Selection for Seed Size in Monogerm Varieties

C. W. Doxtator and R. H. Helmerick[1]

Received for publication March 23, 1962

Selection for seed size in sugar beets has not been of importance in multigerm varieties because of the association of large seed ball size with a large number of germs. However, with true-breeding single germ seed now available (1)[2], seed size and other characters can be studied as in other crop plants.

Since the size of monogerm seed is positively correlated with germ size (2), seed size can be important in obtaining better field stands of beets. With this thought in mind a breeding project was set up in 1958 to determine what changes could be made in seed size by selection and what effect these changes might have on seed yield.

Materials and Methods

Two varieties, 58-401 and 58-413 were selected for study. The variety 58-401 was a mass selection of SLC 15, and 58-413 was a recovered monogerm variety from crosses of sclerotium (Sclerotium rolfsii Sacc.) resistant multigerm types with SLC 15 and was a steckling group.

Polycross seed was harvested from 200 plants of each variety individually. The 400 seed lots were lightly polished by hand and cleaned over a small Clipper cleaner equipped with a bottom or retaining screen having 6/64" round hole perforations. The seed thus prepared was graded by hand using 12" × 12" dockage screens having round hole perforations of 8/64", 10/64", 12/64" and 14/64". The resulting five size fractions were weighed and a weighted average seed size was obtained for each plant.

From the 200 plant progenies of each variety a 15-plant selection was made for large and for small seed size. All plants selected were good seed producers, having produced 90 or more grams per plant. Seed of these progenies was planted in August 1958 at Rocky Ford, Colorado, in four space isolation groups for overwinter seed production. In each group 20 hills spaced 30" × 30" were planted with each seed lot in a 20 replication design. The following spring the hills were thinned to single plants. Plants were harvested individually and average seed size obtained as described previously. From these data 15 plant progenies from each of the four groups were selected and planted at Phoenix, Arizona, in August 1959. Thirty-six stecklings of each line were transplanted at Rocky Ford in four groups in

[1] Plant Breeders, respectively, American Crystal Sugar Company, Rocky Ford, Colorado.
[2] Numbers in parentheses refer to literature cited.

1960. However, a June hailstorm severely damaged the flowering plants and made it impossible to obtain reliable size data. It was then decided to make selection of the large seed sizes in the two varieties for a breeders stock seed increase.

From the 1958-59 Rocky Ford groups which were thinned to single plants, there was a large surplus of stecklings, which was saved by variety and by seed size, for a replicated test to determine differences of size and yield. These stecklings were graded in 3 sizes—large, medium and small—and planted in a split-split plot test of 10 replications. Plots were single rows 20 feet in length and 44 inches apart. Steckling sizes were the main plots (four-rows wide) and were made up of two rows of each variety, with seed sizes in adjacent rows.

Experimental Results

Excellent overwinter stands were obtained in the four group isolations in 1958; a nearly perfect thinning stand was available for seed production the following year. However, it was necessary to rogue out some double-flowering types. Curly top was present and further discards had to be made at harvest. In all, there were 722 plants harvested from the four groups out of a possible 1200. Table 1 gives the seed size data for the 1958 selection and the 1959 progenies as well as data on the 1959 selection.

Table 1.—Average seed size of the 1958 parents, the 1959 progenies, and the 1959 selection.

		1958 Parents		1959 Progeny		1959 Selection
Variety	Seed size selection	No. plants selected	Avg. size in 64th"	No. plants harvested	Avg. size in 64th"	Avg. seed size of selected plants
58-401	Large	15	13.12	275	10.76	13.02
	Small	15	9.40	238	9.94	9.33
58-413	Large	15	12.61	91	11.28	12.72
	Small	15	10.75	118	10.45	9.77

As shown in Table 1, the difference between the large and small seed selection in 1958 was large for both varieties. The progenies also differed in size, with the selection for large seed producing large seed and the selection for small seed producing small seed. The trend for large seed plants to produce larger seed than those selected for small was great enough to indicate a substantial parent-progeny correlation. The relationship is shown in Table 2.

As seen in Table 2, the parent-progeny correlation for large seed size in 58-401 is highly significant and is suggestively large for 58-413. Although both correlations for small seed were posi-

tive, neither was significant. Further evidence of a parent-progeny relationship was found from a survey of the individual plant progenies, as follows:

Table 2.—Correlations between seed size of parents and the average seed size of their progenies.

Variety	Seed size selection	Number of parent plants	Avg. no. of progeny plants from each parent	Correlation r
58-401	Large	15	18.3	+0.64*
	Small	15	15.9	+0.05
58-413	Large	15	6.1	+0.40
	Small	15	7.9	+0.12

* Significant beyond the 1% point

Table 3.—Difference in seed size obtained from selection for steckling size and seed size, in two monogerm varieties.

