SUGARBEET TOLERANCE AND WEED CONTROL FROM POSTEMERGENCE ETHOFUMESATE 4SC

Alexa L. Lystad[1] and Thomas J. Peters[2]

[1]Research Specialist and [2]Extension Sugarbeet Agronomist Weed Control Specialist
North Dakota State University & University of Minnesota, Fargo, ND

Introduction

Sugarbeet (*Beta vulgaris* L.) is a high value, root crop with approximately 18% sucrose content in the root (Milford 2006). Weed control is an important component in profitability of sugarbeet production (Soltani et al. 2018). Weeds can also affect sugarbeet quality by reducing sucrose percentage and decreasing the aesthetics of production fields. Ethofumesate is a broad spectrum, soil-applied herbicide for control of broadleaf and grass weeds in sugarbeet (Edwards et al. 2005). Some weed species controlled with ethofumesate are common lambsquarters (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.), barnyardgrass (*Echinochloa crus-galli*), and wild oat (*Avena fatua* L.), which are known to reduce yield in sugarbeet (Ekins and Cronin 1972). Ethofumesate is a commonly used soil-applied herbicide, however, it can be applied postemergence at 12 fl oz/A. Generic Crop Science has developed a new Ethofumesate 4SC label that increases postemergence use rates from 12 to 128 fl oz/A to sugarbeet with greater than two true leaves. Field and greenhouse experiments were conducted in 2018 and 2019 to evaluate sugarbeet tolerance and herbicide efficacy.

Materials and Methods

Sugarbeet Tolerance

Experiments were conducted near Downer, MN, Hickson, ND, Horace, ND and Prosper, ND in 2018 and Crookston, MN, Hickson, ND, Prosper, ND, and Wolverton, MN in 2019. The experimental area was prepared for planting by applying the appropriate fertilizer and tillage to each location. Sugarbeet was planted between May 3 and June 7 across 2018 and 2019.

Herbicide treatments were applied when sugarbeet was at the 2-lf stage with a bicycle wheel sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to the center four rows of six row plots 30 feet long. Treatments consisted of one application of ethofumesate at 0, 8, 16, 32, 64, and 128 fl oz/A. All treatments contained Destiny HC at 1.5 pt/A which was provided by Winfield United.

Sugarbeet injury was evaluated as a visual estimate of percent growth reduction of the middle 4 rows per plot compared to the adjacent 2 untreated rows. Sugarbeet was harvested from the center two rows of the four treated rows within a plot in the fall and assessed for yield and quality. Yield components were analyzed using SAS Data Management software PROC MIXED procedure to test for significant differences at p=0.05. Experimental design was randomized complete block with 6 replications.

Ethofumesate Efficacy

Experiments were conducted on indigenous populations of common lambsquarters, redroot pigweed, and waterhemp in sugarbeet grower fields near Moorhead, Lake Lillian, and Oslo, Minnesota and Minto and Prosper, North Dakota in 2018 and 2019. The experimental area was prepared for planting by applying the appropriate fertilizer and tillage to each location. Sugarbeet was planted between May 7th and 15th in both years.

Herbicide treatments were applied at the 2-lf sugarbeet stage. All treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to the center four rows of six row plots 40 feet in length.

Sugarbeet injury and weed control was evaluated. All evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with four replications. Data were analyzed with the ANOVA procedure of ARM, version 2019.4 software package.

Results

Sugarbeet Tolerance

Sugarbeet stature reduction ranged from 0 to 28% 7 DAT (days after treatment) and 0 to 29% 14 DAT (Table 1). Stature reduction increased as ethofumesate rate increased from 8 to 128 fl oz/A. Ethofumesate at 8 and 16 fl oz/A had similar stature to the untreated check at 7, 14 and 28 DAT. Ethofumesate at 32 fl oz/A had slightly reduced stature compared to the untreated check at 7 and 14 DAT but had grown out of the injury and looked similar to the untreated check at 28 DAT. Ethofumesate at 64 and 128 fl oz/A had greater injury compared to the untreated check at 7, 14 and 28 DAT. Visible stature reduction tended to decrease throughout the growing season.

Table 1. Stature reduction in response to Ethofumesate 4SC rate across 7 environments in 2018-2019[a].

Ethofumesate[b]	**7 DAT[c]**	**14 DAT**	**28 DAT**
--fl oz/A--	-------------------% stature reduction-------------------		
0	0 a	0 a	0 a
8	2 a	1 a	0 a
16	2 a	2 a	1 a
32	7 b	6 b	2 a
64	16 c	14 c	8 b
128	28 d	29 d	18 c
LSD (0.05)	**5**	**5**	**4**
	------------------*P*-value-------------------		
	<0.0001	<0.0001	<0.0001

[a]Means within a main effect not sharing any letter are significantly different by the LSD at the 5% level of significance.
[b]High surfactant methylated oil concentrate at 1.5 pt/A added to each post treatment.
[c]Stature reduction 7 and 14 days after treatment (DAT).

