Herbicide and Variety Effects on Sugarbeet Stand Establishment

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ABSTRACT

The objective of this research was to evaluate sugarbeet stand establishment as influenced by herbicide treatment and variety, with particular emphasis on their interaction. The study was conducted at one site in 1988 and at three sites in 1989. Variables examined in the 1988 experiment included planting depth, preplant incorporated herbicide, postemergence herbicide, and sugarbeet variety. A possibility of a preplant herbicide X variety interaction was noted in 1988, so the number of preplant treatments and locations was expanded in 1989, with all treatments planted at one depth and treated with postemergence herbicide. Initial populations varied by as much as 13,000 plants/A, but no herbicide X variety interactions were observed. Cycloate plus ethofumesate resulted in the largest sugarbeet stand reductions. Holly Hybrid 50 had the highest initial plant populations while MonoHy R-2 and 55 had the lowest plant populations, but these differences were not correlated with sugarbeet yields. It appears that infomation about stand establishment can be obtained from herbicide studies or variety studies without concern about their interaction.

Additional Key Words: *Beta vulgaris*, herbicide X variety interaction

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A large portion of the cost of sugarbeet production is spent in obtaining an adequate stand of weed-free sugarbeets. Careful selection and application of herbicides and planting to stand can reduce costs considerably. Very good weed control can be obtained with complementary preplant incorporated/postemergence herbicide treatments (Miller and Fornstrom, 1989). Planting to stand is successful if seed spacing is selected to match the expected emergence rate (Fornstrom, 1980). However, emergence rates often are highly variable even within one set of cultural practices and climatic conditions.

In previous studies, plant population reductions due to herbicide treatment and planting depth have been reported (Schweizer, 1979; Fornstrom and Miller, 1989). It also has been observed that large differences in plant populations may be due to variety (Steen, 1988). However, most herbicide and planter studies have been carried out with only one variety. Smith and Schweizer (1983) found an interaction between herbicide and variety for 45-day sugarbeet weight and visual injury, but no interaction for stand count or harvest yield.

The objective of this research was to evaluate sugarbeet stand establishment as influenced by herbicide treatment, sugarbeet variety, and particularly their possible interaction.

MATERIALS AND METHODS

This research was conducted at one location near Powell, Wyoming in 1988 and at two locations near Powell and one location near Torrington, Wyoming in 1989. Powell is in the Big Horn Basin area and Torrington is in the North Platte River area. The 1988 experiment included comparison of planting depths, preplant herbicide treatments, sugarbeet varieties, and postemergence herbicide treatments. The 1989 experiments compared preplant herbicide treatments and sugarbeet varieties, all planted at one depth and all treated with postemergence herbicide. All plots were conventionally tilled. Sugarbeets were planted in 30-inch rows at the Torrington location and in 22-inch rows at the other locations. Preplant herbicides were applied in a 7-inch band with a planter-mounted sprayer delivering 40 gpa at 26 psi (Teejet 80015E tip) and incorporated immediately with a rotary-power incorporator operating at a depth of 1 inch. Postemergence herbicides were applied to sugarbeets in the two to four leaf stage; a tractor-mounted sprayer delivered 40 gpa at 27 psi (Teejet 8001E tip) in a 7-inch band with two nozzles per row.

The 1988 experiment was conducted at the University of Wyoming Powell Research and Extension Center on a clay loam soil (40 percent sand, 29 percent silt and 31 percent clay) with 1.3 percent organic matter and pH 7.7. The experimental design was a randomized complete block with a split block, factorial arrangement and four replications. Main plots were seeding depths, subplots herbicide treatments, and sub-subplots sugarbeet varieties. Comparisons included: seeding depths of approximately 3/4 inches and 1-1/4 inches; preplant incorporated herbicide treatments of cycloate [S-ethyl cyclohexylethylcarbamothioate] plus ethofumesate [(±)-2-ethoxy-2, 3-dihydro-3,3-dimethyl-5-benzofuranyl methanesulfonate], cycloate plus diethatyl [N-(chloracetyl)-N-(2,6-diethylphenyl)glycine], ethofumesate plus diethatyl and a non-treated check; postemergence herbicide treatments of desmedipham [ethyl [3-[[(phenylamino)carbonyl]oxy]phenyl] carbamate] plus phenmedipham [3-[(methoxycarbonyl)amino]phenyl] (3-methylphenyl) carbamate] applied at two rates and a non-treated check; and sugarbeet varieties MonoHy 5891, R-2 and D-2, American Crystal Hybrid 164 and 177, and Holly Hybrid 50. Depth bands of 1 inch or 1 1/2 inch were used to obtain the two planting depths. The sugarbeets had to be replanted due to crusting caused by a heavy rain on May 7 and 8. The power incorporator was used to till the row center during replanting, but no additional preplant herbicide was applied.

