

MANAGE RESISTANCE *Now*

Protect your land, one field at a time



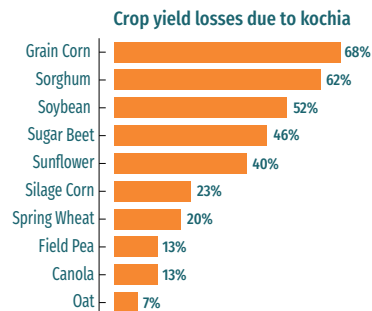
MANAGING HERBICIDE-RESISTANT KOCHIA

KOCHIA: A GROWING CONCERN

Kochia (*Bassia scoparia*) is an annual broadleaf noxious weed that is an increasing concern for crop producers throughout Canada.

The troublesome weed can significantly impact crop yield. Research shows mean yield losses are greatest in grain corn, followed by sorghum, soybean, sugar beet, silage corn, sunflower, spring wheat, field pea, canola and oat. Near-complete crop failure (>90% yield loss) was observed in corn, sorghum, sugar beet and sunflower.¹

Proper management practices can help growers protect yield and preserve their crop protection options for the future.



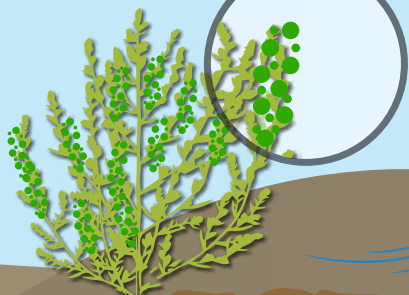
WIDELY ADAPTABLE AND PROLIFIC SPREADER

Kochia is difficult to control due to its ability to spread quickly and to thrive in challenging conditions such as heat, drought and high-saline soils.

Preventing kochia from setting seed (in field and non-crop areas) is critical to reducing its spread

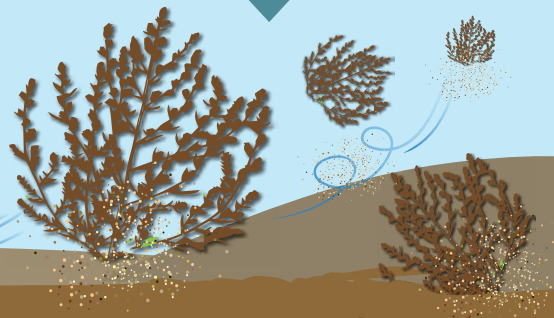
YEAR 1, SUMMER

Each kochia plant produces 15,000 seeds on average, ranging up to 120,000 seeds per plant.



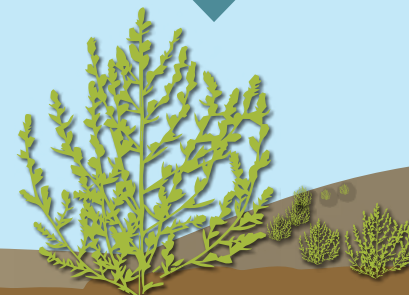
YEAR 1, FALL

If left uncontrolled, the stem of a mature plant will break at its base and roll like a tumbleweed across fields, dispersing seeds as it goes. Avoiding this from happening is critical.



YEAR 2, SPRING

When a resistant plant sets seed, thousands of those seeds will germinate the following year and a resistant population can build quickly. A tell-tale sign of this is a 'kochia trail.'



Identifying kochia

Kochia is one of the first weeds to emerge in the spring. The leaves are hairy and elliptical shaped with a trademark pink underside. Without proper weed control, the compact seedling will mature into a branchy bush, up to two metres in height. The colour of the stem, and sometimes the entire plant, changes from green to crimson.

ABOUT HERBICIDE-RESISTANT KOCHIA

Herbicide-resistant kochia is one of the largest weed threats to crop production in Western Canada. Group 2 resistance was first reported in 1988; today, nearly all kochia populations in Western Canada are considered Group 2-resistant. A 2017 Alberta survey found 50% of kochia populations resistant to Group 9 herbicides² and 28% resistant to at least one Group 4 herbicide.³ The same survey showed 16% of fields with triple resistance (Groups 2, 4 and 9 combined or stacked resistance).³ About 58% of kochia populations in Manitoba were Group 9-resistant in 2018, and 1% were resistant to Group 4 herbicides.⁴

Kochia is at high risk of evolving resistance due to its biology. The weed's seeds are short-lived in the soil, lasting only one to two years. This may sound beneficial, but it actually increases selection for herbicide resistance. Due to its ability to self- and cross-pollinate, kochia plants can be pollinated by one with different genetics and pass along resistance.

