

# Rapid spread of glyphosate-resistant kochia [*Bassia scoparia* (L.) A.J.Scott] in Manitoba

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## Introduction & Objective

Kochia [*Bassia scoparia* (L.) A.J.Scott] is a tumbleweed capable of long-distance seed dispersal resulting in the transport of seeds among multiple fields within a single year<sup>1</sup>. Prolific seed production, a short-lived seedbank, high genetic variability, pollen- and seed-mediated gene flow, phenotypic plasticity, and tolerance to drought, salinity and cold temperatures make this weed an ideal candidate for rapid evolution of herbicide resistance. Kochia is the first known glyphosate-resistant (GR) weed species in western Canada<sup>2</sup>. In 2011, the first confirmations of GR kochia were found in chemical-fallow fields located in Warner County, Alberta<sup>3</sup>. Baseline surveys in 2012 (Alberta) and 2013 (Manitoba and Saskatchewan), identified glyphosate resistance in 5%, 5% and 1% of kochia populations in Alberta, Saskatchewan and Manitoba, respectively<sup>4,5</sup>. Unlike Alberta and Saskatchewan, the first confirmations of GR kochia in Manitoba were in the GR crops, soybean and corn<sup>5</sup>. **The objective of this study was to determine the status of GR kochia in Manitoba in 2018, five years after the baseline survey.**

## Materials & Methods

- Randomized stratified survey based on cultivated land area within each ecodistrict.
- Kochia samples were collected post-harvest from 297 pre-determined (township-scale) locations in Manitoba in October 2018.
- Same methods as 2013 baseline survey<sup>5</sup>, but different sample locations.
- Seed was harvested and 72 individuals from each population (three replications) were grown in the greenhouse.
- Seedlings 3 to 5 cm tall were treated with glyphosate (Roundup WeatherMax® at 900 g a.e. ha<sup>-1</sup> using a moving-nozzle track sprayer (275 kPa; 200 L ha<sup>-1</sup> H<sub>2</sub>O carrier).
- Plants were rated visually as susceptible (dead or nearly dead) or resistant (some injury but new growth, or no injury) three weeks after application.
- Populations were categorized based on the percentage of plants considered resistant (**Fig. 1**):
  - Susceptible (0% resistant)
  - Low resistance (1-20% resistant)
  - Moderate resistance (21-60% resistant)
  - High resistance (61-100% resistant)

