# Progress Report on Weed Control Studies at Fort Collins, Colorado[1]

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THE TREND toward complete mechanization of the field work of growing the sugar beet crop has focused the attention of the industry on the problems of early season control of weeds in the crop. A weedy initial stand of sugar beets can be cleaned up by hand work to obtain a satisfactory thinned stand that will be relatively weed-free for the balance of the season and will produce a normal crop. With customary practices and equipment it is much more difficult, if not impossible, to achieve such results by machine work alone, if initial stands are weedy.

In two of the 1947 projects of the Sugar-Beet Field Station at Fort Collins,[3] several chemical or cultural methods were tried for the control of weeds in initial stands of sugar beets. The first of these projects was a replicated test of several treatments that might promote better emergence of the sugar beet seedlings and/or control weeds in the initial stands. In the second project, newly discovered chemicals that are important as weed toxicants were applied to the soil. 2,4-Dichlorophenoxyacetic acid (2,4-D) and Isopropyl-N-Phenyl-Carbamate (IPPC) in sand were sprinkled in dry condition on the soil, following basic experiments conducted at Beltsville, Md.[4] Sugar beets were then seeded at intervals after the chemicals had been lightly worked into the surface layer.

The first of these tests was carried to harvest and yield data were obtained. The second test was started somewhat late in the season and only general observations on weed growth and emergence of sugar beet seedlings were recorded.

## Emergence and Weed-control Experiment

This test consisted of 8 randomized blocks of 12 treatments. The plots were 4 rows wide and 50 feet in length with rows 20 inches wide and plant spacing in the row of approximately 12 inches. The two inside rows of each plot were harvested for yields. Two 20-beet samples were taken for analysis and the cleaned weight of all roots obtained for calculation of yields.

The treatments included in this test were as follows:

1. Check: no special treatment.

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[3]Investigations of the Division of Sugar Plant Investigations at Fort Collins, Colo., are cooperative with the Agronomy Section of the Colorado Agricultural Experiment Station and the experiments reported in this paper were conducted on the Agronomy Farm of the latter agency.

[4]Mitchell, John W., and Marth, Paul C., "Sensitivity of grasses and some crop plants to Isopropyl-N-Phenyl-Carbamate" Science 106: 15-17, 1947.

2. Ridge cover: a separate cultural operation immediately after planting in which all the space between the rows was given a shallow cultivation and about 1½ to 2 inches of additional soil was thrown on the beet row as a ridge. The ridges were removed 4 to 5 days later.
3. Blade weeder: a flat, blade weeder was run at a depth of 1 inch immediately ahead of the drill shoe of the planter.
4 to 7. Mulches: narrow bands of four mulching materials were spread, very lightly, on the beet rows immediately after planting. The purpose of the mulches was control of soil crust and possible conservation of moisture in the row.
8. Salt: a side-dressing of 500 pounds per acre, applied after thinning, to test possible accessory fertilizer value of salt.
9. IPPC: 5 pounds per acre of the chemical applied as spray for weed control, to the beet rows prior to thinning.
10. Salt: a solution of about 2½ pounds of salt per gallon of water was applied as spray for weed control on the beet rows at the rate of 90 gallons per acre. Applied before thinning.
11. Sodium nitrate: applied as spray for weed control at same rate as for treatment 10.
12. "Fertidene": an organic iodine compound, applied with sprinkling can immediately after planting at rate of 1 gram in 10 quarts of water per 100 feet of row. Purpose was to test possible growth-promoting effect of the chemical.