Sugarbeet root yield and sucrose content were not affected by ethofumesate rate, however, recoverable sucrose content generally decreased as ethofumesate rate increased (Table 2). Ethofumesate decreased recoverable sucrose content at 128 fl oz/A to 8,024 lbs/A compared to the untreated check at 8,484 lbs/A. While ethofumesate at 64 fl oz/A numerically decreased recoverable sucrose per acre, it was still statistically comparable to the untreated check. Root yield and sucrose content was an average of 30 tons/A and 15.6% across all treatments and environments.

Table 2. Root yield, recoverable sucrose, and sucrose content in response to Ethofumesate 4SC rate across 7 environments in 2018-2019.[a]

Ethofumesate[b]	**Root Yield[c]**	**Sucrose Content**	**Rec. Suc[d]**
--fl oz/A--	---Tons/A---	---%---	---lbs/A---
0	30	15.7	8,484 ab
8	30	15.6	8,343 abc
16	30	15.7	8,440 ab
32	31	15.7	8,511 a
64	29	15.7	8,143 bc
128	29	15.4	8,024 c
LSD (0.05)	**NS**	**NS**	**349**
	-------------------------*P*-value-----------------------		
	0.1703	0.2844	0.0410

[a]Means within a main effect not sharing any letter are significantly different by the LSD at the 5% level of significance.
[b]High surfactant methylated oil concentrate at 1.5 pt A added to each post treatment.
[c]Root yield reported in tons per acre.
[d]Recoverable sucrose reported in pounds per acre.

Ethofumesate reduced sugarbeet stature at rates greater or equal to 32 fl oz/A, however, stature reduction decreased as time progressed. Sugarbeet stature and yield components were negatively affected by rates of ethofumesate of 64 fl oz/A or greater.

Ethofumesate Efficacy Results

Visible common lambsquarters control ranged from 43 to 100% when herbicide treatments were evaluated 7 DAT and from 26-96% 14 DAT (Table 3). Glyphosate alone gave 98 and 95% control 7 and 14 DAT, respectively. While ethofumesate at 32 and 64 fl oz/A plus glyphosate provided 100% numerical common lambsquarters control 7 DAT, adding ethofumesate with glyphosate did not significantly improve common lambsquarters control compared to glyphosate alone.

Common lambsquarters control from ethofumesate generally increased as the ethofumesate rate increased. Common lambsquarters control from 32 fl oz/A ethofumesate was greater at 7 and 14 DAT than control from 16 fl oz/A ethofumesate. However, increasing the rate from 32 to 64 or 128 fl oz/A did not consistently improve common lambsquarters control.

Table 3. Common lambsquarters visible control 7 and 14 DAT across 10 environments[a] in 2018 and 2019.

		Common Lambsquarters	
Treatment	**Rate**	**7 DAT**	**14 DAT**
	----fl oz/A----	--------------%---------------	
Glyphosate	32	98 a	95 a
Ethofumesate	16	48 e	45 e
Ethofumesate	32	70 cd	66 d
Ethofumesate	64	64 d	77 bcd
Ethofumesate	128	79 bc	84 abc
Ethofumesate + glyphosate	32 + 32	100 a	96 a
Ethofumesate + glyphosate	64 + 32	100 a	95 a
LSD (0.05)		**13**	**16**
		------------*P*-value-------------	
		<0.0001	<0.0001

[a]Means within a main effect not sharing any letter are significantly different by the LSD at the 5% level of significance.

Visible redroot pigweed control ranged from 32 to 100% when evaluated 7 DAT and 15 to 98% when evaluated 14 DAT (Table 4). Ethofumesate alone at rates ranging from 16 to 128 fl oz/A controlled 44 to 64 and 47 to 76% redroot pigweed 7 and 14 DAT, respectively. Redroot pigweed control was greater at 32 fl oz/A ethofumesate alone compared to 16 fl oz/A, 14 DAT, but control did not significantly increase as the ethofumesate rate increased.

Glyphosate alone or with ethofumesate at 32 or 64 fl oz/A provided the greatest redroot pigweed control 7 and 14 DAT, however, the addition of ethofumesate did not improve redroot pigweed control compared to the glyphosate alone at 7 DAT. Glyphosate plus ethofumesate at 32 or 64 fl oz/A tended to be better than glyphosate alone 14 DAT, suggesting the residual control benefit of mixing ethofumesate with glyphosate. Ethofumesate at 32 fl oz/A combined with glyphosate provided redroot pigweed control similar to ethofumesate at 64 fl oz/A combined with glyphosate at both 7 and 14 DAT.

Visual waterhemp control ranged from 46 to 91% and from 31 to 91% at 7 and 14 DAT, respectively (Table 5). Waterhemp control from glyphosate was 62% at 7 DAT and 53% at 14 DAT suggesting waterhemp were glyphosate resistant biotype. Ethofumesate tended to increase waterhemp control as ethofumesate rate increased. This was observed at both 7 and 14 DAT.

