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GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE IN SELECTED CLONES OF SUGARCANE

S. N. Swamy Gowda[1], K. Saravanan[2] and C. R. Ravishankar[3]

[1] & [3]Zonal Agricultural Research Station, (U.A.S., Bangalore), V.C. Farm, Mandya (Karnataka), India.
[2]Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar (Tamil Nadu), India.

Abstract

Thirty sugarcane clones were tested during August season of 2008-09 and 2009-10 in a randomized complete block design with two replications at Zonal Agricultural Research Station, V.C. Farm, Mandya, Karnataka (India) to study the variability parameters for cane yield and quality traits in plant and ratoon crops. The observations were recorded for cane yield components *viz*., number of tillers, number of millable cane, stalk length, stalk diameter, single stalk weight, internodal length, number of internodes, juice brix per cent, juice pol per cent, juice purity per cent, CCS per cent, sugar yield and cane yield. Analysis of variance revealed highly significant differences between genotypes for all the characters studied. Wide range of variation was observed for number of tillers, number of millable cane, stalk diameter, cane and sugar yield and for quality traits, juice brix per cent, juice pol per cent and CCS per cent in both plant and ratoon crops. Maximum genotypic and phenotypic coefficients of variation were exhibited by number of tillers, single stalk weight, sugar yield and cane yield in both plant and ratoon crops. Among quality characters lowest values for both coefficients were recorded by purity per cent in both plant and ratoon crops. Maximum genetic gain as per cent of mean was observed for number of tillers, number of millable cane, sugar and cane yield in plant crops. Whereas, in ratoon crop highest genetic gain as per cent of mean was recorded for number of tillers, single stalk weight, sugar and cane yield. All characters showed high heritability which suggests that selection should be in both plant and ratoon crops based on yield contributing characters having high PCV, GCV, heritability and genetic advance along with mean value.

Key words : Genetic variability, heritability, genetic advance, genotypic and phenotypic variance.

Introduction

Sugarcane industry is the most significant agro-based industry in India. Programme of sugarcane breeding in Karnataka, since 1965, has aimed at good yielding sugarcane varieties through different programmes, like introduction of sugarcane, true seeds (Fluff) from SBI Coimbatore and effecting of local crossing programme to produce indigenous seeds for the on-going variety selection process. Sugarcane varieties in commercial cultivation are complex polyploids. The heterozygous and polyploid nature of this crop has resulted in generation of greater genetic variability. 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 programme. According to Anshuman *et al*. (2002), genetic variability and heritability are useful parameters that can help in crop improvement. Genotypic and phenotypic co-efficient of variation along with heritability as well as genetic advance are very much essential to improve any triat of sugarcane because this would help in knowing whether or not the desired objective can be achieved from the material (Tyagi and Singh, 1998). Therefore, the present study was an attempt to assess the variability parameters including genotypic and phenotypic coefficients of variation and the genetic advance as well as heritability estimates for quantitative and qualitative characters for thirty sugarcane clones in plant and ratoon crops.

Materials and Methods

The experimental material was developed from biperental open pollinated and poly crosses of sugarcane fluff generated at Zonal Agricultural Research Station (U.A.S., Bengaluru), V.C. Farm, Mandya, Karnataka, India. The experimental material for the present study consisted of 30 clones of sugarcane including two

standards *viz.,* Co 62175 and Co 86032 representing early and mid-late maturing groups and the experiment was laid out during August season of 2008-2009 for plant crop and during 2009-2010 for ratoon crop in randomized complete block design with two replications, each genotype planted in six rows and each row having of six meter length with a plot size of 32.4m^2. The setts having three eye buds each were planted with three setts per meter. The crop received 250 kg N, 100kg P_2O_5 and 125 kg K_2O ha^{-1}. All the recommended package of practices were adopted during the entire crop season. The crop was harvested at 12 month and ratooned thereafter. The ratoon crop was reaped at 12 month of age. The observations were recorded on five randomly tagged canes at 12th month stage. The following field and laboratory observations were recorded *viz*., number of tillers (000/hectare), number of millable canes (000/ hectare), stalk length (m) stalk diameter (cm), single stalk weight (kg), internodal length (cm), number of internodes, juice brix per cent, juice pol per cent, juice purity per cent, CCS per cent, sugar yield (ton/hectare) and cane yield (ton/hectare).

Analysis of variance was used for calculating genotypic, phenotypic and environmental 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).

Results and Discussion

The analysis of variance for all the characters revealed the significant differences among genotypes for cane and quality triat studies indicated sufficient variability and considerable improvement can be achieved among the materials studied (table 1). Among the quantitative characters, number of tillers, number of millable cane, stalk diameter, number of internodes, internodal length, juice brix per cent, juice pol per cent, sugar yield and cane yield showed wide range variation in plant and ratoon crop (tables 2 & 3) providing wide scope of selection for these triats and relatively narrow range of variations was noticed for stalk length, juice purity percent and CCS per cent. These results are in conformity with the observation of Ghosh and Singh (1996) and Patel *et al.* (2006).