The soil in the experimental field is Fort Collins Clay loam. In 1946, spring wheat was seeded late on this field and was more weedy than is usual for grain crops. The wheat stubble was irrigated, manured at a moderately heavy rate and fall plowed. Some early germinating weeds such as (*Kochia scoparia* L. Roth), Russian thistle (*Salsola pestifer* A. Nels.) and lambquarter (*Chenopodium album* L.) emerged in late March and early April. Foxtail grass (*Setaria* spp.) was emerging when seedbed preparation was started in mid-April. Because of wet soil the preparation of the seedbed was not completed till April 21. The test was planted May 5 with a four-row tractor drill. Sheared, commercial, sugar beet was planted at the rate of 4½ pounds per acre. In a standard germination test of a sample of this seed, 400 seed pieces produced 438 sprouts from 283 viable seed pieces.

At the time of planting very few weeds were in evidence, but germinating weeds could be found in the soil. Surface moisture had been depleted at this time and very few of the beet seeds were placed in contact with moist soil. A few beet seedlings had emerged by May 13, but the majority emerged in the period May 16 to 20, following showers that began May 9. Showery conditions continued to the end of May at which time moderate to heavy stands of weeds were present on all areas of the test except the plots of treatment 2 and in the rows of treatment 3.

On June 4 and 5 all plots of the test, except those of treatments 9, 10 and 11, were cultivated by hand with Planet Jr. garden cultivators. Weed growth was sufficient to make this job difficult, but a good kill of the weeds between the rows was obtained. The sprays were applied to treatments 9, 10 and 11 on June 5 and 6. Complete first cultivation of the test with a tractor was delayed by weather conditions until June 16. The tools used for the tractor cultivation were knives run close to the rows with duckfeet in the middles. By this time weed growth on the sprayed plots was so dense and vigorous that a good job was impossible and the middles of these rows were finally cleaned by hand hoeing on June 23. In general, cultural operations to mid-June were not timely because of weather conditions. Heavy weed growth had been favored. The test was blocked and thinned by hand on June 24 and 25. Reasonably good and clean-thinned stands were obtained on all plots of the test. Summaries of the counts of initial and thinned stands are given in table 1.

**Table 1.** Emergence and weed-control experiment, Fort Collins, Colorado, 1947. Summary of initial and thinned stands of sugar beet plants.

| Treatment | Stands[1] | |
|---|---|---|
| | Initial (seedlings per 100 feet of row) | Thinned (plants per 100 feet of row) |
| 1. Check: no treatment | 346 | 91.4 |
| 2. Ridge cover | 367 | 96.5 |
| 3. Blade ahead of drill | 346 | 96.2 |
| 4. Mulch: powdered alfalfa | 340 | 89.6 |
| 5. Mulch: chopped alfalfa | 329 | 87.2 |
| 6. Mulch: rotted manure | 339 | 88.2 |
| 7. Mulch: fresh manure | 343 | 91.2 |
| 8. Salt: side dress after thinning | 334 | 91.5 |
| 9. IPPC: spray before thinning | 359 | 92.6 |
| 10. Salt: spray before thinning | 341 | 91.0 |
| 11. $N_aNO_3$: spray before thinning | 350 | 83.6 |
| 12. "Fertidene": at planting | 349 | 88.9 |

[1]Initial stands given as 4-plot averages. Thinned stands given as 8-plot averages.

Treatments 8 and 12 are not of interest in the present discussion and may be dismissed with the comment that their yields did not significantly differ from the yields of the check. Since the mulches, treatments 4 to 7, inclusive, appear to have had no effect on germination of beet seed, as indicated by the initial stands, under the conditions of this test they may be similarly dismissed.

It appears doubtful that any of the treatments appreciably affected germination of the beet seed or emergence of the beet seedlings. Similarly there is little evidence that the thinned stands were affected by any of the treatments. Treatment 11, which received the sodium nitrate spray, is a possible exception. However, even in this case the comparatively low average stand for this treatment is principally due to poor stands on two of the plots where weed growth was particularly dense and vigorous and the beet seedlings were subjected to very severe weed competition prior to thinning.

The IPPC spray, treatment 9, caused no observable effects on either weeds of any kind or the beet seedlings. Since in reports of the control of quackgrass this chemical was applied to the soil, it is possible that the spray used in this case (an emulsion of a toluene solution of the chemical) would not be expected to affect the plants.

