



## Triple herbicide-resistant kochia control

CATEGORY [weeds](#) | August 14, 2019

A kochia survey in southern Alberta in 2017 found that all kochia populations were resistant to Group 2 ALS inhibitors, 50% of populations were resistant to Group 9 glyphosate, and 18% of populations resistant to Group 4 (dicamba) herbicides. Kochia populations with triple resistance to Group 2, Group 4, and Group 9 modes of action were found in 10% of the 305 populations collected and tested.

A kochia survey was conducted in Alberta in 2017 to determine the distribution and abundance of multiple resistant kochia to Group 2 (ALS inhibitor), Group 4 (synthetic auxin) and Group 9 (glyphosate) herbicide modes of action. After harvest, surveyors collected 10 to 20 mature kochia plants at 305 randomly determined sites. Seed from the samples were collected, grown in flats, and sprayed with Roundup WeatherMax (Group 9), Refine SG (Group 2) and Banvel II (Group 4) when seedlings were 3 to 5 cm tall.

### **Resistance increasing**

Similar to the results of a previous kochia survey in 2012 and 2013, all kochia populations were categorized as resistant to the Group 2 ALS inhibitors.

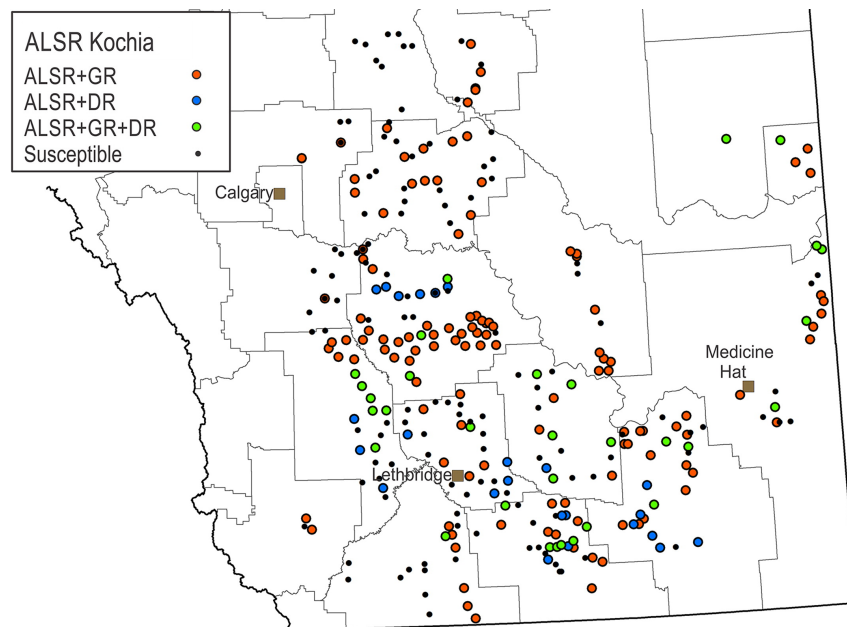
Glyphosate resistance was confirmed in 153 of 305 samples (50%). Glyphosate resistance was confirmed in 15 of 16 counties, compared to only three counties in 2012. These populations were also

resistant to Group 2 herbicides. An average of 38% of individuals in a population were found to be glyphosate resistant, indicating that most of the populations were segregating for resistance (i.e., not yet all resistant).

Considering glyphosate-resistant kochia was only found in 5% of the populations in three counties in 2012, the researchers found the incidence of glyphosate-resistant kochia alarming, but not surprising since kochia's tremendous gene flow (seed spread) previously allowed rapid evolution of Group 2 resistance. They expect glyphosate-resistant kochia to reach two-thirds of populations when surveyed within the next 5 years. They also expect a similar trend in Saskatchewan.

Glyphosate-resistant (Group 9+2) kochia sites were found within 98 annually cropped fields, 12 oil well sites, and 12 ditch areas. Within those annually cropped fields, glyphosate-resistant kochia was found in small-grain cereals (37%), oilseeds (canola, flax, and mustard; 14%), pulses (lentil and field pea; 19%), and large-grain cereals (corn; 11%). The eight corn fields with glyphosate-resistant kochia were located throughout Newell county. Less than 20% of the glyphosate-resistant kochia was found on chemfallow.

**Double-resistant: ALS inhibitor + glyphosate (ALSR + GR) or ALS inhibitor + dicamba (ALSR + DR), and triple-resistant: ALS inhibitor + glyphosate + dicamba (ALSR + GR + DR) kochia in southern Alberta in 2017.**



Resistance to Group 4 dicamba herbicide (and Group 2 but not glyphosate) was found in 55 of the 305 populations (18%) in nine counties. These populations were also resistant to Group 2 herbicides.