Similar experiments were conducted at three locations in 1989: the Powell Research and Extension Center; a cooperator location in the Heart Mountain area of Park County, Wyoming; and the University of Wyoming Torrington Research and Extension Center. These locations represent the typical range of environmental conditions found in Wyoming. Sugarbeets are grown in the Big Horn Basin area and the North Platte valley of Wyoming on light to heavy soils. The first site, also used for the 1988 study, was on the Powell Research and Extension Center which has a clay loam soil. The second site, on a cooperator's farm about 20 miles from the Powell Research and Extension Center, has a sandy loam soil (69 percent sand, 17 percent silt and 14 percent clay). The third site, on the Torrington Research and Extension Center in the North Platte valley of southeastern Wyoming, has a sandy loam soil (78 percent sand, 12 percent silt and 10 percent clay). Varieties chosen for this study were those approved by the Western Sugar-Grower Joint Research Committee. Because of problems with curly top virus in the Big Horn Basin, varieties approved for use there differ from those approved in the North Platte Valley. Thus, for the study, the varieties at Torrington were different from those at the other two locations.

The experimental design was a randomized complete block with a split plot arrangement and four replications. Main plots were preplant herbicide treatments and subplots were sugarbeet varieties.

At Powell and the cooperator location, comparisons included: preplant incorporated herbicide treatments of cycloate, ethofumesate, diethatyl, cycloate plus ethofumesate, diethatyl plus ethofumesate and a non-treated check; and sugarbeet varieties MonoHy 5891, 55, R-2 and D-2, Holly Hybrid 50, and American Crystal Hybrid 164. The study conducted at Torrington compared the same herbicide treatments, but with sugarbeet varieties MonoHy 6176, 1605 and 55 and Monohikari. The Torrington plots had to be replanted due to frost, which occurred during beet emergence. Again, the power incorporator was used to till the row centers during replanting with no additional preplant herbicide applied.

Evaluations included stand counts (sugarbeets per 10 ft of randomly selected row in each plot) before the postemergence herbicide application, after the postemergence herbicide application, and at harvest, and yield sampling (beets harvested from 10 ft of randomly selected row in each plot). Weed counts (weeds in 2-3 inch bands in 10 ft of randomly selected row for each herbicide plot) were made in the 1988 experiment. All counts were converted to number per acre. An analysis of variance was performed on the data and results combined where possible. Means were separated by Fischer's protected LSD at the 5 percent level of significance.

RESULTS AND DISCUSSION

Plant populations and yields of sugarbeets as a function of seeding depth, preplant herbicide, postemergence herbicide and variety for the Powell, 1988 experiment are shown in Table 1. Plant populations were influenced by planting depth, preplant herbicide treatment and variety, but not by postemergence herbicide treatment. No initial population is shown for MonoHy D-2 due to a planter problem. The planter over-planted 1½ replications of the MonoHy D-2 teatment. Yields were influenced by preplant herbicide, postemergence herbicide, and variety. Treatments with preplant herbicide yielded more than those with no preplant herbicide. Treatments with no postemergence herbicide yielded more than those treated with postemergence herbicide, suggesting herbicide injury. Visual injury ratings ranged from 10 to 20 percent for treatments receiving postemergence herbicide. Tonnage yields were highest for MonoHy R-2 while percent sugar was highest for American Crystal Hybrid 177. No preplant herbicide X variety interactions were found with the replanted plant population. The only plant population interaction ($P = 0.097$) was between preplant herbicide and variety for the initial planting (data not shown). Plant populations for MonoHy 5891 were lowest when treated with cycloate plus ethofumesate and highest when treated with cycloate plus diethatyl or diethatyl plus ethofumesate; this was opposite the trend for the other varieties.

