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Estimation of the Extent of Variability for Different Morphological and Juice Quality Characters Among Early Generation Sugarcane Clones

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A B S T R A C T

Ninety-three early generation sugarcane clones were evaluated for different morphological and juice quality characters among early generation sugarcane clones. Highest genotypic coefficient of variance (GCV) and phenotypic coefficient of variance (PCV) were recorded for Number of millable cane (NMC) and single cane weight respectively. High heritability coupled with high genetic advance as percent of means was observed for germination percent, NMC/hectare, cane height and inter node length. It indicated that direct selection of those traits would be effective. Similarly, high heritability with moderate genetic advance as percent of means were observed for cane diameter and juice sucrose percent, indicating the role of dominant genetic effects in determination of these characters and its improvements.

Introduction

Sugarcane is a perennial, tropical monocotyledonous crop which is cultivated in the tropical and sub-tropical regions of the world primarily for its ability to store high concentrations of sugar in the inter-nodes of the stem and propagated through stem cuttings. Sugarcane cultivation spans a wide region located between 35^0N to 35^0S of the equator. The agro-climatic conditions under which sugarcane grow, affect the duration and the productivity of the crop. The tropical climates permit longer periods of crop growth which result in higher cane yields, but not necessarily the highest sugar content in the cane. The climatic conditions of the production environment determine the kind of genetic material which would adapt to such conditions. The varietal requirements and breeding objectives differ according to the agro-climatic region. Sugarcane is an important cash crop of world as well as India. Sugar industry being the second largest agro-based processing industry after textile, contributes 2.0% of the gross domestic product in India. Sugarcane is grown under diverse conditions in india, nearly comparable to those in the rest of the world. The area under sugarcane in india is divided into five agro-climatic zones,each of which has a separate breeding programme. Thus present investigation was conducted in sugarcane to eastimat the variability, heritability and

genetic advance for for different morphological and juice quality characters among early generation sugarcane clones.

Materials and Methods

The present investigation was conducted at Sugarcane Breeding Block, Norman Borlaug Crop Research Center G B Pant University of Agriculture and Technology, Pantnagar, Distt. Udham Singh Nagar, Uttarakhand. The experimental material comprised of 93 Clones of sugarcane including 87 C_2 Clones and 6 check varieties (Co Pant-3220, Co Pant-97222, Co Pant-90223, Co Pant-84212, Co Pant-5224, Co S-8436). The experiment was conducted in Augmented Block Design. Each entry was allotted to a single row plot measuring 3.5 m long and plot to plot spacing of 90 cm. The observation were recorded on fourteen characters including morphological as well as juice quality parameters viz., germination percentage, number of tillers, number of millable cane, cane height, cane diameter, cane weight, number of internode, internode length, juice brix percentage, juice sucrose percentage, juice purity percentage, commercial cane sugar, cane yield and CCS yield (Table 1).

Statistical analysis

An augmented design-II (Federer, 1956), which holds considerable promise for evaluation of large breeding materials was used. The analysis of variance for augmented design was done using the method given by Federer (1956, 1961) as described by Federer and Ragavarao (1975) and Petersen (1985).

Estimation of variance components

Genotypic and phenotypic components of variance were estimated with the help of following formulae.

Genotypic Variance (σ_g^2) = (vMSS – EMSS) X CF

Phenotypic variance (σ_p^2) = σ_g^2 + EMS

Coefficient of variability

Both genotypic and phenotypic coefficient of variability were computed for each character as per method suggested by Burton and De Vane (1953)

$$\text{Genotypic Coefficient of Variation (GCV)} = \frac{\sigma_g}{\bar{X}} \times 100$$

$$\text{Phenotypic Coefficient of Variation (PCV)} = \frac{\sigma_p}{\bar{X}} \times 100$$

Where,

σ_g = genotypic standard deviation.

σ_p = phenotypic standard deviation.

$\bar{X}$= grand mean of the character

Heritability (h^2)

It was estimated in broad sense by using following formula as suggested by Lush (1940).

$$h^2 = \frac{\sigma_g^2}{\sigma_p^2} \text{ X } 100$$

Where,

σ_g^2 = Genotypic variances

σ_p^2 = Phenotypic variances

Genetic advance

Genetic advance (GA) for each character was computed by adopting the formulae given by Johnson *et al.*, (1955).

