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Research Note

Inter-relationship between sugar yield and its component characters in two segregating populations of Sweet sorghum [*Sorghum bicolor* (L.) Moench.]

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Abstract:
An investigation was carried out at Directorate of Sorghum Research, Hyderabad during 2007-2009 to study the inter-relationship of sugar yield and its attributing traits in F_2 population of two crosses of sweet sorghum *viz*., '27 B × BJ 248' and 'CSV 17 × BJ 248'. Correlation studies in F_2 generation in both the crosses revealed high significant positive correlation of stalk yield, Brix, juice volume, juice yield, juice extraction per cent and total soluble sugar with sugar yield in the crosses. Path analysis indicated maximum positive direct effect of stalk yield, juice yield and Brix on sugar yield. Further, the other traits also exhibited high positive indirect effect *via* stalk yield, juice yield and Brix on sugar yield.

Keywords: Sweet sorghum, sugar yield, Correlation, path analysis

Sorghum [*Sorghum bicolor* (L.) Moench] is grown as a staple food across the Asian and African regions and as a fodder crop in the developed countries like America, Europe and Japan in the world (Doggett, 1988). The specific varieties of sorghum, called 'sweet sorghums' or 'sorgos', have sweet juicy stalks which accumulate 10-25 per cent sugar at grain maturity. These sweet sorghum varieties can be used to produce sorghum syrup or sugar, although many of them are used for forage (Hunter and Anderson, 1997). Sweet sorghum improvement is currently focused for production of both grain and sweet stalk.

There is renewed interest in using sugar rich agricultural crops as feedstocks for biofuel production. Existing feed stocks, such as sugarcane/sugarcane molasses, are unlikely to meet actual demand. The higher cost of cultivation of sugarcane or sugar beets has paved way to search for an alternative source for ethanol production. Sweet sorghum is one such alternative source which has very good potential as a feedstock for ethanol production and has emerged as a supplementary crop to sugarcane (Reddy *et al.,* 2005).

Sugar yield being a quantitative character, is the resultant of various characters working together during the crop growth which are interdependent in their development. It is, therefore, desirable to study the association between yield and yield attributing characters since this would facilitate effective selection for simultaneous improvement of one or more yield influencing components. However, the correlation between the yield and its component characters is often misleading, since it is affected by the inter-relationships among the component traits. Path co-efficient analysis developed by Wright (1921) helps in partitioning of the correlation coefficients into direct and indirect effects and to assess the relative contribution of each component character to sugar yield.

The present investigation was, therefore, undertaken in sweet sorghum with a view to study the association as well as direct and indirect effects of component

characters on sugar yield in two segregating populations of sweet sorghum.

The experiment comprising F_2 populations of two crosses of sweet sorghum *viz.*, '27B × BJ 248' and 'CSV 17 × BJ 248', along with their three parents and 2 F_1's was laid out during *kharif* 2009 in the experimental fields of Directorate of Sorghum Research under irrigated condition in a Randomized Complete Block Design (RCBD) with three replications. Each F_2 populations was grown in plots of ten rows of 3m spaced 60 cm apart with a plant spacing of 15 cm in separate blocks. The data on sugar yield and its six component characters *viz.,* stalk yield (g/plant), Brix (%), juice volume (ml/plant), juice yield (g/plant), juice extraction per cent and total soluble sugars (%) was recorded on 150 competitive plants in the cross 27 B × BJ 248 and 220 competitive plants in another cross CSV 17 × BJ 248. Total soluble sugars and sugar yield were calculated following regression equation given by Corleto and Cazzato (1997), as reported by Reddy *et al.* (2005).

Total Soluble Sugars (TSS) = 0.1516 + (Brix % × 0.8746)

Sugar yield (g/plant) = [TSS(%)/100] × Juice yield (g/plant)

To determine the degree of association of component characters with sugar yield and among the yield components, the correlation coefficients were calculated as per the method of Al-Jibourie *et al.* (1958), considering sugar yield as a dependent character. Path coefficient analysis was carried out using phenotypic correlation values of yield components on yield as suggested by Wright (1921) and as illustrated by Dewey and Lu (1959) using TNAUSTAT- statistical package.

Association of sugar yield with its attributing traits: Association of sugar yield was positive and highly significant with stalk yield, Brix, juice volume, juice yield and juice extraction per cent in both crosses *viz*., 27 B × BJ 248 and CSV 17 × BJ 248. However, the association of total soluble sugars with sugar yield was non-significant but significant and positive in the cross 27 B × BJ 248 (Table 1). Singh and Khan (2004), Kadian and Mehta (2006) and Unche *et al*. (2008) also reported similar results.

