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Studies on variability and character association in sugarcane (*Saccharum spp*) under rainfed condition of North Eastern India

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Research Paper

G.C.BORA[1*], P.K. GOSWAMI[2] AND B.C. BORDOLOI[2]

[1]Department of Plant Breeding and Genetics, Assam Agril. University (AAU), Jorhat -785 013,India.
[2]Sugarcane Research Station, AAU, Buralikson, Golaghat -785 618,India.

ABSTRACT

An investigation was conducted at the Sugarcane Research Station, Buralikson (Assam), India during 2008-2009 and 2010-2011 for studying variability and correlation in thirty one early sugarcane (*Saccharum spp*) clones for yield, yield components and quality characters under the rainfed condition of Assam. The studies revealed moderate to high range of variation for germination (%), shoots number at 120 days, number of millable cane ('000/ha), cane height (cm), single cane weight (kg), cane yield (t/ha) and commercial cane sugar (t/ha). The variation was low for cane diameter and quality characters. The characters showing high genotypic and phenotypic variance, genotypic and phenotypic coefficient of variation, heritability with high genetic advance were number of millable cane, cane height and single cane weight. The characters showing high and significant correlation with cane yield were number of millable cane, germination (r_g = 0.64*), shoot count, cane height and single cane weight. Hence, these characters must be given importance while selecting sugarcane clones for improvement in yield. The sugar recovery had high and significant correlation with field brix and sucrose (r_g = 0.64*). Hence these two characters must be given importance for improvement in sugar recovery.

Key words: Coefficient of variation, heritability, genetic advance, correlation.

*Corresponding Author E-mail: gobin_bora@yahoo.co.in

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INTRODUCTION

Sugarcane is an important cash crop and next to cotton, sugar industry is the second biggest organized agro-based industry in India. Although, sugarcane cultivation is the backbone of rural economy, the productivity of sugarcane in the North Eastern India, particularly in Assam is very low (37.4 t/ha) which is far behind the national average of 66.9 t/ha (Annonymous, 2013). This is mainly due to adoption of low yielding traditional varieties which are not adapted to varying environmental conditions. The success of any crop improvement programme depends on the nature and magnitude of genetic variability present in the population. Heritability measures the relative degree to which a character is transmitted from parent to progeny. Genetic coefficient of variability together with heritability estimates provide the extent of genetic advance expected from selection. Chaudhary (2001) reported high heritability and genetic gain for single cane weight followed by number of millable cane in a study of 36 clones indicating substantial scope for cane yield improvement. Jamoza et al.(2014) reported that where genetic coefficient of variation, broad sense heritability and expected genetic advance were high, a selection strategy based on single stalk weight and number of millable cane could lead to improvement in cane yield. Wright (1921) and Fisher (1936) elaborated the use and significance of correlation in plant improvement. To increase cane and sugar yield through selection for yield attributing and quality characters, the knowledge of association of various characters is important. Consideration of genetic relationships between important attributes in exploiting genetic populations through breeding and directed

selection is essential, primarily to understand how changes made by selecting one character may cause changes in others (Tyagi and Khan, 2010). Ahmed and Obeid (2012) used a total of 12 exotic sugarcane clones in his study on genetic parameters including genetic variation, heritability and genetic advance and reported improvement in cane yield through straight selection for number of millable cane and single stalk weight. Although lots of germplasm exist in sugarcane in the North Eastern India, their systematic study has not yet been made properly in order to recommend an efficient breeding methodology. Therefore, the present investigation was undertaken to estimate the variability and to gather information on association amongst various characters under rainfed condition of Assam and North Eastern India.

MATERIALS AND METHODS

A field experiment was conducted at the Sugarcane Research station, Buralikson (Assam) during 2008-09 to 2010-11 with 31 sugarcane clones viz., CoSe 02235, CoSe 95422,CoSe 92423, CoSe 00421, CoS 687, CoS 94257, CoS 95222,CoS 767, UP 0090, UP 01104, UP 01105, UP 01108, CoP 02181,CoP 02182, CoP 9301, CoP 9206, BO 120, BO 146, BO 91, BO 128, BO 140, BO 139, CoBln 9101, CoBln 02173, CoBln 9605, Co 1148, CoLk 94184, CoLk 9606, CoH92202, CoPant 90223 and CoPant 84212. They were planted in randomized block design with three replications. The plot size was 6 rows of 6 meters length spaced at 90 cm between the rows.

Three budded sets were planted at the rate of 12 buds (4 sets) per meter of rows. The crop was raised following the cultural practices and manurial schedule (NPK at 135:70:60 kg/ha) as recommended for Assam. Observations on germination (%) at 45 days and shoots number at 120 days in thousand were recorded on per plot basis. The number of millable cane (NMC) in thousand and cane yield in tonnes per hectare were also recorded on per plot basis at the time of harvesting. Ten randomly selected plants from each plot were used for recording data on cane height (cm), cane diameter (cm) and single cane weight (kg). The quality analysis was done at 10 months of crop age (in January) following the procedure as per Spencer and Meade (1955) as follows.Pol or Sucrose (%) : The extracted cane juice was clarified with lead sub acetate and the clear juice was polarized in polarimeter installed in the laboratory. After adjusting the refracted light, the pole or sucrose (%) was determined from the hydrometer brix (uncorrected) and corresponding pol reading by referring to the Schmitz table.

