IMPACT OF SOIL-APPLIED HERBICIDES ON SPRING-SEEDED CEREAL COVER CROP IN SUGARBEET

Thomas J. Peters[1], Aaron L. Carlson[1], Mike Metzger[2] and Jim Radermacher[3]

[1]Extension Sugarbeet Agronomist and Weed Control Specialist and [1]Research Specialist
North Dakota State University and the University of Minnesota, Fargo, ND, [2]General Agronomist, Minn-Dak Farmers Cooperative, Wahpeton, ND and [3]Research Agronomist, Southern Minnesota Beet Sugar Cooperative, Renville, MN

Summary

1. Oat is more tolerant of Dual Magnum plus ethofumesate than barley or wheat. Wheat generally was the least tolerant to soil-applied herbicides of the species evaluated.
2. Within species there was a difference in response to herbicide and rate. Dual Magnum generally was safer to cover crop species and ethofumesate more injurious.
3. Sugarbeet injury generally was negligible across herbicide treatments. However, visual sugarbeet injury from ethofumesate at 3pt/A plus Dual Magnum at 1 pt/A or ethofumesate at 3pt/A plus Dual Magnum at 1 pt/A followed by UpBeet at 1 oz/A was greater than from glyphosate alone.

Introduction

The annual survey of sugarbeet farmers in eastern North Dakota and Minnesota indicated spring-seeded cereal cover crops were used on about 44% of sugarbeet acres in 2014 (Table 1). Farmers most commonly plant cover crops to protect sugarbeet from wind and soil erosion during stand establishment. There are other benefits of cover crops. Farmers in Southern Minnesota, in cooperation with the Minnesota Pollution Control Agency (MCPA), grow cover crops in exchange for phosphorus credits. Cover crops suppress weed development since they germinate and emerge much sooner than most weedy species. Cover crops may contribute to maintaining soil quality including soil structure, cycling nutrients and soil fertility. Finally, cover crops may suppress the germination and emergence of weeds.

Table 1. Percent of sugarbeet acres seeded with various cover crops as reported in the annual survey of weed control and production practices in sugarbeet in 2014.

	No. of responses	Acres planted	Barley	Oat	Wheat	Rye	Other	No Response
			----------% of acres planted----------					
Cass	7	4,393	23	-	-	-	-	77
Chippewa[1]	14	7,611	-	43	45	-	-	12
Clay[2]	12	7,544	10	10	-	-	-	80
Grand Forks	9	6,009	21	-	-	-	-	79
Kittson	3	920	-	-	-	-	-	100
Marshall	9	6,359	8	-	15	-	-	77
Norman[3]	7	5,278	54	-	6	-	-	41
Pembina	8	5,132	18	12	15	-	-	55
Polk[4]	32	15,301	27	-	4	9	<1	60
Renville[5]	23	11,019	-	59	13	-	-	28
Richland[6]	12	9,101	40	-	35	-	-	25
Traill	3	573	35	-	-	-	-	65
Traverse[7]	13	8,160	13	3	18	-	3	63
Walsh	10	4,382	2	7	30	-	5	56
Wilkin[8]	26	14,168	20	-	3	-	1	76
Total	188	105,950	18	11	13	1	1	56

[1]Includes Kandiyohi and Swift Counties
[2]Includes Becker County
[3]Includes Mahnomen County
[4]Includes Pennington and Red Lake Counties
[5]Includes Lac Qui Parle, McLoed, Redwood, Stearns, and Yellow Medicine Counties
[6]Includes Roberts (SD) County
[7]Includes Grant and Stevens Counties
[8]Includes Otter Tail County

Waterhemp (Amaranthus spp.), has become an important weed in crop production in many regions of the country including fields rotated to sugarbeet in Minnesota and eastern North Dakota. Waterhemp is a summer annual weed

that germinates much later than other pigweed species, through mid-to late-June and into July in fields in North Dakota and Minnesota. Some farmers are returning to the use of soil-applied herbicides to control waterhemp, partly due to increased occurrences of glyphosate-resistant waterhemp biotypes. However, little is known about the tolerance of soil-applied herbicides to spring-seeded cereal cover crops that typically are seeded at or shortly ahead of sugarbeet planting. Thus, sugarbeet growers today must decide between using cover crops or soil-applied herbicides, but not both.

The objectives of these field experiments was to investigate barley, oat, and wheat ground cover and sugarbeet safety following preemergence herbicide application.

