Evaluation of Herbicides for Weed Control in Sugarbeets in Manitoba

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The use of preplant, incorporated herbicides on sugarbeet fields is limited in Manitoba by the nature of the soils in the growing areas. Conversely, pre-and postemergence selective herbicides requiring no soil incorporation are more readily accepted in commercial practice.

TCA in (1, 5)[2] preemergence applications at rates of 8 to 9 lb./A and at postemergence rates of 4 lb/A is commercially used for the control of green foxtail [*Setaria virdis* (L) Beauv.].

Selective herbicides for postemergence control of broadleaf weeds in sugarbeet fields are reliably effective on limited numbers of weed species. Their successful use required the identification of weed species in the early seedling stages and a knowledge of the effectiveness of the available herbicides on each species. Complete weed control necessarily involves the application of one, or several chemicals in various combinations and at different rates.

Field testing of herbicides, singly and/or in combination, provides data on weed control and crop tolerance from the time of application. In addition, valuable information may be obtained at harvest from the yields of roots.

Methods

Two tests including preemergence and postemergence applications of herbicide treatments and hand weeding were conducted in 1970 at one location. Each trial included 12 treatments and was replicated 8 times.

The effectiveness of the treatments on weeds was assessed visually and by counting and weighing the weeds by species over a given length of row. Stand reductions, leaf damage, and the persistence of damage symptoms were used as a preliminary evaluation of crop tolerances.

The plots were four-rows wide and 50 ft long.

In each plot:

Row #1—was an untreated check.

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[2] Numbers in parentheses refer to literature cited.

Row #2—received a herbicide or herbicide combination treatment and hand weeding.
Row #3—received TCA preemergence at 8 lb./A.
Row #4—received the same treatment as #2 and delayed hand weeding.

Rows 1 (untreated check) and 3 (8 lb./A TCA preemergence) in each plot were hand weeded and thinned at normal thinning time. One of the pair of chemically treated rows in each plot (#2) was also thinned and weeded at this time, while the remaining one (#4) was timely thinned (June), but weeded much later in the summer (early August).

In Spring such a layout allows the comparison of each treated row with an adjacent untreated check and with a row receiving the standard TCA application, and it overcomes the difficulties frequently arising in comparisons with distant check plots when weeds are irregularly distributed within the experimental area. In addition, the timely and the delayed hand weeding of the two treated rows within each plot allow the simultaneous observation of the crop growing with and without the competition of weeds escaping the herbicidal effects.

In Fall the even rows in each plot were harvested and weighed separately. Thus, each pair of them constituted a main plot, and each one individually a sub-plot in a split-plot design (9) including a series of chemical treatments (main plots) and a series of superimposed hand treatments (sub-plots). Rows 1 and 3 were not harvested, acting as buffers between rows during the growing season. Controls that received only hand treatments and no herbicides were included for yield comparisons.

Common names, chemical names and other names of the chemicals used in the tests are given in the following list.

Common names or code numbers	Chemical names	Other names
TCA	Trichloroacetic acid	
Herbicide 273 (Endothall)	7 oxabicyclo (2.2.1) heptane 2, 3 - dicarboxylic.	
C 15935		
BAS 3502		
Delachlor (CP 52223)	2 - chloro-1Y (isobutoxymethyl) —2', 6' - acetoxylidide	
Phenmedipham (S4075)	methyl m-hydroxycarbanilate m-methylcarbanilate	Betanal
Dalapon	2.2 - dichloropropionic acid	

Table 1.—Spring evaluation of the effects on sugarbeet plots of preemergence application of herbicides at different rates, singly or in combination.

Treatment	Rate lb/A	Crop tolerance	Barnyard grass	Green foxtail	Redroot pigweed	Lambs-quarters	Other(*) br. lf.	Rank
1. TCA	8	8.9	1.0	6.5	0	0	0	9
2. Herbicide 273	4½	8.5	0	4.0	0	0	5.0	8
3. Herbicide 273	6	8.4	2.0	6.5	0	0	5.0	7
4. C-15935[1]	1¼	6.4	3.0	6.0	7.5	8.0	6.0	3
5. TCA + 15935	8 + 1¼	6.8	4.0	8.5	7.0	8.0	7.0	1
6. BAS 3502	3	9.0	0	5.0	4.0	5.0	5.0	6
7. BAS 3502	4	8.9	0	6.5	5.0	6.0	7.0	4
8. Delachlor	1½	8.3	2.0	8.5	6.5	4.5	2.0	5
9. Delachlor + phenmedipham[2]	1 + 1	7.8	3.0	7.5	5.0	9.0	7.0	2

[1] 25% Wettable powder.
[2] Phenmedipham applied postemergence.

Table 2.—Spring evaluation of the effects on sugarbeet plots of postemergence application of herbicides at different rates, singly or in combination.

