

Weed Resistance and Herbicide Tolerant Crops

K. Neil Harker
Lacombe, AB

Weed resistance does not appear to be in significant decline in western Canada and remains a concern for growers and others involved in weed management. The introduction of herbicide-tolerant (HT) crops has provided a reprieve for some growers who have encountered weed resistance on their farms. However, individual HT crops have different risks and benefits, and should be considered separately.

For growers experiencing resistance to Group 1 (ACCase inhibitor) herbicides, Clearfield canola and wheat provide in-crop options for control of those grassy weed biotypes. However, imidazolinone herbicide applications in Clearfield crops exert additional Group 2 (ALS inhibitor) selection pressure. In western Canada there are already numerous cases of grassy and broadleaf species resistance to Group 2 herbicides. In the Brown soil zone, kochia resistance to Group 2 herbicides is widespread. The same can be said for chickweed in the Black soil zone. Unfortunately, the frequency of Group 2 resistance biotypes in unselected populations appears to be relatively high, leading to rapid selection for dominantly resistant populations. Given the extensive use of Group 2 herbicides for difficult weeds in cereals and pulses, additional use of imidazolinone herbicides in Clearfield crops will only increase Group 2 resistance challenges.

The introduction of RR crops has provided unique herbicide mode of action opportunities for in-crop weed control. RR corn and RR soybeans are currently relatively minor players on the Canadian Prairies (although that appears to be changing). On the other hand, RR canola is used on more than half of all western Canada canola acres. Before RR canola, most growers saved some of their best land for canola production. Now, RR canola has the reputation of being a “clean-up crop” and is often successfully grown on land with high densities of troublesome weeds. Lower weed species richness and higher weed-free quadrats in recent Prairie weed surveys are probably one manifestation of a higher level of weed control in RR canola crops. Nevertheless, because glyphosate is such an important herbicide in direct-seeding systems, some growers reserve its use only for “burn-off” treatments prior to, or immediately after planting. These growers do not want to risk compromising glyphosate use in conservation tillage systems by adding in-crop selection pressure for weed resistance.

In areas other than Canada, there are examples of weed resistance to glyphosate. Globally, six weed species have been documented to be resistant to glyphosate. From rigid ryegrass in Australia, to goosegrass in Malaysia, to Canada fleabane in the United States, there is ample evidence that glyphosate resistance to weeds in Canada is not unrealistic. Canada fleabane resistance in the East Central United States is predominantly associated with RR soybean production and appears to be rapidly spreading. Canada fleabane is a windblown species that does not respect international borders or those that patrol them. We hope not see to that unwelcome guest in Canada anytime soon.

Not everyone is reserving glyphosate for strategic applications in conservation tillage systems. By 2001, a few years into the RR crop era, global glyphosate sales were greater than the total of

the next 12 top-ranking herbicides. Since 2001, RR crops have continued to gain market share – the trend continues. Given, the relatively low risk of glyphosate resistance compared with resistance to other herbicides, we may be seeing less new cases of weed resistance had RR crops been unavailable. Nevertheless, it is not prudent to use glyphosate at every available opportunity. The Ontario Weeds Committee recently established a “Responsible Glyphosate Use” subcommittee; other jurisdictions are considering the same.

The first commercial transgenic crop in Canada was glufosinate-tolerant (Liberty-Link) canola. Glufosinate is used exclusively in glufosinate-tolerant crops. Therefore, given how little glufosinate-tolerant crops are employed in most rotations there is relatively little selection for herbicide resistance. In addition, there appears to be a very low frequency of resistant biotypes in unselected populations. There are no documented cases of resistance to glufosinate anywhere in the world. Therefore, of the three main HT crops, glufosinate appears to have the least risk of resistance occurring. In addition, should resistance to glufosinate occur, the consequence is that glufosinate would have less utility in the small proportion of crops it is currently used in. This is in contrast to the extensive use of sulfonylurea and imidazolinone herbicides in numerous crops, or the almost exclusive use of glyphosate in several RR crops or in conservation tillage systems.