Both the salt and sodium nitrate sprays caused evident injury to susceptible weeds such as redroot (*Amaranthus retroflexus* L.), wild buckwheat (*Polygonum convolvulus* L.) and foxtail grasses (*Setaria* spp.) as well as the beet seedlings. In the case of the weeds, evaluation of the effects of the sprays was difficult for the reason that these same weeds are also susceptible to frost injury and had been damaged by freezing temperatures which followed a late season snow storm May 28. However, few, if any, weeds were killed by either the freeze or the sprays. At most, growth of some weed plants had been only slightly checked by burning of leaf edges and damage to the growing tips of the plants. Since beet seedlings had not been appreciably damaged by the freeze, the effect of the sprays was more evident than in the case of the weeds. Both salt and sodium nitrate caused considerable burning of sugar beet leaves. Most of the beet seedlings made quick recovery from the effects of the salt spray, but some that received the sodium nitrate spray were killed.

The cultural practices, treatments 2 and 3, were effective in the control of weeds in initial stands of sugar beets under the conditions of this test. All the area of the ridge-covered plots was essentially weed-free at all times and the sugar beet seedlings made unusually rapid and vigorous growth. Treatment 3, in which the blade weeder was run ahead of the drill shoe at planting, was effective in the control of weeds immediately in the beet rows. Weed growth between the rows of this treatment was as great as in the check plots, but these weeds were killed by the first cultivation and an essentially weed-free initial stand of sugar beets was attained by this method. Growth of the seedlings was nearly as rapid and vigorous as that of the ridge-covered beets and by mid-June there was little apparent difference in the progress and condition of the sugar beet plants in these two treatments.

The cultivation of June 4 to 5 gave fairly effective control of weeds between the rows of treatments 1, 4 to 8 and 12. However the weeds in the row remained and continued to give the beet seedlings competition until the plots were thinned June 24 to 25. The beet seedlings in these treatments made good progress in spite of the weeds, but were markedly smaller when thinned than the beet plants in treatments 2 and 3. As previously noted, since sprays were to be used for weed control on treatments 9, 10 and 11, the plots of these treatments were not cultivated until June 16 when the tractor cultivator failed to do an effective job and the plots had to be cleaned between the rows by hand hoeing June 23. Since the sprays were ineffective, the beet seedlings in these plots were subjected to competition from weeds, both in and between the rows, until just before

thinning. Growth of the beet seedlings in these plots was markedly poorer than with any of the other treatments and at time of thinning many were small and weak. However, counts of the thinned stands indicated that, except for a few plants killed by the sodium nitrate spray, very few beet plants had actually been lost. Weed competition had weakened, but had not killed these plants by late June.

Thinned stands were counted July 3. At that time the beet plants in plots of treatment 2, ridge cover, were growing vigorously and some were touching in the row. The plants of treatment 3 were not quite so large, but were vigorous and making excellent progress. The plants of treatments 1, 4 to 8 and 12, subjected to weed competition only within the row after cultivation on June 5, averaged markedly smaller, but their general condition was good and they were just beginning to make excellent progress. In the case of the sprayed plots, treatments 9, 10 and 11, condition of the beet plants varied from nearly as good as the check on a few plots that had been subjected to the least weed competition to plants that were very small and weak in the plots where weed competition had been severe. Many of these beet plants had only 3 to 5 living leaves and these were small and pale. Also at that time most of the plots of these three treatments had a slight to moderately heavy infestation of sugar beet webworm. Evidently the webworm moths had selected the weedy plots for egg deposition. The plots having the weakest beet plants, where weed growth had been heaviest, had the greatest populations of webworms and had suffered the most damage to the foliage. Damage by the insect on July 3 varied from slight to nearly complete skeletonization of the beet leaves.

