Results of Experiments on Chemical Weed Control in Sugar Beets

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The use of chemicals for the control of weeds in sugar beet agriculture is relatively recent. The chief impetus for this phase of research was furnished by the results obtained by Robbins and Bainer in 1947 (1)[2]. Several of the sugar companies tried pre-emergence weed control tests following the leads which had been established by these two workers. Also about this time other agencies became interested in experimentation with herbicides to control weeds in sugar beets. In the last four years cooperative and independent testing of chemicals has been carried on by the Beet Sugar Development Foundation, the United States Department of Agriculture, state experiment stations, commercial chemical companies, and by individual sugar companies.

Table 1.—Average Number Beets (B) and Grasses (G) in T.C.A. Treated and Non-treated Areas in 3 Different Fields—1950.

Field No.	No Treatment		5 lbs. T.C.A.		10 lbs. T.C.A.		15 lbs. T.C.A.		20 lbs. T.C.A.		25 lbs. T.C.A.	
	B	G	B	G	B	G	B	G	B	G	B	G
1	55	24	67	2	54	1	57	1	.	....	....	....
2	32	42	29	10[1]	24	8[1]	23	2	29	0	.. .	. .
3	46	17	50	3[1]	53	1	40	1	40	0	....	....

[1] These grasses died within one week after counts were made.

A large number of chemicals have been screened as to their herbicidal effects and this information has been fairly well disseminated to the workers in this particular field. As yet no one chemical appears to be effective in controlling all of the weeds in the different beet growing areas and it appears that the answer may be the use of specific chemicals for specific kinds of weeds.

The results of small plot tests in 1949 indicated that sodium trichloroacetate might hold some promise as a control for annual grasses. Since annual grasses are the principal weeds in the beet growing areas of southern Minnesota, northern Iowa and south-central Nebraska, it was decided to explore the possibilities of this herbicide for the specific problem which exists in these areas. The purpose of this paper is to present the results obtained in the strictly experimental phases of this problem. The results obtained in the commercial application are presented by Robinson and Quamme (2).

Methods and Materials

Sodium trichloroacetate was applied either as a pre-emergence or post-emergence spray in all experiments reported. In all cases the 90 percent material was used, and unless otherwise noted was applied in 30 gallons of water per acre as a blanket application.

[1] Plant Pathologist, Rocky Ford, Colorado, and Research Assistants at Mason City, Iowa, and East Grand Forks, Minnesota, respectively, American Crystal Sugar Company.

[2] Numbers in parentheses refer to literature cited.

The grassy weeds which were encountered most frequently *in* all of the test areas were:

Green foxtail	*Setaria viridis*
Yellow foxtail	*S. lutescens*
Burr bristlegrass	*S. verticillata*
Barnyard grass	*Echinochloa crusgalli*
Annual bluegrass	*Poa annua*

Table 2.—Average of Yields and Sucrose Content of Treated and Non-treated Plots (From five fields) in Mason City District—1950.

Rate T.C.A. Lbs. per A.	Tons Beets per Acre	Percent Sucrose	Lbs. Sugar per Acre
5	11.34	14.8	3,445
10	12.48	14.9	3,755
15	11.40	14.6	3,368
20	11.57	15.7	3,641
25	8.98	16.6	2,981
Untreated	10.76	14.8	3,067

Results

Tests in 1950 consisted of six-row plots in five farmers' fields in the Mason City territory. In most instances these strips were only 200 feet long. The rates of application were 5, 10, 15, 20, and 25 pounds of 90 percent T.C.A. per acre as pre-emergence spray treatments. As indicated by the results in Table 1 all of the rates of treatment effectively controlled the grass weeds. The data for this was secured by counting the number of grass seedlings in an area 12 inches x 6 inches running parallel to the beet row. Five such counts were made in each field for each treatment. Also five beet counts were made per 100 inches of row for each treatment. Each figure is the average of five counts.

The light rate of five pounds proved to be about as effective as the heavier rates. Not only was the grass almost entirely eliminated by thinning time but there was no further growth of grass in the treated areas for the rest of the growing season. However, the year following treatment, the growth of grass in some of these areas was just as luxuriant as it was in the areas untreated the previous year.

The yields in tons and pounds sugar per acre and sucrose content of the beets are presented in Table 2.

The results from these tests in 1950 were so uniform that it was tentatively determined to do some commercial application in 1951 and also expand the experimental work to determine the minimum effective rate of application as well as to determine whether the gallonage of the carrier could be cut enough so that low volume sprayers could be employed.