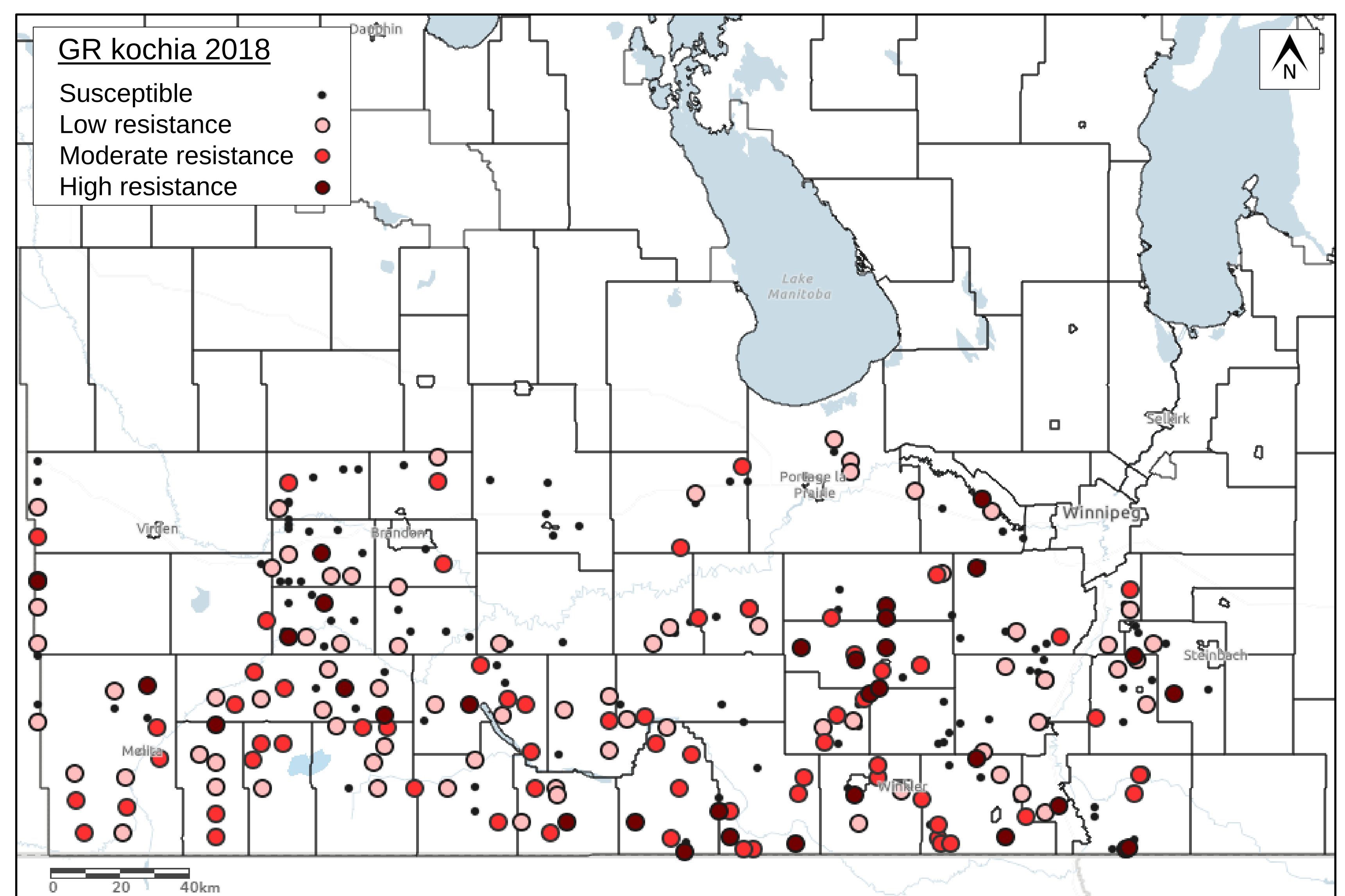


**Figure 1.** (a) Kochia populations in the greenhouse exhibiting (b) susceptibility, (c) low resistance, and (d) high resistance.