Acre yields and percentage sucrose from this test are summarized in table 2. In general, the differences in yield of roots were much smaller than would have been expected from the condition and progress of the sugar beet plants as observed in early July. Apparently, beet plants in this test made remarkable recoveries from the effects of weed competition and insect injury early in the season. However, the yields from treatments 2 and 3, that suffered little, if any, weed competition at any time were the highest of the test and the yields from treatments 9, 10 and 11, that had been subjected to severe weed competition and some webworm injury, were the lowest. Some differences are slightly above the difference required for statistical significance at the 5-percent point. None of the treatments affected quality of the beets as indicated by percentage sucrose, therefore, the acre yields of gross sugar follow the trends of the root yields.

The results of this test may have some important implications. Ridge cover, as employed in this test consisted of a complete cultivation that stirred all the soil between the rows to a depth of 2 or 3 inches and threw a shallow additional cover of loose dirt on the rows. It gave complete weed control and an essentially weed-free initial stand of sugar beets. However, this cultural practice necessitates two additional cultural operations and involves the risk of having the beet seedlings caught in the ridge should adverse weather prevent the removal of the ridge at the proper time.

**Table 2.**—Emergence and weed-control experiment, Fort Collins, Colorado, 1947. Acre yields of roots and gross sugar and percentage sucrose. (Data given as 8-plot averages.)

| Treatment | Acre yields | | |
|---|---|---|---|
| | Roots | Gross sugar | Sucrose |
| | (tons) | (pounds) | (percentage) |
| 1. Check: no treatment | 14.98 | 4256 | 13.99 |
| 2. Ridge cover | 15.73 | 4419 | 13.96 |
| 3. Blade ahead of drill | 15.61 | 4472 | 14.16 |
| 4. Mulch: powdered alfalfa | 14.26 | 4000 | 13.95 |
| 5. Mulch: chopped alfalfa | 15.15 | 4276 | 13.91 |
| 6. Mulch: rotted manure | 15.25 | 4355 | 14.04 |
| 7. Mulch: fresh manure | 14.86 | 4227 | 14.05 |
| 8. Salt: side dress after thinning | 15.42 | 4371 | 14.03 |
| 9. IPPC: spray before thinning | 14.05 | 3976 | 14.00 |
| 10. Salt: spray before thinning | 13.93 | 3921 | 13.97 |
| 11. $NaNO_3$: spray before thinning | 13.61 | 3824 | 13.85 |
| 12. "Fertidene": at planting | 15.15 | 4263 | 13.93 |
| General mean of experiment | 14.83 | 4197 | 13.99 |
| F value | 2.03* | 1.83 | [1] |
| 2 x the S. E. of a difference (Odds of 19 : 1) | tons 1.39 | pounds 445 | |
| S. E. of mean in percentage of general mean | percentage 3.31 | percentage 3.75 | percentage 1.54 |

[1] $V_e$ exceeds $V_t$.

A blade weeder knife run flat at a depth of about 1 inch immediately ahead of the drill shoe at planting effectively controlled weeds in the beet row itself. Since weeds between the beet rows were killed by the first cultivation this treatment also produced an essentially weed-free initial stand of sugar beets. This treatment has the advantage over ridge cover of requiring no additional cultural operations and involves no risk to normal emergence of the sugar beet seedlings. In this test the yields of roots and sugar per acre were approximately identical from these two treatments and slightly higher than the yields from any other treatment used.

In this experiment spraying with IPPC, salt, or sodium nitrate was ineffective as a weed control. The IPPC spray, as used, had no apparent effect on weeds or sugar beet plants. The salt spray slightly burned the leaves of susceptible weeds and beets, but killed neither. The sodium nitrate spray killed a few beet plants and may have damaged susceptible weeds slightly more than the salt spray, but was also ineffective as a weed control.