In the 2012 survey, no Group 4 herbicide resistant kochia was found. Dicamba-only resistant kochia was found at one oil well site, four ditch areas, and 19 fields (two-thirds cereals, one-quarter pulses, the remainder oilseeds).

Kochia populations were also segregating for dicamba resistance with an average of 14% of individuals in a population resistant to dicamba. The researchers indicated that this low frequency is consistent with early stages of resistance development in populations across the southern prairie region.

### **Triple-resistant kochia confirmed**

Kochia resistant to Group 2, Group 4, and Group 9 modes of action was found in 31 of the 305 populations (10%) in nine counties, as well as Special Area 3.

All triple-resistant populations were found in fields of cereals (50%), oilseeds (15%), pulses (15%), and chemfallow (20%), except one population from a ditch. The average frequency of glyphosate-resistant individuals in the populations was 34%, and 17% for dicamba-resistant kochia, again indicating that the populations were rapidly segregating for resistance. The researchers believe Group 4 resistant kochia development will follow the same rapid spread as that of ALS inhibitor and glyphosate resistance.

### **Reduced herbicide control options**

With the occurrence of triple-resistant kochia, herbicide control options become more limited since growers have traditionally relied on Group 4 herbicides as the foundation for kochia control.

In other research, Beckie and colleagues found that glyphosate-resistant kochia generally germinated later and had lower overall germination than glyphosate-susceptible populations. Time to 90% loss of seed viability in the soil seedbank after crop harvest ranged from 228 days at Scott, Saskatchewan to 235 days at Lethbridge, Alberta.

The researchers suggest that the short seedbank longevity, delayed and reduced germination, and slower seedling development of glyphosate-resistant kochia may potentially provide additional non-herbicidal weed control options. These could include delayed preseed weed control, or alternatively, early seeding to enhance crop competitiveness. Other practices could include control of kochia weed escapes that minimize gene flow (by both seed and pollen) with practices such as harvest weed seed control, and patch management by alternative herbicides, mowing or tillage.

**Table 1.** Herbicides (group number in parenthesis) to control kochia resistant to ALS inhibitors, dicamba, and glyphosate (groups 2 + 4 + 9, respectively) at pre-seeding, in-crop (10 selected field crops), and chem-fallow in western Canada (Anonymous 2018).<sup>a</sup>

	Wheat	Barley	Oat	Corn	Canola	Mustard	Flax	Soybean	Pea	Lentil
<b>Pre-seeding</b>										
Ethalfuralin (3)	—	—	—	—	X	X	—	X	X	X
Bromoxynil (6)	X	X	X	—	X	—	—	—	—	—
Carfentrazone (14)	X	X	X	X	X	X	X	X	X	X
Saflufenacil (14)	X	X	X	X	—	—	—	X	X	X
Sulfentrazone (14)	—	—	—	—	—	X	X	X	X	—
Flumioxazin (14)	X	—	—	—	—	—	—	X	X	X
Sulfentrazone + pyroxasulfone (14,15)	—	—	—	—	—	—	—	X	X	—
Flumioxazin + pyroxasulfone (14,15)	X	—	—	—	—	—	—	X	—	—
<b>In-crop</b>										
Bromoxynil (6)	X	X	X	X	—	—	X	—	—	—
Glufosinate (10) <sup>b</sup>	—	—	—	X	X	—	—	—	—	—
Topramezone (27)	—	—	—	X	—	—	—	—	—	—
Bromoxynil + pyrasulfotole (6,27)	X	X	—	—	—	—	—	—	—	—
<b>Chem-fallow</b>										
Carfentrazone (14)	—	—	—	—	—	—	—	—	—	—
Saflufenacil (14)	—	—	—	—	—	—	—	—	—	—
Flumioxazin (14)	—	—	—	—	—	—	—	—	—	—
Flumioxazin + pyroxasulfone (14,15)	—	—	—	—	—	—	—	—	—	—

<sup>a</sup>Follow Anonymous (2018) if any discrepancy.

<sup>b</sup>Liberty Link varieties only.

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Beckie, H.J., Hall, L.M., Shirriff, S., Martin, E., Leeson, J. (2019) Triple-resistant kochia [*Kochia scoparia* (L.) Schrad.] in Alberta. Can J Plant Sci 99:281–285 <https://doi.org/10.1139/cjps-2018-0256>

Beckie H.J., Blackshaw R.E., Leeson J.Y., Stahlmanpw, Gaines T.A. and Johnson E.N. (2018). Seedbank persistence, germination and early growth of glyphosate-resistant *Kochia scoparia*. Weed Research <https://doi.org/10.1111/wre.12294>