Dry Matter of the Petiole as an Index for the Selection of Sugar Beet Plants[1]

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A previous paper (1)[3] reported that open-pollinated populations of sugar beets had significantly greater total variances than an F_1 hybrid for percent dry matter of the petiole and percent sucrose. Percent dry matter of the petiole was positively correlated with percent sucrose and negatively correlated with root weight.

Results of divergent selections for percent dry matter of the petiole and the effects of these selections on root weight and percent sucrose are reported in this paper.

Materials and Methods

The details of the methods of selecting individual plants, that deviate from the mean of each population in excess of that expected by chance have been described by Powers (2). Divergent selections were made for percent dry matter of the petiole from each of three populations; CS7, a high yielding variety selected for commercial production in Western Canada; A90-54, a variety with high sucrose content; and 5957, a selection from A90-54 for decumbent tops. All selections were made from a total of 100 plants per population. The frequency distributions and variances for percent dry matter of the petiole and percent sucrose for these populations have been reported previously (1). Plant selections were made as shown in Table 1.

Table 1.—Sugar beet plants selected from open-pollinated populations for high and low percent dry matter of the petiole.

Accession number	Description	No. of roots	Petiole, percent dry matter	Root, weight ounce	Root, percent sucrose
CS7	Standard tonnage	100	11.42	27.0	17.5
6139	High % dry matter *ex* CS7	9	14.21	36.7	18.8
6142	Low % dry matter *ex* CS7	6	9.07	22.0	16.4
A90-54	High-sucrose-content	100	13.09	19.7	19.9
6140	High % dry matter *ex* A90-54	11	15.75	20.0	20.5
6143	Low % dry matter *ex* A90-54	3	10.23	25.0	17.4
5957	Decumbent top *ex* A90-54	100	13.45	17.2	19.8
6141	High % dry matter *ex* 5957	12	16.19	18.3	20.7
6144	Low % dry matter *ex* 5957	4	10.57	19.6	19.5

[1] Contribution of the Canadian Sugar Factories, Taber, Alberta, Canada.

[2] Plant Breeder.

[3] Numbers in parentheses refer to literature cited.

In 1961 seed was produced from each of the six selection groups by permitting the plants within each group to interpollinate in isolation. Nine, eleven, and twelve roots were selected for high percent dry matter of the petiole from CS7, A90-54, and 5957, respectively. The seed lots produced from the selected roots were numbered 6139, 6140, and 6141, respectively. Six, three and four roots were selected for low percent dry matter of the petiole from CS7, A90-54, and 5957, respectively and the seed lots produced from these selected roots were numbered 6142, 6143, and 6144, respectively. Strain 6143 produced insufficient seed for testing.

In 1962, seed of the above selections and their parents was planted in a field experiment to evaluate the effectiveness of the selection method. The field experiment consisted of eight replications of one row plots each 60 feet long. The rows were spaced 22 inches and the plants within the row were 12 inches apart. The experiment was planted on April 26, 1962. On September 5, one petiole was taken at random from a healthy mature leaf from each of 20 plants from each plot. Percent dry matter was determined by drying in a forced draft oven at 90°C for 48 hours. On September 25, 50 feet of row were harvested to determine weight of roots and percent sucrose.

Results and Discussion

Data on the performance of the progeny for yield of roots, percent sucrose and percent dry matter of the petiole are shown in Table 2.

Table 2.—Performance of the progenies of sugar beet selections for high and low percent dry matter of the petiole.

