Inc.; [5]FMC of Canada Ltd.
Adjuvants: [a]Merge® @ 0.5% v/v; [b]Turbocharge® @ 0.5% v/v; [c]Amigo® @ 0.5% v/v; [d]Agral® 90 @ 0.25% v/v

Results and Discussion

- 1,037 tests were conducted on 576 samples, representing 35 weed species.
- 75% of the fields were occupied by HR weeds in 2022 (**Table 3; Fig. 2**).
- The estimated area occupied by HR weed patches decreased from 2.2 million ha in 2016[4] to 1.4 million ha in 2022, while the equivalent field area increased from 2.7 million ha in 2016 to 3.0 million ha in 2022 (**Table 3**).
- Based on previous grower estimates[4] combined with the area where HR weeds were present before crop harvest in Manitoba in 2022 (**Table 3**), HR weeds cost Manitoba farmers about $81 million annually.
- New issues of concern that warrant further investigation include (**Table 3; Fig. 3**):
  - Putative ACCase inhibitor-resistant barnyardgrass, quackgrass and stinkgrass.
  - Putative ALS inhibitor-resistant quackgrass, spiny sowthistle, lambsquarters and horseweed.
- This survey did not test for glyphosate or auxinic herbicide resistance in kochia due to limited mature seed present pre-harvest. However, the 2018 post-harvest survey of Manitoba documented glyphosate and dicamba resistance in 50% and 1% of the kochia populations sampled, respectively[7].
- Extreme precipitation caused flooding during the spring of 2022 and late seeding of crops. Late weed recruitment likely altered the weed communities present.

Results

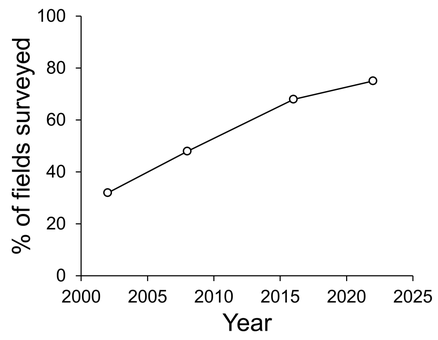

Figure 2. The percentage of surveyed fields occupied by herbicide-resistant weeds in the current (2022) and historical (2002, 2008 & 2016)[2-4] surveys of Manitoba.

Table 3. Frequency of confirmation of each weed biotype resistant to acetyl-CoA carboxylase (ACCase)- or acetolactate synthase (ALS)-inhibiting herbicides among fields tested and among all fields sampled, and the land area and field area occupied.

Common name	Scientific name	Resistance	Tested fields	All fields	Area occupied	Field area
Grass:			%	%	ha	ha
Wild oat	*Avena fatua*	ACCase	100	37	430,178	1,469,609
Green foxtail	*Setaria viridis*	ACCase	88	27	848,363	1,170,531
Yellow foxtail	*Setaria pumila*	ACCase	43	12	211,687	561,454
Barnyardgrass*	*Echinochloa crus-galli*	ACCase	33	11	146,349	455,787
Stinkgrass*	*Eragrostis cilianensis*	ACCase	33	3	157,530	157,530
Quackgrass*	*Elymus repens*	ACCase	100	1	11	31,130
Wild oat	*Avena fatua*	ALS	82	30	396,199	1,213,825
Barnyardgrass	*Echinochloa crus-galli*	ALS	86	29	393,857	1,084,472
Yellow foxtail	*Setaria pumila*	ALS	9	3	45,064	113,632
Green foxtail	*Setaria viridis*	ALS	2	<1	40,103	40,103
Quackgrass*	*Elymus repens*	ALS	100	1	11	31,130
Wild oat	*Avena fatua*	ACCase + ALS	82	30	396,197	1,183,768
Barnyardgrass*	*Echinochloa crus-galli*	ACCase + ALS	37	12	182,667	479,032
Quackgrass*	*Elymus repens*	ACCase + ALS	100	1	11	31,130
Broadleaf:						
Kochia	*Bassia scoparia*	ALS	100	19	115,793	752,060
Pigweeds.	*Amaranthus* spp.[a]	ALS	31	13	351,347	613,484
Pale smartweed	*Persicaria lapathifolia*	ALS	76	10	11,676	395,278
Spiny sowthistle*	*Sonchus asper*	ALS	59	7	68,664	300,762
Lambsquarters*	*Chenopodium album*	ALS	12	4	99,216	151,153
Horseweed*	*Erigeron canadensis*	ALS	33	1	645	65,116
False cleavers	*Galium spurium*	ALS	40	1	54,940	54,940
Shepherd's purse	*Capsella bursa-pastoris*	ALS	50	1	21	44,098
Chickweed	*Stellaria media*	ALS	100	<1	<1	34,351
All HR Weeds			**80**	**75**	**1,404,228**	**2,998,079**

