Weed Control and Labor Requirements in Sugarbeets†

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ABSTRACT

A field experiment was conducted at Torrington, WY, during 1987 and 1988 to determine weed control, labor requirements and weed control costs with and without herbicides in sugarbeets. Early season weed populations were reduced 91 to 97% and mid-season weed populations 89 to 97% with all complementary preplant incorporated and postemergence desmedipham plus phenmedipham treatments. Lowest total hoeing times (5.3 to 9.7 hr/A) were obtained with these combination treatments. The benefits of herbicides over the hand weeded check ranged from a low of $77/A with postemergence applications of sethoxydim plus oil concentrate to a high of $152/A with complementary preplant incorporated applications of cycloate plus ethofumesate followed by postemergence applications of desmedipham plus phenmedipham. Based on regression analysis of hoeing time and weed population, one hand weeding of a light weed infestation of 3,000 plants/A would cost approximately the same as a postemergence desmedipham plus phenmedipham application.

Additional Key Words: Hand labor, herbicide, weed control costs

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Weed control is a major production cost associated with sugarbeets; unless weed management strategies are planned intelligently, profitability can be reduced. Farmers employ various mechanical, chemical and hand labor methods to control weeds and to prevent yield and quality losses in sugarbeets. In Wyoming, herbicides are applied to over 70% of the fields prior to planting sugarbeets, 35% are sprayed postemergence, and over 6% are treated after thinning (Taylor et al, 1986). Sugarbeets also are cultivated one to three times during the season and weed escapes are controlled by one to three hand hoeings.

Complementary applications of preplant and postemergence herbicides have proven to be particularly effective in providing season-long control of many annual weeds in sugarbeet production (Miller and Fornstrom, 1988; Schweizer, 1980; Wicks and Wilson, 1983, Winter and Weise, 1982). However, the use of soil applied herbicides for weed control in sugarbeets is declining (Dexter, 1988). Reasons cited for this decline include incorporation requirement, sugarbeet injury, and high broadcast herbicide costs because of limited band incorporation equipment.

The objective of this research was to compare weed control, labor requirements, and weed control costs with preplant, postemergence and complementary herbicide treatments. This information should allow farmers to plan weed management strategies more intelligently and maximize profitability.

MATERIALS AND METHODS

Field experiments were conducted at the University of Wyoming Research and Extension Center, Torrington, WY in 1987 and 1988. The soil was a Bayard fine sandy loam (coarse, loamy mixed Mesic Torriorthentic Haplustoll 74% sand 14% silt and 12% clay) with 1.2% organic matter and pH 7.5. Weeds in the experimental area included redroot pigweed (*Amaranthus retroflexus* L.), common lambsquarters (*Chenopodium album* L.), wild buckwheat (*Polygonum convolvulus* L.), hairy nightshade (*Solanum sarrachoides* Sendtner), common sunflower (*Helianthus annuus* L.) Russian thistle (*Salsola iberica* Sennen & Pau), kochia (*Kochia scoparia* (L.) Schrad.) and green foxtail (*Setaria viridis* (L.) Beauv.). The predominant weed species were green foxtail in 1987 and common lambsquarters in 1988.

Sugarbeets ('Monohikari') were planted April 14 in 1987 and April 13 in 1988, in 30 inch rows 1 to 1.25 inches deep at three seeds/ft of row. Plots were four rows wide and 55 ft long. The plots were sprinkler irrigated. The experimental design was a randomized complete block with a split plot arrangement with four replications.

Cycloate (S-ethyl cyclohexylethylcarbamothioate), ethofumesate (±-2- ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuranyl methanesulfonate), diethatyl (N-(chloroacetyl)-N-(2,6-diethylphenyl)glycine), cycloate plus ethofumesate and ethofumesate plus diethatyl were applied preplant with a tractor-mounted sprayer delivering 40 gpa at 25 psi in a 7 inch band and incorporated to a depth of 1.5 inches with a PTO driven rotary incorporator. A 50:50 mixture of desmedipham (ethyl[3-[[(phenylamino)carbonyl]oxy]phenyl]carbamate) plus phenmedipham (3-[(methoxy carbonyl)amino]phenyl(3-methylphenyl) carbamate), sethoxydim (2-[l-(ethoxyimino) butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-l-one) plus oil concentrate (oc), sethoxydim plus desmedipham plus phenmedipham, or a split application of a half rate of desmedipham plus phenmedipham followed by sethoxydim and oc plus another half rate of desmedipham plus phenmedipham were applied postemergence with a tractor mounted sprayer that used two nozzles per row and delivered 40 gpa at 26 psi in a 7 inch band. All treatments except the split application of desmedipham plus phenmedipham were applied to 4 to 6-leaf sugarbeets and 1 to 2 inch tall weeds. The first half rate in the split desmedipham plus phenmedipham treatment was applied to 2 to 4-leaf sugarbeets and 0.5 inch tall weeds and the sethoxydim plus the remaining half rate of desmedipham plus phenmedipham was applied at the 4 to 6-leaf stage of sugarbeets and 0.5 to 1 inch tall weeds (5 to 7 days after the initial treatment).