Purity (%) = Sucrose (%)/Corrected brix (%) x 100 CCS (%) = [S-(B-S) x 0.4] x 0.73 where CCS = Commercial Cane Sugar, S = Sucrose (%) juice, B = Brix (%) juice.

RESULTS AND DISCUSSION

The present study (Table 1) showed wide range of variation for germination (%), number of millable cane, single cane weight, cane yield and commercial cane sugar (t/ha). This indicated sufficient variability for these characters among the materials handled. It was moderate for shoots number at 120 days and cane height. The range of variation was low for cane diameter, field brix, sucrose, purity and CCS (%). This is due to less variability for these characters amongst the materials studied. Wide range of variation was also observed by Ahmed and Obeid (2012) for NMC. The genotypic and phenotypic variance was high for germination (%), shoots number, NMC, cane height and cane yield ; moderate for purity (%) and low for cane diameter, single cane weight, field brix, sucrose and CCS (%). Genetic coefficient of variation (GCV) is another measure of relative genetic variation of a trait in a population (Ram and Hemaprabha, 1992). There was high GCV and phenotypic coefficient of variation (PCV) for germination (%), NMC, cane height, single cane weight, cane yield and CCS (t/ha). Traits exhibiting relatively high GCV estimates may respond favourably to selection. They were moderate for shoots number, cane diameter and CCS (%) whereas they were low for field brix, sucrose and purity. The differences between GCV and PCV for most of the traits were small indicating high prospects for genetic progress through selection under conditions of this investigation (Ram, 2005). Similar results based on GCV and PCV had also been reported earlier by Chaudhary, 2001; Kamat and Singh, 2001 ; Kumar and Singh, 2003 and Sabitha et al., 2007.

Genetic coefficient of variation along with heritability estimates gives a better indication of genetic variation for a trait than either parameter alone. The heritability estimates in broad sense in the present study were high for the characters viz., germination (%), shoots number, NMC, cane height, single cane weight, cane yield (t/ha), field brix, and CCS (t/ha). Other characters showed moderate to low heritability. The effectiveness of selection depends not only on heritability but also on genetic advance (Shoba et al., 2009). The characters showing high genetic advance were cane height, single cane weight and NMC whereas it was moderate for cane diameter, shoots number, germination (%) and cane yield. The genetic advance was low for all other characters. The characters showing high GCV, PCV, heritability and genetic advance were NMC, cane height and single cane weight. Hence these characters may be improved directly through simple selection. The characters with high GCV, PCV, heritability but moderate or low genetic advance were germination (%), cane yield and CCS (t/ha). These character could be improved by selection of clones for this characters followed by intermating among the selected clones and progeny testing as is evident from high heritability with low genetic

Table 1. Nature of variability in sugarcane under rainfed condition of Assam.

Sl. No.	Characters	Range	Mean	Genotypic variance	Phenotypic variance	Genotypic coefficient of variation	Phenotypic coefficient of variation	Heritability (%) in broad sense	Genetic advance as (%) of mean
1	Germination (%) at 45 days	27.74 – 73.43	53.56	151.12	157.61	22.99	23.48	95.88	24.80
2	Shoots number at 120 days('000/ha)	61.88– 114.80	87.04	177.40	188.76	15.30	15.78	93.98	26.60
3	NMC ('000/ha)	24.60– 111.81	81.52	278.12	290.84	20.46	20.92	95.63	33.59
4	Cane height (cm)	159.00-274.67	217.97	1564.73	1622.72	18.15	18.48	96.43	80.02
5	Cane diameter (cm)	1.82 – 2.57	2.26	0.026	0.034	7.07	8.16	75.01	29.00
6	Single cane weight (Kg)	0.50 – 1.32	0.83	0.037	0.041	23.02	24.27	89.96	38.00
7	Cane yield (t/ha)	32.54 – 86.16	64.17	158.82	176.41	19.64	20.70	90.03	24.63
8	Field brix in January	16.94 – 20.29	18.67	0.96	1.03	5.24	5.44	92.68	1.94
9	Sucrose (%) in January	15.54 – 19.95	17.79	0.77	1.00	4.94	5.63	76.95	1.59
10	Purity (%) in January	76.75 – 94.77	86.91	13.43	17.01	4.22	4.75	78.93	6.71
11	Commercial cane sugar (%)	9.80 – 15.38	12.55	1.57	1.84	9.98	10.81	85.25	2.38
12	Commercial cane sugar (t/ha)	4.61 – 12.04	8.31	3.47	3.75	22.43	23.33	92.38	3.69

Table 2. Correlations between yield, yield contributing and quality characters in Sugarcane.