Results of genetic analysis for different characters in terms of GCV per cent, PCV per cent, genetic advance over mean (per cent of mean) and heritability per cent estimates for different characters are presented in (tables 2 & 3) for both plant and ratoon crop respectively. Sugar yield ton/hectare, cane yield ton/hectare, numbers of tillers (000'/hectare) and single cane weight exhibited high variability among genotypes as revealed by higher magnitude of phenotypic and genotypic coefficient variation (tables 2 & 3) in both plant and ratoon crops, suggesting that these characters are under the influence of genetic control (Verma *et al*., 1988; Hapse and Hapse, 1990). Bhatnagar (2003) had reported high values of genotypic and phenotypic coefficient of variation for number of millable cane and single stalk weight. The difference between PCV and GCV for sugar yield, cane yield, number of tillers, number of millable cane and stalk length was narrow implying less influence of environment on the triats, thus showing high heritability and genetic advance as per cent of mean. Hence, simple selection could lead to better improvement, the same was also reported by earlier workers *viz*., Nair *et al*. (1980), Singh *et al*. (1983), Verma *et al*. (1988) and Ghosh and Singh (1996).

Among the quality parameters juice purity per cent, juice brix per cent, juice pol per cent and CCS per cent had low GCV and PCV values (tables 2 & 3) in both plant and ratoon crops indicating the presence of limited genetic variability for these characters. These findings are in agreement with Nair *et al***.** (1980), Singh *et al*. (1983) and Ghosh and Singh (1996). Among cane yield components *viz.,* stalk length, stalk diameter in plant crop and stalk length and internodal length in ratoon crop exhibited lowest values of GCV and PCV, which is in accordance with the finding of Nair *et al*. (1980) and Singh *et al*. (1996). It is important to note that the difference between the estimates of GCV and PCV are high for single stalk weight and number of internodes in plant crops whereas in ratoon crops it is observed for the characters like stalk length, single stalk weight, internodal length and internodal number. The results revealed major role of environment variation in expression of these triats.

Genotypic coefficient of variations is not a correct measure to know the heritable variation present and should be considered together with heritability estimates. In the present experiment, moderate to high heritability estimates were noticed for all the characters studied (tables 2 and 3) except for juice purity per cent in plant crop and stalk length in ratoon crop suggesting that selection of clones for these characters will be effective. Similar results were also reported by Khairwal *et al*. (1978), Singh *et al*. (1983), Kadian *et al*. (1997) and Patel *et al*. (2006). Maximum heritability values for cane yield characters in the plant crop were obtained by number of tillers (93.68%), number of millable cane (85.92%) and stalk diameter (65.82%) where stalk diameter (88.38%) had reported the maximum heritability in ratoon crop followed by number of tillers (88.10%) and single stalk

Table 1 : Analysis of variance results for cane yield and quality triats in sugarcane.

S. no.	Characters	MS Genotype		MS error		S.E ±		C.V. %	
		PC	RC	PC	RC	PC	RC	PC	RC
1	Number of tillers (000'/ ha)	2013.82**	1539.51**	65.76	103.26	5.73	7.62	5.13	5.97
2	Number of millable cane (000'/ha)	319.14**	587.94**	24.17	67.32	3.48	7.22	4.72	9.65
3	Stalk length (m)	0.10**	0.13**	0.03	0.04	0.11	0.17	6.48	11.18
4	Stalk diameter (cm)	0.20**	0.16**	0.04	0.03	0.14	0.09	6.31	4.22
5	Single stalk weight (kg)	0.17**	0.26**	0.06	0.04	0.18	0.13	13.67	13.17
6	Internodal length (cm)	5.32**	5.51**	1.45	2.03	0.85	0.93	8.82	10.60
7	Number of inter nodes	10.56**	9.48**	3.99	3.39	1.41	1.07	8.56	9.81
8	Juice brix per cent	5.63**	5.02**	0.11	0.45	0.23	0.38	1.84	2.91
9	Juice pol per cent	5.35**	4.72**	0.23	0.65	0.34	0.39	2.82	3.31
10	Juice purity per cent	2.27**	6.11**	0.93	2.65	0.68	0.70	1.03	1.08
11	CCS per cent	3.02**	2.48**	0.20	0.44	0.32	0.34	3.73	4.03
12	Sugar yield t/ha	29.21**	39.42**	1.65	1.47	0.91	0.68	6.70	6.87
13	Cane yield t/ha	1857.84**	2537.84**	66.44	59.49	5.76	6.03	8.06	7.07

PC : Plant crop, **RC**: Ratoon crop; * = 0.05 probability level; ** = 0.01 probability level.

Table 2 : Range, coefficients of variation, heritability (broad sense), genetic advance (per cent of mean) for cane yield and quality characters in plant crop.