Steckling size	No. of comparisons	F Value	Avg. seed size 64th inches
Large			11.92
Medium	40	18.15**	11.79
Small			11.46
		(Sign. Diff.)	.23
Variety			
58-413		6.24*	11.85
58-401	60		11.61
		(Sign. Diff.)	.20
Seed Size			
Large		63.74**	11.99
Small	60		11.46
		(Sign. Diff.)	.22

* Significant beyond the 5% point
** Significant beyond the 1% point

1. 58-401 Large. The largest seed progeny of the 275 plants harvested came from the second largest parent.

2. 58-401 Small. The smallest seed progeny of the 238 plants harvested came from the second smallest parent.

3. 58-413 Large. The largest seed progeny of the 91 plants harvested came from the third largest parent.

4. 58-413 Small. The smallest seed progeny of the 118 plants harvested came from the smallest seed parent.

5. Large seed progenies had fewer seeds per pound than small seed progenies.

As mentioned previously, all stecklings thinned from the 1959 seed groups were graded into large, medium and small sizes for a seed size and yield test, in a split-split plot design. The average

steckling weight for the three classes was: large—.16 pounds, medium—.09 pounds, and small—.03 pounds. The analysis of variance in this test for seed size is given in Table 3.

It will be observed that size of stecklings affected seed size. The differences obtained were highly significant. The two varieties also differed significantly in seed size, 58-413 being the larger. It is of interest to note that during the flowering period the observation was made in the isolated seed fields that this variety had larger flower buds, but was attributed at that time to possible differences of soil in the different isolated fields.

By far the most significant was, however, the difference in seed size due to selection. As indicated in Tables 1 and 2, one open-pollinated plant selection for large and for small seed, significantly divided the varieties for the seed size character.

The analysis of variance is given in Table 4 for seed yield obtained in the same test.

There were no significant differences in this test for seed yield as shown in Table 4. There was, however, an indication of a slight trend for large stecklings to produce more seed. Although the seed sizes yielded alike, the number of seeds per pound ranged from 19,500 for the largest to 72,000 for the smallest size.

Table 4.—Differences in seed yield obtained from selections for steckling size and seed size, in two monogerm varieties.

Steckling size	No. of comparisons	F Valle	Av. grams seed per plant
Large			67.7
Medium	40	1.15 (NS)	64.8
Small			59.8
Variety			
58-401	60	2.00 (NS)	66.4
58-413			61.0
Seed Size			
Large	60	2.22 (NS)	63.8
Small			63.5

Discussion

The results obtained in this experiment indicate that seed size in monogerm varieties can be easily improved by ordinary mother line selection. Although it was not possible to test progenies of the second selection, the results of the first progeny test were so satisfactory that it can be expected that further differences were obtained in the later selections.

One of the most important discoveries made was the effect of steckling size on seed size. Because of this discovery, stecklings of the second selection were grown at Phoenix, Arizona, and after thermal induction were graded as nearly as possible to the same

size and extra care was used in transplanting at Rocky Ford, so that uniform conditions for regrowth would be obtained. In the 1958-59 overwinter planting, where the stands were thinned to one beet per hill there was no possibility of obtaining a uniform size of stecklings and consequently some of the recorded seed sizes from these plants may have been in error due to this environmental factor.

The lack of a parent-progeny relationship in small seed size (Table 2) is distinctly different than that obtained with the large seed size. This lack of relationship can be due to at least two environmental factors: first, plants were all harvested at the same time, and some of the plants may not have been as mature as others. This would tend to reduce seed size on some plants and cause errors in classification; secondly, a mild epidemic of curly top occurred in all groups except 58-401 Large, and it was necessary to discard many plants in these three groups. Others may have been affected. If curly top affects seed size this would also cause errors in classification.

The effect of seed size on seed yield is an important consideration, and was studied in this experiment. Since both sizes yielded alike, it is apparent that the difference between the two sizes must have been in number of seeds per pound.

It is evident in the two varieties studied in this experiment that there is a wide range in seed size due to heritable factors. Since uniformity of seed size is important for maximum recovery and drillability of commercial monogerm beet seed, it would seem important that selection work be conducted for the size of seed desired.

Summary

1. A selection for large and small seed was made in two varieties of monogerm sugar beets using the "mother" line method of breeding.

2. Progeny tests showed that in general, large seed parents produced large seed progenies and small seed parents produced small seed progenies.

3. It was found that large stecklings produced larger seed than small stecklings.

4. Yield of seed per plant was not affected by selection for seed size. However, selection for large size reduced the number of seeds per pound.

Literature Cited

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