# Sequential Herbicide Application for Weed Control in Sugarbeets†


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## ABSTRACT

**Preplant and postemergence applied herbicides were compared for their effect on individual weed species and on sugarbeets. A combination of cycloate plus ethofumesate or diethatyl plus ethofumesate provided the best broadleaf weed control with crop selectivity similar to cycloate, ethofumesate, and diethatyl alone. A split application of desmedipham plus phenmedipham was more effective than a single application in reducing broadleaf and grass weed density. Broadleaf weed density was reduced 70 to 77 percent with postemergence or preplant applied herbicide treatments, respectively, and by 93 percent when preplant and postemergence herbicides were applied sequentially. Sugarbeet injury and stand reduction increased when preplant and postemergence applied herbicides were combined as compared to sugarbeet selectivity when preplant and postemergence applied herbicides were used separately.**



**Additional Key Words:** Cycloate, ethofumesate, diethatyl, desmedipham, phenmedipham, sethoxydim, trifuralin



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Weeds are a major problem in growing sugarbeets (*Beta vulgaris* L.). Weeds that emerge soon after planting sugarbeets are more competitive than late-emerging weeds (Dawson, 1965; Weatherspoon and Schweizer, 1969), and broadleaf weeds generally are considered more competitive than grasses (Brimhall, Chamberlain and Alley, 1965; Zimdahl and Fertig, 1967). Broadleaf weeds are most competitive after they begin to shade the crop (Dawson, 1965). As few as one kochia [*Kochia scoparia* (L.) Schrad.] per 3 m of row (Weatherspoon and Schweizer, 1971) or one redroot pigweed (*Amaranthus retroflexus* L.) per four sugarbeets (Brimhall, Chamberlain, and Alley, 1965) have reduced sugarbeet root yields by 24 and 21%, respectively. Weed interference with sugarbeets can be prevented if sugarbeets are kept free of weeds for 8 weeks after planting (Wicks and Wilson, 1983). Sugarbeet growers have relied upon mechanical and chemical forms of weed control to provide early season weed-free periods. With the cost of handhoeing increasing, the interest in chemical weed control has increased. Sequential applications of herbicides at planting and after crop emergence have proven effective in providing early season weed control (Schweizer, 1980; Winter and Wiese, 1982; Wicks and Wilson, 1983; Miller and Fornstrom, 1989). Other popular weed control programs have omitted the use of herbicides at planting and relied on sequential applications of herbicides after planting (Dexter, 1988). The objectives of these experiments were to compare preplant and postemergence weed control programs to determine how each program controlled individual weed species and affected sugarbeet growth.

## MATERIALS AND METHODS

Field experiments were initiated near Scottsbluff, Nebraska, in the spring of 1987, 1988, and 1989 on a Tripp sandy loam (Typic Haplustol) with pH 8 and 1% organic matter content. Plots were located in a different field each year and each field was moldboard plowed and roller harrowed during the first week of April. Preplant herbicides were applied during the second week of April with a roller harrow set to incorporate the herbicide at a 2 to 5 cm depth. Sugarbeets ('Monohikari') were planted to stand during the second week of April at a rate of 3 seeds per 30 cm of row. Postemergence herbicides were applied when sugarbeets were in the two or four true-leaf stage of growth. Herbicides were applied broadcast in water at 200 L of water per hectare with a tractor mounted sprayer. Treatments containing trifluralin were incorporated with a rolling cultivator immediately after application. Visual estimates of sugarbeet injury where 0 = no injury and 100 = completely killed were recorded in early May and mid June. Sugarbeet plants were counted in mid June from the middle two rows of each experimental unit for a distance of 7.5 m. Weed densities were counted in mid June in a 4 $m^2$ area in the center of each experimental unit. Sugarbeets were cultivated three times beginning in mid May and were irrigated to ensure optimum sugar production. Weeds missed by herbicide treatments were removed by hand in late June. Sugarbeets were topped and harvested during early October with a mechanical two-row harvester. A 9 kg subsample from each plot was washed, weighed, and analyzed for sucrose content by the method outlined by the Association of Official Agriculture Chemists (1955).

