KOCHIA CONTROL IN SUGARBEET AND CROPS IN SEQUENCE WITH SUGARBEET

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Summary

1. Kochia, 1-inch to 2-inches tall, is easier to control with glyphosate than kochia 3- to 4-inches tall.
2. Ethofumesate preemergence (PRE) provides good to excellent kochia control when it is activated into the soil, before kochia germination and emergence.
3. Kochia control in the crop sequence is the most effective kochia control in fields to be planted to sugarbeet. However, the landscape is changing with the advent of Group 14 kochia resistant biotypes.
4. Glyphosate applied in relevant mixtures with adjuvants has resulted in the most consistent kochia control in sugarbeet.

Introduction

Glyphosate-resistant (GR) kochia is resurfacing as a weed control challenge in both sugarbeet fields and fields in sequence with sugarbeet in Minnesota, and eastern North Dakota. While waterhemp gets a lot of attention, 57% of respondents attending the Grafton sugarbeet growers' seminar identified kochia as their most important weed control challenge. Growers attending the Grand Forks and Wahpeton seminars called kochia their second most important weed control threat. The challenge with kochia is effective herbicides. There are very few effective kochia control herbicide options in sugarbeet. Conversely, herbicides are a major component of kochia control programs, especially with advent of strip tillage sugarbeet in the northern Red River Valley. Kochia typically emerges in April and May, but some kochia biotypes emerge as late as June (Beckie et al. 2018). Kochia is most severe when drought conditions reduce both sugarbeet stands and early season sugarbeet growth and development. Finally, kochia interferes with sugarbeet root yield by virtue of its rapid growth, resulting in sugarbeet interference due to its enormous growth potential.

The outcome of relying on herbicides, along with kochia's competitive characteristics and high genetic diversity, are population shifts and evolution of herbicide-resistant populations in many regions in Minnesota and eastern North Dakota. Kochia has evolved resistance to at least four herbicide sites of action. They are (ALS) inhibitors, synthetic auxins, photosystem II (PSII) inhibitors, and EPSP synthase inhibitors or glyphosate, which are also herbicides effective for kochia control in crops in sequence with sugarbeet.

Kochia control in crops in sequence with sugarbeet. Researchers from Colorado, Kansas, Nebraska, South Dakota, and Wyoming selected their favorite programs for kochia control in corn, soybean, sugarbeet, spring wheat and fallow in 2010 and 2011 (Sbatella et al., 2019). Overall, preferred programs were a combination of soil residual followed by (fb) POST herbicides applied singly or in repeat herbicide applications. Kochia control was arranged by crop and location across years (Figure 1). Herbicide programs approved for kochia control in corn or soybean demonstrated greater overall control with less variability across environments compared with herbicides for kochia control in fallow, wheat, or sugarbeet (Sbettala et al. 2019). The potential for a kochia control failure was relatively low in corn, regardless of the herbicide program evaluated, whereas in sugarbeet, there was no herbicide program evaluated that provided greater than 86% kochia control at any field location. The median kochia control was 40% in sugarbeet across all sites (Figure 1).

Effective, long-term kochia management in sugarbeet will likely depend on programs used across the sequence including corn, soybean, spring wheat, and spring barley. However, Brian Jenks at the North Central Research and Extension Center recently reported PPO (Group 14) resistant kochia (Figure 2). Furthermore, some kochia control herbicides create challenges as their crop rotation restrictions do not allow sugarbeet to be planted the following year. Corn, wheat, and to an extent, soybean, create dense canopies formed early in the growing season that compete with kochia. In contrast, sugarbeet is a poor competitor because of slow growth and development and relatively short stature.

