Canadian Agronomist
DIGGING INTO RESEARCH

Use herbicide mixtures for glyphosate-resistant kochia control in chemfallow

CATEGORY **weeds** | *June 8, 2021*

Control of glyphosate-resistant kochia was achieved with the use of effective tank-mixtures utilizing Group 4, 14 or 4+19 herbicide groups. But the confirmation of Group 4 resistance in kochia highlights the need for careful herbicide stewardship to prevent further selection of multiple herbicide-resistant kochia.

In 2011, the first cases of Group 9 glyphosate-resistant (GR) kochia in Canada were confirmed in chemical fallow fields located in Warner County, Alberta. Previously, all populations were considered resistant to Group 2 herbicides. Since then, GR-kochia has rapidly spread across Alberta, increasing from an estimated 5% of kochia populations in 2012 to 50% of kochia populations in 2017 – and that resistance has spread across the Prairies.

In chemfallow, glyphosate is heavily relied upon for weed control, but with GR kochia spreading across the Prairies, alternative herbicide control options are required. The objective of this study

was to determine herbicide mixtures with multiple modes of action to manage GR and glyphosate-susceptible (GS) kochia in chemical fallow fields.

Field experiments were conducted near Lethbridge and Coalhurst, Alberta in 2014 and 2015. Plots were split between GR kochia and GS kochia. Kochia was seeded in early spring at a rate of 30 seeds/ft^2 (300 viable seeds/m^2) in all environments, with the exception of Lethbridge in 2015 where it was seeded at 40 seeds/ft^2 (400 viable seeds/m^2). The GR Kochia did not have any Group 4 resistant biotypes.

The herbicide treatments tested included an untreated control and glyphosate applied alone or in mixture with 13 other herbicide combinations, which were either registered for kochia management in chemical fallow, or to determine whether they would be effective for this usage. Herbicide treatments were applied post-emergence when kochia plants reached 10 cm in height

Table 1. Herbicide treatments used at Lethbridge and Coalhurst, AB in 2014 and 2015 to manage gly (GR) and glyphosate-susceptible (GS) kochia in chemical fallow

Herbicide common names	Herbicide trade name	MOA[a]	Concentration/ formulation[b]	Rate (g ai/ae ha^{-1})	Merge adjuvant
Glyphosate	Roundup WeatherMAX®	9	540 g/L SN	450	
Glyphosate + dicamba	Roundup WeatherMAX® + Banvel® II	9 4	540 g/L SN 480 g/L SN	450 + 290	
Glyphosate + dicamba	Roundup WeatherMAX® + Banvel® II	9 4	540 g/L SN 480 g/L SN	450 + 580	
Glyphosate + dicamba/diflufenzopyr	Roundup WeatherMAX® + Distinct®	9 4/19	540 g/L SN 70% WG	450 + 75/25	0.5% v/v
Glyphosate + dicamba/diflufenzopyr	Roundup WeatherMAX® + Distinct®	9 4/19	540 g/L SN 70% WG	450 + 150/50	0.5% v/v
Glyphosate + saflufenacil	Roundup WeatherMAX® + Heat®	9 14	540 g/L SN 70% WG	450 + 18	0.5% v/v
Glyphosate + saflufenacil	Roundup WeatherMAX® + Heat®	9 14	540 g/L SN 70% WG	450 + 50	0.5% v/v
Glyphosate + carfentrazone	Roundup WeatherMAX® + Aim®	9 14	540 g/L SN 240 g/L EC	450 + 18	1.0% v/v
Glyphosate + carfentrazone + sulfentrazone	Roundup WeatherMAX® + Aim® + Authority®	9 14 14	540 g/L SN 240 g/L EC 480 g/L SN	450 + 9 + 53	1.0% v/v
Glyphosate + carfentrazone + sulfentrazone	Roundup WeatherMAX® + Aim® + Authority®	9 14 14	540 g/L SN 240 g/L EC 480 g/L SN	450 + 9 + 105	1.0% v/v
Glyphosate + MCPA/dichlorprop/mecoprop-p	Roundup WeatherMAX® + Optica Trio	9 4/4/4	540 g/L SN 600 g/L SN	450 + 395/765/320	
Glyphosate + 2,4-D ester	Roundup WeatherMAX® + 2,4-D ester LV 700	9 4	540 g/L SN 660 g/L EC	450 + 560	
Glyphosate + pyraflufen-ethyl/2,4-D ester	Roundup WeatherMAX® + Blackhawk®	9 14/4	540 g/L EC 6.1/473 g/L EC	450 + 188/167	
Glyphosate + pyraflufen-ethyl/bromoxynil	Roundup WeatherMAX® + Conquer® II	9 14/6	540 g/L SN 25/235 g/L EC	450 + 4.5/140	

[a] Abbreviation: MOA, mode of action
[b] Formulation abbreviations: EC, emulsifiable concentrate; SN, solution; WG, wettable granule

Note that Authority, and Optica Trio are not registered for chemfallow application.