Materials and Methods

Experiments were conducted near Crookston, Foxhome, Herman, and Lake Lillian, MN in 2014. Barley, oat and wheat cover crops were used individually within an experiment. Hard red spring wheat was chosen for use at Crookston and Herman, barley was used at Foxhome, and oat was selected for Lake Lillian. Small grains were spread perpendicular to plots across the experimental area with a 3-point mounted rotary spreader at between 0.75 and 1 bu/A, depending on specie. Cover crops were shallow incorporated with tillage perpendicular to plots prior to planting sugarbeet. Sugarbeet was seeded approximately 1-inch deep in 22-inch rows at each location. Herbicides were applied to the center four rows of six-row by 30-foot long plots.

All barley, oat, and wheat ground cover and sugarbeet injury evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Sugarbeet stand counts were taken in the center 2 rows of plots and cover crop density was collected by counting emerged small grain in a ¼ square meter quadrat. Experimental design was randomized complete block with 4 replications. Data were analyzed with the ANOVA procedure of ARM, version 9.2014.2 software package.

Results and Discussion

Oat germinated and emerged similarly through soils treated with Dual Magnum, ethofumesate, and Dual Magnum plus ethofumesate and gave acceptable ground coverage at Lake Lillian (Table 2). There were no difference among the herbicides treatments evaluated or herbicide treatment rates.

Wheat and barley ground cover was dependent on herbicide treatment and rate (Table 2). Dual Magnum generally was safer to wheat and barley than ethofumesate or Dual Magnum plus ethofumesate. Wheat and barley ground coverage was acceptable in plots treated with Dual Magnum and unacceptable in plots treated with ethofumesate or ethofumesate plus Dual Magnum. Generally, as ethofumesate rate increased, regardless of being applied alone or in combination with Dual Magnum, barley and wheat ground cover decreased.

Dual Magnum at 0.5 pt/A gave the greatest wheat ground cover among preemergence herbicide treatments evaluated. At both Crookston and Herman, as Dual rate increased, wheat ground cover decreased. Ground cover in plots treated with Dual Magnum at 1 pt/A was significantly less than the untreated at both Crookston and Herman. Wheat did not tolerate ethofumesate or Dual Magnum plus ethofumesate at either the Crookston or Herman location. Ethofumesate at 2 pt/A was no safer to wheat than ethofumesate at 3 pt/A.

Barley responded to herbicides more similarly to wheat than oat (Table 2). Barley ground cover in plots treated with Dual Magnum at 0.5 pt/A was similar to the untreated plots. However, ground cover in plots treated with Dual Magnum at 1 pt/A was less than with Dual Mangum at 0.5 pt/A. Barley showed some tolerance to ethofumesate or Dual Magnum plus ethofumesate. However, ground cover ranged from 21% to 35% and would not be acceptable to most growers.

Sugarbeet stand counts from these experiments showed no significant differences among treatments (Table 3). Data is presented from the Foxhome, Crookston and the Lake Lillian locations but was not collected at the Herman location due to water ponding resulting from excessive precipitation in June and July. In general, there was more stand loss at the Foxhome location, especially from ethofumesate at 3 pt/A. This might be attributed to the soil type, an Espelie fine sandy loam.

Table 2. Ground cover as a percentage of untreated evaluated 19 to 28 days after planting.

Treatment[1]	Rate	19 DAP[3] Foxhome Barley	28 DAP Crookston Wheat	24 DAP Herman Wheat	24 DAP Lake Lillian Oat
	pt or oz/A	----------% ground cover----------			
Untreated		100	100	100	100
Dual Magnum	0.5	85	75	78	80
Dual Magnum	1	57	62	57	85
Ethofumesate	2	35	27	26	68
Ethofumesate	3	32	25	24	74
Dual + Etho	0.5+2	34	30	31	95
Dual + Etho	1+2	31	20	19	92
Dual + Etho	0.5+3	21	26	14	77
Dual + Etho	1+3	24	21	10	100
Dual + Etho / UpBeet[2]	1+3 / 1oz	29	27	5	84
LSD (0.05)		**16**	**27**	**17**	**NS**

[1]Roundup PowerMax at 28 fl oz/A plus Prefer 90 NIS at 0.25% v/v plus N-Pak AMS at 2.5% v/v was applied at the sugarbeet 4- to 6-leaf stage and was repeated on approximately 14 day intervals at 28 fl oz/A and 22 fl oz/A for weed control in all treatments including the untreated.
[2]Upbeet at 1 oz/A plus methylated seed oil at 1.5% v/v was applied when sugarbeet were cotyledon to 2-leaf.
[3]DAP=days after planting

Table 3. Sugarbeet stand as percent of untreated evaluated 19 to 28 days after planting.