Pre-emergence and post-emergence tests were made in the Mason City, Grand Island, and Rocky Ford areas in 1951.

Four field tests were made in the Mason City districts to determine whether reduced gallonage sprays would be as effective as the 30- and 40-gallon rates which had been used in previous tests. There were two rates

of treatment for the T.C.A., namely: five pounds and eight pounds of 90 percent material per acre. Each rate was applied as a blanket application in 10-, 20-, and 30-gallon per acre treatments. Yields were not procured for these experiments; however, grass weed control was equally satisfactory with all of the treatments.

In another test made in the Mason City area, an experiment was made to determine the effects of rate and time of treatment on yields of beets and on the effectiveness of grass control. The rates and stages of treatments and results for this experiment are given in Table 3. This experiment was made as a randomized block with three replications. The plots were eight rows wide and 50 feet long. All rates of T.C.A. were applied in 30 gallons of water per acre.

Table 3.—Results Obtained with Two Rates of Treatment of 90 Percent T.C.A. at the Designated Stages of Beet Growth. Mason City, Iowa—1950.

Rate T.C.A. Lbs. per A.	Beet Stage at Treatment	Tons Beets per Acre	Percent Sucrose	Lbs. Sugar per Acre
5	Time of Planting	19.11	16.8	6,438
10	Time of Planting	19.70	17.2	6,773
5	Barely emerging	19.80	17.0	6,713
10	Barely emerging	17.64	17.3	6,078
5	Cotyledon to 2 leaf	18.67	16.5	6,142
10	Cotyledon to 2 leaf	16.77	17.5	5,866
5	4 to 6 leaf stage	17.57	17.2	6,051
Checks		17.22	17.4	5,978
Difference required for Significance		2.01	.70	555

The data presented in Table 3 quite clearly indicate that maximum benefits are obtained in pre-emergence treatments. There is a marked drop in tonnage yield with the 10-pound treatment rate when applied as a post-emergence treatment. This also holds true for the five-pound rate but to a lesser degree. This drop in tonnage is undoubtedly caused by the marked dwarfing effect on the beets which is evident from two to four weeks after the application of post-emergence treatments with T.C.A. However, regardless of this definite injury to the beets in post-emergence treatments none of the treatments was significantly lower than the untreated plots. However, in beets planted late in the season post-emergence treatment for grass control could very possibly make a marked difference in yield.

Table 4.—Effect of Different Rates of Treatment of T.C.A. on Tonnage, Percent Sucrose, and Pounds Sugar per Acre of Sugar Beets. Mason City, Iowa—1951.

Rate T.C.A. Lbs. per A.	Tons Beets per Acre	Percent Sucrose	Lbs. Sugar per Acre
2	18.02	17.7	6,361
3	18.06	17.6	6,358
4	17.77	17.3	6,148
5	18.79	17.4	6,552
6	18.05	17.3	6,249
7	18.94	17.2	6,526
Difference required for Significance	2.28	.45	758

Rates of treatment with T.C.A. were also tried in this area. T.C.A. at the rates of two, three, four, five, six and seven pounds was applied in 30 gallons of water per acre as pre-emergence treatments. Each plot was eight

rows wide and 50 feet long and each treatment was replicated three times. Grass control was satisfactory in all treatments until after thinning time. No grass was hoed out of the plots after the beets had been thinned. Only the broadleaf weeds were pulled. Just prior to harvest, grass was appearing above the beet foliage in the two, three, and four pound rates. The five, six and seven-pound rates of application held the grass in check for the entire season.

Table 4 presents the yields obtained in the above test.

Although the data indicate no significant differences in yield, there would definitely have been a saving in labor over any untreated check. Also if these plots had been harvested with a harvester grass roots *in* the two-, and three-pound rates would probably have given a little trouble.

Two pre-emergence tests with T.C.A. were made in the Grand Island area. Only one of these tests was harvested. The test consisted of five treatments replicated three times. The plot size was six rows wide and 50 feet long. The results of this test are given in Table 5.

Table 5.—The Effect of Pre-emergence Treatment with T.C.A. at the Designated Rates on the Yield of Sugar Beets. Grand Island, Nebraska—1951.

Rate T.C.A. Lbs. per A.	Tons Beets per Acre	Percent Sucrose	Lbs. Sugar per Acre
4	17.69	13.37	4,644
8	16.78	13.32	4,453
12	16.35	14.03	4,592
16	15.88	13.87	4,420
Check	14.82	14.07	4,128
Difference required for significance	3.46	.93	927

Two post-emergence tests were also run in this area but again only one of the tests was harvested. The spray treatments were applied when the beets were in the cotyledon to the very early two-leaf stage and in all cases there was a stunting of the beets. This stunting was especially severe at the eight- and 10-pound rates. The data for this experiment are presented in Table 6.