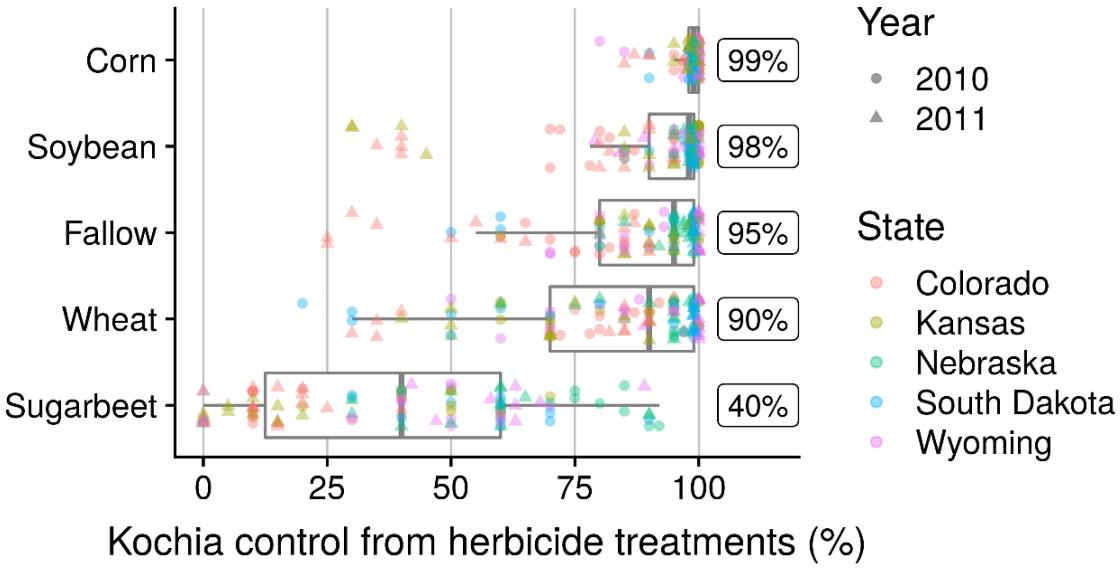

Figure 1. Kochia control, 30 days after final application of herbicide treatment, labeled for corn, soybean, fallow, wheat, and sugarbeet. Each point represents a plot in a field. Percentages are the median kochia control from herbicide treatments within each crop.

Figure 2. Control of 2- to 2.5-inch kochia with Sharpen at 1 and 2 fl oz/A with AMS and MSO, 13 DAT (image courtesy of Dr. Brian Jenks). Kochia biotypes were putative group 14 resistant biotypes collected from multiple western ND locations.

Eastern North Dakota and Minnesota. Dr. Joseph Ikley, North Dakota Extension Weed Control Specialist, lists his preferred kochia control programs in corn, soybean, and wheat. Recommendations are presented as product per acre. Please use the North Dakota Weed Control Guide to verify herbicide rates and crop rotation restrictions for soils and crop sequences on your farm.

1. Spring
    a. Corn
        i. Verdict (16-18 fl oz) + atrazine[1] (0.38 to 0.5 lb) or Harness MAXX (2 qt) + atrazine (0.38 to 0.5 lb) PRE fb PowerMax + Status (5 fl oz) POST (requires RR corn)
        ii. Acuron[2] (1.25 qt) or Acuron Flexi (1.25 qt) fb Acuron (1.25 qt) or Acuron Flexi (1.25 qt) + PowerMax (requires RR corn)
        iii. Capreno (3 fl oz) + PowerMax + atrazine (0.38 to 0.5 lb) EPOST (V2 to V4 corn, (less than 3-inch kochia) (requires RR Corn)
    b. Soybean
        i. Authority Edge[3] (full rate for soil type) fb PowerMax + dicamba or Liberty (dicamba use requires Xtend or XtendFlex soybeans, Liberty requires Enlist, LibertyLink, LLGT27, or XtendFlex soybeans)
        ii. Fierce MTZ[4] (full rate for soil type) fb PowerMax + dicamba or Liberty (dicamba use requires Xtend soybeans, Liberty requires Enlist, LibertyLink, LLGT27, or XtendFlex soybeans)
        iii. Authority MTZ[5] (full rate for soil type) fb PowerMax + dicamba or Liberty (dicamba use requires Xtend soybeans, Liberty use requires Enlist, LibertyLink, LLGT27, or XtendFlex soybeans
    c. Spring Wheat
        i. Huskie FX[6] (full rate)
        ii. Starane NXT[7] (full rate)
        iii. Talinor[8] (full rate)

