# Selection of Sugar Beets for Tolerance to Endothal Herbicide

R. T. Nelson, R. R. Wood and R. K. Oldemeyer[1]

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Some injury to sugar beets has been observed in the seedling stage where the herbicide endothal (disodium 3, 6-endoxohexahydrophthalate) was used at rates sufficiently high to give good weed control. Comparative observations in commercial sugar beet fields have frequently shown as much as 15% reduction in prethinning stand on endothal treated areas. Also, over-all seedling vigor of surviving plants is generally retarded but occasional beets have shown no apparent injury from the endothal used for weed control. This suggested a genetic difference in tolerance to endothal between beets of a variety; and on this assumption, selection for tolerance was initiated in December of 1957.

First attempts at finding endothal tolerant sugar beets included the germination of seed on blotters, and on agar, impregnated with a solution of endothal. Before any beets were actually saved for variety improvement and progeny tests these methods were replaced by growing beets in coarse sand moistened with endothal solution.

The first selection was made on a monogerm variety. Selection by two different criteria was done in the greenhouse using flats three inches in depth as containers. Selection A was made on the basis of normal development of primary root on seedlings growing in flats treated at a rate of 10 pounds of endothal per acre. Selection B was based on seedlings surviving a rate of 140 pounds of endothal per acre. In both cases, the endothal was applied at time of planting and was mixed in sufficient water so that the entire volume of sand was moistened.

Approximately 120 plants were selected for each group and the selected plants amounted to about 4% of the parent population. The selected plants were grown in the greenhouse for rapid seed production, and immediately on getting the seed, a progeny test was run using flats and coarse sand. Rates of endothal of 10 and 140 pounds per acre were again used. The results of growing seedlings of the original parent seed and seed of Selections A and B at the 10-pound rate of endothal showed no difference in stand, but more vigor was noted in seedlings of the selections. The progeny test made at the 140-pound rate was

[1] Agronomist, Agronomist, and Plant Breeder, respectively, Agricultural Experiment Station, The Great Western Sugar Company, Longmont, Colorado.

in favor of the selections both in vigor and stand in spite of their apparent poorer seed quality as compared with the parent seed. Percentage emergence and percentage survival of seedlings at the 140-pound rate were equal. Based on monolocular seed units planted, percentage survival within each of the three groups was as follows:

| | |
|---|---|
| Parent | 9.5% survival |
| Selection A | 13.5% survival |
| Selection B | 21.5% survival |

This first progeny test was completed during the period September 4 to October 4, 1958. The survival of plants of the parent was about twice as high as was obtained in December of 1957. This is assumed to be environmental effect of temperature and moisture and possibly light which were not kept constant. This does not distract from the gain in survival of the selections over the parent which from greenhouse results was taken to be substantial, and particularly in case of the Selection B.

Further testing of the parent and progeny was conducted in a replicated test in the field during 1959. A randomized split plot design was used. The variables being the three beet varieties and four endothal rates, namely 0, 1½, 3, and 4½ pounds per acre applied as a band treatment just ahead of planting. Usual commercial use has been ¾ to 1½ pounds per acre. The equivalent broadcast rates would be 3⅔ times these rates.

Endothal application and planting was completed April 29. There was a total of eight replications, four of which were sprinkle irrigated immediately after planting. Sprinkling had no apparent effect as ample rain was received. Data of eight replications were therefore combined. Pre-thinning counts of beets and weeds were completed on June 4. Thinning and removal of all weeds was completed by manual means June 9. Photographs of seedling beets were taken as record of seedling vigor.

Stand and weight of beets at harvest, October 22, were based on six rows per plot, each row being 18 feet in length. Sugar percentage and thin juice apparent purity were based on beets from only two rows per plot. Data obtained appear in Tables 1, 2, and 3.

In Table 3 the harvest results show no difference for any of the measurements whether analyzed to measure differences between varieties or rates of endothal application. From the results of Table 3, and from other analysis of the data which has been made but not reported here, one finds no interaction of variety

and rate of endothal. Since the maximum rate of endothal used did not depress yield or quality of any of the varieties, one has to conclude the rates of endothal were too low to differentiate varieties. Table 1 shows no major difference in emergence or stand of beets which can be attributed to endothal rate. The difference between results of varieties presented in Table 1 can more logically be attributed to difference in seeding rate. The seed of Selection A and Selection B was smaller and more seed units were planted in comparison with the parent variety.

