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COMPONENTS OF RECOVERABLE SUGAR AND PATH ANALYSIS IN DIPLOID VARIETIES OF SUGARBEET

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ABSTRACT

Eighteen diploid, multigerm, varieties of sugarbeet (*Beta vulgaris* L.) were studied for phenotypic and genotypic correlations and associations between recoverable sugar yield and its components by path analysis. In general, phenotypic and genotypic correlations showed the same trend but genotypic correlations were of higher magnitude than phenotypic. Recoverable sugar was significantly correlated with root yield and root length. Sucrose showed significant positive correlation with purity and recovery. It was revealed by path analysis that root yield/ha, sucrose and purity are of utmost importance for contributing to recoverable sugar yield in diploid genotypes under Indian agroclimatic conditions.

Key words: *Beta vulgaris*, recoverable sugar, root yield.

Yield is a complex character and is dependent on a number of components. Information on the association of different characters among themselves and their relationship with yield are of utmost importance for making selection. Path coefficient analysis measures direct influence of a variable upon another and permits separation of correlation coefficients into components of direct and indirect effects [1].

In sugarbeet, recovery percent of sucrose and recoverable sugar/ha are of great economic importance. The recovery percent of sugar, which is a measure of sugarbeet quality, is determined by sucrose content and purity of juice. The purity of juice is important for sucrose recovery because soluble nonsucrose constituents hinder in sugar crystallization and also reduce extraction of sucrose. The main nonsucrose impurity constituents are potassium, sodium and aminonitrogen [2]. Therefore, in purity determinations, the amount of these constituents has also to be taken into consideration.

Information on the relationship of recoverable sugar with root yield and quality components in diploid open-pollinated varieties in subtropical India is lacking. The present study analyses direct and indirect effects of yield components and quality characters contributing towards recoverable sugar in diploid varieties using path analysis.

MATERIALS AND METHODS

Eighteen diploid varieties of sugarbeet (*Beta vulgaris* L.) were grown in randomized block design with three replications at the Indian Institute of Sugarcane

Research, Lucknow. Each plot consisted of 4 rows of 6 m length, spaced 50 cm apart. The plant-to-plant distance was 20 cm. Observations were recorded on 10 plants taken at random per replication on root weight per plant, top weight, root length, crown size, leaves/plant, and yield/plot. Sucrose per cent was recorded by the Sachs Ie Docte method. Data on quality characters, viz., Na^+, K^+ and aminonitrogen content in beetroots were obtained by the method of Carruthers and Oldfield [2] to find out purity and recovery per cent. Recoverable sugar was calculated by multiplying root yield with recovery. Phenotypic and genotypic correlations were studied, and path analysis among characters was calculated [1].

RESULTS AND DISCUSSION

The correlations at genotypic and phenotypic level, in general, showed the same trend (Table 1). Genotypic correlations were generally higher than phenotypic correlations. Positive genotypic correlation of recoverable sugar was observed with root yield/ha, root weight, root length, sucrose, purity and recovery. Similar simple correlation of recoverable sugar with root weight, sucrose content and purity have been reported in random and improved sugarbeet populations [3]. Root yield/ha and root weight/plant showed negative correlations with sucrose content and purity. Negative association between root weight and sucrose was reported in random and

Table 1. Correlations among sugar yield components in diploid varieties of sugarbeet

Character		Root yield/ ha	Root weight/ plant	Top weight/ plant	Root length	Crown size	No. of leaves/ plant	Sucrose %	Purity %	Recovery %
Recoverable sugar/ha	G	0.94**	0.52*	−0.10	0.75**	−0.03	−0.14	0.07	0.16	0.09
	P	0.68**	0.40	0.53*	0.38	0.10	−0.01	0.40	0.14	0.37
Root yield/ha	G		0.47*	2.27	0.46*	−0.27	0.06	−0.26	−0.23	−0.26
	P		0.34	0.18	0.33	−0.09	0.04	−0.08	−0.16	−0.13
Root weight per plant	G			0.16	0.19	−0.01	0.03	−0.38	−0.12	−0.33
	P			0.26	0.26	−0.01	0.12	−0.06	−0.23	−0.11
Top weight per plant	G				−0.65**	0.75	1.16**	−0.21	0.19	−0.12
	P				−0.40	0.51*	0.60*	0.13	0.01	0.12
Root length	G					−0.82**	−1.19**	0.49*	0.35	0.48*
	P					−0.26	−0.45	0.08	0.07	0.06
Crown size	G						0.86**	0.42	0.13	0.36
	P						0.58*	0.18	−0.07	0.13
Leaves/plant	G							−0.33	−0.18	−0.31
	P							−0.12	−0.02	−0.09
Sucrose %	G								0.89**	0.99**
	P								0.40	0.95**
Purity %	G									0.94**
	P									0.64**