Accession number	Description	Petiole, percent dry matter	Roots, percent sucrose	Roots, tons per acre
CS7	Standard tonnage	11.74	17.98	20.05
6139	High % dry matter *ex* CS7	12.65**	18.64**	18.07*
6142	Low % dry mitter *ex* CS7	10.92**	17.59*	19.85
A90-54	High-sucrose-content	13.35	19.81	15.52
6140	High % dry matter *ex* A90-54	14.24**	20.14	12.55**
6143	Low % dry matter *ex* A90-54	..	..	.....
5957	Decumbent top *ex* A90-54	13.56	20.05	12.60
6141	High % dry matter *ex* 5957	14.98**	20.38	12.16
6144	Low % dry matter *ex* 5957	12.81**	19.85	14.58*
Standard error of the mean		0.14	0.13	0.55
Least significant difference P.05		0.39	0.37	1.53
Least significant difference P.01		0.51	0.49	2.02
Coefficient of variability (%)		3.04	1.95	9.44

* Significantly different from parental variety at the 5% level.
** Significantly different from parental variety at the 1% level.

The three progenies, 6139, 6140, and 6141, from plants selected for high percent dry matter of the petiole had a significantly higher percent dry matter of the petiole than their respective parents, CS7, A90-54, and 5957. Likewise, the selections for low percent dry matter of the petiole, 6142 and 6144 had a significantly lower percent dry matter of the petiole than their respective parents.

Of the three high-percent dry matter selections, 6139 had a significantly higher percent sucrose than its parent, whereas, the increase in percent sucrose of 6140 and 6141 over their respective parents was not significant at the 5 percent level. The low-percent dry matter selection 6142 was significantly lower than CS7 in percent sucrose, while 6144 was not significantly lower than 5957.

The selections for high percent dry matter resulted in significant reductions from their respective parents in weight of roots for 6139 and 6141 but not for 6140, whereas the selections for low percent dry matter resulted in progenies with a significant increase in root weight for 6144 but not for 6142.

In comparing 6139 and 6142, the two selections from CS7, the plants selected for low percent dry matter of the petiole had a lower mean root weight than the plants selected for high percent dry matter of the petiole (Table 1). The correlation coefficients reported (1), which were calculated on an interpopulation basis, apparently did not hold, in this instance, for the few extreme plants. However, the yield of roots of 6142 was significantly higher than that of 6139. Thus, the performance of these progenies lends support to the validity of the correlation coefficients reported earlier (1).

Although a significant increase in percent sucrose was obtained by selecting for high percent dry matter of the petiole in CS7, no improvement in root yield was observed by selecting for low percent dry matter of the petioles from the same variety. A significant reduction in percent sucrose was observed for 6142 however.

By comparing 6141 and 6144, the two selections from 5957, a similar phenomenon was observed as described for CS7. The plants selected for low percent dry matter of the petiole produced progeny which had a significantly higher root yield than the parental variety. The selection for high percent dry matter of the petiole, however, produced progeny which were not significantly higher in percent sucrose than the parental variety. This observed difficulty in increasing percent sucrose in the high-sucrose variety 5957, parallels the observed difficulty in selecting for increased root weight in the high-root-weight variety CS7.

The observation that the progeny of selections for high percent dry matter of the petiole are significantly higher in percent sucrose than the progeny of the respective selections for low percent dry matter of the petiole suggests a close association between these characters. This close association may be due to genetic linkage or due to a metabolic sequence which at a certain stage of plant growth attains equilibrium.

Summary and Conclusions

Individual sugar beet plants were selected for percent dry matter of the petiole from each of three populations. The results show that effective selection can be made for this character and that simultaneous changes can occur in root weight and percent sucrose of the progeny. Selections for high percent dry matter of the petiole produced progeny with improved sugar content and selections for low percent dry matter of the petiole produced progeny with improved root weight.

Literature Cited

(1) BERGEN, P. 1962. An improved method for the evaluation and selection of sugar beets (*Beta vulgaris* L.) 1. The selection of individual plants. J. Am. Soc. Sugar Beet Technol. 11 (8): 668-675.

(2) POWERS, LEROY. 1957. Identification of genetically-superior individuals and the prediction of genetic gains in sugar beet breeding programs. J. Am. Soc. Sugar Beet Technol. 9 (5): 408-432.