Treatment	Rate lb/A	Crop tolerance	Barnyard grass	Green foxtail	Redroot pigweed	Lambs-quarters	Other(*) br. lf.	Rank
1. TCA	8	9.0	0	6.5	0	0	0	9
2. Herbicide 273	.8	9.0	0	4.0	0	0	6.0	7
3. TCA + Herbicide 273[1]	8 + .6	9.0	0	8.0	0	0	8.0	5
4. Dalapon	3	8.6	0	8.0	0	0	0	8
5. BAS 3502	4	9.0	0	0	6.0	0	7.0	6
6. Phenmedipham	1	8.0	0	7.0	4.0	6.0	7.0	4
7. Phenmedipham	1½	6.8	0	7.5	4.0	7.0	8.0	3
8. TCA + Phenmedipham[2]	8 + 1	6.8	0	8.0	4.0	7.5	8.0	2
9. TCA + Phenmedipham[2]	8 + 1½	5.8	0	8.5	4.5	8.0	8.0	1

[1] Herbicide 273 applied postemergence.
[2] Phenmedipham applied postemergence.

(*) Weed species included under the heading "Other broadleafs" were ladysthumb (*Polygonum pensylvanicum* L.) wild buckwheat (*Polygonum convolvulus* L.) common wild mustard (*Brassica* Kaber) (DC.) L. C. Wheeler *pinnatifida* (stokes) L. C. Wheeler and stinkweed (*Thlaspi arvense* L.)

Results

Tables 1 and 2 summarize the spring evaluation of the two-treatment series. Crop tolerance and weed control were scored on a scale ranging from 0 to 9 in which 0 indicates no tolerance and 9 no crop damages. The column on the right gives the ranking of the treatments for weed control only. Crop tolerance scores were not considered in the ranking of the treatments, for yield reductions did not result from plant damage observed in early summer.

The data in Tables 3 and 4 allow several sets of comparisons. Some are discussed here.

First, comparisons may be made between sub-plot means within the early or late weeded series. With few exceptions the yields in the early weeded series exceed those of the check treatments, thus indicating that in the absence of weed competition the crop fully recovered from early plant damage. The exceptions to this trend occur in the preemergence herbicide test, and the yield differences are not statistically significant.

Comparisons within the late weeded series show the damaging effect on yields of the competition from surviving weeds, and give an additional assessment of the degree of weed control of various treatments. Statistically significant differences occur in this series.

A third set of comparisons is possible between sub-plot means within each main plot. Differences in numbers of beets per plot and in yields are statistically significant and obviously related to the degree of weed control achieved by each treatment.

There appears to be a close association between yield reductions and late weeding. The latter resulted in lowering the harvest stands through damage from competition during the growing season and, possibly, from the weeding operations in the fall. Thus stand losses are identified as a component of the reduction in yields.

A second component is to be found in the reduction in size and weight of the roots in the weedy sub-plots. The pertinent data calculated from Tables 3 and 4 are summarized in Tables 5 and 6, from which several comparisons can be made.

The analysis of these data indicates that the smaller average size of roots in the late weeded plots was a larger component of yield reductions than the lower number of plants per acre harvested.

Tables 3 and 4 give the harvest stands and the yields of roots. The statistical analysis of these data gives significant F values (1% level) for the main plots and sub-plot mean squares.

Table 3.—Effects on sugarbeet stands and yields of spring and fall hand-weedings and preemergence applications of herbicides at different rates, singly or in combination.

Treatment	Rate lb/A	No of beets in 100′ rows			Yield of roots - tons/acre			Rank
		Spring wd.	Fall wd.	Main plots	Spring wd.	Fall wd.	Main plots	
1. TCA	8	91	70	80	8.0	4.3	6.2	8
2. TCA	8	86	70	78	9.0	4.9	6.9	5
3. Herb. 273	4½	81	72	77	8.0	4.2	6.1	9
4. Herb. 273	6	90	79	84	8.2	4.5	6.4	7
5. C-15935	1¼	73	68	71	8.6	5.7	7.1	4
6. TCA + C-15935	8 + 1½	79	79	79	8.1	7.3	7.7	3
7. BAS 3502	3	86	67	77	9.0	3.8	6.4	7
8. BAS 3502	4	86	73	79	8.7	4.6	6.7	6
9. Delachlor	1½	89	74	82	10.0	6.4	8.2	2
10. Delachlor + phenmedipham	1 + 1	93	86	90	9.0	7.7	8.4	1
11. Check a)		84	60	72	8.3	2.4	5.3	
12. Check b)		81	57	69	8.5	2.7	5.6	
MEANS		85	71	78	8.6	4.9	6.8	

	LSD		LSD	
	5%	1%	5%	1%
Between 2 main plot means	8.2	10.8	.81	1.08
Between 2 sub-plot means	2.9	3.8	.32	.42
Between 2 sub-plot means in any one main plot	10.0	13.2	1.11	1.47
Between any other two treatment means	10.8	14.3	1.13	1.50

Table 4.—Effects on sugarbeet stands and yields of spring and fall hand-weedings and postemergence applications of herbicides at different rates, singly or in combination.

