SUGARBEET TOLERANCE AND ROTATIONAL CROP SAFETY FROM ETHOFUMESATE 4SC APPLIED POSTEMERGENCE

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Summary

1. Minimal to no visual sugarbeet injury was observed throughout the 2017 growing season. Sugarbeet growth, root yield, percent sucrose, and recoverable sucrose were not affected by ethofumesate or timing of ethofumesate application.
2. No adverse effects were observed throughout the 2018 growing season to rotational crop stand establishment or plant development from any treatment. Minimal to no visual crop injury was observed across all locations.
3. Environmental factors, such as weather, had a negative impact on yield at certain locations.
4. At Richville, MI, reduced grain moisture at harvest was observed in corn when ethofumesate was applied July 15 or later the previous growing season.

Introduction

Crop diversity is essential when practicing sustainable agriculture. Diversifying crop sequences introduces multiple growth cycles to a single field and aids in reducing inputs, such as pesticides, nutrients, etc. (Liebman and Dyck 1993). Decreased weed pressure is also a result of crop rotations, as well as increased crop yield (Peterson and Varvel 1989). Rotational benefits are evident when practicing a grass-legume rotation. In the Red River Valley, common rotational practices include alternating shallow and deep-rooted crops, as well as incorporating grain crops and legume crops (Tanner 1948). Sugarbeet is a deep-rooted crop grown in the Red River Valley. Herbicide residues from the previous growing season can potentially injure sensitive plants within the crop rotation (Sheets and Harris 1965). Ethofumesate is a herbicide labeled in sugarbeet for controlling grass and small-seeded broadleaf weeds (Peters and Lystad 2017) with historical reports of rotational crop injury (Schroeder and Dexter 1978). Willowood USA, a company that produces generic crop protection products for the agriculture industry, such as 'Ethofumesate 4SC', has increased the maximum label rates for post-emergence use in sugarbeet from 0.8 to 8 pt/A, along with decreasing the Pre-Harvest Interval (PHI) from 90 to 45 days.

The objective of this study was to evaluate crop safety from Ethofumesate 4SC at rates greater than 12 fl oz/A (0.8 pt/A) applied post-emergence in Roundup Ready (RR) sugarbeet in 2017 and the carry-over effects in wheat, corn, soybean, and dry bean in 2018.

Materials and Methods

Experiments were conducted near Crookston, Foxhome, and Lake Lillian, MN, Prosper, ND, and Richville, MI in 2017 and 2018. In 2017, the experimental area was prepared for planting by applying the appropriate fertilizer and tillage to each location. Sugarbeet was strategically planted at each location between the end of April and the beginning of May to achieve 9, 10, and 11-month crop rotation intervals in 2018 following ethofumesate treatment applications in 2017. Sugarbeet varieties included "SV36271RR", "BT80RR52", "HM4062", "BT9230", and "HM9619RR" at Prosper, ND, Crookston, MN, Foxhome, MN, Lake Lillian, MN, and Richville, MI, respectively.

Herbicide treatments included applications of ethofumesate at multiple rates and timings throughout the summer as well as an untreated control (Table 1). Applications made in June, July, and August simulated 11, 10, and 9-month crop rotation intervals, respectively. Applications at Prosper, ND were made with a bicycle sprayer early in the season and a backpack sprayer later in the season in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to all 6 rows of the 6-row plots 40 feet in length in each of 3 experimental areas. High-surfactant methylated oil concentrate (HSMOC) used in all treatments across all locations was a liquid formulation from Winfield United called ‘Destiny HC’. Weeds, insects, and diseases were managed throughout the growing season.

Table 1. Treatment list in 2017.

Number	Treatment	Rate (fl oz)	Timing of application
1	Untreated control	0	
2	Etho[1]/etho/etho/etho	32/32/32/32	A=2-lf stage/ B=A+14 days / C=B+ 14 days / D=C+14 days
3	Ethofumesate	128	E=June 15
4	Ethofumesate	128	F=July 15
5	Ethofumesate	128	G=August 15

[1]Ethofumesate

Sugarbeet injury was a visual estimate of percent growth reduction of all 6 rows per plot. Sugarbeet was harvested from the experimental area in the fall and assessed for yield and quality. Sugarbeet that were not collected for yield assessment were removed from the experimental area to simulate harvest similar to a commercial field setting. 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.