Weed populations with preplant, postemergence and preplant/postemergence treatments for the Powell, 1988 experiment are shown in Table 2. In nearly all cases herbicide-treated sugarbeets had significantly lower weed populations than the non-treated checks. Weed populations ranged from 700 to 22,300 plants/A in herbicide treated plots compared to 42,000 plants/A in the non-treated check. Previous research (Miller and Fornstrom, 1989) indicates that the time required to remove these

Table 1. Plant populations and yields of six varieties of sugarbeets planted at two planting depths and treated with preplant incorporated and postemergence herbicides, Powell Research and Extension Center, 1988.

Item of Comparison	Rate lb ai/A	Plant Population, 1000 plants/A A. Post[1] 6/15/88	Harvest 9/22/88	Yield Tons/A	% Sugar
Depth					
1 inch		32.2	20.3	18.9	16.0
1½-inch		37.9	22.6	18.9	16.0
LSD (0.05)		1.9	1.0	NS	NS
Preplant					
cycloate + ethofumesate	1.5 + 1.5	32.9	21.3	19.2	16.0
cycloate + diethatyl	2.0 + 2.0	36.4	21.8	19.7	16.0
ethofumesate + diethatyl	2.0 + 2.0	34.4	21.4	18.8	16.0
check	———	36.5	21.2	18.0	16.0
LSD (0.05)		2.7	NS	1.2	NS
Postemergence					
desmedipham + phenmedipham	0.6 + 0.6	34.4	20.8	18.4	16.0
desmedipham + phenmedipham	0.3 + 0.3	35.2	21.6	18.7	16.0
check	———	35.6	21.9	19.7	16.0
LSD (0.05)		NS	NS	1.0	NS
Variety					
MonoHy 5891		42.2	23.1	18.2	16.0
MonoHy D-2		–	22.5	19.7	15.8
American Crystal Hybrid 164		32.8	19.3	17.4	16.3
Holly Hybrid 50		37.2	21.0	19.3	15.7
American Crystal Hybrid 177		28.5	20.0	17.1	16.6
MonoHy R-2		34.6	22.7	21.9	15.8
LSD (0.05)		3.0	1.7	1.4	0.3
Averages		35.1	21.4	18.9	16.0

[1]A. Post – approximately 10 days after postemergence herbicide application.

weeds with two hand hoeings would range from 5 to 25 hours/A for the 700-42,000 weeds/A, respectively.

Results of the 1988 research indicated that sugarbeet populations may be influenced by an interaction between preplant herbicide and variety, but that effects of planting depth and postemergence herbicide were independent of variety. Thus the 1989 studies were designed with a larger number of preplant herbicide treatments but with only one planting depth, and all were treated with the high rate of postemergence herbicide to emphasize the complementary preplant-postemergence herbicide effect on sugarbeets.

Plant populations and yields of the four sugarbeet varieties treated with different preplant herbicides in 1989 at the Torrington Research and Extension Center are shown in Table 3. While the initial population was low enough to require replanting, the replanted population was excessive. This population was thinned somewhat by the postemergence herbicide applica-

Table 2. Weed populations with preplant incorporated and postemergence herbicides in sugarbeets, Powell Research and Extension Center, 1988.