Waterhemp control from 64 or 128 fl oz/A ethofumesate was better than control from 16 fl oz/A ethofumesate at 7 DAT. Waterhemp control from 128 fl oz/A ethofumesate was better than 16 or 32 fl oz/A ethofumesate at 14 DAT. Ethofumesate tended to improve waterhemp control 14 DAT compared to 7 DAT, suggesting residual control. There was no difference in waterhemp control between 32 or 64 fl oz/A ethofumesate plus glyphosate at either 7 or 14 DAT. Although ethofumesate alone at 128 fl oz/A provided similar waterhemp control as compared to glyphosate plus ethofumesate, applying ethofumesate alone at 64 or 128 fl oz/A may not be an effective strategy due to less sugarbeet tolerance at higher ethofumesate rates and increased input costs from high rates of ethofumesate compared to lower rates of ethofumesate mixed with glyphosate. Glyphosate applied with ethofumesate also provides greater control of other broadleaf weeds in fields including redroot pigweed and common lambsquarters in addition to potentially controlling germinating waterhemp with susceptible alleles.

Table 4. Redroot pigweed visible control 7 and 14 DAT across 10 environments[a] in 2018 and 2019.

Treatment	Rate	Redroot Pigweed 7 DAT	Redroot Pigweed 14 DAT
	----fl oz/A----	-------------%--------------	
Glyphosate	32	99 a	93 ab
Ethofumesate	16	44 fg	47 e
Ethofumesate	32	50 ef	62 d
Ethofumesate	64	54 def	71 cd
Ethofumesate	128	64 cd	76 cd
Ethofumesate + glyphosate	32 + 32	99 a	98 a
Ethofumesate + glyphosate	64 + 32	100 a	99 a
LSD (0.05)		**10**	**14**
		-------------*P*-value-----------	
		<0.0001	<0.0001

[a]Means within a main effect not sharing any letter are significantly different by the LSD at the 5% level of significance.

Table 5. Waterhemp visible control 7 and 14 DAT across 10 environments[a] in 2018 and 2019.

Treatment	Rate	Waterhemp 7 DAT	Waterhemp 14 DAT
	----fl oz/A----	---------------%----------------	
Glyphosate	32	62 bcd	53 cd
Ethofumesate	16	58 cd	65 bcd
Ethofumesate	32	63 bcd	66 bc
Ethofumesate	64	74 abc	78 ab
Ethofumesate	128	80 ab	84 a
Ethofumesate + glyphosate	32 + 32	86 a	86 a
Ethofumesate + glyphosate	64 + 32	91 a	91 a
LSD (0.05)		**18**	**16**
		-----------*P*-value------------	
		0.0001	<0.0001

[a]Means within a main effect not sharing any letter are significantly different by the LSD at the 5% level of significance.

Summary

Ethofumesate 4SC applied postemergence at rates from 8 to 128 fl oz/A did not influence sugarbeet density, root yield, or sucrose content. However, Ethofumesate 4SC significantly reduced recoverable sucrose and sugarbeet stature at 128 fl oz/A when sugarbeet tolerance experiments were combined across locations in 2018 and 2019.

Ethofumesate is not a stand-alone postemergence herbicide for common lambsquarters, redroot pigweed, or waterhemp control, however, ethofumesate can increase efficacy of postemergence glyphosate applications. Results suggest a mixture of ethofumesate at 32 fl oz/A plus glyphosate applied early POST can improve burndown and residual control of common lambsquarters, redroot pigweed, and waterhemp compared to ethofumesate or glyphosate alone. However, similar control from glyphosate alone was observed in common lambsquarters and redroot pigweed. Benefits of adding ethofumesate to an early POST glyphosate application may not become apparent until later in the growing season. Benefits of ethofumesate may not be observed if application is not timed to an activating rainfall. Additional research may be conducted to evaluate two-spray programs of glyphosate and ethofumesate.

References

Edwards D, Zinn N, Prieto R, Wyatt TJ, Brown L, Al-Mudallal A, et al. (2005) Reregistration eligibility decision for ethofumesate. Environmental Protection Agency. 738-R-05-010. https://www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/red_PC-110601_1-Sep-05.pdf. Accessed: September 26, 2017

Ekins WL, Cronin CH (1972) NC 8438, a promising new broad spectrum herbicide for sugarbeet. J Amer Soc of Sugar Beet Technol 17:134-143

Milford GFJ (2006) Plant structure and crop physiology. Page 30 in Draycott AP ed. Sugarbeet. United Kingdom: Blackwell Publishing Ltd

Soltani N, Dille A, Robinson DE, Sprague CL, Morishita DW, Lawrence NC, Kniss AR, Jha P, Felix J, Nurse RE, and Sikkema PH (2018) Potential yield loss in sugar beet due to weed interference in the United States and Canada. Weed Tech 32:749-753