$GA = h^2.K.\ \sigma_p$

Where,

h^2 = Heritability of the character.
K = Selection differential which is equal to 2.06 at 5 percent intensity of selection (Lush, 1949).
σ_p = Phenotypic standard deviation of the character

Genetic advance as per cent of mean (GAM)

Genetic advance as per cent of mean (%)=

$$\frac{\text{Genetic advance}}{\text{General mean of population (Gm)}} \times 100$$

The estimates of variability parameters that are coefficient of variation at genotypic (GCV), phenotypic (PCV), environmental level (ECV), heritability (%) and genetic advance as percentage of mean. In general the estimated values of PCV were higher than GCV for all the characters studied indicating role of environment on the performance of clones. GCV and PCV values were categorized as low (0-10%), moderate (10-20%) and high (20 and above) as indicated by Sivasubramanian and Menon (1973). The heritability was categorized as low (0-30%), moderate (30-60%) and high (60 and above) as given by Robinson *et al.,* (1949). Genetic advance as per cent mean was categorized as low (0-10%), moderate (10-20%) and high (20 and above) as given by Johnson *et al.,* (1955).

Results and Discussion

Analysis of variance revealed significant differences among clones for the NMC, single cane weight, inter node length and cane yield. The variances (mean square) for Germination per cent, NMC, cane height and intermodal length, were found to be highly significant. Significant values of mean squares were also observed for cane diameter, sucrose percent and juice purity percent. Analysis of variances was also revealed significant differences among checks varieties for the Number of millable canes, cane height, intermodal length and cane yield. The variances (mean square) for number of millable canes, cane height, and internodal length of checks were found to be highly significant, however mean square values were also observed significant for cane yield among the checks. PC 2011-12-185 and PC 2011-12-186 selected as best clone and exhibited superior performance over the best check for the Brix percent, sucrose percent, CCS%, and CCS yield, while PC 2011-12-201 showed superiority over best check for Cane yield, CCS yield. PC 2011-12-532 clone selected for Brix %, Sucrose %, CCS % and CCS Yield.

The phenotypic and genotypic coefficient of variation estimated for the various cane and yield attributes are discussed here. Comparative study of coefficient of variation on various characters revealed relatively high contribution of genotypic variation in determining the total phenotypic variation for most of the characters, except in case tillers/ha, single cane weight, number of internode, CCS % and CCS yield, where environmental variation contributes a slightly high in total phenotypic variation. NMC exhibited highest GCV followed by cane height, germination percent and single cane weight.

The lowest GCV was observed for juice purity percent. PCV was recorded highest for single cane weight followed by NMC, cane height, number of internodes / cane. The lowest phenotypic coefficient of variation was observed for juice purity percent. The range for environmental coefficient of variation (ECV) was observed low for juice purity percent to highest for single cane weight.

Table.1 Analysis of variance of augmented block design for fourteen characters in early generation sugarcane clones

mean sum of square															
Source of variation	**d.f.**	**Germination percentage**	**No. of Tillers**	**No. of millable cane**	**Cane height (m)**	**Cane diameter (cm)**	**Cane weight (kg)**	**No. of internodes**	**Internode length (cm)**	**Juice Brix percentage**	**Juice Sucrose percentage**	**Juice Purity percentage**	**Commercial cane sugar percentage**	**Cane yield (t/ha)**	**Commercial cane sugar yield**
Blocks	2	0.245	4.507	100.976**	0.015	0.478**	0.079	8.31	2.065**	35.159**	29.664**	4.985	10.592**	202.839	5.879
Entries	92	11.865**	210.894	259.439**	0.133**	0.055*	0.06	5.672	2.189**	3.653	3.154*	10.647*	1.6	143.957	3.601
Checks	5	3.525	64.76	187.572**	0.287**	0.0503	0.055	0.088	8.582**	1.151	2.397	3.198	0.737	353.508*	4.109
Varieties	86	11.556**	212.258	246.836**	0.123**	0.065*	0.063	6.585	1.878**	4.43	3.654*	10.815*	1.754	142.598	3.587
Checks vs variety	1	80.147**	824.262**	1702.637**	-0.0268	-0.742	-0.213	-44.864	-3.041	-50.643	-36.086	33.484*	-7.332	-786.894	2.332
Error	10	1.174	86.353	10.547	0.0044	0.017	0.038	3.4	0.146	1.923	1.152	3.46	1.084	79.296	2.139
	Least significant difference 5%														
Between checks		1.927	16.532	5.778	0.119	0.237	0.349	0.028	0.681	2.467	1.909	3.309	1.852	15.843	2.602
Between test entries		3.339	28.635	10.007	0.206	0.41	0.604	0.084	1.179	4.273	3.307	5.732	3.208	27.44	4.507
Between entries of same block		3.606	30.93	10.809	0.223	0.443	0.653	0.098	1.274	4.616	3.572	6.191	3.465	29.639	4.868
Check vs entries		2.945	25.254	8.826	0.182	0.362	0.533	0.065	1.04	3.769	2.917	5.055	2.829	24.2	3.974