The only way herbicide resistance can be prevented is impractical – stop herbicide use. There appear to be two suggestions that make sense in terms of reducing herbicide resistance problems in HT crops. First, limit the use of the HT crops with a high frequency of resistance mutations. Second, limit the use of HT crops where the consequences of obtaining resistance are great. Neither of these strategies will be practical unless optimal agronomic practices are used to keep weeds at levels that do not require excessive herbicide applications. Emphasizing crop health and employing diverse rotations will greatly improve the chances of reducing the selection pressure for resistance by reducing herbicide use.

References

- Arntzen, C. J., A. Coghlan, B. Johnson, J. Peacock, and M. Rodemeyer. 2003. GM crops: science, politics and communication. *Nature Reviews – Genetics* 4:839-843.
- Baylis, A. D. 2000. Why glyphosate is a global herbicide: strengths, weaknesses and prospects. *Pest Manage. Sci.* 56:299–308.
- Beckie, H. J., Thomas, A. G., Legere, A., Kelner, D. J., Van Acker, R. C., and Meers, S. 1999. Nature, occurrence, and cost of herbicide-resistant wild oat (*Avena fatua*) in small-grain production areas. *Weed Technol.* 13:612-625.
- Beckie, H. J., J. Y. Leeson, A. G. Thomas, and L. M. Hall. 2004. Alberta weed survey of herbicide-resistant weeds in 2001. *Weed Survey Series, Pub. 04-1.* AAFC, Saskatoon, SK. 66 p.
- FAO. 2003. Report of the expert consultation on environmental effects of genetically modified crops. June 16-18, 2003. Rome, Italy. Available online: <ftp://ftp.fao.org/docrep/fao/field/006/ad690e/ad690e00.pdf> [Accessed June 9, 2004].

Harker, K. N., R. E. Blackshaw, K. J. Kirkland, D. A. Derksen, and D. Wall. 2000. Herbicide-tolerant canola: weed control and yield comparisons in western Canada. *Can J. Plant Sci.* 80:647-654.

Harker, K. N. 2004. My view. *Weed Sci.* 52:183-184.

Heap, I. 2004. International survey of herbicide-resistant weeds. Available online: <http://www.weedscience.org/in.asp> [Accessed December 2, 2004].

Lee, L. J. and J. Ngim. 2000. A first report of glyphosate-resistant goosegrass (*Eleusine indica* (L.) Gaertn.) in Malaysia. *Pest Manag. Sci.* 56:336-339.

Leeson, J. Y., A. G. Thomas, H. J. Beckie, L. M. Hall, C. Brenzil, R. C. Van Acker, K. R. Brown, and T. Andrews. 2004. Group 2 herbicide use in the Prairie Provinces. *Proc. Can. Weed Sci. Soc.*, November 28 – December 1. Winnipeg, MB. Poster Abstract.

Lyon, D. J., A. J. Bussman, J. O. Evans, C. A. Mallory-Smith, and T. F. Peeper. 2002. Pest management implications of glyphosate-resistant wheat (*Triticum aestivum*) in the western United States. *Weed Technol.* 16:680-690.

Powles, S. B., D. F. Lorraine-Colwill, J. J. Dellow, and C. Preston. 1998. Evolved resistance to glyphosate in rigid ryegrass (*Lolium rigidum*) in Australia. *Weed Sci.* 46:604-607.

Powles, S. B. 2003. My view. *Weed Sci.* 51:471.

Saskatchewan Soil Conservation Association. 2001. Roundup-Ready Wheat Position Paper. *Sask. Soil Conserv. Assoc.* Online: <http://ssca.usask.ca/Positions/RRposition.htm> [Accessed: June 10, 2004].

Stringham, G. R., V. L. Ripley, H. K. Love, and A. Mitchell. 2003. Transgenic herbicide tolerant canola – the Canadian experience. *Crop Sci.* 43:1590-1593.

Thomas, A. G., J. Y. Leeson, C. A. Brenzil, L. M. Hall, T. Andrews, K. R. Brown, and R. C. Van Acker. 2004. Residual weed populations in the Prairie Provinces. *Proc. Can. Weed Sci. Soc.*, November 28 – December 1. Winnipeg, MB. Poster Abstract.

VanGessel, M. J. 2001. Glyphosate-resistant horseweed from Delaware. *Weed Sci.* 49:703-705.