Treatment	Rate lb ai/A	Weed Population, 1000 plants/A[1]								
		SOLNI	SINAR	POROL	POLCO	KCHSC	SETVI	AVEFA	AMARE	TOTAL
Preplant										
cycloate + ethofumesate	1.5 + 1.5	0.1	0.3	0.2	1.1	0.1	0.2	0.1	0.0	1.9
cycloate + diethatyl	2.0 + 2.0	0.2	0.2	0.5	2.4	0.0	0.8	0.2	0.0	4.3
ethofumesate + diethatyl	2.0 + 2.0	0.2	0.2	0.0	1.3	0.1	0.2	2.2	0.0	4.2
check		2.0	1.6	7.6	3.5	0.4	7.4	3.2	1.3	27.0
LSD (0.05)		0.6	0.9	3.0	1.3	0.2	2.1	1.5	0.4	4.6
Postemergence										
desmedipham + phenmedipham	0.6 + 0.6	0.3	0.2	0.8	1.8	0.0	1.5	1.2	0.1	5.8
desmedipham + phenmedipham	0.3 + 0.3	0.6	0.3	1.7	1.6	0.1	1.8	1.5	0.2	7.7
check		1.0	1.2	3.8	2.8	0.3	3.2	1.5	0.7	14.5
LSD (0.05)		0.4	0.4	1.5	0.9	0.2	NS	NS	0.4	2.2
Preplant * Postemergence										
cyc + etho/des + phen	1.5+1.5/0.6+0.6	0.0	0.0	0.0	0.6	0.0	0.2	0.0	0.0	0.7
cyc + etho/des + phen	1.5+1.5/0.3+0.3	0.2	0.2	0.0	0.7	0.0	0.2	0.3	0.0	1.5
cyc + etho	1.5+1.5	0.0	0.6	0.6	1.9	0.2	0.3	0.0	0.0	3.6
cyc + diet/des + phen	2.0+2.0/0.6+0.6	0.2	0.2	0.0	1.9	0.0	0.7	0.0	0.0	3.0
cyc + diet/des + phen	2.0+2.0/0.3+0.3	0.0	0.0	0.2	2.4	0.0	0.9	0.2	0.0	3.6
cyc + diet	2.0+2.0	0.5	0.5	1.3	2.8	0.0	0.9	0.3	0.0	6.3
etho + diet/des + phen	2.0+2.0/0.6+0.6	0.1	0.0	0.0	1.0	0.0	0.2	1.8	0.0	3.0
etho + diet/des + phen	2.0+2.0/0.3+0.3	0.0	0.0	0.0	0.9	0.0	0.2	2.5	0.0	3.6
etho + diet	2.0+2.0	0.6	0.5	0.0	1.9	0.3	0.3	2.4	0.0	6.4
des + phen	0.6+0.6	0.9	0.7	3.1	3.4	0.0	5.1	3.1	0.3	16.6
des + phen	0.3+0.3	2.1	1.0	6.5	2.4	0.5	5.8	3.1	0.9	22.3
check		3.0	3.1	13.1	4.6	0.7	11.4	3.3	2.8	42.0
LSD (0.05)		0.9	0.9	2.9	NS	NS	2.3	NS	0.8	4.3

[1]SOLNI = black nightshade, SINAR = wild mustard, POROL = common purslane, POLCO = wild buckwheat, KCHSC = kochia, SETVI = green foxtail, AVEFA = wild oat and AMARE = redroot pigweed.

Table 3. Plant populations and yields of four varieties of sugarbeets treated with six preplant incorporated herbicides, Torrington Research and Extension Center, 1989.

	Rate	Plant Population, 1000 plants/A			Yield	
Item of Comparison	lb ai/A	Initial 5/25/89	A. Post[1] 6/7/89	Harvest 9/30/89	Tons/A	% Sugar
Herbicide						
cycloate	3.0	67.0	50.0	35.5	15.2	18.0
ethofumesate	2.5	67.2	52.2	38.2	17.4	17.9
diethatyl	4.0	66.8	54.1	40.9	18.6	18.6
cycl + etho	1.5 + 1.5	65.8	50.7	40.3	15.2	18.5
diet + etho	2.0 + 2.0	67.0	51.9	42.0	17.7	18.9
check	———	68.5	53.6	36.7	16.3	18.6
LSD (0.05)		NS	NS	NS	NS	NS
Variety						
MonoHy 6176		74.3	58.9	41.4	16.2	18.6
Monohikari		59.1	43.0	34.6	16.2	18.7
MonoHy 1605		72.0	57.5	41.4	15.7	18.3
MonoHy 55		62.6	49.7	38.5	18.7	18.0
LSD (0.05)		3.2	4.4	4.7	1.5	0.4
Mean		67.0	51.3	38.9	16.7	18.4

[1]A. Post – approximately 10 days after postemergence herbicide application.

tion, but still remained high and differences among treatments were nonsignificant. MonoHy 55 had the highest tonnage yield of 18.7 tons/A, but the lowest sugar percentage (18.0 percent). Monohikari had the highest sugar percentage (18.7 percent). There were no significant interactions between herbicides and varieties in the Torrington experiment.