**, *Significant at 1% and 5%, respectively.
G—genotypic, and P—phenotypic correlations.

F_1 populations of sugarbeet [3]. However, these negative associations between root weight and sucrose were not present in the commercial varieties, thereby suggesting that breeding procedure and selection had changed this association [3]. Root yield/ha recorded negative correlation with sucrose and purity in this study. Since the plant population/ha was optimum, it is the root weight per plant which is reflected in the gross yield/ha.

Significant positive correlation of sucrose with purity and recovery was found. Significant positive correlation of sucrose content with recovery from mill data was reported earlier [4]. This indicates that selection for low impurities in root will be beneficial to achieve high recoverable sugar.

Path analysis is useful in partitioning the direct and indirect associations among attributes. [5]. Estimates of direct and indirect components of recoverable sugar/ha showed that there was direct positive effect of root yield/ha, root weight/plant, top weight, root length, and sucrose content on recoverable sugar, while the remaining characters had negative direct effect. It was also interesting to note that sucrose content had direct positive effect on recoverable sugar, however, its indirect effect through root weight, top weight and purity was negative, which clearly indicates that increase in recoverable sugar will have to be achieved with high root yield and moderate sucrose level. Similar results have been reported [6, 7] with diploid hybrid of sugarbeet. The negative direct effect of crown size on recoverable sugar is also of great interest, as bigger crown size is supposed to effect adversely root yield contributing characters like root weight per plant, top weight, and root length. Bigger crown also affects quality characters and purity, which is evident from its negative phenotypic correlation with purity. The genotypic correlation of crown size with purity is weak and of no significance. Crown size also showed negative indirect affect on recoverable sugar through other attributes (Table 2).

Table 2. Path analysis in diploid varieties of sugarbeet. Direct (diagonal) and indirect effects of different sugar yield components on recoverable sugar

Character	Root yield/ ha	Root weight/ plant	Top weight/ plant	Root length	Crown size	No. of leaves/ plant	Sucrose %	Purity %	Genotypic correlation with recoverable sugar
Root yield/ha	**0.39**	0.14	0.20	0.25	−0.02	−0.02	−0.18	0.17	0.94**
Root weight/plant	0.18	**0.30**	0.12	0.11	−0.01	0.01	0.27	0.09*	0.52*
Top weight/plant	0.11	0.05	**0.72**	−0.36	0.04	−0.38	−0.15	0.14	−0.01
Root length	0.18	0.06	−0.47	**0.55**	−0.05	0.39	0.35	−0.26	0.75**
Crown size	−0.10	−0.00	0.55	−0.45	**−0.06**	−2.77	0.30	−0.10	−0.03
Leaves/plant	0.02	0.01	0.84	−0.65	0.05	**−0.32**	−0.23	0.14	−0.14
Sucrose %	−0.10	−0.12	−0.15	0.27	0.02	0.11	**0.71**	−0.66	0.07
Purity %	−0.09	−0.04	0.14	0.19	0.01	0.06	0.63	**−0.74**	0.16
Residual	0.26								

**, *Significant at 1% and 5%, respectively.

Negative direct effect of leaves/plant on recoverable sugar is nonsignificant. However, this shows that increase in leaf number beyond an optimum level directly increases impurity. This becomes more evident when the associations between leaf number and crown size, and crown size and purity are taken into account. This explains that increase in leaf area through the size of lamina may be more effective than through leaf number.

The large effect of root yield on recoverable sugar/ha and negative correlation between root yield and sucrose in different genotypes have been observed by different workers [3, 4, 8]. The role of impurities in getting proper recovery is also quite evident from our results.

Thus, root weight, top weight, root length, and sucrose content appear to be most valuable characters for selection of diploid genotypes of sugarbeet under the hot Indian conditions. Plants with smaller crown size will be an added advantage in reducing impurities. The data thus indicate that further progress with these varieties could be achieved by increasing emphasis on sucrose and purity percentage. Further, a compromise on maximum root weight would be necessary to achieve significant increase in recoverable sugar.

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