The experimental design was a factorial experiment in a randomized complete block design with four replications. Treatments consisted of five preplant applied herbicides and four postemergence applied herbicides (Table 1). Herbicides were applied separately and in all possible combinations for a total of 29 chemical treatments. Rates of herbicide application were selected from information collected from herbicide screening trials and from manufacturers labels. Individual experimental units were 6 sugarbeet rows spaced 56 cm apart by 12 m long. A hail storm in late August of 1987 severely injured sugarbeet plants; therefore, root yield data from 1987 were omitted. Sugarbeet vigor, stand, and weed density were consistent among years and therefore, data for the 3-yr period were pooled and subjected to analysis of variance. Mean separation was performed using Fisher's Protected Least Significant Difference (LSD) Test at the 0.05 level of significance.

**Table 1.** Herbicides, rates, and times of application at Scottsbluff, NE in 1987 through 1989.

| Herbicide | Rate | Time of application† | Growth Stage |
|---|---|---|---|
| | (kg $ha^{-1}$) | | |
| cycloate | 2.8 | PPI | None |
| ethofumesate | 1.7 | PPI | None |
| diethatyl | 3.3 | PPI | None |
| cycloate + ethofumesate | 1.1 + 1.1 | PPI | None |
| diethatyl + ethofumesate | 1.6 + 1.6 | PPI | None |
| desmedipham + phenmedipham | 0.6 + 0.6 | Post | 4 true leaves |
| desmedipham + phenmedipham/‡<br>desmedipham + phenmedipham | 0.2 + 0.2/<br>0.2 + 0.2 | Post<br>Post | 2 true leaves<br>4 true leaves |
| desmedipham + phenmedipham/<br>sethoxydim + desmedipham +<br>phenmedipham (OC)§ | 0.2 + 0.2/<br>0.2 + 0.2 +<br>0.2 | Post<br>Post | 2 true leaves<br>4 true leaves |
| desmedipham + phenmedipham/<br>desmedipham + phenmedipham/<br>trifluralin | 0.2 + 0.2/<br>0.2 + 0.2<br>0.6 | Post<br>Post<br>Post | 2 true leaves<br>4 true leaves<br>4 true leaves |

†Abbreviations: PPI – preplant incorporated, Post – postemergence.
‡Sequential applications.
§OC - A mixture of paraffinic petroleum and surfactant.
Cornbelt Chem. Co., P.O. Box 410, McCook, NE 69001.

## RESULTS AND DISCUSSION

Weed density was uniform within the plot area. Yellow foxtail [*Setaria glauca* (L.) Beauv.], common lambsquarters (*Chenopodium album* L.), hairy nightshade (*Solanum sarrachoides* Sendtner), kochia [*Kochia scoparia* (L.) Schrad], redroot pigweed (*Amaranthus retroflexus* L.), and toothed spurge (*Euphorbia serrata* L.) were the predominant weeds in the experiment. Preplant applied herbicides differed in their ability to control broadleaf weeds (Table 2). Common lambsquarters density was highest in ethofumesate treated areas and declined when other preplant treatments were utilized. Diethatyl treated areas had a higher kochia density than other herbicide treated areas. Preplant applied herbicides did not differ in their ability to control yellow foxtail, hairy nightshade, redroot pigweed and toothed spurge. Total broadleaf weed density was highest on experimental units treated with ethofumesate and diethatyl and lowest in areas treated with cycloate, cycloate plus ethofumesate, and diethatyl plus ethofumesate.

**Table 2.** Response of weeds and sugarbeets to herbicides applied and incorporated before sugarbeet planting and to herbicides applied after sugarbeet emergence.