Plots were prepared in the spring using a field cultivator. Tillage was applied in the same direction as the previous herbicide treatments to prepare the seed bed and incorporate recommended fertilizer for each crop. “DKC45-64RR2” corn, “AG0934RR2” soybean, and “Prosper” wheat was planted into three different experimental areas with planting rates of 31,000 seeds per acre, 150,000 seeds per acre, and 163 pounds per acre, respectively at Crookston, MN, Prosper, ND, Foxhome, MN, and Lake Lillian, MN. Crop varieties planted at Richville, MI were “Stine 9316” corn, “Stine 14RD16” soybean, and “Zenith” dry bean with planting rates of 32,000, 150,000, and 106,000 seeds per acre, respectively. Weeds, insects, and disease were managed throughout the 2018 growing season.

Crop injury was evaluated on May 29, June 9, and June 20, 2018 at Prosper; June 5, June 14, June 25, and July 9, 2018 at Crookston; May 31, June 14, and July 12, 2018 at Lake Lillian; and May 31, June 15, June 29, July 16, and August 14 at Richville, MI. All evaluations were a visual estimate of percent fresh weight reduction in the six treated rows compared to the untreated control. Stand was collected at the same time as the first visual injury evaluations by counting the first 10 feet of the middle two rows in each plot. The first 30 feet of each plot was counted in Richville, MI. Plant height was collected at the same time as the last visual injury evaluation by averaging multiple measurements recorded throughout the plot. Data were analyzed as previously described.

Results and Discussion

Sugarbeet Results:

Visual sugarbeet injury was negligible at any location throughout the growing season. Yield data were combined across locations (Table 2). No differences were observed across all locations. The average root yield, extractable sucrose, and percent sugar across locations were 28.5 ton/A, 8,499 pounds per acre (lb/A), and 16.6%, respectively.

Table 2. Ethofumesate effects on sugarbeet yield across locations in 2017.

Treatment[1]	Root Yield	Extractable Sucrose	Sugar
	-------------ton/A-----------	-------------lb/A-------------	--------------%---------------
Untreated Check	28.7	8,485	16.6
32 / 32 / 32 / 32 fl oz/A	28.4	8,532	16.7
June 15 at 128 fl oz/A	28.4	8,513	16.6
July 15 at 128 fl oz/A	28.9	8,610	16.6
Aug 15 at 128 fl oz/A	28.3	8,356	16.4
LSD (0.05)	NS	NS	NS

[1]Treatment – ethofumesate was applied at the rates given and at the timings referenced in Table 1.

Rotational Crop Results:

Wheat, soybean, corn and dry bean stand and development were not impacted by ethofumesate at 9, 10, and 11 months after application (Table 3). Neither a single application of ethofumesate at 128 fl oz/A nor 4 applications at 32 fl oz/A impacted crop injury or stand establishment at any location, regardless of crop.

Table 3. Ethofumesate impact on stand and development across rotational crops in 2018.

Treatment[1]	Wheat		Soybean		Corn		Dry Bean	
	Stand	Injury	Stand	Injury	Stand	Injury	Stand	Injury
	---yd^2---	---%---	---30'---	---%---	---30'---	---%---	---30'---	---%---
Untreated Check	63	0	159	0	44	0	157	0
32 / 32 / 32 / 32 fl oz/A	61	0	155	2	44	5	158	0
June 15 at 128 fl oz/A	60	3	155	2	45	0	153	0
July 15 at 128 fl oz/A	63	3	157	0	45	5	153	0
Aug 15 at 128 fl oz/A	62	0	160	2	45	5	154	0
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS

[1]Treatment – ethofumesate was applied at the rates given and at the timings referenced in Table 1.

Wheat yield components were unaffected by ethofumesate at all rates and timings and were combined across all locations (Table 4). Test weight averaged 56.4 pounds per bushel (lb/bu) with moisture and yield averaging 14.1% and 40.6 bushels per acre (bu/A), respectively.

Table 4. Ethofumesate carry-over impact on wheat yield across locations in 2018.

Treatment[1]	Test Weight	Moisture	Yield
	---------------lb/bu-------------	---------------%----------------	--------------bu/A-------------
Untreated Check	56.7	13.7	40.0
32 / 32 / 32 / 32 fl oz/A	55.7	13.7	41.6
June 15 at 128 fl oz/A	57.0	14.1	40.1
July 15 at 128 fl oz/A	56.8	13.8	40.0
Aug 15 at 128 fl oz/A	55.6	14.1	41.4
LSD (0.05)	NS	NS	NS

[1]Treatment – ethofumesate was applied at the rates given and at the timings referenced in Table 1.

