

A Method of Selection for Earliness of Root Development in Sugar Beets

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Sugar beet varieties distinguished by earliness of root development are valuable for different areas, different latitudes, different elevations, different humidity conditions, etc. Varieties showing large differences in sugar percentage differ also in earliness of root development. Selection conducted in different climates has produced varieties with different degrees of earliness in root development. This process can be accelerated by direct selection on rate of root growth. Such selection has led also to good results in connection with increased yield. Success of selection for rate of root development is facilitated by selection during the vegetative period when differences in this character are clearer. The largest variability in root weight in sugar-beet populations was observed during the early period of growth. The variability of root weight diminished during development, and, as an average of 5 years' results, showed coefficients of variation of root weight for the 6 months May through October of 79, 56, 55, 45, 42 and 44, respectively.

The difference in yields between different varieties decreases also toward the end of the vegetative period (Table I).

Table 1.—Average weight of root expressed as percentage of that in U.S. 22/2, Salt Lake City, 1948.

	June 9	July 23	August	September	October
	Percent	Percent	Percent	Percent	Percent
Barres	223	228	224	220	179
E-type, U.S. 22/2	100	100	100	100	100
Z type, U.S. 35	97	87	92	98	97

Selection work for increased root weight showed that the percentage of correctly selected roots is higher in the middle of the summer than in the fall (Table 2).

Selection was made in E-type and Z-type varieties (Table 2). Both of these varieties were planted at the same time in alternate plots each containing 120 plants. Five repetitions of this experiment were harvested in late July and on October 10. In both harvest dates all harvested roots were weighed individually, thus the effect of selection in the summer and in the fall could be compared. Twenty percent of the largest roots were selected in the E-type variety in the summer and in the fall. Selection of the same root-weight classes at both dates (Table 2) was also made in the Z-type variety. The percentage of selected roots in the Z-type variety appeared much higher in the fall than in the summer. In the fall the percentage of the large roots proved almost the same in the E-type and Z-type varieties. Therefore, selection in the fall was less efficient than selection in the summer. The progeny of the groups selected in the fall usually showed the same properties as the variety from which it originated.

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Table 2.—Root weight in E-type and Z-type varieties.

Variety	Root weight in grams										Total three heaviest groups
	10	20	30	40	50	60	70	80	90	Over 100	
	%	%	%	%	July		%	%	%	%	%
E-type	3	5	7	8	11	25	17	6	8	10	24
Z-type	9	15	17	25	16	10	4	2	2		4
Variety	Root weight in grams										Total three heaviest groups
	100	200	300	400	500	600	700	800	900	Over 1000	
	October										
E-type	4	8	13	13	15	13	12	9	5	8	22
Z-type	6	9	16	17	15	12	9	8	3	5	16

A study of ontogenetic development in beets suggests a new method of selection for earliness of root development:

1. The first stages of ontogenetic development are characterized by a rapid rate of growth of leaves in all races and varieties of beets, sugar beets, mangels, red garden beets, etc. The growth rate of roots increases later.

2. The enlargement of tap-roots is a secondary process and it does not represent a fixed character for all races of *Beta vulgaris*. The critical time of development, when the weight of the root exceeds the weight of the leaves, does not occur simultaneously in different varieties (even in sugar beets) and does not depend upon the weight of the seedlings or upon the final yield of the roots in the fall.

3. The period or phase in the ontogenetic development when the roots begin to grow faster than the leaves is governed by heritable characters. This change in development occurs 10 to 40 days earlier in the E-type variety US 22/2 than in the Z-type US 35 (Table 3).

4. The time at which the change in rate of growth of leaves and roots occurs clearly classified the varieties according to their agricultural earliness. Varieties in which the change occurs early are early maturing and their comparative yields in relation to the sugar beet are higher at mid-season than at the end. The late-maturing varieties have a higher increment of root growth at the end of the vegetative period than at mid-season.

Table 3.—Yield of different varieties shown in percentage from that of U.S. 22/2 in August and November, Salt Lake City, 1948.

Variety	Yield of roots	
	August 9	November 3
	Percent	Percent
Swiss chard (very late root development)	45	48
Z-type sugar beet, U.S. 35	92	97
E-type sugar beet, U.S. 22/2	100	100
Mangel (early root development)	224	177
Red garden beet (early root development)	119	58

Selection for Rate of Root Development

Each population of beets contains races with early and late root development but either can show high or low productivity. Therefore, when high-yielding varieties with early root development are selected, the degree of earliness and the level of productivity must be taken into consideration. Experimental trials are helpful in showing the best way to select plants which possess a high rate of leaf growth in July and August together with early root development (Table 4).

Table 4.—Average weight per root in mid-season of progenies selected from E-type and Z-type varieties, and of hybrids between the two selected groups.

	From parental E-type	varieties Z-type	From the hybrid
	Grams	Grams	Grams
Group with early root development	351	342	365
Group with late root development	301	277	272

The progenies obtained from the group of plants twice selected in the summer for early root development were also higher yielding when tested during the harvest in October. Selection in the hybrid population for two generations was more effective than selection in either of the parental varieties.

It is best to select for earliness of root development in commercial beet plantings. The quantity of selected plants does not exceed one percent and does not damage the planting. Selections should be made at the time the differences in the weight of the root between varieties appear clear, which is usually in July or August. Beets with good tops are chosen first. Then the foliage and the root from each selected plant should be weighed separately. Beets with a root weight exceeding the top weight form a group of "early maturing plants." The selected plants should then be transplanted. The rate of root development can be checked again during harvest in the fall.

Summary

Largest variability in root weight in sugar beets occurred in the early period of growth, differences between varieties decreasing toward the end of the vegetative period. When comparisons were made involving both sucrose and yield types of sugar beet, it was found that selections for root weight were less efficient when done in the fall than when they were made in summer. The time at which the ratio of root weight to leaf weight decreases is governed by heritable characteristics and the decrease occurs early in early-maturing varieties. Experimental trials indicate that the best way to select sugar beet plants is to choose those possessing a high rate of leaf growth in July and August, together with early root development.