Kochia control in sugarbeet. Ethofumesate should be applied preplant incorporated (PPI) or PRE at 6 to 7.5 pt/A in sugarbeet fields when kochia, especially GR kochia, is a weed control challenge (Peters and Lueck 2016; Peters and Lystad 2021). Ethofumesate at less than 6 pt/A provided inconsistent kochia control, even when incorporated into the soil. Herbicide applications POST should be timed to kochia growth stage rather than sugarbeet growth stage. Kochia control POST is greatest in sugarbeet, even with glyphosate products, when it is less than 3-inches tall. The addition of Betamix improved kochia control from Roundup PowerMax + ethofumesate POST. However, Betamix rate must be carefully selected based on sugarbeet growth stage to ensure sugarbeet safety, especially when Betamix follows soil applied (PPI or PRE) ethofumesate.

Objectives

The objectives of this research were to 1) evaluate non-glyphosate herbicide options for kochia control in sugarbeet and; 2) provide kochia control options in Minnesota and North Dakota fields when corn, soybean, or wheat are seeded in sequence with sugarbeet.

Material and Methods

Three kochia experiments were planned for 2022. Two field experiments were conducted on natural kochia populations that were a mixture of glyphosate susceptible and glyphosate resistant biotypes, one near Fairview, MT and a second near Manvel, ND in 2022. The third experiment was kochia planted in strips across sugarbeet near Horace, ND. The Manvel, ND experiment was terminated due to the late plant from an overland spring flood, causing a less than expected kochia infestation. Kochia at the Horace, ND location generally was glyphosate sensitive and was easily control with glyphosate.

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[1]Atrazine requires a second cropping season after herbicide application crop rotation restriction to sugarbeet.
[2]Acuron/Flexi requires an 18 month after application crop rotation restriction to sugarbeet.
[3] Authority Edge requires up to 36 months after application crop rotation restriction to sugarbeet.
[4] Fierce MTZ requires up to 18 months after application crop rotation restriction to sugarbeet.
[5] Authority MTZ requires up to 24 months after application crop rotation restriction to sugarbeet.
[6] Huskie FX requires a 9 month after application crop rotation restriction to sugarbeet.
[7] Starane NXT requires a 9 month after application crop rotation restriction to sugarbeet.
[8] Talinor requires a 15 month after application crop rotation restriction to sugarbeet.

Soil residual herbicides were applied after sugarbeet planting in a furrow irrigated field in 24-inch rows at Farview, MT. Treatments were applied through 8002 XR flat fan nozzles with a backpack sprayer with CO_2 at 40 psi to deliver 17 GPA. Experiments were conducted to evaluate ethofumesate PRE and POST applications of Betamix, Spin-Aid, Ultra Blazer, and ethofumesate at rates and timings to maximize kochia control and minimize sugarbeet injury.

Table 1. Herbicide treatment, rate, and application timing, Fairview, ND, 2022.