Evaluations included sugarbeet vigor loss, sugarbeet and weed populations, hoeing times, sugarbeet harvest populations and yields. Sugarbeet and weed populations were determined by counting two randomly selected areas 3 inches wide by 10 ft long in each plot 14 days after post-emergence applications to 4 to 6-leaf sugarbeets. After plant counts were made, the authors and their students hand hoed the plots and times were recorded. Long handled hoes were used and very little finger weeding was done. Plots were cultivated once with a five inch band before the first hoeing. A second weed count was performed on June 30 and the plots hoed on July 1. Sugarbeet final stand and yields were determined by hand harvesting 10 ft of row in each plot and counting the beets. Sugar percentage and tare were determined by Holly Sugar Corporation. All plots were essentially weed-free at harvest.

For economic comparisons, cycloate, ethofumesate, diethatyl, sethoxydim and desmedipham plus phenmedipham were valued at $6.85, 31.50, 9.35, 50.00 and 52.30/lb of active ingredient, and oil concentrate was valued at $3.75/qt. Hand labor was charged at $4.00/hr. The application of preplant herbicides was assumed to add $4.00/A to the cost of the planting operation and the application of postemergence herbicides was assumed to be a separate operation which would cost $4.00/A. These were prevailing prices at Torrington, WY, in April 1988. Herbicide rates and costs are presented in Table 1.

Since there was no year by treatment interaction the data for 1987 and 1988 were combined. Data were subjected to analysis of variance and means separated at the 0.05 level of probability using Fisher's Least Significant Difference test.

Table 1. Herbicide rates and cost of treatments at Torrington, WY in 1987 and 1988.

Herbicide	Rate	Herbicide[†] cost	Application cost
	(lb ai/A)	----- ($/A) -----	
cycloate	3.0	5	4
ethofumesate	2.5	18	4
diethatyl	4.0	9	4
cycloate + ethofumesate	1.5+1.5	13	4
ethofumesate + diethatyl	2.0+2.0	19	4
sethoxydim + oil concentrate(oc)	0.2+1qt	3	4
desmedipham + phenmedipham	0.5+0.5	12	4
sethoxydim + desmedipham + phenmedipham	0.2+0.5+0.5	14	4
desmedipham + phenmedipham/ sethoxydim + desmedipham + phenmedipham +oc	0.25+0.25/ 0.2+0.25+0.25+1qt	15	8

[†]Herbicide cost based on 7 inch band over 30 inch row spacing.

RESULTS AND DISCUSSION

Sugarbeets were planted to stand and no plots were thinned. Sugarbeet stands were adequate at harvest for all treatments (Table 2). Sugarbeet vigor loss ranged from 0 to 3% with preplant incorporated or postemergence treatments alone and 0 to 15% with complementary preplant incorporated and postemergence treatments. Single and split applications of desmedipham plus phenmedipham provided similar sugarbeet selectivity (Table 2). Sugarbeet recovery was excellent with all treatments and yield or percent sucrose were statistically similar whether weeds were controlled only by hand weeding or by a combination of herbicides and hand weeding (Table 2).

Herbicide treatments reduced early season weed populations 33 to 97% and hoeing times 38 to 89% compared to the untreated check (Table 3). Similarly, herbicide treatments reduced mid-season weed populations 48 to 97% and hoeing time 48 to 88% compared to the untreated check. Complementary preplant incorporated plus postemergence desmedipham plus phenmedipham treatments were more effective than preplant or postemergence treatments alone (Table 3). The complementary preplant incorporated plus postemergence desmedipham plus phenmedipham treatments reduced total weed populations 89 to 97% compared to 72 to 88% for preplant or 37 to 79% for postemergence applications alone. Total hoeing time ranged from 5.3 to 9.7 hr/A for the complementary preplant incorporated plus postemergence desmedipham plus phenmedipham treatments compared to 10.0 to 17.1 hr/A for preplant treatments or 13.4 to

29.6 hr/A for postemergence treatments alone. Weed control and hoeing times with desmedipham plus phenmedipham alone or as a combination treatment was not improved by the addition of sethoxydim in this study (Table 3).