Ethofumesate had no effect on soybean yield at all rates and timings evaluated across all locations. Soybean grown at Lake Lillian, MN, Foxhome, MN and Richville, MI locations had an average moisture and yield of 13.3% and 64.6 bu/A, respectively (Table 5). Soybean yield data from Crookston, MN and Prosper, ND were evaluated separately due to hail storms in June and September, respectively, which decreased the average yield to 37.7 bu/A. However, analyzing soybean yield data when combined across all locations did not reveal any treatment differences.

Table 5. Ethofumsate carry-over impact on soybean yield in 2018.

Treatment[1]	Foxhome, MN; Lake Lillian, MN; Richville, MI			Prosper, ND; Crookston, MN		
	Test Weight	Moisture	Yield	Test Weight	Moisture	Yield
	-------lb/bu------	-----%-----	------bu/A------	-----lb/bu----	-------%------	----bu/A---
Untreated Check	54.3	13.3	63.6	55.4	13.6	38.0
32 / 32 / 32 / 32 fl oz/A	53.8	13.2	65.6	54.8	13.6	38.0
June 15 at 128 fl oz/A	54.2	13.2	64.0	54.4	13.6	36.9
July 15 at 128 fl oz/A	54.1	13.3	62.4	54.6	13.6	39.1
Aug 15 at 128 fl oz/A	55.2	13.3	67.4	54.8	13.5	36.6
LSD (0.05)	NS	NS	NS	NS	NS	NS

[1]Treatment – ethofumesate was applied at the rates given and at the timings referenced in Table 1.

Corn yield components were generally unaffected by ethofumesate at the rates and timings evaluated (Table 6). Corn in Richville, MI showed decreased grain moisture when ethofumesate applications of 128 fl oz/A were made in July and August. Corn grain from these two treatments averaged 15.7% moisture, compared to 16.5% in the untreated check plots. Corn yield data from Crookston, MN was not included in the combined location analysis due to damage from the hail storm in June. Crookston corn yield was 143 bu/A when averaged across treatments versus 229 bu/A when averaged across treatments and the other four locations. This was likely due to weather.

Table 6. Ethofumesate carry-over impact on corn yield in 2018.

	Prosper, ND, Foxhome, MN, Lake Lillian, MN, Richville, MI			Crookston, MN		
Treatment[1]	Test Weight	Moisture	Yield	Test Weight	Moisture	Yield
	--------lb/bu-------	---------%---------	-------bu/ac-------	-----lb/bu-----	-----%-----	--bu/A--
Untreated Check	54.8	18.4	231.8	61.7	15.5	136.7
32 / 32 / 32 / 32 fl oz/A	54.5	18.4	227.4	62.6	16.5	150.2
June 15 at 128 fl oz/A	55.2	18.3	226.2	61.6	15.6	156.1
July 15 at 128 fl oz/A	54.9	18.2	228.9	61.8	15.2	137.0
Aug 15 at 128 fl oz/A	55.3	17.9	229.2	62.6	16.1	136.7
LSD (0.05)	NS	NS	NS	NS	NS	NS

[1]Treatment – ethofumesate was applied at the rates given and at the timings referenced in Table 1.

Dry bean at Richville did not show any growth or developmental reductions from ethofumesate throughout the growing season. Moisture and yield, when averaged across treatment, were 15% and 31.1 bu/A, respectively (data not presented).

Conclusion

Previous studies report ethofumesate residue damaging rotational crops, especially wheat (Schweizer 1975). Ethofumesate in sugarbeet did not damage narrow leaf crops including wheat and corn planted in sequence with sugarbeet in our experiments. However, crop residue at application in previous experiments were different from our experiment. Ethofumesate was applied to bare soil in Schweizer's experiment, which differs from our experiment where ethofumesate was applied post-emergence to sugarbeet from 2- to 22-leaves. The lack of injury observed throughout the growing season is, however, consistent with ethofumesate applied post-emergence literature. Wang P et al. (2005) reported degradation of ethofumesate soil-applied was significantly slower than through plant metabolism. Gardner and Branham (2001) conducted a similar study which found ethofumesate dissipated much faster in plots when applied to turf grass rather than bare soil.

Literature Cited

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