Treatment[1]	Rate	19 DAP[3] Foxhome	28 DAP Crookston	Herman	24 DAP Jun 17 Lake Lillian
	pt or oz/A	----------% sugarbeet stand----------			
Untreated		100	100	-[4]	100
Dual Magnum	0.5	91	101	-	104
Dual Magnum	1	102	100	-	96
Ethofumesate	2	63	106	-	99
Ethofumesate	3	79	97	-	98
Dual + Etho	0.5+2	92	103	-	100
Dual + Etho	1+2	118	102	-	91
Dual + Etho	0.5+3	104	99	-	94
Dual + Etho	1+3	77	96	-	97
Dual + Etho / UpBeet[2]	1+3 / 1oz	86	103	-	99
LSD (0.05)		**NS**	**NS**	**-**	**NS**

[1]Roundup PowerMax at 28 fl oz/A plus Prefer 90 NIS at 0.25% v/v plus N-Pak AMS at 2.5% v/v was applied at the sugarbeet 4- to 6-leaf stage and was repeated on approximately 14 day intervals at 28 fl oz/A and 22 fl oz/A for weed control in all treatments including the untreated.
[2]Upbeet at 1 oz/A plus methylated seed oil at 1.5% v/v was applied when sugarbeet were cotyledon to 2-leaf.
[3]DAP=days after planting
[4]- = evaluation not taken

Sugarbeet injury expressed as visual growth reduction injury was collected at Crookston and Herman 27 and 24 days after planting, respectively (Table 4). There was no significant injury at the Herman location. However, there was some injury at Crookston, especially in plots treated with ethofumesate at 3 pt/A and plots treated with ethofumesate plus Dual Magnum. Injury was noted as visual stature reduction. Ethofumesate at 3 pt/A plus Dual Magnum at 1 pt/A followed by UpBeet at 1 oz/A to cotyledon to 2-leaf sugarbeet also caused visual injury expressed as chlorosis and injury was greater than ethofumesate plus Dual Magnum alone.

An experiment was conducted near Prosper, ND to determine if the loss in ground cover in plots treated with soil-applied herbicide could be overcome by increasing the cover crop seeding rate (data not presented). The answer was generally ‘no’. That is, seeding a grass species at a greater density generally meant more grass was killed by the soil-applied herbicide. Thus, we were not able to overcome the detrimental effects of soil-applied herbicide on cover crop establishment by increasing the cover crop seeding rate.

Table 4. Sugarbeet injury as percent growth reduction at Crookston and Herman 27 and 24 days after planting, respectfully.

Treatment[1]	Rate	Foxhome	Crookston	Herman	Lake Lillian
	pt or oz/A	----------% sugarbeet injury----------			
Untreated		-[4]	0	0	-
Dual Magnum	0.5	-	0	0	-
Dual Magnum	1	-	3	0	-
Ethofumesate	2	-	4	0	-
Ethofumesate	3	-	9	0	-
Dual + Etho	0.5+2	-	9	0	-
Dual + Etho	1+2	-	9	0	-
Dual + Etho	0.5+3	-	6	5	-
Dual + Etho	1+3	-	16	5	-
Dual + Etho / UpBeet[2]	1+3 / 1oz	-	29	3	-
LSD (0.05)		**-**	**8**	**NS**	**-**

[1]Roundup PowerMax at 28 fl oz/A plus Prefer 90 NIS at 0.25% v/v plus N-Pak AMS at 2.5% v/v was applied at the sugarbeet 4- to 6-leaf stage and was repeated on approximately 14 day intervals at 28 fl oz/A and 22 fl oz/A for weed control in all treatments including the untreated.
[2]Upbeet at 1 oz/A plus methylated seed oil at 1.5% v/v was applied when sugarbeet were cotyledon to 2-leaf.
[3]DAP=days after planting
[4]- = evaluation not taken

Future Research

There were several questions that arose from these experiments. First, why did spring seeded cereals respond differently to Dual Magnum and ethofumesate? Was the difference related to the herbicide, herbicide rate, or did timing of activating rainfall contribute to cover crop stand reduction? Second, we currently believe the best way to control waterhemp in sugarbeet is preemergence. Thus we need to understand the interaction between soil-applied herbicides and cover crops. However, Dual Magnum, Outlook, and Warrant applied lay-by might be safer to cover crop species than a preemergence application of Dual Magnum or ethofumesate. Finally, these experiments were not designed to measure weed suppression by cover crops. This parameter will be incorporated into future experiments.