Table 2. Sugarbeet response to preplant, postemergence or complementary treatments averaged over two years.

	Sugarbeets			
Treatment	**Vigor loss**	**Stand at harvest**	**Sucrose**	**Yield**
	(%)	(1000pl/A)	(%)	T/A
cycloate (cycl)	0	31.0	16.9	28.0
cycl/sethoxydim (seth) + oc	3	31.9	17.0	27.9
cycl/desmedipham (desm) + phenmedipham (phen)	5	30.9	16.7	29.0
cycl/seth + desm + phen	7	32.7	17.0	28.2
cycl/desm + phen/seth + desm + phen + oc	10	31.4	17.0	28.4
ethofumesate (etho)	0	30.1	16.9	28.0
etho/seth + oc	0	31.4	16.8	27.7
etho/desm + phen	6	30.5	16.9	28.3
etho/seth + desm + phen	7	31.4	17.0	27.4
etho/desm + phen/seth + desm + phen + oc	7	29.4	16.8	27.9
diethatyl (diet)	0	29.4	17.0	27.8
diet/seth + oc	0	28.7	16.7	27.7
diet/desm + phen	3	30.1	16.8	30.0
diet/seth + desm + phen	5	32.6	16.7	27.3
diet/desm + phen/seth + desm + phen + oc	7	31.4	16.9	28.2
cycl + etho	3	30.6	16.7	28.8
cycl + etho/seth + oc	4	30.8	16.9	27.7
cycl + etho/desm + phen	7	30.9	16.7	27.9
cycl + etho/seth + desm + phen	15	29.4	16.7	28.8
cycl + etho/desm + phen/seth + desm + phen + oc	12	31.4	17.0	27.5
etho + diet	0	29.3	16.7	30.0
etho + diet/seth + oc	2	29.4	16.9	27.8
etho + diet/desm + phen	8	29.3	16.6	27.5
etho + diet/seth + desm + phen	7	32.7	16.8	28.1
etho + diet/desm + phen/seth + desm + phen + oc	9	30.5	16.8	28.5
seth + oc	0	31.0	16.9	27.1
desm + phen	1	31.7	16.6	26.8
seth + desm + phen	3	32.2	16.7	26.8
desm + phen/seth + desm + phen + oc	3	31.7	17.0	27.7
hand weeded	0	32.2	16.7	27.2
LSD (0.05)	6	NS	NS	NS

The effectiveness of preplant incorporated herbicides averaged over postemergence treatments or postemergence herbicides averaged over preplant incorporated treatments is shown in Table 4. Diethatyl was less effective in controlling weeds and reducing hoeing times compared to other preplant incorporated treatments. Weed populations averaged 16,400 plants/A and hoeing time 12.7 hr/A in diethatyl treated plots compared to weed populations of 5,800 to 10,400 plants/A and hoeing times of 7.2 to 9.5 hr/A in plots treated with other preplant incorporated herbicides. In addition, cycloate plus ethofumesate or ethofumesate plus diethatyl combinations generally were more effective than the individual herbicides. Postemergence applications of desmedipham plus phenmedipham reduced weed populations 70 to 77% and total hoeing times 53 to 61% compared to untreated plots. Desmedipham plus phenmedipham gave similar weed control with a regular or split application. Sethoxydim plus oil concentrate reduced weed populations and total hoeing time 17% compared to no postemergence herbicide but had little influence on weed control or hoeing times when combined with desmedipham plus phenmedipham.

Table 3. Weed populations and hoe-times with preplant, postemergence or complementary treatments averaged over two years.