Identifying herbicide-resistant kochia

When scouting early in the season, signs of resistance are kochia plants that appear unaffected while other susceptible weeds are controlled. Lab testing is available to confirm resistance to Group 2, 4 and 9, but it is safe to assume that all kochia is Group 2-resistant.

BEST PRACTICES TO MANAGE HERBICIDE RESISTANCE

Adopting best management practices (BMPs) is essential to avoid or delay herbicide resistance. In general, these include:

- 1 Rotate crops**
- 2 Mix and rotate herbicides**
- 3 Use recommended rate and timing**

Refer to [this factsheet](#) for more herbicide resistance BMPs that apply to all weeds.



Kochia seedling
Photo: Manitoba Agriculture and Resource Development

When scouting early in the season, signs of resistance are kochia plants that appear unaffected while other susceptible weeds are controlled.

Kochia resistance milestones:

- 1988 – Group 2 resistance (SK & MB)**
- 2011 – Group 9 resistance (AB)**
- 2012 – Group 9 resistance (SK)**
- 2012 – Group 2 and 9 multiple resistance (AB)**
- 2013 – Group 2 and 9 multiple resistance (SK)**
- 2013 – Group 9 resistance (MB)**
- 2015 – Group 2 and 4 multiple resistance (SK)**
- 2017 – Group 2, 4 and 9 multiple resistance (AB)**
- 2021 – Group 2 and 9 multiple resistance (QC)**

MANAGING MULTIPLE HERBICIDE-RESISTANT KOCHIA

Due to the prevalence of kochia resistance, it's essential to be proactive and have an integrated weed management plan. There are specific BMPs related to managing herbicide resistance in kochia. This includes a combination of cultural, mechanical, biological and chemical control measures:

- **Plan diverse crop rotations** – Crop rotations that use a combination of early- and late-seeded crops will help keep kochia populations in check. Diversifying your crop rotation will also help ensure different herbicides are used each growing season. Incorporating winter cereals or forages that will compete with kochia can also reduce weed pressure for subsequent crops.
- **Mitigate saline areas** – Kochia thrives in saline areas that are unsuitable for crop production. Mitigate kochia growth in these areas by seeding them to saline-tolerant perennial forage.
- **Increase crop competition** – Increasing seeding density and using narrow row widths will help the crop better compete with kochia and reduce kochia seed production.
- **Spray early** – Take advantage of kochia's early emergence to control flushes prior to crop emergence. Pre-seed tank mixes that combine a Group 9 herbicide and a pre-emergence broadleaf herbicide (with multiple effective modes of action) will provide multiple different selection pressures on the kochia population and help to mitigate resistance development.
- **Scout fields early and often** – Evaluate kochia control about two to three weeks after application. Look out for suspicious patches of kochia that may be resistant.
- **Use in-crop herbicides following best practices** – Mix and rotate herbicides — when possible, use at least two effective modes of action and always use labelled rates and timing. Herbicide layering with pre-emergent and post-emergent treatments are recommended. See crop specific recommendations in the next section.
- **Use proper application techniques** – To ensure optimum control, use recommended adjuvants and adjuvant rates, check your water source to ensure it is good quality, maintain adequate spray coverage by adjusting your water volume, and pay close attention to sprayer speed and boom height.
- **Prevent plants from setting seed** – It's essential to manage any kochia patches to limit weed seeds from entering the soil seedbank. This can be accomplished by spot spraying, fall burndown herbicide applications, using targeted tillage, or mowing before seed set. Kochia seed viability tends to begin around mid-August.⁵ Patches can also be grazed or hand pulled.
- **Consider cover crops** – Where feasible, cover crops should be considered as an alternative to fallow. Fall-seeded cover crops can be effective at suppressing kochia density and biomass in the spring.
- **Use harvest weed seed control equipment** – Installing a weed seed mill on your combine can help to avoid kochia weed seeds from being spread across the field. Kochia is a good target for harvest weed seed control because its seed shatters very late in the season.