| | Weed density | | | | | | | Sugarbeets | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | Yellow foxtail | Common lambs-quarters | Hairy night-shade | Kochia | Redroot pigweed | Toothed spurge | Total broadleafs | Vigor loss | Stand | Sucrose | Yield |
| | (plants per 4 m²) | | | | | | | (%) | (plants per 15 m row) | (%) | (t ha⁻¹) |
| | | | | | | Preplant | | | | | |
| cycloate | 2 | 2 | 1 | 4 | 3 | 1 | 11 | 2 | 78 | 15.6 | 45.9 |
| ethufumesate | 4 | 8 | 4 | 4 | 2 | 14 | 32 | 1 | 77 | 16.0 | 46.6 |
| cycloate + ethofumesate | 2 | 4 | 3 | 2 | 2 | 4 | 15 | 3 | 65 | 15.3 | 56.7 |
| diethatyl | 1 | 4 | 4 | 7 | 3 | 9 | 27 | 0 | 70 | 15.7 | 44.3 |
| diethatyl + ethofumesate | 1 | 2 | 2 | 3 | 1 | 4 | 12 | 1 | 66 | 15.8 | 52.6 |
| LSD (0.05) | NS | 3 | NS | 3 | NS | NS | 8 | NS | NS | NS | 8.8 |
| | | | | | | Postemergence | | | | | |
| desmedipham (desm) + phenmedipham (phen) | 13 | 13 | 3 | 2 | 9 | 2 | 29 | 9 | 66 | 15.8 | 44.1 |
| desm + phen/desm + phen | 4 | 5 | 2 | 4 | 8 | 1 | 20 | 5 | 75 | 15.5 | 46.8 |
| desm + phen/sethoxydim + desm + phen | 1 | 3 | 1 | 1 | 9 | 6 | 20 | 9 | 72 | 15.5 | 49.5 |
| desm+phen/desm + phen/trifluralin | 4 | 2 | 1 | 1 | 7 | 3 | 14 | 8 | 64 | 14.1 | 43.9 |
| LSD (0.05) | 6 | 5 | 2 | 2 | NS | NS | 7 | NS | NS | NS | NS |

Combinations of cycloate plus ethofumesate and diethatyl plus ethofumesate reduced broadleaf weed density more than ethofumesate or diethatyl alone. Sugarbeet vigor, stand, and percent sucrose did not vary between preplant applied herbicides. Root yield was highest in experimental units treated with cycloate plus ethofumesate and diethatyl plus ethofumesate. Root yields were similar in areas treated with cycloate, ethofumesate, and diethatyl.

Postemergence applied herbicides differed in yellow foxtail, common lambsquarters, hairy nightshade, and kochia control (Table 2). A single application of desmedipham plus phenmedipham at 0.6 plus 0.6 kg $ha^{-1}$ applied when sugarbeets were in the 4-true-leaf stage of growth was less effective in reducing yellow foxtail, common lambsquarters, and total broadleaf density than was a split application applied at 0.2 plus 0.2 kg $ha^{-1}$ when sugarbeets had 2 and 4 true leaves. There also was a trend for the split desmedipham plus phenmedipham treatment to cause less sugarbeet injury and less stand reduction than the higher dosage single application. Grass density declined, although not significantly, when sethoxydim was added to a split application of desmedipham plus phenmedipham as compared to a split application of desmedipham plus phenmedipham. The addition of sethoxydim to desmedipham plus phenmedipham did not affect broadleaf weed control as compared to desmedipham plus phenmedipham applied alone.

Broadleaf weed density varied while yellow foxtail density was similar when the four postemergence herbicide treatments were averaged over each preplant herbicide treatment (Table 3). Broadleaf weed density was highest when postemergence herbicide treatments followed diethatyl applied at planting; this is similar to the results of Miller and Fornstrom (1989), who also found diethatyl followed by sequential postemergence herbicide treatments was less effective in controlling weeds than other preplant applied herbicides. Broadleaf weed density declined when postemergence herbicide treatments followed ethofumesate, cycloate plus ethofumesate, or diethatyl plus ethofumesate applied at planting, as compared to postemergence herbicides following diethatyl. Sugarbeet vigor loss was lowest and sugarbeet stand or root yield highest when postemergence applied herbicides followed diethatyl applied at planting. Sugarbeet vigor loss increased and sugarbeet stand and root yield decreased when postemergence applied herbicides followed diethatyl plus ethofumesate as compared to diethatyl applied alone.

When the five preplant applied herbicides were averaged over each of the postemergence applied herbicides there were no differences in sugarbeet selectivity and broadleaf weed density (Table 3). Yellow foxtail density was lowest when postemergence applied treatments contained sethoxydim. When herbicide treatments were combined in sequence, preplant applied herbicides had more influence on broadleaf weed control and crop selectivity than postemergence treatments.