Plant populations and yields for the 1989 experiments conducted at the Powell Research and Extension Center and the Cooperator location are combined in Table 4. Although plant populations and percent sugar yield were different at the two locations, trends were similar and data were combined. Application of postemergence herbicide and an inadvertent hand thinning reduced the stand at the cooperator location. Cycloate plus ethofumesate combined with the postemergence herbicide was particularly detrimental to plant stand. Holly Hybrid 50 had the highest initial plant population and MonoHy R-2 and 55 the lowest. American Crystal Hybrid 164 had the highest sugar percentage. There were no significant interactions between herbicides and varieties for either location.

Laboratory studies also were conducted to compare emergence rates of varieties used in the field studies. In 1988, sugarbeet emergence from a packed sand medium at 4 percent moisture content and 50°F was measured (procedure of Akeson and Widmer, 1980). In 1989, a petri dish germination test at 50°F was conducted. In neither case did results correlate with field emergence (Miller, Fornstrom, and Ball, unpublished; Fornstrom and Miller, unpublished).

The primary objective of this research was to determine whether there were any interactions between preplant herbicides

Table 4. Plant populations and yields of six varieties of sugarbeets treated with six preplant incorporated herbicides, Powell Research and Extension Center and Cooperator locations, 1989.

Item of Comparison	Rate lb ai/A	Plant Population, 1000 plants/A Initial 5/23/89	A. Post[2] 6/6/89	Harvest 9/19/89	Yield Tons/A	% Sugar
Location						
Powell REC		27.1	26.5	29.0	20.0	15.3
Cooperator		39.7	22.1	21.5	20.0	16.5
LSD (0.05)		3.3	4.0	1.6	NS	0.2
Preplant herbicide						
cycloate	3.0	35.4	27.0	26.7	20.3	16.1
ethofumesate[1]	3.0(2.5)	33.6	24.7	26.2	20.6	15.8
diethatyl	4.5	31.7	25.0	23.8	19.0	15.9
cycl + etho	2.0 + 2.0	29.9	19.4	23.1	18.8	15.9
etho + diet	2.0 + 2.0	33.5	24.2	26.1	19.9	15.9
check	———	36.4	25.8	25.6	21.4	16.0
LSD(0.05)		NS	3.9	NS	NS	NS
Variety						
Holly Hybrid 50		40.7	27.9	28.6	19.7	15.9
MonoHy D-2		34.1	24.0	25.6	20.7	15.9
American Crystal Hybrid 164		35.3	27.8	26.6	18.8	16.2
MonoHy 5891		32.9	24.1	25.2	20.4	15.9
MonoHy R-2		27.5	20.9	22.8	21.0	15.6
MonoHy 55		30.0	21.4	22.8	19.4	16.0
LSD(0.05)		3.5	2.7	2.3	NS	0.2
Mean		33.4	24.3	25.3	20.0	15.9

[1]Ethofumesate was applied at 3.0 lb ai/A at the Powell Research and Extension center and at 2.5 lb ai/A at the Cooperator location.
[2]A. Post – approximately 10 days after postemergence herbicide application

and sugarbeet varieties with respect to stand establishment. Although there were differences in plant populations influenced by herbicide treatment and variety in the individual experiments, none of the three experiments conducted in 1989 indicated any stand establishment interaction between herbicide treatment and variety, and only a minor interaction ($P = 0.097$) was noted in the 1988 experiment. Thus, it appears that information on stand establishment for the varieties studied can be obtained from either herbicide studies or variety studies without concern of their interaction.

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