Treatment	Rate (fl oz/A)	SGBT (leaf stage)
Etho[1] / RU PowerMax3[2] / RU PowerMax3	64 / 25 / 25	PRE / 2 / 6
Etho / RU PowerMax3 / RU PowerMax3	96 / 25 / 25	PRE / 2 / 6
RU PowerMax3 + Etho[3] / RU PowerMax3 + Etho / RU PowerMax3 + Etho	25 + 4 / 25 + 4 / 20 + 4	2 / 6 / 10
RU PowerMax3 + Etho + Betamix / RU PowerMax3 + Etho + Betamix / RU PowerMax3 + Etho + Betamix	25 + 4 + 12 / 25 + 4 + 24 / 20 + 4 + 24	2 / 6 / 10
RU PowerMax3 + Etho + Spin-Aid / RU PowerMax3 + Etho + Spin-Aid / RU PowerMax3 + Etho + Spin-Aid	25 + 4 + 12 / 25 + 4 + 24 / 20 + 4 + 24	2 / 6 / 10
Etho / RU PowerMax3 / Ultra Blazer[4]	96 / 25 / 16	PRE / 2 / 6
Etho / Ultra Blazer[4] / Ultra Blazer[4]	96 / 12 / 12	PRE / 6 / 10
Etho / RU PowerMax3 / Ultra Blazer[5]	96 / 25 / 16	PRE / 2 / 6
Etho / RU PowerMax3 + Loyant / RU PowerMax3 + Loyant	96 / 25 + 0.28 / 25 + 0.28	PRE / 2 / 6
Etho / RU PowerMax3 + Loyant / RU PowerMax3 + Ultra Blazer[5]	96 / 25 + 0.28 / 25 + 16	PRE / 2 / 6

[1] etho = ethofumesate.

[2]Roundup PowerMax3 applied with Prefer 90 NIS at 0.25%v/v and Amsol Liquid AMS at 2.5% v/v.

[3]Roundup PowerMax3 + ethofumesate, Betamix, or Spin-Aid applied with Destiny HC HSMOC at 1.5 pt/A and Amsol Liquid AMS at 2.5 % v/v.

[4]Ultra Blazer applications applied with Prefer 90 non-ionic surfactant at 0.125% v/v.

[5]Ultra Blazer applications applied with Prefer 90 non-ionic surfactant at 0.25% v/v.

Visible sugarbeet growth reduction was evaluated using a 0% to 100% scale, (0 is no visible injury and 100 is complete loss of plant / stand) at the 2-lf sugarbeet stage and 7, 14, and 21 days after 2-lf stage application. Visual percent kochia control was evaluated using a 0% to 100% scale (0 is no control and 100 is complete control) at the 2-lf stage and 7, 14, 21 and 28 days after the 2-lf sugarbeet stage or when kochia was approximately 1-inch tall.

All evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared with the adjacent untreated strip. Experimental design was randomized complete block with four replications. Data was analyzed with the ANOVA procedure of ARM, version 2022.7 software package.

Results and Discussion

Sugarbeet injury ranged from 0-29% in this experiment (Table 2). Increased injury was observed in treatments containing Ultra Blazer, either alone or in tank mixtures. Sugarbeet injury was negligible across all other herbicide treatments. Sugarbeet injury was greatest from Ultra Blazer followed by Ultra Blazer. We anticipated more growth reduction injury with treatments containing Loyant; however, injury was negligible. Environmental conditions may have influenced sugarbeet injury as air temperature at applications (71°F and 62°F) and relative humidity were less as compared with applications in eastern North Dakota and Minnesota.

Kochia control was exceptional across most treatments. The trial was conducted in a flood-irrigated production field. The utilization of irrigation likely ensured herbicide activation, which was observed in weed control evaluations.

Table 2. Visible kochia control in response to herbicide treatment, Fairview, ND, 2022.[1]