## Application of Chemicals to the Soil

Because of lateness of the season and other considerations, the work undertaken on this phase of weed-control investigations in 1947 was much curtailed from the originally proposed cooperative project between the Division of Sugar Plant Investigations and the Division of Fruit and Vegetable Crops and Diseases.[5] The project in its curtailed form consisted of four observation blocks each approximately 60 by 60 feet in size. To three of these, chemicals were applied on the surface of the soil and the fourth was held untreated as a check. These blocks were a part of the 10-acre field used for general sugar beet experiments on the Agronomy Farm of

[5] The writer is indebted to J. W. Mitchell, P. C. Marth and L. W. Kephart for suggestions relative to timing of applications and the amounts of the chemicals to use in these preliminary trials.

the Colorado Agricultural Experiment Station at Fort Collins, Colorado, and on each a series of sugar beet plantings were to be made at approximately weekly intervals.

The land had not been worked from April 21 to May 15, hence a moderately heavy growth of weeds was present when work was started on the latter date. The 2-4-D was mixed with dry sand and broadcast by hand on the appropriate blocks after which the whole area of the test was cultivated with a springtooth cultivator and smoothed with a harrow. Both these tools were run in a direction diagonal to that of the beet rows subsequently planted. The shipment of IPPC was not received until 2 days after this cultivation. It was applied May 18 to its appropriate block in the same way as the 2,4-D but on the cultivated surface and was lightly worked into the surface of the soil with a rotary-type garden cultivator. Thus the 2,4-D was mixed into the surface 3 to 4 inches of soil and the IPPC only into about the surface inch of soil. Showers totalling nearly 1 inch of precipitation had occurred in the period May 9 to 12 and the soil was in excellent condition for working. Practically all weeds were killed by this cultivation. Frequent showers maintained sufficient moisture in the surface soil for germination of the beet seed planted until near the end of June. Germination of the June 20 planting was nearly normal, but that of the June 27 planting was not complete until after irrigation in July.

The treatments consisted of the application of 10 pounds per acre of 2,4-D on block I, 20 pounds per acre of 2,4-D on block II, 40 pounds per acre of IPPC on block III, and the untreated check block IV.

The first planting of sugar beets was made May 16 following the application of 2,4-D and 2 days before the application of IPPC. Subsequent plantings of beets were made on May 24, May 31, June 6, 16, 20 and 27. The June 27 planting was actually only a replanting of the 2,4-D blocks first planted on May 16 and on which practically no beet plants had emerged.

By the middle of June there was a moderately heavy weed growth on the check block and by the end of June weeds appeared to be giving beet seedlings of the June 16 and 20 plantings severe competition on this block. Both the blocks treated with 2,4-D and the block treated with IPPC were essentially weed-free in mid-July and remained nearly weed-free for the balance of the season. Only a few weeds, chiefly purslane, appeared late in the summer on the open areas of the blocks treated with 2,4-D. In the case of the block treated with IPPC the beets had made sufficient growth to have smothered any weeds appearing in late summer.

Notes taken July 5 of the initial stands of sugar beets present at that time on these plots are summarized in table 3. In general the effects from the 20-pound rate of application of 2,4-D had been more lasting than the effects of the lighter rate. Practically no beets were found on either the May 16 or May 24 planting on either of the 2,4-D blocks. Beginning with the third planting of beets on May 31, a little over 2 weeks after the appli-

cation of 2,4-D, there was a gradual increase in the number of sugar beet plants that had emerged and survived from the successive plantings until the June 27 planting. Emergence of this planting was very sparse due to insufficient moisture for germination. However, the more or less uniform partial emergence of beet seedlings indicated that the effects of the 2,4-D on germinating beet seed had ceased on the block to which 10 pounds per acre of the chemical had been applied and had practically ceased on the block receiving the heavier application of the chemical. In this test it required approximately 6 weeks' time to dissipate effects of applications of 10 and 20 pounds per acre of 2,4-D to a sufficient degree to permit nearly normal emergence of sugar beet seedlings.