Characters	Correlation coefficient	Cane Yield (t/ha)	NMC ('000 /ha)	Shoots number ('000/ha)	Cane height (cm)	Cane diameter (cm)	Single cane weight (Kg)	Germination (%)	Field brix in Jan.	Sucrose (%) in Jan.	Purity(%) in Jan.	CCS (%) in Jan.
CCS (t/ha)	G	0.94**	0.64**	0.70**	0.50**	0.50**	0.73**	0.63**	0.52**	0.64**	0.41*	0.42*
	P	0.93**	0.61**	0.66**	0.46**	0.39*	0.64**	0.60**	0.49**	0.56**	0.36*	0.41*
Cane yield (t/ha)	G		0.77**	0.72**	0.52**	0.46**	0.71**	0.64**	0.37	0.52**	0.35	0.13
	P		0.71**	0.66**	0.47**	0.34	0.62**	0.60**	0.33	0.43*	0.32	0.11
NMC ('000/ha)	G			0.73**	0.16	0.07	0.26	0.65**	-0.03	0.17	0.28	-0.09
	P			0.70**	0.16	0.02	0.23	0.63**	-0.02	0.17	0.26	-0.07
Shoots number('000/ha)	G				0.06	0.17	0.31	0.87**	0.29	0.30	0.40*	0.24
	P				0.04	0.11	0.26	0.83**	0.27	0.24	0.34	0.21
Cane height (cm)	G					0.74**	0.66**	0.02	0.31	0.52**	0.21	0.10
	P					0.66**	0.63**	0.02	0.30	0.44*	0.17	0.09
Cane diameter (cm)	G						0.64**	0.01	0.38*	0.49**	0.05	0.10
	P						0.54**	-0.03	0.27	0.33	-0.01	0.04

Table 2 Contd.

Single cane weight (Kg)	G	0.14	0.58**	0.71**	0.14	0.25
	P	0.13	0.49**	0.54**	0.11	0.18
Germination (%)	G		0.26	0.20	0.37*	0.27
	P		0.25	0.18	0.34	0.26
Field brix in January	G			0.80**	0.32	0.59**
	P			0.68**	0.29	0.54**
Sucrose (%) in January	G				0.51**	0.61**
	P				0.50**	0.59**
Purity (%) in January	G					0.49**
	P					0.46**

G : Genotypic , P : Phenotypic ,* Significant at 5% probability level , ** Significant at 1% probability level.

advance.

The genotypic and phenotypic correlation coefficients (Table 2) showed that in most of the cases genotypic correlation coefficients were higher than their phenotypic counter parts indicating a fairly strong inherent relationship among the traits. The CCS (t/ha) showed highly significant correlation with cane yield, NMC, shoots number, cane height, single cane weight, germination (%), field brix and sucrose . The cane yield showed highly significant correlation with NMC, shoots number, cane height, single cane weight and germination (%) both at genotypic and phenotypic levels. Similar observations were also made by Kamat and Singh (2002) ; Chaudhary and Joshi (2005); Singh et al.(2005) ; Kadian et al.,(2006) and Das et al.(2007). Khan et al.(2012) reported positive correlation of cane yield with cane girth, weight per stool, sugar yield, tiller number and purity (%).

There was highly significant correlation for NMC with shoots number and germination (%) ; shoots number with germination (%) ; cane height with cane diameter and single cane weight ; cane diameter with single cane weight ; single cane weight with field brix and sucrose ; field brix with sucrose and CCS (%) ; sucrose with purity and CCS (%) ; and purity with CCS (%). There was no significant negative correlation for any pair of characters in our study. However, Khan et al., 2012 reported negative correlation for cane yield with Pol (%) and CCS (%). Tyagi and Lal, 2007 while studying phenotypic associations in sugarcane, concluded that selecting for stalk number, diameter and length should be emphasized in sugarcane variety development programs where high cane yield is the primary goal. In the present study also germination (%), shoots number, number of millable cane, cane height and single cane weight were found to be the yield components due to their positive and significant association with cane yield. Therefore, these characters should be given due importance while selecting sugarcane clones for higher cane yield. On the other hand sugar yield could be improved by selection for field brix and sucrose (%) as is evident from their strong positive association with sugar yield. However, intermating among the selected clones followed by progeny selection would give significant increase in sugar recovery as is evident from high heritability with low genetic advance.

CONCLUSION

This study revealed that the characters showing higher extent of variation, high heritability and high genetic advance were germination (%), shoot number, NMC, cane height, single cane weight and cane yield. Since cane yield had significant positive correlation with these characters, the selection strategy based on them might result in significant genetic improvement in cane yield. The sugar recovery could be improved by selection for higher field brix, sucrose (%) and purity(%) as they had a significant positive correlation with sugar recovery. However, in order to achieve significant increase in sugar recovery, intermating among the selected clones followed by progeny testing would be desirable as is evident from high heritability with low genetic advance.

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