Treatment	Rate	Sugarbeet Injury		Kochia Control	
		14 DAAC[2]	21 DAAC	14 DAAC	21 DAAC
	---fl oz/A---	----------%----------			
Etho3 / RU PowerMax3[4] / RU PowerMax3	64 / 25 / 25	0 a	0 a	98 ab	98 a
Etho / RU PowerMax3 / RU PowerMax3	96 / 25 / 25	0 a	0 a	99 a	99 a
RU PowerMax3 + Etho[5] / RU PowerMax3 + Etho / RU PowerMax3 + Etho	25 + 4 / 25 + 4 / 20 + 4	8 b	0 a	99 a	98 a
RU PowerMax3 + Etho + Betamix / RU PowerMax3 + Etho + Betamix / RU PowerMax3 + Etho + Betamix	25 + 4 + 12 / 25 + 4 + 24 / 20 + 4 + 24	0 a	1 a	95 ab	98 a
RU PowerMax3 + Etho + Spin-Aid / RU PowerMax3 + Etho + Spin-Aid / RU PowerMax3 + Etho + Spin-Aid	25 + 4 + 12 / 25 + 4 + 24 / 20 + 4 + 24	5 ab	3 a	93 b	95 ab
Etho / RU PowerMax3 / Ultra Blazer[6]	96 / 25 / 16	20 c	0 a	93 b	93 ab
Etho / Ultra Blazer[4] / Ultra Blazer[6]	96 / 12 / 12	29 d	23 b	14 c	23 c
Etho / RU PowerMax3 / Ultra Blazer[7]	96 / 25 / 16	24 cd	1 a	96 ab	90 b
Etho / RU PowerMax3 + Loyant / RU PowerMax3 + Loyant	96 / 25 + 0.28 / 25 + 0.28	5 ab	1 a	96 ab	95 ab
Etho / RU PowerMax3 + Loyant / RU PowerMax3 + Ultra Blazer[7]	96 / 25 + 0.28 / 25 + 16	24 cd	1 a	98 ab	94 ab
LSD (0.10)		**6**	**4**	**5**	**7**

[1]Means within a rating timing that do not share any letter are significantly different by the LSD at the 10% level of significance.
[2]DAC= days after application C treatment.
[3]etho = ethofumesate.
[4]Roundup PowerMax3 applied with Prefer 90 NIS at 0.25%v/v and Amsol Liquid AMS at 2.5% v/v.
[5]Roundup PowerMax3 + ethofumesate, Betamix, or Spin-Aid applied with Destiny HC HSMOC at 1.5 pt/A and Amsol Liquid AMS at 2.5 % v/v.
[6]Ultra Blazer applications applied with Prefer 90 non-ionic surfactant at 0.125% v/v.
[7]Ultra Blazer applications applied with Prefer 90 non-ionic surfactant at 0.25% v/v.

A greenhouse experiment was conducted in the winter of 2022 evaluating kochia control from Ultra Blazer alone or mixed with Roundup PowerMax at various sizes (Peters and Lystad 2023). In summary, Ultra Blazer plus NIS applied to 2-inches or less kochia provided the greatest control (data not shown). Ultra Blazer plus Roundup PowerMax provided greater kochia control as compared with Ultra Blazer alone. Similarly, Ultra Blazer alone provided the least kochia control at 14 and 23% at 14 and 21 days after application C (DAAC), respectively, in the field experiment (Table 2). The use of Roundup PowerMax3, prior to Ultra Blazer application, increased kochia control from 23 to 90%; however, provided less kochia control as compared with the other treatments.

We observed Ultra Blazer does not have a technical fit for kochia control in sugarbeet since kochia germinates and emerges early in the season and sugarbeet must be greater than the 6-lf stage for application. This combination of weed size and sugarbeet growth stage explains the inconsistent kochia control we have observed from Ultra Blazer in previous experiments. The majority of kochia size in a production field, like at Fairview, ND, was greater than 2-inches at the 6-lf sugarbeet stage, resulting in unacceptable kochia control from Ultra Blazer applications.

Common lambsquarters was also evaluated in this experiment (data not shown). Treatments with ethofumesate PRE significantly improved common lambsquarters control compared with no PRE. Roundup PowerMax3 plus either Betamix or Spin-aid improved common lambsquarters control as compared with Roundup PowerMax3 alone. Ultra Blazer alone did not provide acceptable control on common lambsquarters.

Recommendations in sugarbeet
Ethofumesate at 6 pt/A or greater PRE followed by glyphosate alone or repeat glyphosate plus ethofumesate applications, beginning when kochia is less than 3-inches tall, provides the greatest kochia control in sugarbeet.

References

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