S. no.	Characters	Range		Co-efficient of variation (%)		Heritability (%)	Genetic advance (% of mean)
		Min	Max	Genotypic	Phenotypic		
1.	Number of tillers (000'/ha)	114.75	218.85	19.74	20.39	93.68	39.36
2.	Number of millable cane (000'/ha)	78.35	132.00	11.65	12.57	85.92	22.24
3.	Stalk length (m)	2.06	2.81	7.58	9.97	57.74	11.80
4.	Stalk diameter (cm)	2.63	4.11	8.76	10.80	65.82	14.72
5.	Single stalk weight (kg)	1.15	2.45	12.16	18.30	44.17	16.95
6.	Internodal length (cm)	10.30	16.70	10.19	13.48	57.20	15.89
7.	Number of inter nodes	18.50	30.00	7.77	11.56	45.16	10.76
8.	Juice brix per cent	14.60	21.70	9.21	9.39	96.17	18.59
9.	Juice pol per cent	13.65	20.48	9.48	9.89	91.86	18.73
10.	Juice purity per cent	90.68	95.57	0.87	1.35	41.98	1.17
11.	CCS per cent	9.69	14.59	9.88	10.56	87.55	19.04
12.	Sugar yield (t/ha)	12.93	32.15	19.37	20.50	89.31	37.72
13.	Cane yield (t/ha)	100.00	234.00	18.65	19.33	93.09	37.06

weight (73.26%) this suggests that simple selection for these triats would be effective. It is reported that a high heritability estimate for single stalk weight (Nair *et al*., 1980).

Heritability estimates along with expected genetic gain is more useful than the heritability value alone in predicting the resultant effect for selecting the best genotype (Johnson *et al*., 1955). Genetic advance was high for sugar yield, cane yield, number of tillers, number of millable cane and Single stalk weight for both plant and ratoon crops. It was moderate for stalk length, stalk diameter, number of internodes, internodal length, juice brix per cent, juice pol per cent, CCS per cent in both plant and ratoon crops. Purity per cent of juice exhibits

Table 3 : Range, coefficients of variation, heritability (broad sense), genetic advance (per cent of mean) for cane yield and quality characters in ratoon crop.

S. no.	Characters	Range		Co-efficient of variation (%)		Heritability (%)	Genetic advance (% of mean)
		Min	Max	Genotypic	Phenotypic		
1.	Number of tillers (000'/ha)	119.35	223.90	16.25	17.31	88.10	31.42
2.	Number of millable cane (000'/ha)	72.65	138.10	12.37	15.69	62.16	20.09
3.	Stalk length (m)	1.69	2.59	9.76	14.84	43.25	13.26
4.	Stalk diameter (cm)	2.30	3.59	11.64	12.38	88.38	22.40
5.	Single stalk weight (kg)	0.95	2.70	21.81	25.48	73.26	39.15
6.	Internodal length (cm)	9.90	16.00	8.35	13.49	38.28	10.63
7.	Number of inter nodes	11.50	20.50	13.45	16.65	65.28	22.40
8.	Juice Brix per cent	14.20	22.30	10.48	10.87	92.84	20.80
9.	Juice Pol per cent	12.47	19.97	11.07	11.56	91.81	21.85
10.	Juice Purity per cent	88.38	96.16	2.31	2.55	82.01	4.30
11.	CCS per cent	8.63	13.93	11.28	11.97	88.69	21.86
12.	Sugar yield (t/ha)	8.47	29.95	22.60	23.62	91.54	44.56
13.	Cane yield (t/ha)	69.60	219.50	26.35	27.28	93.28	52.43

lowest genetic advance as per cent of mean. The result of present study clearly indicated the importance of cane yield, sugar yield, number of tillers, number of millable cane as they exerted high GCV and PCV coupled with high heritability and genetic advance (Verma *et al*., 1999; Thippeswamy *et al*., 2001 and Patel *et al*., 2006). High heritability coupled with high genetic advance indicated that these triats were controlled by additive gene action. Hence, phenotypic selection could be effective in improvement of such triats. Purity per cent registered low heritability coupled with low GCV, PCV and genetic advance as per cent of mean suggesting selection will be less effective for this triats.

In general, characters *viz*., numbe of millable cane, stalk length, stalk diameter, single stalk weight, juice pol per cent, sugar yield and cane yield showed depression in ratoon crop as compared to plant crop. Reduction in cane length and thickness was also reported by Sundara *et al*. (1989). Low values of GCV & PCV in plant crop (table 2) was recorded for Juice quality characters *viz.,* juice pol per cent, juice purity per cent, CCS per cent whereas, in ratoon crop (table 3), more GCV & PCV had more values were recorded compared to plant crop indicating that these triats had showed improvement in the ratoon stage reflecting more influence of genetic variance over error variance.

Conclusion

The present investigation suggested that the selection for yield contributing characters with high genotypic and phenotypic co efficient of variability, heritability and genetic advance as per cent of mean along with high mean value and low depression in ratoon crop will be more effective for development of genotypes with ratoonability.

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