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# Selection of Sugar Beets for Size of Root Under Wide and Normal Spacings[1]

JOHN O. GASKILL[2]

The use of 40 x 40-inch spacing as an aid in testing sugar-beet varieties was suggested by Xnckols (3) in 1936. He pointed out that, with conventional 12 x 20-inch spacing, errors are introduced by variations in stand which cannot be avoided by the use of competitive beets and stated that the use of 40-inch spacing, as a method of eliminating the effects of irregular competition, had been tested with some promise.[3] In 1938 Nuckols (4) proposed the use of this spacing as an aid in selection of sugar-beet roots for breeding purposes, and discussed several advantages of the method.

[1]Contribution from the Division of Sugar Plant- Investigations, .Bureau of Plant Industry, U. S. Department or Agriculture.

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[3]A competitive beet is one which is surrounded by normally spaced beets.

Gaskill and Doming (2) in 1938, reported results obtained from a replicated experimenl in which 32 strains or varieties of sugar beets were compared under 40 x 40-inch and 10 x 20-inch spacings. The correlation coefficients for varietal performance under the 2 spacings were found to be 0.62 for weight of root and 0.78 for sucrose percentage, both values being highly significant. Individual weights and analyses for 960 roots, representing 6 varieties, indicated that variability in weight of root was much less under wide spacing than under normal spacing, the difference being highly significant. Variability in sucrose percentage, under the 2 respective spacings. did not differ greatly. These data showed further that, in weight of root, a sample of TO beets taken at random from 40 x 40-inch spacing was equivalent, in statistical accuracy, to a sample of 24 competitive beets taken at random from 10 x 20-inch spacing.

Deming (1) in 1940, stated that 2 years' results, involving a total of 11 varieties, showed the same relative trend in yield and sucrose percentage for both 10 x 20-inch and 40 x 40-inch spacings.

The work reported in this paper was undertaken primarily for tlie purpose of comparing the relative effectiveness of selection for root size under* 40 x 40-inch and 10 x 20-inch spacings.

## Methods

Four varieties of sugar beets were used for this experiment. They may be described as f ollows:

1.—U. S. 215—Seed No., Acc. 5012—An inbred strain, not highly uniform.

2.—Synthetic Check ($F_2$)—Seed No., Ace. 1016—The second commercial increase of a pool of seed of 9 standard European brands.

3.—5-577-0—The second generation of a so-called "hybrid" involving 3 inbred strains.[4]

4.—6-194-0—The third generation of a "hybrid" involving many inbred strains.[4]

Except for No. 2, the above varieties are more or less resistant to *Cercospora* leafspot. However, this disease was not an important factor under the conditions of this experiment.

In 1938, near Ault, Colorado, plants of the first 2 varieties were grown under ordinary field conditions in 2 spacings, namely: 40 x 40-inch and 10 x 20-inch. After elimination of non-competitive beets in the latter spacing at harvest, each of the 4 populations amounted to approximately 1,000 plants.

[4]Actual degree of hybridization was not determined.

Foliage was removed in the usual manner for mother beets, and 2 groups, of approximately 150 roots each, were selected from each population as follows: Group 1—largest roots; Group 2—smallest roots.

Each of the 8 groups of roots so obtained was brought to seed in 1939 in an isolated location. Seed from each location was harvested as a pool.

Varieties 5-577-0 and 6-194-0 were grown in 1938 under wide spacing only, and large roots were selected as outlined for varieties 1 and 2, except that roots with undesirable shape were avoided. Seed was grown in the following season as described above.

In 1940 the 10 seedlots produced were included, together with seed of the parents, in a field test primarily for comparison of root-yielding ability. The test was located in a field near that in which the selections had been made. A modified Latin-square design was used with 8 replications of each variety, plots were 4 rows wide and 47 feet long, and plants were spaced 12 inches apart in 20-inch rows. At harvest time all roots in the 2 center rows of each plot were topped, washed, weighed, and analyzed for sucrose percentage. Root yields were determined on an actual-weight basis.

## Results

Performance of progenies of U. S. 215 closely paralleled that of progenies of Synthetic Check, and consequently the results obtained from the 2 groups of progenies were combined as shown in table 1.

Identical average root yields were obtained for progenies of large roots selected under wide and normal spacings. This yield figure, taken as an average of all progenies of large roots (32 plots), exceeded the mean yield of the parents by 0.81 ton per acre. This difference closely approached the 5-percent level of significance (0.87).

The average root yield of progenies of small roots selected under normal spacing was only 0.40 ton per acre below the mean yield of the parents; a difference far from significant. On the other hand, the acre yield shown for progenies of small roots selected under wide spacing was 1.54 tons below that of the parents, and 1.14 tons below that shown for progenies of small roots selected under normal spacing. Both these differences were significant, and the former exceeded the 1-pereent point.

Sucrose percentages obtained for the progenies of large roots were consistently below those obtained for the parents, and conversely, sucrose percentages of progenies of small roots were consistently above those of the parents, but these differences were not significant.

In gross sucrose per acre, progenies differed only slightly from the parents except for the progeny of small roots selected under wide spacing which produced 311 pounds per acre less than the parent; a difference which closely approached significance.