Treatment	Rate lb/A	No of beets in 100′ rows			Yield of roots - tons/acre			Rank
		Spring wd.	Fall wd.	Main plots	Spring wd.	Fall wd.	Main plots	
1. TCA	8	89	72	81	14.4	8.5	11.4	5
2. TCA	8	79	70	75	13.2	8.1	10.7	9
3. Herb. 273	.8	87	67	77	14.0	7.6	10.8	8
4. TCA + Herb. 273	8 + .6	83	74	79	13.5	9.0	11.2	6
5. Dalapon	3	81	73	77	13.3	8.6	10.9	7
6. BAS 3502	4	78	64	71	13.1	6.5	9.8	8
7. Phenmedipham	1	79	74	76	13.2	9.9	11.5	4
8. Phenmedipham	1½	80	78	79	13.4	10.0	11.7	3
9. TCA + phenmedipham	8 + 1	82	86	84	13.8	11.7	12.7	1
10. TCA + phenmedipham	8 + 1½	85	89	87	12.9	11.3	12.1	2
11. Check a)		83	63	72	13.2	5.9	9.5	
12. Check b)		81	67	77	12.8	6.7	9.8	
MEANS		82	73	77	13.4	8.6	11.0	

	LSD		LSD	
	5%	1%	5%	1%
Between 2 main plot means	6.8	9.1	1.27	1.69
Between 2 sub-plot means	3.1	4.0	.38	.50
Between 2 sub-plot means in any one main plot	10.6	14.0	1.31	1.73
Between any other two treatment means	10.1	13.4	1.57	2.08

Table 5.—Effects on average root weights of spring and fall hand-weeding and of pre-emergence applications of herbicides at different rates, singly or in combinations.

Tretment	Weight per root in lb			Rank
	Spring wd.	Fall wd.	Main plots	
1. TCA	.75	.53	.64	8
2. TCA	.88	.59	.73	4
3. Herb. 273	.84	.48	.63	9
4. Herb. 273	.77	.49	.66	7
5. C-15935	.99	.70	.85	1
6. TCA + C-15935	.86	.78	.82	2
7. BAS 3502	.88	.49	.68	6
8. BAS 3502	.85	.55	.70	5
9. Delachlor	.96	.74	.85	1
10. Delachlor + phenmedipham	.83	.75	.79	3
11. Check a)	.83	.34	.58	
12. Check b)	.89	.36	.63	
MEANS	.86	.57	.71	

	LSD	
	5%	1%
Between 2 main plot means	.082	.108
Between 2 sub-plot means	.028	.037
Between 2 sub-plot means in any one main plot	.099	.132
Between any other two treatment means	.107	.142

Table 6.—Effects on average root weights of spring and fall hand-weeding and of postemergence application of herbicides at different rates, singly or in combinations.

Tretment	Weight per root in lb			Rank
	Spring wd.	Fall wd.	Main plots	
1. TCA	1.35	.98	1.17	6
2. TCA	1.40	.97	1.18	5
3. Herb. 273	1.37	.95	1.16	7
4. TCA + Herb. 273	1.38	1.04	1.21	4
5. Dalapon	1.37	.99	1.18	5
6. BAS 3502	1.43	.86	1.14	8
7. Phenmedipham	1.41	1.14	1.28	2
8. Phenmedipham	1.43	1.08	1.25	3
9. TCA + phenmedipham	1.42	1.17	1.30	1
10. TCA + phenmedipham	1.29	1.07	1.18	5
11. Check a)	1.34	.82	1.08	
12. Check b)	1.32	.90	1.11	
MEANS	1.38	1.00	1.19	

	LSD	
	5%	1%
Between 2 main plot means	.123	.164
Between 2 sub-plot means	.036	.047
Between 2 sub-plot means in any one main plot	.121	.161
Between any other two treatment means	.151	.200

Conclusions

The preemergence herbicide test confirmed the effectiveness of TCA in controlling green foxtail (*Setaria viridis* (L.) Beauv.) and of Herbicide 273 on ladysthumb (*Polygonum Pensylvanicum* L.) and Wild buckwheat (*Polygonum Convolvolus* L.). Both these herbicides are presently in commercial use, with Herbicide 273 used mainly in postemergence applications.

Experimental products such as C-15935 (*Ciba*) and delachlor (*Monsanto*) alone or in combination with TCA gave good overall control of the weeds occurring in the plots.

The evaluation of the treatments conducted in spring was confirmed in fall by the yield data.

The postemergence herbicide test showed a good degree of weed control with Phenmedipham (2, 4, 7, 8) applied alone and in combination with TCA. Redroot pigweed (*Amaranthus retroflexus* L.) was present in the experimental area, but it is known that its seedlings quickly become resistant to Betanal.

Dalapon (6, 10) at 3 lb/A gave satisfactory control of green foxtail, comparable to that of TCA at 8 lb/A preemergence.

The ranking of the treatments in this second trial is also essentially identical in the spring and fall evaluations.

Under the conditions prevailing in 1970 in the area of the test, the use of a split-plot design for the analysis of the yield data successfully complemented the information obtained from the spring evaluation of the treatments.

The estimation of yield losses due to weed competition and the breakdown of these losses in two components also provides information of practical value in extension work.

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