CROP-SPECIFIC CONSIDERATIONS

Kochia is problematic in many crops, and while resistance management best practices apply across the board, some are crop specific.



Cereals

Multiple herbicide-resistant kochia is a challenge for wheat producers as many in-crop herbicides for wheat have Group 2 and 4 active ingredients and Group 9 is often used for pre-/post-harvest kochia management and pre-seed burn-off. Tank-mixing a Group 9 herbicide with an additional broadleaf herbicide applied pre-seed will help to fight resistance and control early flushes. Group 4 and 9 herbicides can still be useful tools for kochia management in cereal crops, but growers should consider using multiple effective mode of action products and rotating or layering with other herbicide actives, including Groups 2, 3, 14 and 15.

Other cereal herbicides available for kochia control in-crop include: Groups 2, 5, 6 and 27. Since Group 4 and 9 kochia resistance is not on every farm, farmers who are currently employing good rotation practices should continue doing so, but can enhance their management by adding products or combinations that deliver multiple effective modes of action as well as other non-herbicide best management practices. This preserves all the tools for as long as possible.



Canola

It's a recommended practice to seed canola into fields that showed good control of kochia in the previous year's crop. A pre-seed tank mix that includes multiple modes of action will be effective. Pre-seed or pre-emergence options include Group 3, 6, 14 and 27 herbicides. In-crop options include Groups 9 and 10. Glufosinate-resistant canola varieties provide a good option for post-emergence kochia control. It is recommended to avoid growing glyphosate-resistant canola on fields infested with kochia.



Pulses

Controlling kochia prior to pulse crop emergence is vital as there are limited in-crop management options due to wide-spread Group 2 resistance. Tank-mixing a Group 9 herbicide for spring burn-off with a pre-emerge burndown and residual herbicide is recommended. Modes of action available for kochia control before growing pulses: Groups 3, 4, 6, 14 and 15. In-crop option include Groups 5 and 6.

Note for all crops: While using a pre- and post-emergence (herbicide layering) strategy is a recommended practice, growers need to be careful to not overuse Group 14 pre-herbicides.

Proactive resistance management leads to economic benefits

A recent study reported that the long-term return to a proactive resistance management strategy for kochia in Western Canada varies by farm but can be worth as much as \$20 per acre per year over 10 years (Frisvold, G. unpublished). The study concluded that although resistance management practices to control herbicide-resistant kochia can add cost in the short-term, farmers gain significant economic benefits over the long-term.

MANAGE RESISTANCE *Now*

Protect your land, one field at a time

For more information, visit ManageResistanceNow.ca

This information is brought to you by CropLife Canada, Canola Council of Canada, Manitoba Crop Alliance, Prairie Oat Growers Association and SaskWheat.



¹ Geddes, C.M., and Sharpe, S.M. 2022. Crop yield losses due to kochia (*Bassia scoparia*) interference. *Crop Protection* 157:105981. doi: 10.1016/j.cropro.2022.105981

² 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

³ Geddes, C.M., Ostendorf, T.E., Owen, M.L., Leeson, J.Y., Sharpe, S.M., Shirriff, S.W., and Beckie, H.J. 2021. Fluroxypyr-resistant kochia [*Bassia scoparia* (L.) A.J. Scott] confirmed in Alberta. *Canadian Journal of Plant Science* [In press]. doi:10.1139/cjps-2021-0111

⁴ Geddes, C.M., Pittman, M.M., Gulden, R.H., Jones, T., Leeson, J.Y., Sharpe, S.M., Shirriff, S.W., and Beckie, H.J. 2021. Rapid increase in glyphosate resistance and confirmation of dicamba-resistant kochia (*Bassia scoparia*) in Manitoba. *Canadian Journal of Plant Science*. [In press]. doi:10.1139/cjps-2021-0169

⁵ Geddes, C.M., and Davis, A.S. 2021. The critical period for weed seed control: A proposed framework to limit weed seed return. *Weed Research* 61:282-287.