Treatment	Seasonal weed stand[†]			Hoe-times		
	Early	Mid	Total	1st	2nd	Total
	-- (1000pl/A) --			-- (hr/A) --		
cycloate (cycl)	10.3	6.5	16.8	7.3	5.6	12.9
cycl/seth + oc	10.2	5.8	16.0	6.9	5.2	12.1
cycl/desmedipham(desm) + phenmedipham(phen)	3.1	2.3	5.4	3.9	3.1	7.0
cycl/seth + desm + phen	1.8	2.4	4.2	3.2	2.9	6.1
cycl/desm + phen/seth + desm + phen + oc	2.7	1.3	4.0	3.6	2.7	6.2
ethofumesate (etho)	12.9	6.8	19.7	8.0	6.1	14.1
etho/seth + oc	12.5	5.9	18.4	7.8	6.3	14.1
etho/desm + phen	3.6	2.5	6.1	3.9	3.0	6.9
etho/seth + desm + phen	1.8	1.6	3.4	3.2	2.8	6.0
etho/desm + phen/seth + desm + phen + oc	2.4	2.5	4.9	3.6	3.0	6.6
diethatyl (diet)	16.8	8.0	24.8	9.4	7.7	17.1
diet/seth + oc	21.2	9.8	31.0	11.1	8.6	19.7
diet/desm + phen	5.7	3.7	9.4	5.3	4.4	9.7
diet/seth + desm + phen	5.7	3.6	9.3	5.3	4.2	9.5
diet/desm + phen/seth + desm + phen + oc	2.4	3.4	5.8	3.5	3.8	7.3
cycl + etho	6.6	4.4	11.0	5.4	4.6	10.0
cycl + etho/seth + oc	7.3	3.0	10.3	5.7	3.7	9.4
cycl + etho/desm + phen	1.6	0.9	2.5	2.7	2.6	5.3
cycl + etho/seth + desm + phen	1.9	0.9	2.8	3.4	2.5	5.9
cycl + etho/desm + phen/seth + desm + phen + oc	1.6	0.8	2.4	2.8	2.5	5.3
etho + diet	8.3	4.6	12.9	5.8	4.9	10.7
etho + diet/seth + oc	8.5	3.8	12.3	6.3	4.2	10.5
etho + diet/desm + phen	2.5	1.2	3.7	3.6	2.6	6.2
etho + diet/seth + desm + phen	2.9	0.9	3.8	3.4	2.5	5.9
etho + diet/desm + phen/seth + desm + phen + oc	3.0	1.2	4.2	3.8	2.6	6.4
seth + oc	41.0	14.6	55.6	19.0	10.6	29.6
desm + phen	17.9	8.3	26.2	10.9	7.3	18.2
seth + desm + phen	16.0	7.8	23.8	9.7	6.1	15.8
desm + phen/seth + desm + phen + oc	12.8	6.2	19.0	8.0	5.4	13.4
untreated check	61.0	27.7	88.7	30.3	20.3	50.6
LSD(0.05)	5.0	3.2	8.2	3.6	2.0	5.6

[†]Early-season weed populations were counted the last week of May and mid-season weed populations counted June 30. Weed species present in the early season counts included redroot pigweed, kochia, Russian thistle, hairy nightshade, common sunflower, common lambsquarters, wild buckwheat, and green foxtail and in the mid-season counts redroot pigweed, hairy nightshade, common lambsquarters, common sunflower, and green foxtail.

Table 4. Total weed populations and hoe-times with preplant incorporated and postemergence treatments averaged over two years.

Treatment	Seasonal weed stand†			Hoe-times		
	Early	Mid	Total	1st	2nd	Total
	-- (1000pl/A) --			-- (hr/A) --		
Preplant (averaged over postemergence treatment)						
cycloate	5.6	3.7	9.3	5.0	3.9	8.9
ethofumesate	6.6	4.8	10.4	5.3	4.2	9.5
diethatyl	10.4	5.7	16.4	6.9	5.8	12.7
cycloate + ethofumesate	3.8	2.0	5.8	4.5	2.7	7.2
ethofumesate + diethatyl	5.0	1.9	6.9	4.6	3.3	7.9
none	30.0	12.7	42.7	15.6	9.9	25.5
LSD(0.05)	2.8	1.7	4.5	2.0	1.2	3.2
Postemergence (averaged over preplant treatment)						
sethoxydim + oc	16.8	7.2	24.0	9.5	6.4	15.9
desmedipham + phenmedipham	5.8	3.2	9.0	5.1	3.9	9.0
sethoxydim + desmedipham + phenmedipham	5.1	2.9	8.0	4.7	3.5	8.2
desmedipham + phenmedipham/ sethoxydim + desmedipham + phenmedipham + oc	4.2	2.4	6.6	4.2	3.3	7.5
none	19.4	9.7	29.1	11.0	8.2	19.2
LSD(0.05)	2.5	1.5	4.0	1.8	1.1	2.9

†Early-season weed populations were counted the last week of May and mid-season weed populations counted June 30. Weed species present in the early season counts included redroot pigweed, kochia, Russian thistle, hairy nightshade, common sunflower, common lambsquarters, wild buckwheat, and green foxtail and in the mid-season counts redroot pigweed, hairy nightshade, common lambsquarters, common sunflower, and green foxtail.