[a]Includes *Amaranthus retroflexus* and *Amaranthus powellii*

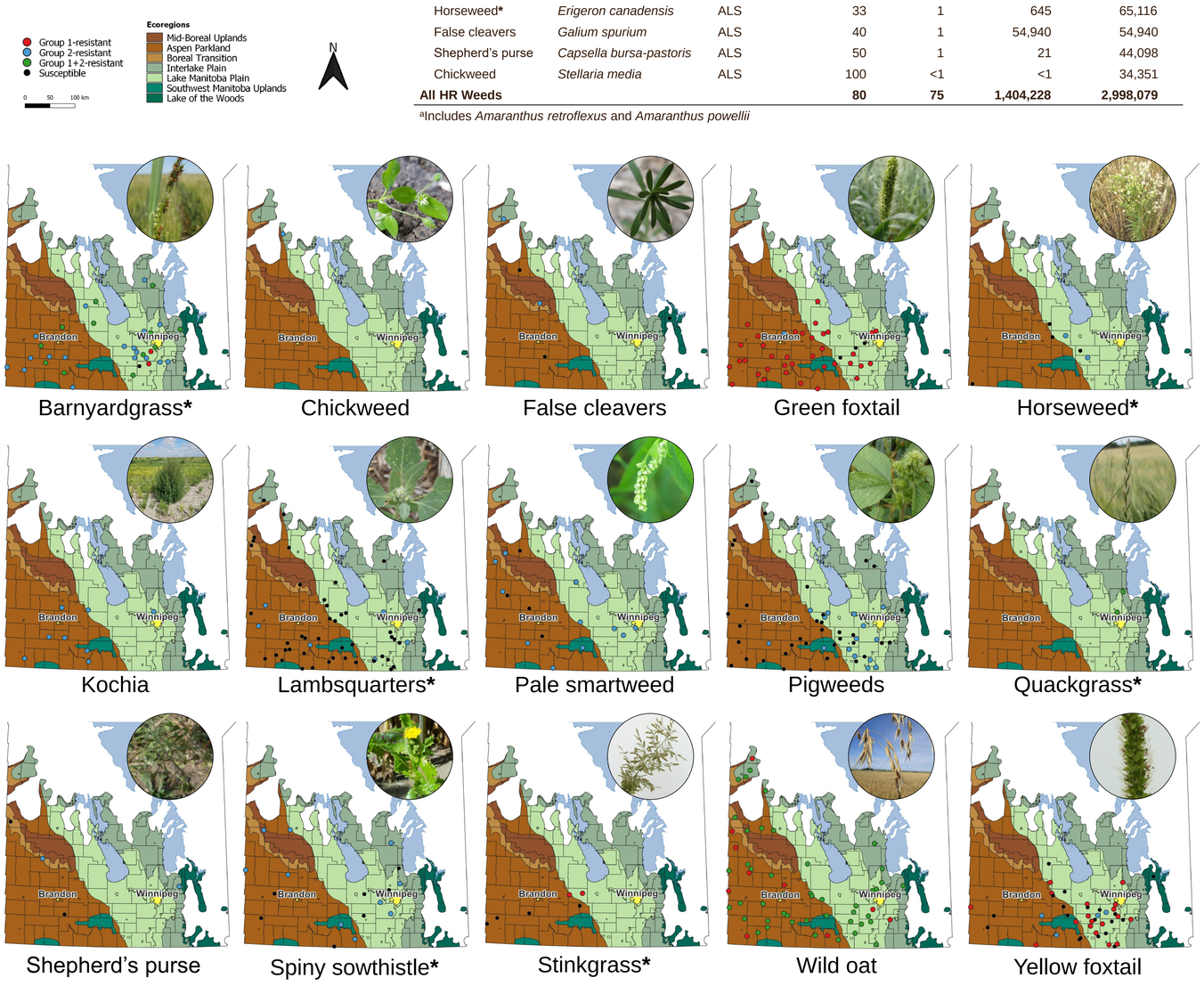

Figure 3. Maps showing the locations of populations exhibiting resistance to acetyl-CoA carboxylase (ACCase)-, acetolactate synthase (ALS)-, and ACCase + ALS-inhibiting herbicides for each weed species with resistant biotypes in a 2022 survey of 155 fields in Manitoba.

*HR weeds with an asterisk were new for Manitoba and are therefore considered "putative-resistant" until confirmed using dose-response experiments.

Conclusions

Overall, **75% of the sampled fields in Manitoba had at least one HR weed** biotype present before crop harvest. **HR weeds occupied 1.4 million ha of cropland** in 2022, equivalent to a field area of 3.0 million ha. **HR weeds cost Manitoba farmers an estimated $81 million annually** in increased weed control expenses and reduced crop yields and quality. The growing impact of HR weeds warrants greater investment in integrated weed management programs.

References

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