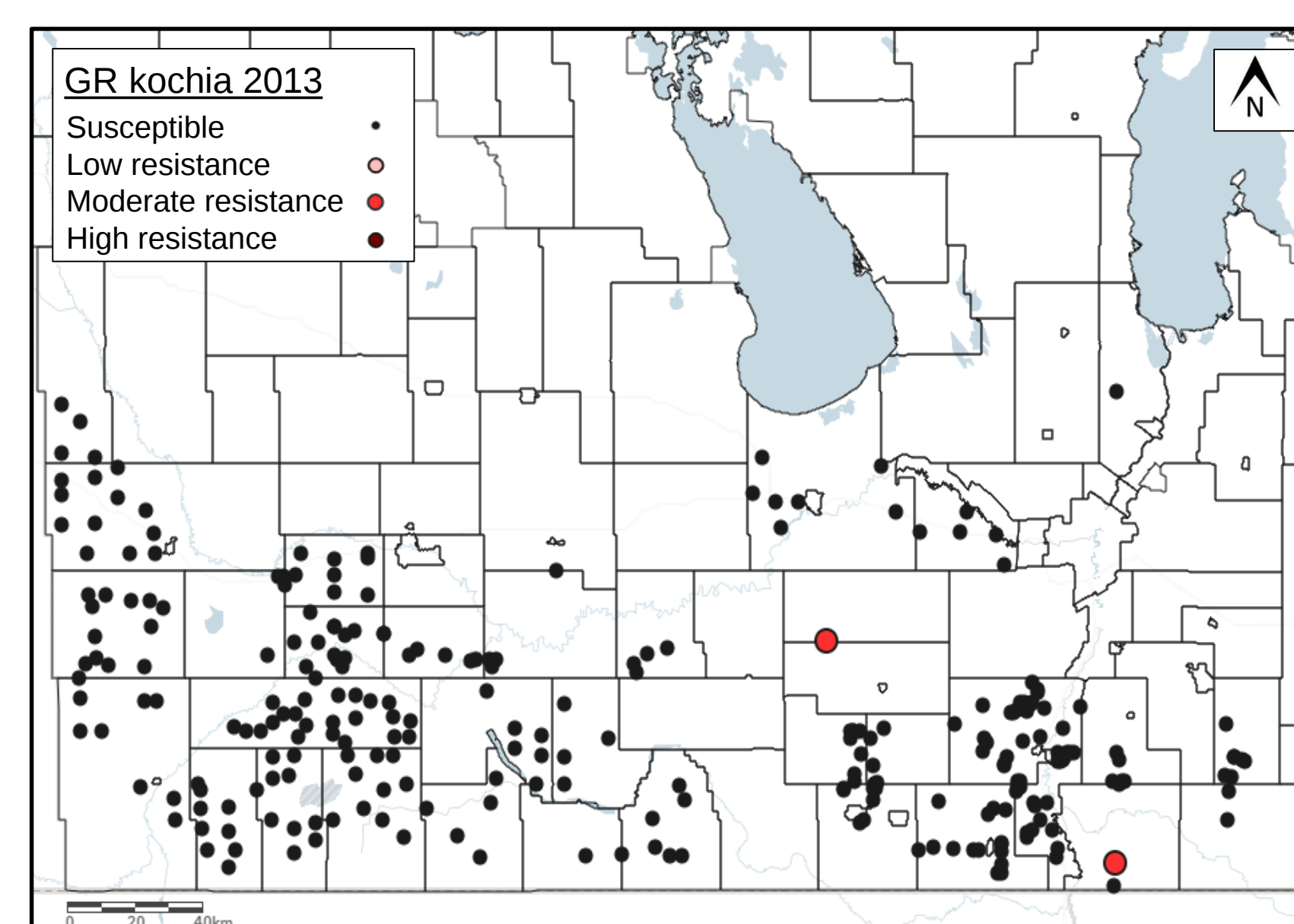
## Results & Discussion

- After five years, the incidence of glyphosate resistance increased from 1% to 59% of kochia populations in Manitoba (Figs. 2 & 3).** The rapid increase of GR kochia in Manitoba coincides with similar observations in Alberta, where glyphosate resistance spread rapidly from 5% to 50% of kochia populations in the five-year period from 2012 to 2017<sup>6</sup>. This agrees also with the near-complete assimilation of acetolactate synthase inhibitor (group 2) resistance in kochia over two decades following the first confirmation in western Canada in 1988<sup>7</sup>. The rapid spread of GR kochia is stark evidence of unhindered herbicide resistance gene flow in this species.
- Unlike the 2013 baseline survey of Manitoba<sup>5</sup>, **GR kochia was confirmed in a range of field crops in 2018**, including: small-grain cereals (48% of kochia populations), canola (53%), soybean (77%), corn (70%), other crops (53%), and uncropped areas (21%) (**Figs. 4 & 5**).
- Several kochia populations were heterogeneous and consisted of a low percentage of resistant individuals (Figs. 2 & 5).** It is unlikely that these populations have a current economic impact, and they probably exist unnoticed by growers and agricultural professionals. However, the large number of populations with low resistance (<20% of individuals) indicates that resistance in these populations is building and will do so in the absence of changes to current management regimes.
- Kochia populations collected from the GR crops soybean and corn had a greater percentage of resistant plants and a lower percentage of populations considered susceptible**, which indicates greater selection pressure for glyphosate resistance in these crops compared with more-competitive GR crops like canola (**Fig. 5**).
- Growers will need to shift their kochia management programs** to compensate for the lack of efficacy of this important herbicide. These management programs will consist of increased reliance on alternative herbicide sites-of-action pre-emergence, adoption of herbicide-resistant crops with stacked resistance traits, and integration of non-chemical tools into current weed control strategies.

