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RESEARCH ARTICLE

GENETIC VARIABILITY FOR CANE YIELD, EARLINESS AND QUALITY TRAITS IN SUGARCANE UNDER SUBTROPICAL REGION OF INDIA

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ABSTRACT

Sugarcane (*Saccharum spp.* complex) is an important cash crop of sugar industry. It is generally grown in tropics; however its productivity depends on the varieties cultivated from different maturity group, the agro-climatic conditions of the region and cultural practices followed. The subtropical region for sugarcane cultivation occupies about 50 per cent of the national area. So, present study was under taken to evaluate twelve elite sugarcane clones belonging to early maturity group under subtropical condition of India at Punjab Agricultural University, Regional Research Station, Kapurthala, during 2013 in randomized block design in plot size of 36 m^2 having three replications with an inter-row spacing of 75cm. The data were recorded on eight yield and quality traits *viz*. cane length (m), cane diameter (cm), single cane weight (kg), juice/cane (kg), juice extraction (%), brix (%) in juice, sucrose (%) in juice and Purity (%). The analysis of variance revealed significant differences among the clones for all the traits studied. The magnitudes of phenotypic variances were higher than genotypic variances for all the traits. Moderate to high heritability coupled with high genetic advance were recorded for juice/cane, juice extraction %, single cane weight, cane length and sucrose per cent. Positive and significant associations of juice/cane, juice extraction, brix per cent and sucrose per cent in juice were recorded with single cane weight. The mean performance of different clones for traits studied ranged, cane length (1.71 – 2.70m), cane diameter (2.12 – 2.73cm), single cane weight (0.99 – 1.69kg), juice/cane (0.50 – 1.05kg), Juice extraction (44.41 – 74.48%), brix (13.35 – 18.63%), pol (11.33 – 17.22%) and purity (83.01 – 91.13%). The characters with high heritability coupled with genetic advance and positive association with cane yield are advocated as selection criteria for yield improvement in sugarcane and identification of promising early maturing clones under subtropical conditions.

INTRODUCTION

Sugarcane (*Saccharum spp.* complex) is an important cash crop of India for sugar industry. It is generally grown in both tropics and sub-tropic regions, however its productivity depends on the varieties cultivated from different maturity groups, prevailing agro-climatic conditions of the region and other cultural practices to great extent. This species has C4 photosynthesis, resulting in a vigorous biomass accumulation under tropical conditions, but it is limited in temperate regions due low temperature during early growth period and at maturity. Sugarcane is responsible for ~70% raw table sugar production worldwide (Contreras *et al.,* 2009). The subtropical region for sugarcane cultivation occupies about 50 per cent of the national area (5.06 m ha) with a productivity of 66.9 t/ha, cane yield of 338.9 million tons and sugar 25.0 million tons during 2012-2013 (Anonymous, 2013). It is clonally propagated via stem cuttings, facilitating the preservation of cultivar genetic identity in this crop. Sugarcane varieties in commercial cultivation are complex polyploid. The heterozygous and polyploid nature of this crop has resulted in generation of greater genetic variability. The extent of genetic variability present in any crop is of paramount importance for its improvement. The information on the nature and the magnitude of variability present in the genetic material is of prime importance for a breeder to initiate any effective selection program. Genotypic and phenotypic coefficients of variation along with heritability as well as genetic advance are very essential to improve any trait of sugarcane because this would help in knowing whether or not the desired objective can be achieved from the material (Tyagi and Singh, 1998). Since, cane yield is a complex trait the association of different traits with it would be an important criterion for the development of high yielding, high sugared and early maturing varieties in sugarcane. So, present study was under taken to assess the extent of genetic variability, heritability, genetic advance and selection indices based on the association studies of cane yield with some important traits of elite sugarcane clones under subtropical condition of India.

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MATERIALS AND METHODS

The experimental material for the present study consisted of 12 genotypes of sugarcane including two standard checks viz. CoJ 64 and CoJ 85 representing early maturing group. were evaluated under subtropical condition of India at Punjab Agricultural University, Regional Research Station, Kapurthala, during 2013-14 in randomized block design in plot size of 36 m^2 having three replications with an inter-row spacing of 75cm. The data were recorded on eight yield and quality traits *viz*. cane length (m), cane diameter (cm), single cane weight (kg), juice/cane (kg), juice extraction (%), brix (%) in juice, sucrose (%) in juice and purity (%).The data were statistically analyzed and analysis of variance was used for calculating genotypic and phenotypic coefficients of variance for all characters. The broad sense heritability was estimated according to the method suggested by Johnson *et al*. (1955) and the expected genetic advance was calculated by the method given by Robinson *et al*. (1949). Further, mean values of different traits were used to work out the association studies following Steel and Torrie (1980).

RESULTS AND DISCUSSION

The analysis of variance for all the characters showed that genotypes included in the test differed significantly (p 0.05) with respect to all characters studied. This indicates that there was significant amount of phenotypic variability and all the genotypes differ with regard to the characters that opened a way to proceed for further improvement through simple selection (Punia, 1982). Mean values for single cane yield varied between 0.99-1.69Kgs while cane length ranged from 1.71-2.70 m (Table 1). Likewise juice extraction percentage varied from 44.41-74.48 with an average of 62.37 per cent. A good range of juice quality parameters was recorded viz. brix (13.35 – 18.63%), pol (11.33 – 17.22%) and purity (83.01 – 91.13%) between clones at 10 month stage. Magnitudes of phenotypic variances were higher than genotypic variances for all the traits. The high phenotypic and genotypic coefficients of variation were observed for single cane weight (PCV = 18.29; GCV = 14.44%), juice per cane (PCV =21.23; GCV = 18.77%) and juice extraction (PCV =18.35; GCV = 15.77%). High genotypic and phenotypic coefficients of variation for a single cane weight were reported earlier by Singh and Sangwan (1980).