**Table 3.** Response of weeds and sugarbeets to sequential herbicide applications before sugarbeet planting and after sugarbeet emergence.

| Treatment | Weed density | | Sugarbeet | | | |
|---|---|---|---|---|---|---|
| | Yellow foxtail | Broadleaf | Vigor loss | Stand | Sucrose | Yield |
| | (plants per 4 $m^2$) | | (%) | (plants per 15m row) | (%) | (t $ha^{-1}$) |
| Preplant (averaged over 4 postemergence treatments) | | | | | | |
| cycloate | 1 | 5 | 16 | 53 | 15.9 | 42.8 |
| ethofumesate | 2 | 3 | 18 | 58 | 15.6 | 42.3 |
| cycloate + ethofumesate | 1 | 2 | 18 | 62 | 15.4 | 44.6 |
| diethatyl | 1 | 7 | 12 | 67 | 15.6 | 48.4 |
| diethatyl + ethofumesate | 1 | 4 | 20 | 52 | 15.6 | 43.0 |
| LSD (0.05) | NS | 2 | 4 | 9 | NS | 5.1 |
| Postemergence (averaged over 5 preplant treatments) | | | | | | |
| desmedipham (desm) + phenmedipahm (phen) | 2 | 6 | 16 | 58 | 15.7 | 41.7 |
| desm + phen/desm + phen | 2 | 3 | 18 | 56 | 15.5 | 45.2 |
| desm + phen/sethoxydim + desm + phen | 0 | 4 | 18 | 58 | 15.5 | 45.9 |
| desm + phen/desn + phen/ trifluralin | 1 | 3 | 16 | 62 | 15.8 | 44.1 |
| LSD (0.05) | 1 | NS | NS | NS | NS | NS |

As sugarbeet growers design their weed control programs they need to identify the weed problem and select a herbicide program that addresses the pest. If weed density is low, either a preplant or postemergence applied herbicide followed by hand labor provides an economical weed control program (Winter and Wiese, 1982). If only a preplant herbicide is utilized, a combination of cycloate plus ethofumesate or diethatyl plus ethofumesate provides the best broadleaf weed control with crop selectivity similar to cycloate, ethofumesate, and diethatyl. If only postemergence weed control is desired, a split application of desmedipham plus phenmedipham is more effective than a single application and can be combined with sethoxydim if improved grass control is needed. If weed density merits sequential herbicide application, broadleaf weed density can be reduced to the greatest extent when cycloate plus ethofumesate, ethofumesate and diethatyl plus ethofumesate are applied at planting and followed by a postemergence applied herbicide treatment. These results are similar to those of Miller and Fornstrom, (1989), who also found that a preplant application of cycloate plus ethofumesate or diethatyl plus ethofumesate followed by a postemergence herbicide application provided the greatest reduction in weed density.

## LITERATURE CITED


Association of Official Agriculture Chemists. 1955. Official methods of analysis. 8th ed. Washington, DC. Pages 564-568.

Brimhall, P. B., E. W. Chamberlain, and H. P. Alley. 1965. Competition of annual weeds and sugarbeets. Weeds 13:33-35.

Dawson, J. H. 1965. Competition between irrigated sugarbeets and annual weeds. Weeds 13:245-249.

Dawson, J. H. 1977. Competition of late-emerging weeds with sugarbeets. Weed Sci. 25:168-170.

Dexter, A. G. 1988. Metolachlor for weed control in sugarbeets. Proc. North Central Weed Contr. Conf. 42:22.

Miller, S. D. and K. J. Fornstrom. 1989. Weed control and labor requirements in sugarbeets. J. Sugar Beet Res. 26(3&4):1-9.

Schweizer, E. E. 1980. Herbicides applied sequentially for economical control of annual weeds in sugarbeets. Weed Sci. 28:152-159.

Weatherspoon, D. M. and E. E. Schweizer. 1969. Competition between kochia and sugarbeets. Weed Sci. 17:464-467.

Weatherspoon, D. M. and E. E. Schweizer. 1971. Competition between sugarbeets and five densities of kochia. Weed Sci. 19:125-128.

Wicks, G. H. and R. G. Wilson. 1983. Control of weeds in sugarbeets *(Beta vulgaris)* with hand hoeing and herbicides. Weed Sci. 31:493-499.

Winter, S. R. and A. F. Wiese. 1982. Economical control of weeds in sugarbeets *(Beta vulgaris)*. Weed Sci. 30:620-623.

Zimdahl, R. L. and S. N. Fertig. 1967. Infuence of weed competition on sugarbeets. Weeds 15:336-339.