## Results



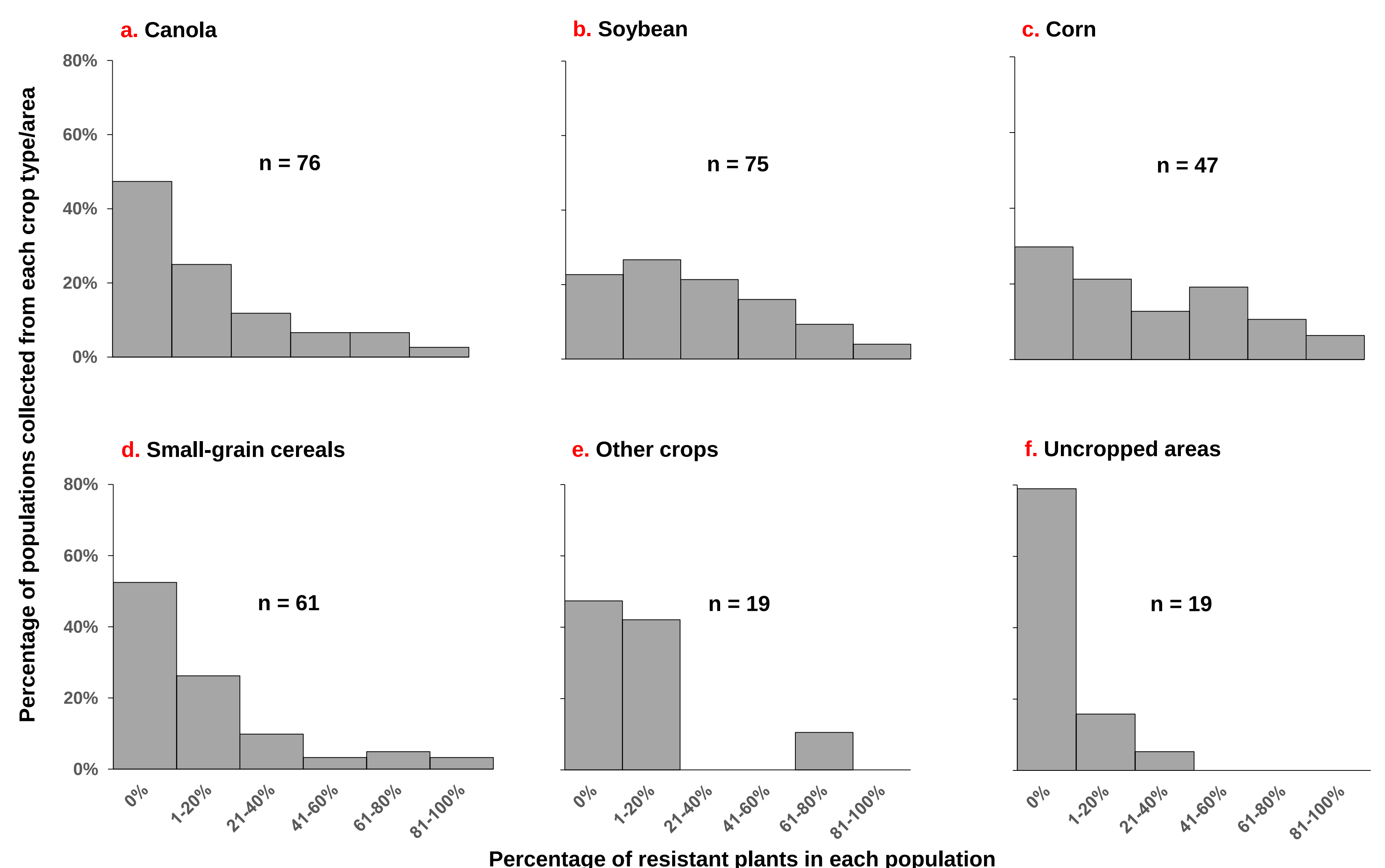
**Figure 2.** Glyphosate-resistant (GR) kochia populations in Manitoba in 2018. Populations categorized as glyphosate-susceptible (black), or low (1-20% resistant plants in the population; light red), moderate (21-60%; red), and high (61-100%; dark red) resistance.



**Figure 3.** Glyphosate-resistant (GR) kochia populations in Manitoba in 2013.



**Figure 4.** A patch of kochia in spring wheat.



**Figure 5.** The percentage of resistant plants in kochia populations collected from (a) canola, (b) soybean, (c) corn, (d) small-grain cereals, (e) other crops, and (f) uncropped areas in Manitoba in 2018.

## Main Findings

In Manitoba, ...

- glyphosate resistance spread from 1% to 59% of kochia populations in five years
- uncontrolled kochia populations are more-likely GR than glyphosate-susceptible
- GR crops soybean and corn have greater selection pressure for glyphosate resistance

## Literature cited

- Beckie et al. 2016. Weed Sci 64:624-633
- Heap. 2019. www.weedscience.org
- Beckie et al. 2013. Weed Sci 61:310-318
- Hall et al. 2014. Can J Plant Sci 94:127-130
- Beckie et al. 2015. Can J Plant Sci 95:345-349
- Beckie et al. 2019. Can J Plant Sci 99:281-285
- Beckie et al. 2011. Weed Technol 25:170-175

## Acknowledgements

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