Kochia seedling density was assessed two weeks after emergence. Kochia herbicide control was assessed 3 weeks after herbicide application (WAA). Kochia aboveground biomass was sampled 6 WAA.

Effective herbicide mixtures required

The best glyphosate mixture treatments that resulted in acceptable (≥ 80%) control and biomass reduction of GR kochia among all environments were Roundup + Banvel II (glyphosate + dicamba; 450 + 580 g ae/ha), Roundup + Distinct (glyphosate + dicamba/diflufenzopyr; 450 + 150/50 g ai/ae/ha), Roundup + Heat (glyphosate + saflufenacil; 450 + 50 g ai/ae/ha), and Roundup + Aim + Authority (glyphosate + carfentrazone + sulfentrazone; 450 + 9 + 105 g ai/ae/ha).

The label rate of Banvel at 290 g ae/ha (plus glyphosate at 450 g ae/ha) suppressed GR kochia with less than 80% control at the Lethbridge location, but had excellent GR kochia control (94% visual control in 2014/2015) at Coalhurst in both years. The 2X label rate of Banvel provided excellent control of GR Kochia averaging 91% visual control at all 4 site years.

The label rate of Distinct (plus glyphosate) provided acceptable control at 2 of 4 site years. The 2x label rate of Distinct showed excellent control with an average 90% resulting in up to a 90% reduction of GR kochia biomass at Coalhurst.

The low label rate of Heat (18 g ai/ha) (plus glyphosate) showed acceptable (≥ 80%) visual control in three out of four environments, and reduced GR kochia biomass by 84%. The high label rate of Heat (50 g ai/ha) (plus glyphosate) showed excellent GR kochia control with 91% control among environments. This herbicide tank mixture provided an excellent, effective option for control of GR kochia in chemical fallow.

Roundup + Aim + Authority at the label rates (450 + 9 + 53 g ai/ae/ha) resulted in an average 90% visual control but only a 72% reduction in biomass in 2014. Increasing the rate of Authority in this mixture to 105 g ai/ha resulted in excellent visual control of GR kochia at an average of 96% control and a 98% reduction in kochia biomass in 2014. This combination was among the best mixture options for controlling GR kochia, in part, because it included a quick contact herbicide resulting in rapid necrosis and plant cell death, in addition to extended residual activity to help control subsequent emergence of kochia seedlings.

Roundup + 2,4-D did not provide acceptable control of GR or GS kochia in Lethbridge.

Roundup + Optica Trio provided acceptable control at 3 of 4 site years, with suppression rated at 79% control at the 4th site year. This resulted in a 90% biomass reduction in 2014. This is the label rate for Optica Trio applied post-emergence in cereals – but is not registered as a chemfallow treatment. GR kochia control would also rely on just Group 4 active ingredients.

Blackhawk + Roundup did not achieve commercially acceptable control of GR kochia at either site in 2015.

Herbicide stewardship

The current study revealed several effective options for control of GR kochia in chemical fallow, but some relied on Group 4 herbicides for effective control. Due to the recent discovery of triple-resistant kochia in Alberta (Group 2+4+9), glyphosate mixtures with multiple effective modes of action are required for successful and sustainable kochia management.

For this reason, farmers are urged to adopt a proactive approach to integrated weed management, with herbicides as part of an important role supported by several other non-chemical tools. The use of cover crops, strategic spot tillage, mowing, and patch management are all tools that could help prolong the efficacy of these herbicide mixtures by mitigating seed production and limiting the number of kochia seeds returned to the soil seedbank.

Funding was provided by the Alberta Barley Commission, Alberta Canola Producers Commission, Alberta Crop Industry Development Fund, Alberta Wheat Commission, BASF Canada, Dow AgroSciences, Nufarm Canada, Valent Canada, and Western Grains Research Foundation

Alysha T. Torbiak, Robert E. Blackshaw, Randall N. Brandt, Linda M. Hall, Bill Hamman, and Charles M. Geddes. Herbicide mixtures control glyphosate-resistant kochia (*Bassia scoparia*) in chemical fallow, but their longevity warrants careful stewardship. *Canadian Journal of Plant Science*. **101**(2): 188-198.

Open Access: https://cdnsciencepub.com/doi/pdf/10.1139/cjps-2020-0205