Association among sugar yield attributing characters: In both the crosses, the association of stalk yield with juice yield; Brix per cent with total soluble sugars; juice volume with juice yield and juice extraction per cent; juice yield with juice extraction per cent were positive and significant among sugar yield attributing characters. However, in the cross CSV 17 × BJ 248, stalk yield with total soluble sugars and Brix; Brix with juice yield and juice yield with total soluble sugars exhibited significant positive association. On the other hand, significant negative association of juice extraction per cent with total soluble sugars and Brix was observed in the cross CSV 17 × BJ 248. The reports of Singh and Khan (2004), Kadian and Mehta (2006), Kachapur and Salimath (2009), Unche *et al*. (2008) and Sandeep *et al*. (2010) were in agreement with the above results.

Path analysis: The results of path analysis of component characters of sugar yield indicated maximum positive direct effect of juice yield followed by Brix and stalk yield on sugar yield. However, stalk yield showed low positive direct effect and exhibited high positive indirect effect on sugar yield *via* juice yield resulting in high positive correlation of this trait with sugar yield. On the other hand, total soluble sugars and juice volume which showed negative direct effect on sugar yield had positive indirect effect *via* Brix and juice yield, respectively, resulting in high positive correlation (Table 2). These results were in agreement with the earlier reposts of Mallikarjun *et al*. (1998) and Kachapur and Salimath (2009). In general, the results indicated that the indirect contribution of many characters *via* juice yield resulted in their positive correlation with sugar yield.

The results on association of sugar yield with its attributing traits indicated importance of stalk yield, juice yield and Brix in improving sugar yield as these traits had direct relation with sugar yield. Therefore**,** improvement in these traits automatically improves sugar yield.

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Table 1. Correlation coefficients of sugar yield with its attributing characters in F_2 generation of the cross 27 B × BJ 248 (C_1) and CSV 17 × BJ 248 (C_2) in sweet sorghum.

Character	Cross	Brix (%)	Juice volume (ml/plant)	Juice yield (g/plant)	Juice extraction per cent	Total soluble Sugars (%)	Sugar yield (g/plant)
Stalk yield (g/plant)	C_1	0.157	0.914**	0.915**	0.011	0.157	0.895**
	C_2	0.211**	0.934**	0.953**	-0.104	0.210**	0.942**
Brix (%)	C_1		0.078	0.079	-0.141	0.999**	0.405**
	C_2		0.094	0.135*	-0.239**	0.999**	0.354**
Juice volume (ml/plant)	C_1			0.999**	0.399**	0.079	0.934**
	C_2			0.990**	0.214**	0.093	0.948**
Juice yield (g/plant)	C_1				0.399**	0.081	0.936**
	C_2				0.187**	0.134*	0.969**
Juice extraction per cent	C_1					-0.140	0.296**
	C_2					-0.240**	0.128
Total soluble Sugars (%)	C_1						0.406**
	C_2						0.353**

* Significant at P = 0.05 **Significant at P = 0.01

Table 2. Path analysis indicating direct and indirect effects of component characters on sugar yield in F_2 generation of the cross 27 B × BJ 248 (C_1) and CSV 17 × BJ 248 (C_2) in sweet sorghum

Character	Cross	Stalk yield	Brix	Juice volume	Juice yield	Juice extraction per cent	Total soluble sugars	'r' with sugar yield
Stalk yield (g/plant)	C_1	0.1325	0.0755	-0.1700	0.8806	0.0003	-0.0243	0.895**
	C_2	0.1529	0.1202	-0.1173	0.8640	-0.0057	-0.0726	0.942**
Brix (%)	C_1	0.0208	0.4809	-0.0145	0.0764	-0.0045	-0.1541	0.405**
	C_2	0.0323	0.5697	-0.0119	0.1226	-0.0131	-0.3453	0.354**
Juice volume (ml/plant)	C_1	0.1210	0.0375	-0.1861	0.9614	0.0126	-0.0122	0.934**
	C_2	0.1428	0.0538	-0.1256	0.8977	0.0117	-0.0322	0.948**
Juice yield (g/plant)	C_1	0.1212	0.0382	-0.1860	0.9623	0.0126	-0.0124	0.936**
	C_2	0.1457	0.077	-0.1244	0.9068	0.0102	-0.0463	0.969**
Juice extraction per cent	C_1	0.0014	-0.0680	-0.0742	0.3839	0.0316	0.0216	0.296**
	C_2	-0.0159	-0.1363	-0.0269	0.1697	0.0547	0.0829	0.128
Total soluble Sugars (%)	C_1	0.0209	0.4808	-0.0147	0.0775	-0.0044	-0.1541	0.406**
	C_2	0.0321	0.5696	-0.0117	0.1215	-0.0131	-0.3453	0.353**

Residual effect of C_1 = 0.1143 Residual effect of C_2= 0.0970
*Significant at P = 0.05 **Significant at P = 0.01