Table 1.—Field comparison of progenies of large and small sugar-beet roots selected under wide and normal spacings; data presented as 8-plot averages, except where otherwise indicated.*

| | Seed No. | Root yield per acre | Sucrose | Gross sucrose per acre |
|---|---|---|---|---|
| | | (tons) | (percentage) | (pounds) |
| U. S. 215: | | | | |
| Parent | Acc. 5012 | 20.22 | 14.29 | 5833 |
| Progenies of large roots from: | | | | |
| Wide spacing† | 9-1019-0 | 20.92 | 13.54 | 5716 |
| Normal spacing‡ | 9-1021-0 | 21.23 | 13.99 | 5972 |
| Progenies of small roots from: | | | | |
| Wide spacing | 9-1020-0 | 19.03 | 14.43 | 5507 |
| Normal spacing | 9-1022-0 | 20.65 | 14.34 | 5947 |
| Synthetic Check: | | | | |
| Parent | Acc. 1016 | 20.30 | 13.94 | 5719 |
| Progenies of large roots from: | | | | |
| Wide spacing | 9-1017-0 | 21.22 | 13.78 | 5839 |
| Normal spacing | 9-1024-0 | 20.91 | 13.64 | 5704 |
| Progenies of small roots from: | | | | |
| Wide spacing | 9-1018-0 | 18.41 | 14.63 | 5423 |
| Normal spacing | 9-1023-0 | 19.07 | 14.35 | 5475 |
| Averages (each based on 10 plots): | | | | |
| Parents | | 20.26 | 14.12 | 5776 |
| Progenies of large roots from: | | | | |
| Wide spacing | | 21.07 | 13.66 | 5778 |
| Normal spacing | | 21.07 | 13.82 | 5838 |
| Progenies of small roots from: | | | | |
| Wide spacing | | 18.72 | 14.53 | 5405 |
| Normal spacing | | 19.86 | 14.25 | 5711 |
| Average gains of progenies over performance of parents (shown as differences between 16-plot means): | | | | |
| Progenies of large roots from: | | | | |
| Wide spacing | | +0.81 | —0.46 | + 2 |
| Normal spacing | | +0.81 | —0.30 | + 62 |
| Progenies of small roots from: | | | | |
| Wide spacing | | —1.54** | +0.41 | —311 |
| Normal spacing | | —0.40 | +0.23 | — 65 |
| Differences required for significance (Odds 19:1) | | 1.00 | 0.50 | 335 |

*Plants spaced 12 inches apart in 20-inch rows.
†Plants spaced 40 inches apart in 40-inch rows.
‡Plants spaced 10 inches apart in 20-inch rows.
**Exceeds the 1-percent level of significance.

The results obtained from selection of large roots under wide spacing are summarized in table 2 for all 4 varieties. In root yield the progenies exceeded the parents by an average of 1.15 tons per acre, and in sucrose percentage the parents exceeded the progenies by an average of 0,61. Both these differences were highly significant. In gross sucrose per acre the difference was very small and far from significant.

Table 2.—Field comparison of 4 sugar-beet varieties with progenies obtained from large roots selected under wide spacing; data presented as 8-plot averages, except where otherwise indicated.*

| | Seed No. | Root yield per acre (tons) | Sucrose (percentage) | Gross sucrose per acre (pounds) |
|---|---|---|---|---|
| U. S. 215: | | | | |
| Parent | Acc. 5012 | 20.22 | 14.29 | 5833 |
| Progeny | 9-1019-0 | 20.92 | 13.54 | 5716 |
| Synthetic Check: | | | | |
| Parent | Acc. 1016 | 20.30 | 13.94 | 5719 |
| Progeny | 9-1017-0 | 21.22 | 13.78 | 5830 |
| Narrow-base hybrid: | | | | |
| Parent | 5-577-0 | 18.74 | 14.21 | 5340 |
| Progeny | 9-1025-0 | 19.48 | 13.23 | 5203 |
| Wide-base hybrid: | | | | |
| Parent | 6 194-0 | 18.32 | 14.39 | 5292 |
| Progeny | 9-1026-0 | 20.03 | 13.80 | 5724 |
| Averages (each based on 32 plots): | | | | |
| Parents | | 19.40 | 14.22 | 5548 |
| Progenies | | 20.55 | 13.61 | 5621 |
| Diff. (gain of progenies) | | + 1.15 | — 0.61 | + 75 |
| Diff. required for significance (applicable to 32-plot averages) | | | | |
| Odds 19:1 | | 0.71 | 0.35 | 237 |
| Odds 99:1 | | 0.96 | 0.47 | 320 |

*Selections were made from beets spaced 40 inches apart in 40-inch rows; beets in field test were spaced 12 inches apart in 20-inch rows.

## Conclusions

While definite conclusions cannot be drawn from 1 year's results, the data presented suggest the following tentative conclusions regarding selection for weight of root:

1.—Improvement in root-yielding ability can be obtained in certain varieties by selection of large roots under wide-spacing conditions, with subsequent mass increase.

2.—No difference was shown between the effectiveness of selection of large roots under wide spacing and under normal spacing.

3.—Genetic lack of vigor apparently was strongly associated with the size of small roots under wide spacing, while such a relationship was not shown for small roots under normal spacing.

The results obtained from this experiment tend to substantiate previously published suggestions that the wide-spacing method may be used to advantage in connection with very small seedlots, both for preliminary evaluation of breeding strains and for selection of mother beets.

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# Comparison of Field Seeding of Sugar Beets and Mangel Wurzels with Two Methods of Transplanting[1]

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Experiments regarding transplanting of sugar beets for commercial beet-sugar production have been reported by Nuckols (2), Pritchard and Longley (3), Goss and Holt (1), and various other investigators. The reports differed as to the feasibility of transplanting for this purpose, and the method has not come into general use.

Transplanting of seedlings obtained from very small seedlots recently has become a common practice in connection with sugar-beet breeding work. The principal reasons for the adoption of this method are: First, that the limited numbers of seedlings obtained from such seedlots can be used to maximum advantage, and second, that gaps

[1]Contribution from the Division of Sugar Plant Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.

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