Table 1. Genetic variability parameters for different traits in sugarcane under subtropical conditions

Traits	Mean	Range	h^2 %	GA	PCV	GCV
Cane length (m)	2.35	1.71-2.70	56.65	15.99	13.70	10.31
Cane diameter (cm)	2.50	2.12-2.73	26.40	15.44	10.01	5.14
Single cane weight (kg)	1.30	0.99-1.69	62.39	23.50	18.29	14.44
Juice/cane (kg)	0.80	0.50-1.05	76.03	33.72	21.53	18.77
Juice extraction (%)	62.37	44.41-74.48	75.47	28.52	18.35	15.94
Brix (%)	16.75	13.35-18.63	78.08	17.53	10.90	9.63
Pol (%)	14.87	11.33-17.22	79.85	21.71	13.20	11.79
Purity (%)	88.08	83.09-91.13	54.26	3.89	3.48	2.56

After partitioning phenotypic variance, it was found that genotypic variance was higher than the environmental one for five characters studied. These results indicate that a negligible role was played by the environmental factors in the inheritance of these characters in sugarcane. The high genotypic variance for different traits in sugarcane has also been reported by other researchers (Balasundarum and Bhagyalakshmi, 1978; Nair *et al*., 1980). Genotypic coefficient of variation is not a correct measure to know the heritable variation present and should be considered together with heritability estimates. In the present study, high heritability estimates were recorded for pol per cent (79.85%), brix (78.08%) juice per cane (76.03%) and juice extraction (75.47%) (Table 1). This suggests that simple selection for these traits would be effective. Moderate heritabilities were recorded for single cane weight, cane length and purity per cent. Similar results were obtained by Sahi *et al.* (1977) for juice quality characters. Heritability estimates along with expected genetic gain is more useful than the heritability value alone in predicting the resultant effect for selecting the best genotypes (Johnson *et al*., 1955). Maximum genetic gain was observed for juice per cane (33.72%) followed by juice extraction (28.52%), single cane weight (23.50%) and pol percent (21.71%) indicating that there exists a scope to improve cane yield and quality traits to a considerable extent by adopting suitable breeding procedures. High genetic advance (as percent of mean) for single cane weight was also reported by Tyagi and Singh (1998).

Stalk diameter had low heritability with moderate genetic advance. Pandey (1989) had earlier reported the low genetic advance with moderate amount of heritability for stalk diameter suggesting a little scope in the improvement of this character. In general, genotypic correlation coefficients were higher than their corresponding phenotypic correlation coefficients indicating a fairly strong inherent relationship among the traits. The lower estimates of phenotypic correlation indicated that the relationships were affected by environment at phenotypic level. Such environmental influence in reducing the correlation coefficients in rice was also reported by Chaudhary and Singh (1994). The correlation coefficient results (Table 2) indicated that the single cane yield was positively correlated with cane diameter (1.00), cane length (0.346) and juice per cane (0.566). The pol %, brix% and purity % were negatively correlated with single cane yield. It is concluded that the increase in cane yield was due to combined effect of length of stalk and stalk girth. According to Raman *et al*. (1985) height and cane girth were major yield contributing factors. Our results are in agreement with these workers as far as contribution of length of stalk and stalk girth to cane yield is concerned.

The negative correlation of pol% with cane yield and positive correlation with sugar yield is one of the major constraints in the improvement of sugarcane (Table 2). For plant breeders, yield in crops is one of the most important and complex traits. Continued improvement of yield remains the top priority in most breeding programs (Cox *et al*., 1996). Brix% and cane yield in sugarcane depends on various growth and component traits, which is the final outcome of a combination of different yield components, such as cane girth, stalk number per stool, stalk weight and pol % (Olaoye, 1995). Many component analyses have been performed for complex traits based on morphological and physiological characterizations (Bull *et al*., 2000; Petrasovits *et al*., 2007). It could be more effective that yield components were selected to increase yield because of

Table 2. Phenotypic (above diagonal) and genotypic (below diagonal) correlation coefficients among different traits in sugarcane

Traits	Cane length	Cane diameter	Single cane weight	Juice/cane	Juice Extraction	Brix	Pol	Purity
Cane length		0.138	0.186	-0.164	-0.376*	-0.552**	-0.545**	-0.383*
Cane diameter	0.346*		0.315	0.117	-0.195	-0.100	0.028	0.030
Single cane weight	0.300	1.000**		0.566**	-0.307	-0.201	-0.148	-0.117
Juice/cane	-0.361*	0.592**	0.573**		0.593**	0.405*	0.454**	0.403*
Juice extraction	-0.650**	-0.343*	-0.228	0.656**		0.644**	0.633**	0.551**
Brix	-0.749**	-0.144	-0.245	0.607**	0.875**		0.954**	0.754**
Pol	-0.751**	0.016	-0.142	0.651**	0.836**	0.992**		0.843**
Purity	-0.902**	-0.208	-0.122	0.665**	0.867**	0.984**	1.000**	

(Residual values at 5 % =0.334, 1 % = 0.430); * and ** significant at 0.05 and 0.01 level of significance)

lower heritability for yield and higher heritability for yield components. However, yield is correlated with yield components in complicated ways. Therefore, it is imperative to reveal the genetic relationship between yield and its component traits and their interaction to various environments. This study revealed that characters with high heritability coupled with genetic advance and positive association with cane yield are advocated as selection criteria while selection to be made for higher sugar and cane yield and early maturing clones in sugarcane genotypes under subtropics conditions.

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