Table 6.—Effect of Post-emergence Treatment with T.C.A. at the Designated Rates on Yieldsi and Percent Sucrose of Sugar Beets. Grand Island, Nebraska—1951.

Rate T.C.A. Lbs. per A.	Tons Beets per Acre	Percent Sucrose	Lbs. Sugar per Acre
2	14.20	13.25	3,764
4	16.32	12.18	3,934
6	16.32	13.62	4,411
8	15.37	13.00	4,007
10	16.73	13.55	4,507
Check	15.91	12.78	4,045
Difference required for significance	2.70	1.24	759

The results on the tests reported in both Tables 5 and 6 were obtained from adjacent rows in the same field, the only difference being in time of treatment. Grass control was excellent except in the two-pound post-emergence treatment. Besides grasses there were also pigweeds present in this field. The pigwed was definitely stunted at the 12-pound pre-emergence rate and better than an 80 percent kill was obtained at the 16-pound pre-emergence rate.

Although neither test shows significant differences in yield, the general tendency is for the pre-emergence treatments to outyield the post-emergence treatments.

An interesting sidelight developed in the tests in this area. Precipitation totaled 7.11 inches within four weeks after the pre-emergence treatments. It was assumed that an excess of rainfall might leach the T.C.A. too deep and either make it inoperative for grass control or cause injury to the beets. In spite of the heavy rainfall the treatments controlled the grass weeds and there was no apparent injury to the beets.

Both a pre-emergence and post-emergence test were conducted at Rocky Ford, Colorado. Only the post-emergence test was harvested. The results for this test are presented in Table 7.

Table 7.—Effect of Post-emergence Treatment with T.C.A. at the Designated Rates on Yields and Sucrose Percent of Sugar Beets. Rocky Ford, Colorado—1951.

Rate T.C.A. Lbs. per A.	Tons Beets per Acre	Percent Sucrose	Lbs. Sugar per Acre
4	18.32	15.69	5,733
6	14.82	13.80	4,090
8	16.01	14.85	4,853
10	17.12	14.79	5,107
Check	14.36	15.16	4,361

Although there were only two replications in this experiment it is probable that the differences in yield are fairly reliable. Certainly the grass was controlled effectively.

There was no precipitation for three weeks after the spray had been applied. During this period, there was little visible evidence of grass control in spite of the fact that the field had been irrigated after treatment. A total of one and ninety-one one-hundredths inches of rainfall was obtained during the fourth week. Five weeks after treatment all of the grass was dead in the treated plots.

Also, in the pre-emergence test, in spite of the fact that the beets had to be irrigated up there was little evidence of grass control until after the rains. From this experience and similar experiences in previous years it is evident that T.C.A. when sprayed on the surface is only effective in grass control when it has been leached down into the root zone of the grasses. This can not be accomplished by row irrigation.

Additional experimentation is necessary to determine whether incorporating the T.C.A. in the upper three or four inches of soil will make it effective as a grass control under conditions of row irrigation with no intervening spring rains.

Discussion

T.C.A. definitely has a place in the control of annual grasses other than wild oats in sugar beet agriculture. From the three years experience of using T.C.A. at the rates effective for grass control there seems to be no residual effect on crops which follow sugar beets. In areas where beet

agriculture is dependent on rainfall the problem of buildup of T.C.A. in the soil will probably be of minor importance.

T.C.A. may not be immediately effective in a very dry spring; however, there is some evidence that in the eastern areas only one-half inch of moisture is necessary to carry the chemical to the root zones of seedling grasses.

Summary

1. Sodium trichloroacetate (90%) used as a pre-emergence spray treatment in sugar beets adequately controlled annual grasses in northern **Iowa,** southcentral Nebraska, and at Rocky Ford, Colorado.

2. Between five and seven pounds of 90 percent T.C.A. applied in 10 to 30 gallons of spray material per acre seem to be an adequate dosage for control of most annual grasses.

3. Adequate rainfall seems to be necessary in order for the **T.C.A.** to be effective.

4. Pre-emergence treatments are more effective than post-emergence treatments.

5. T.C.A. at the dosages tried had little if any effect on sucrose content of the beets and did have a tendency to increase yields.

Literature Cited

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