**Table 1.—Summary of Pre-Thinning Beet Stands.**

| Rate of Endothal (Pounds per acre) | Variety | | |
|---|---|---|---|
| | Parent | Selection A | Selection B |
| | (Beets per 100 inches) | | |
| 0 | 96[1] | 133[1] | 128[1] |
| 1½[2] | 107 | 141 | 146 |
| 3 | 103 | 120 | 127 |
| 4½ | 99 | 113 | 115 |

[1] Within a variety the differences from check are not significant at 5% point as calculated from 4-50 inch counts per plot.

[2] Broadcast rate would be 3⅔ times indicated amount.

**Table 2.—Average Weed Count per Treatment and Percentage Kill of Weeds Obtained with Each Endothal Rate.**

| Rate of Endothal (Pounds per acre) | Plots of | | | Weed Kill |
|---|---|---|---|---|
| | Parent | Selection A | Selection B | (Percent) |
| | (Weeds per 40 feet of row) | | | |
| 0 | 41.4[1] | 37.7 | 34.1 | 0 |
| 1½ | 6.2 | 9.5 | 8.2 | 78.9[2] |
| 3 | 3.6 | 4.1 | 1.6 | 91.8 |
| 4½ | 3.7 | 2.1 | 1.4 | 93.6 |

[1] Weeds remaining in row after first cultivation.

[2] Difference in weed control between 1½, 3, and 4½ pound rates is not significant at 5% point based on counts of 40 feet of row per plot. Difference between any endothal treatment and zero treatment is highly significant.

**Table 3.—Harvest Results Averaged for Variety and Endothal Rate, Respectively, Longmont, Colorado—1959.**

| | Beets per 100 ft. (No.) | Beets per Acre (Tons) | Sugar Content (%) | Thin Juice Apparent Purity[1] (%) | Gross Sugar per Acre (Lbs.) |
|---|---|---|---|---|---|
| Variety results | | | | | |
| Parent | 122 | 22.2 | 17.80 | 95.0 | 7907 |
| Selection A | 122 | 22.3 | 17.86 | 95.4 | 7955 |
| Selection B | 120 | 22.0 | 17.91 | 95.1 | 7880 |
| LSD 5% pt. | ..... | 1.1 | 0.45 | 0.76 | 435 |
| Endothal rate results | | | | | |
| No Endothal | 120 | 22.2 | 17.96 | 95.3 | 7989 |
| 1.5 lb. per acre | 120 | 22.2 | 17.89 | 95.3 | 7943 |
| 3.0 lb. per acre | 122 | 22.3 | 17.81 | 95.0 | 7950 |
| 4.5 lb. per acre | 124 | 21.9 | 17.77 | 94.9 | 7780 |
| LSD 5% pt. | ..... | 1.0 | 0.41 | 0.70 | 392 |

[1] Analysis run on press juice.

Although the pre-thinning stand and harvest data from the field trial show no difference between varieties, the vigor of beets prior to thininng was quite different. One could observe visually that at the higher endothal rates the seedling vigor of the parent variety was very low, that of Selection A was intermediate, and Selection B was most vigorous, showing little retardation in growth. The weed control obtained and reported in Table 2 leaves no doubt but that the endothal was in the soil even where Selection B showed negligible stunting.

Further selection has been made within Selection B in an effort to further increase endothal tolerance. The overall results with selection B have been sufficiently favorable to prompt commercial seed increase of this variety. Further experience will dictate whether all varieties produced will go through endothal tolerance selection, or at least an endothal tolerance rating, before being released to growers in Great Western and Northern Ohio Sugar Company operating territories, where endothal herbicide is presently being used on a large percentage of the acreage planted to sugar beets.

**Summary**

Selection within a monolocular sugar beet variety was made for increased tolerance to the herbicide endothal. Results of progeny tests indicate that endothal tolerance was improved by selection. The evaluation of improvement is based on emergence and survival of beet seedlings grown in the greenhouse under very high endothal rates. Selected progeny tested under moderately high endothal treatment in a field trial showed an increase in seedling vigor over the parent. Harvest data did not prove superiority of selected progeny over the parent, but showed them to be equal. The endothal rates used in the field trial presumably were too low to give definitive results at harvest time. Work on further improving varieties for endothal tolerance is in progress since presently it is considered feasible and of value.