

## BREEDING METHODS WITH SUGAR BEETS; GREENHOUSE AND FIELD TECHNIQUE

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In order to develop varieties superior in performance to those now being used in sugar beet producing areas, the plant breeder must not only use breeding methods best suited to the crop, but he must also make use of practical methods which will achieve results in a minimum length of time. The purpose of this paper is to briefly outline the breeding program which has been developed during the past five years by the Beet Seed Department of the American Crystal Sugar Company, and to indicate some of the progress already made.

Methods of Breeding and Results

The adaptation of varieties to the extreme diversity of crop conditions <sup>2/</sup> found in American Crystal Sugar Company beet growing areas is a problem of first importance. Mass selection and mother line breeding methods are being used in all factory areas for the purpose of obtaining adapted varieties with the minimum of effort and expense. In 1937 at all factory areas, selections of roots from the better yielding varieties were made. In Table I is shown the 1939 yield data from two of these selections, in comparison with the parent varieties.

Table I.—Comparison of Yield of Selected Strains and Original Parent Variety. (1939 data). (Mass Selection Method)

<u>Variety</u>	<u>Tons Beets</u>	<u>% Sucrose</u>	<u>Lbs. Sugar Per Acre</u>	<u>Test Area</u>
No. 1	14.38	13.08	3859	East Grand
Original Parent	<u>13.14</u>	<u>12.54</u>	<u>3327</u>	Forks,
Difference	1.24	.54	532	Minnesota.
Sign. Diff.(19:1)	1.13	.75	426	
No. 2	14.62	13.43	3914	
Original Parent	<u>12.28</u>	<u>13.04</u>	<u>3217</u>	Chaska,
Difference	2.34	.39	697	Minnesota.
Sign. Diff.(19:1)	.96	.39	515	

Variety No. 1 was a selection for a short season area, and made from a foreign variety. Variety No. 2 was selected under leafspot conditions for a leafspot area, and was made from a home grown leafspot resistant variety. The data shown indicate a superior performance for the selections.

Mother line breeding has given equally promising results when used on varieties already improved by mass selection. In 1939 at Rocky Ford, Colorado, 45 mother progenies were tested in field trial with the parent variety. Of these 45 progenies 19 produced significantly higher yields than the improved parent variety. At the present time this method of breeding is being used to an increasing extent at all factory areas.

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<sup>2/</sup> Beets are grown in peat and sedimentary soils; under irrigation and natural rainfall conditions; in altitudes ranging from sea level to 7600 ft.; in latitudes ranging 35° to 49°; and under coastal and continental climates.



An extensive amount of inbreeding is also under way at the present time. Self pollination as well as "brother-sister" sib pollination has been used to obtain pure lines. A sizeable number of lines of fourth and fifth generation of inbreeding have been obtained, and most of these lines possess marked uniformity of type. The most desirable are now being synthesized into experimental hybrid varieties for test purposes.

#### Greenhouse Technique

The use of greenhouses to supplement field breeding operations has been found to be extremely helpful in speeding up the work of variety improvement at Rocky Ford, Colorado. Being a biennial plant, the sugar beet normally takes most of a second summer season to complete its life cycle and produce seed. Consequently, the speed of variety improvement work with beets is half as fast as that which could be obtained from an annual flowering plant such as corn or sorghum. Since beet seed is normally planted in the spring season of each year there is a natural division into two breeding programs and the selected progenies from each program will flower and set seed in alternate years. If however, inbred progenies are planted in August in greenhouses, harvest of stecklinge can be made in December, thus giving adequate time for dormancy under normal cold conditions during the winter months. The stecklinge which are transplanted the following spring will produce seed in July in time for fall planting in greenhouses a second year. Similarly, inbred progenies planted in the field in the spring and producing roots in summer can be replanted in the greenhouse in late December and seed obtained from them in the following April in time for spring planting. Thus, greenhouse space can be used to transform the beet plant from a biennial, flowering in alternate years, to an annual, flowering in summer and winter seasons. This is of real value in speeding up genetic purification by inbreeding.

It is possible to further speed up the breeding work by planting greenhouse produced stecklinge back in the greenhouse in late February (after two months dormancy) and obtain seed for special test plantings in late May of the same year. Inbred lines can be indexed for bolting tendencies during the winter months. This work can be done to great advantage on greenhouse produced stecklinge. If desired, a large amount of hybridization work can be carried on during the winter months in the greenhouse making seed available for test plantings in the coming season.

In using the greenhouses for winter seed production it is necessary to use artificial light to obtain rapid bolting and seed setting. Artificial light has been used for this purpose at Rocky Ford since 1921 with satisfactory results. For summer use, lath shades are employed to reduce the intense heat and light in the greenhouses. Sprinklers placed on the roof of each greenhouse are also used to reduce temperatures to normal during the months of July and August.

#### Field Technique

##### Mass Seed Increase

In selecting beets in the field for mass seed increase, canes or lath stakes are used to mark beets for resistance to leafspot during the months of August and September. Continuous inspection of the marked plants is made and all beets showing susceptibility at later dates are discarded. Selection is made for root type at time of harvest; and for percent sucrose during winter



storage. In the spring, the selected beets of each variety are transplanted in space isolated groups for seed production. Seed obtained from these groups constitutes breeders stock of new selections.

### Inbreeding

Since all roots selected for new breeders stocks are carried in pedigree record, inbred lines are begun from selected roots by placing one or more kraft bags on branches of the plant prior to flowering. Seed obtained from these plants, as well as seed from inbred lines produced in field and greenhouses are planted in three inch pots in the greenhouses in April. Normally, only the small seed lots are thus planted. In May, these plants are removed to the field, and at that time inbreds having large seed lots are planted directly in the field. During the summer this nursery is subjected to periodic night sprinkling from an overhead sprinkler, for the purpose of inducing a leaf-spot epidemic. Usually not more than ten percent of the inbred progenies planted are found to be satisfactory in resistance to the disease. Roots of these selected lines are either used for greenhouse planting, or stored and replanted in the field for further breeding work.

Roots of inbreds obtained from field selections, as well as stecklinge produced from inbred seed in the greenhouses are transplanted to the field each spring, where all are subjected to further inbreeding. Some of the more uniform lines are crossed (using bags) for the production of natural single crosses. In the event that certain of these hybrid combinations appear to be of promise, the seed supplies of the parent inbreds are increased for possible large scale production of hybrid varieties.

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### A STUDY OF SUGAR BEET HYBRIDS

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Since the year 1934, many studies have been made of various wild types of Beta Maritima by our organization, with repeated selections of the most promising types. In view of the fact that these wild types show such great variability, description of them is left to showing a series of lantern slides. (Most of the slides shown were used in connection with a later discussion of the crosses and back crosses between wild types and certain Great Western breeding material).

Considerable optimism is required to persevere in a breeding program which includes many lines of hybrid families. The first generation hybrids are nearly always disappointing in both size and type of roots, these being small, scrawny and very much sprangled. While sugar content and purity are fair, both are generally definitely lower than for commercial beets. The following are typical for 1st generation hybrids between wild Beta Maritima and Great Western families.

Weight of root	-	6 to 10 ozs.
Polarization	-	11 to 14 percent
Purity	-	77 to 84 percent

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