**Table 3.**—Chemical treatment of soil test, Fort Collins, Colorado, 1947. Summary of emergence and survival of sugar beet seedlings from seed plantings at intervals after chemicals were applied. (Notes taken July 5, 1947.) Beet seedlings rated as initial stands.

| Date beets planted | Block I. 2,4-D. 10 lb. per A. May 15, 1947. | Block II. 2,4-D. 20 lb. per A. May 15, 1947. | Block III. IPPC. 40 lb. per A. May 18, 1947. | Block IV. Check, no treatment. |
|---|---|---|---|---|
| May 16 | None | None | Fair to good | Excellent |
| May 24 | None | None | Fair to good | Excellent |
| May 31 | Very few | 2 plants | Fair to good | Excellent |
| June 6 | Very few | Sparse | Good | Excellent |
| June 16 | Thin | Sparse | Good | Good |
| June 20[1] | Thin | Very few | Thin | Thin |
| June 27[2] | Very thin | Very thin | | |

[1]June 20 planting made just as soil moisture barely sufficient for germination of seed. Weeds abundant on check plot.
[2]Soil moisture definitely short for normal germination of seed. This was a replanting of the 2,4-D blocks where the May 16 planting had failed.

On the block treated with 40 pounds per acre of IPPC emergence of sugar beet seedlings from the first three plantings appeared to have been slightly delayed and early growth of these seedlings may have been slightly less vigorous than in the comparable plantings on the check block. Seedlings from the later plantings unquestionably emerged and grew normally.

On June 27 all palntings on the check block were cultivated and the first three plantings thinned. The three plantings having corresponding planting dates on the IPPC block could have been thinned at the same time, but were left for observation during a Field Day planned for the Agronomy Farm for early July. In late July all the blocks of the test were hoed and at that time some beets cut out of the plots not thinned on June 27. In general, this may be regarded as a poor job of long-handled-hoe thinning and was particularly poor on the first three plantings of the IPPC block because of the large size these beets had attained by that time.

None of these plots were harvested for yield. However, approximately 60 feet of row from each planting on each block was dug and the beets counted and weighed in mid-October. Root counts and weights of these beets are summarized in table 4. Since different dates of planting and differences in thinning are involved the root weights probably have no significance. The number of beets harvested is some measure of the effect of the chemicals on emergence and survival of sugar beet plants on the chemically

treated blocks. The number of beets harvested from the successive plantings on the check block may in the same way reflect the effects of weed competition.

When 2,4-D was applied at the rate of 10 pounds per acre emergence of beet seedlings was practically inhibited for at least 2 weeks, the effect of the chemical had been partially dissipated at 3 weeks and practically normal thinned stands were obtained after 4 weeks. When 2,4-D was applied at 20 pounds per acre the effects appear to have persisted for about 2 weeks longer, but were probably entirely dissipated by the end of June or about 6 weeks after application.

**Table 4.**—Chemical treatment of soil test, Fort Collins, Colorado, 1947. Number and weight of beet roots harvested from 60 feet of row per plot October 14, 1947. (Data given as single-plot values.)

| Date beets planted | Block I. 2,4-D. 10 lb. per A. May 15, 1947 | | Block II. 2,4-D. 20 lb. per A. May 15, 1947 | | Block III. IPPC. 40 lb. per A. May 18, 1947 | | Block IV. Check, no treatment | |
|---|---|---|---|---|---|---|---|---|
| | (roots) | (wt.) | (roots) | (wt.) | (roots) | (wt.) | (roots) | (wt.) |
| May 16 | None | --- | [1] | 1.7 | 35 | 28.4 | 59 | 60.9 |
| May 24 | 3 | 1.8 | None | --- | 34 | 38.4 | 55 | 48.6 |
| May 31 | 7 | 7.3 | None | --- | 42 | 39.9 | 54 | 42.9 |
| June 6 | 23 | 17.3 | 3 | 4.3 | 52 | 38.8 | 49 | 32.7 |
| June 16 | 32 | 26.4 | 7 | 7.5 | 43 | 26.4 | 33 | 28.4 |
| June 20 | 37 | 30.8 | 18 | 17.7 | 38 | 32.0 | 37 | 28.7 |
| June 27[2] | 28 | 18.5 | 37 | 19.4 | --- | --- | --- | --- |