Since yield and percent sucrose were the same whether weeds were controlled by hand or in combination with herbicides, weed control costs associated with the various treatments are compared in Table 5. All herbicide treatments reduced weed control costs compared to the hand weeded check. The benefit of herbicides over the hand weeded check ranged from a low of $77/A with postemergence applications of sethoxydim plus oil concentrate to a high of $152/A with complementary preplant incorporated applications of cycloate plus ethofumesate followed by postemergence applications of desmedipham plus phenmedipham. The benefit over the hand weeded check ranged from $124 to 149/A for preplant incorporated treatments, $77 to 125/A for postemergence treatments and $113 to 152/A for complementary preplant incorporated plus postemergence treatments. The greatest benefit over the hand weeded check, regardless of preplant herbicide, was obtained with a complementary postemergence application of desmedipham plus phenmedipham. A split treatment of desmedipham plus phenmedipham decreased hoeing time slightly when compared to a single treatment, but the benefit of a split treatment did not offset the extra cost of the second application. Further, these data indicate that herbicides are essential for minimizing weed control costs in sugarbeets.

Table 5. Weed control costs with various herbicide combinations averaged over two years.

Treatment	Cost of weed control[†] hoeing	herbicide	total	Benefit over hand weeded
	($/A)			
cycloate (cycl)	52	9	61	141
cycl/sethoxydim(seth) + oc	48	16	64	138
cycl/desmedipham(desm) + phenmedipham(phen)	28	25	53	149
cycl/seth + desm + phen	24	27	51	151
cycl/desm + phen/seth + desm + phen + oc	25	32	57	145
ethofumesate (etho)	56	22	78	124
etho/seth + oc	56	29	85	117
etho/desm + phen	28	38	66	136
etho/seth + desm + phen	24	40	64	138
etho/desm + phen/seth + desm + phen + oc	26	45	71	131
diethatyl(diet)	68	13	81	121
diet/seth + oc	79	20	99	103
diet/desm + phen	39	29	68	134
diet/seth + desm + phen	38	31	69	133
diet/desm + phen/seth + desm + phen + oc	29	36	65	137
cycl + etho	40	13	53	149
cycl + etho/seth + oc	38	20	58	144
cycl + etho/desm + phen	21	29	50	152
cycl + etho/seth + desm + phen	24	31	55	147
cycl + etho/desm + phen/seth + desm + phen + oc	21	36	57	145
etho + diet	43	19	62	140
etho + diet/seth + oc	42	26	68	134
etho + diet/desm + phen	25	35	60	142
etho + diet/seth + desm + phen	24	37	61	141
etho + diet/desm + phen/seth + desm + phen + oc	26	42	68	134
seth + oc	118	7	125	77
desm + phen	73	16	89	113
seth + desm + phen	63	18	81	121
desm + phen/seth + desm + phen + oc	54	23	77	125
handweeded	202	–	202	–

[†]Herbicide costs including application were considered as a constant for each treatment based on prevailing prices at Torrington, WY, in April, 1988. Hoeing costs were based on a labor rate of $4/hr. LSD's for hoeing times are given in Table 3.

Hoeing time as a function of weed population is shown in Figure 1. The linear regression analysis shows that 4.4 hr/A were required to walk through a sugarbeet field twice when no weeds were present, and an additional 0.5 hr/A was required for every 1000 weeds/A ($r^2 = 0.92$). Thus a light weed infestation of 3000 plants/A or three weeds/20 ft of row would increase hoeing time 1.5 hr/A. One hand weeding of a light weed infestation would cost approximately the same as a postemergence application of desmedipham plus phenmedipham, based on the $4.00/hr labor charge.

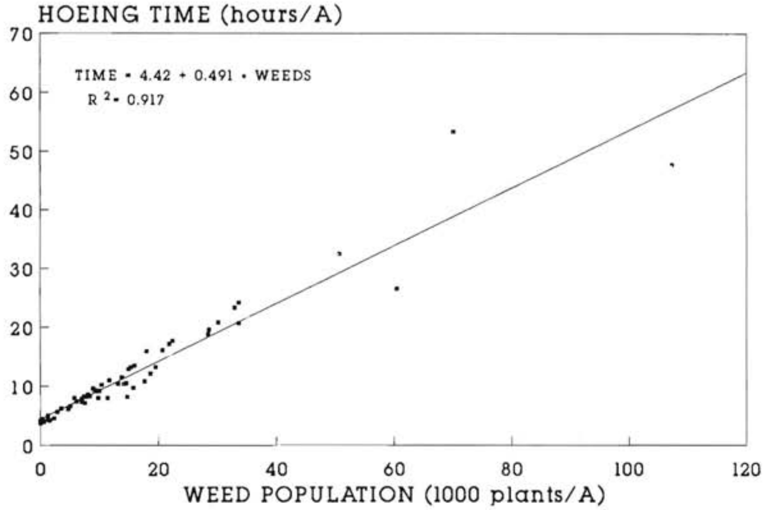

Figure 1. Total hoeing time (first plus second hoeing) as a function of total weed population.

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