Table.2 General mean, Range in clones, Genotypic Coefficient of Variation (GCV%), Phenotypic Coefficient of Variation (PCV%), Environmental Coefficient of Variation (ECV%), Heritability, Genetic Advance and Genetic Advance (% of mean) of early generation sugarcane clones

S. No.	Characters	General Mean	Range in clones	PCV%	GCV%	ECV%	h^2(b)%	GA	GA as% of mean
1	Germination percentage	26.23	19.40-39.35	12.01	11.28	4.13	88.17	7.33	27.96
2	No. of Tillers	112.42	83.14-168.65	12.34	9.16	8.27	55.14	20.2	17.97
3	No. of millable cane	80.12	51.43-134.39	18.08	17.62	4.05	94.97	36.31	45.32
4	Cane Height	2.37	1.32-3.12	13.6	13.3	2.83	95.68	0.81	34.34
5	Cane Diameter	2.38	1.87-3.21	10.07	8.38	5.59	69.2	0.44	18.4
6	Cane Weight	1.34	0.86-2.02	18.22	10.85	14.64	35.43	0.23	17.04
7	No. of Inter node	19.17	14.02-24.70	12.87	8.55	9.62	44.12	2.87	14.99
8	Inter node Length	12.41	8.95-15.82	10.21	9.73	3.08	90.88	3.04	24.5
9	Juice Brix percentage	17.73	13.54-21.54	11.33	8.2	7.82	52.35	2.77	15.66
10	Juice Sucrose percentage	15.96	10.94-19.70	11.32	9.1	6.73	64.68	3.08	19.32
11	Juice Purity percentage	89.98	80.61-95.57	3.45	2.77	2.07	64.18	5.26	5.85
12	Commercial cane sugar percentage	10.67	6.69-13.29	12.03	7.04	9.75	34.26	1.16	10.88
13	Cane Yield	103.72	78.41-127.82	11.11	7.04	8.59	40.23	12.23	11.79
14	Commercial cane sugar Yield	11.07	6.77-15.56	16.56	9.98	13.21	36.34	1.76	15.88

The highest estimated broad sense heritability value was obtained for cane height, followed by NMC, internode length, germination per cent. Heritability estimates in broad sense were moderate for the characters, namely number of internode followed by cane yield and CCS yield, while the estimates was low for CCS yield. The genetic advance as percent of mean for various characters varied from lowest for juice purity to highest for NMC/ha. The genetic advance was high for NMC/ha, followed by cane height, germination percent, internodal length, while the genetic advance was moderate for juice sucrose per cent followed by cane diameter, tillers/ha, single cane weight. Juice purity percent showed lowest genetic advance.

The moderate values of GCV and PCV were obtained for germination percent, cane height and number of tillers, single cane weight and low GCV and moderate PCV for cane yield and juice Brix percent with moderate h^2(b) and GAM %. Moderate PCV and low GCV for number of internodes and low GCV for CCS yield/ha and juice sucrose percent was also found. The germination percent, NMC/ha, cane height, cane diameter, internode length, juice sucrose percent, juice purity were observed as highly heritable characters. Moderate heritability was observed for number of tillers/ha, single cane weight, number of internode, juice brix %, CCS%, cane yield/ha and CCS yield/ha. High heritability coupled with high genetic advance as percent of means was observed for germination percent, NMC/ha, cane height and inter node length, suggesting the preponderance of additive genetic effect in the determination of these characters. It also indicated that selection for these characters will be effective (Table 2). However, high heritability with moderate genetic advance as percent of means was observed for cane diameter and juice sucrose percent, indicating the role of dominant genetic effects in determination of these characters and it require careful selection for the desired improvements in the characters.

In conclusion, High heritability coupled with high genetic advance as percent of means was observed for germination percent, NMC/ha, cane height and inter node length, suggesting the preponderance of additive genetic effect in the determination of these characters. It also indicated that selection for these characters will be effective. However, high heritability with moderate genetic advance as percent of means was observed for cane diameter and juice sucrose percent, indicating the role of dominant genetic effects in determination of these characters and it require careful selection for the desired improvements in the characters.

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