Rate of Herbicide Resistant Weed Development: A Canadian Prairie Case Study

Event

Reliance on herbicidial weed control has led to concerns about increases in herbicide resistant (HR) weed populations, a challenge which dates back to the 1950s in Canada. The introduction of genetically modified herbicide tolerant (GMHT) canola in 1995 heightened these concerns, especially regarding volunteer canola. However, shifts in Prairie agricultural practices over the past 30 years have helped slow the development of new HR weed populations. Comparatively, HR weeds pose a greater challenge in key agricultural regions in the United States (US) where rotations are less crop kind diverse.

Significance

Uncontrolled, persistent weed pressure leads to economic losses for farmers. Thus, effective weed control is imperative for farmers to remain profitable. Prairie farmers have necessarily adopted more diverse and sustainable weed control strategies, including improved crop and herbicide rotations as well as appropriate tank mixing to combat the development of new HR weed populations. Yet, herbicide use as a main form of weed control is often negatively viewed by the public and environmental activists, especially in relation to HR weed development within GMHT cropping systems. This analysis confirms the rate of development of new HR weed species has declined on the Prairies following the introduction of GMHT crops and improvements in farmers' crop rotation and diversification strategies.

Analysis

Prairie HR weed data was collected from the HR Action Committee's International HR Weed Database.[1] This dataset documents new HR cases but does not include the frequency or distribution of HR populations. A new HR case refers to a weed species exhibiting resistance to a herbicide mode of action (MOA), the process by which a herbicide impacts susceptible plants, or combination of MOAs not previously recorded provincially. Between the first reported HR weed on the Prairies in 1988 and 2021, a total of 66 new HR cases were reported. Four weed species have developed resistance to multiple MOAs: wild oat, kochia, green foxtail, and false cleavers. When the total number of specific MOAs involved in reported HR cases is considered, the total is 88 between 1988-2021 including 14 instances of multiple resistant MOAs ranging from 2-4 MOAs per weed. Despite concerns that the issue of HR, especially glyphosate-resistance (GR), would develop more rapidly following the introduction of GMHT crops, regression results reveal that the rate of development of new HR weed cases has exhibited a slight decline over the past 35 years. Of the 66 total HR cases reported on the Prairies, only 5 (8%) include resistance to Group 9 herbicides, the herbicide group containing glyphosate. Comparatively, there are 183 reported cases of weeds resistant to Group 9 herbicides in the US.

Prairie farm management data was collected from the 2020 Crop Rotation Survey which gathered crop rotation and input use data from two separate crop rotations: 1991-94 and 2016-19. Between 1991-94, only 30% of surveyed Prairie farmers (n=94) included pulse crops in their rotations compared to 58% in 2016-19 (n=186). During this same period, the number of farmers who included three or more crop types in their four-year rotations increased from 59% to 80% and the average number of crop types planted in a four-year rotation increased from 2.6 to 3.1. In comparison, the average number of crop types planted in rotations in the major agricultural-producing regions of the US is 2.1.[2] Specific to herbicide use in Saskatchewan, the average number of surveyed farmers applying multiple active ingredients per application has increased by 37% for pre-seed, 8% for in-crop, and 22% for post-harvest herbicide applications between 1991-94 and 2016-19.

Conclusion

While HR weeds make it more difficult to control weed populations, Prairie farmers have addressed this challenge through use of expanded rotations and responsible tank mixing. By adopting these strategies, farmers have helped to keep the number of new HR weed species at a manageable level. Comparatively, HR weeds pose a greater challenge for farmers in the US where crop rotations and management practices are less diverse. The relatively small share of GR weeds in the total number of HR cases indicates that the widespread adoption of GMHT canola on the Prairies has not heightened the problem of GR weeds to the extent anticipated by critics of glyphosate use. However, the problem of HR weeds may become more pressing in the future. It is imperative that farmers maintain access to technologies necessary for effective weed control strategies, while investment into innovative solutions to combat the problem of HR weeds in the long-term is supported.

The research article this is based on can be found at: https://doi.org/10.1080/21645698.2025.2477231.

[1] Heap, I. 2024. The International Herbicide-Resistance Weed Database. Available at: http://www.weedscience.org/.

[2] Merlos, F.A. & Hijmans, R.J. 2020. The scale dependency of spatial crop species diversity and its relation to temporal diversity. Proceedings of the National Academy of Sciences 117(42), 26176-26182. https://doi.org/10.1073/pnas.2011702117.