[1]This beet was possibly from the June 27 planting, but appeared to be an older beet. If from the May 16 planting, it was probably an escape on a spot in the row that received none of the chemical.

[2]June 27 planting was a replanting of the 2,4-D blocks where the May 16 planting had failed.

There is no evidence that IPPC applied at 40 pounds per acre in this test materially reduced the emergence of sugar beet seedlings or prevented their survival. Such differences in stand, as are indicated by the number of roots harvested from these single rows, were most likely, due to normal variability and careless thinning of these plots. The low weight of roots harvested from the first planting on this block may or may not reflect an effect of the chemical. Further tests with better control of all factors will be necessary to decide this point.

It is probable that weed competition contributed to the lower numbers of roots harvested from the June 16 and 20 plantings on the check block. These plantings were very weedy when hoed and thinned in late July and elimination of the weeds was the chief concern of the laborers doing this job. In fact, the greater number of beets harvested from the June 20 planting on the IPPC block, in comparison with the check, may be directly due to the absence of weeds on the IPPC block at that time.

In this test applications of 10 and 20 pounds per acre of 2,4-D and 40 pounds per acre of IPPC practically eliminated weed growth for the balance of the season. Since both monocotyledonous and dicotyledonous weeds emerged in appreciable numbers on the check block during the same time it appears that both chemicals were equally effective in controlling

both types of weeds. It seems unreasonable to believe that IPPC would inhibit growth of dicotyledonous weeds and at the same time permit emergence and normal growth of sugar beet seedlings. In this test the chemical was very lightly worked into the surface soil and it is probable that the beet seed was placed below the zone of soil holding most of the chemical. Additional tests of these chemicals are necessary before conclusions are possible as to their effectiveness as weed controls for the sugar beet crop.

## Summary

In tests conducted at Fort Collins, Colorado, in 1947, neither common salt nor sodium nitrate proved effective in killing weeds in sugar beet rows when the chemicals were applied as sprays to weedy rows of sugar beet seedlings prior to thinning. The spray solutions were made by dissolving 2½ pounds of chemical per gallon, and the application rate was about 90 gallons per acre. A spray of IPPC, approximately 5 pounds per acre, also was ineffective.

Ridge covering directly after planting followed by removal a few days later of the excess soil above the drilled seed was highly effective in preventing initial growth of weeds; a planting-time cultivation of the beet row obtained by placing a weeder blade immediately ahead of the drill shoe of the seeder to run at a depth of about 1 inch effectively prevented weed growth in the drill row itself, but weeds grew abundantly in the middles. These were eliminated by ordinary cultivation. Ridge cover, as used in this test, would have advantages if very heavy emergence of weeds was expected. With moderately heavy emergence of weeds, such as occurred in this test, the use of the blade weeder was as effective as ridge cover so far as weeds in the drill row were concerned and has the advantage that no additional cultural operations are involved and there is no risk to emergence of sugar beet seedlings.

In a preliminary experiment 2,4-D (10- and 20-pound per acre rates) and IPPC (40-pound per acre rate) were applied as surface treatments. Both chemicals almost completely prevented weed growth throughout the balance of the season. Dependent upon application rate, 2,4-D required 3 to 6 weeks for the chemical to dissipate enough from the soil so that sugar beet seedlings could emerge. On the other hand, IPPC had only slight effect even when the sugar beet seeds were planted at about the time of its application to the soil.