



Research Article

ESTIMATION OF VARIABILITY PARAMETERS IN SUGARCANE UNDER WATER LOGGING CONDITIONS

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Abstract: The present investigation was carried out with eighteen clones including four water logging tolerant checks. The experiment was conducted at the Sugarcane Breeding Experimental Block of Norman Borlaug Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar, India. Genetic variability was studied for 14 different morphological and quality characters. Analysis of variance revealed significant differences among all the clones for all characters studied. Highest PCV was exhibited by number of tillers (16.60%) followed by germination (15.63%). The lowest PCV (3.43%) was observed for juice sucrose. The analysis of heritability and genetic advance indicated that morphological characters viz. juice extraction percent, cane height, number of tillers, germination percent, NMC and cane thickness recorded moderate to high estimates, suggesting that selection of morphological traits would be effective for developing improved water logging tolerant clones.

Keywords: Coefficient of variation, Genetic advance, Heritability, Sugarcane, Variability parameters, Water logging

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Introduction

Sugarcane is a major sugar cum industrial crop grown asexually all over the India and world. It is grown on wide range of soil in tropical and subtropical climate. After providing for seeds, 50 % of sugarcane can be utilized for the production of white sugar, 30 % for low jiggery and 20 % for alcohol directly from sugarcane juice along with molasses. India is second after Brazil in area and production. The important states of sugarcane cultivation in India are Uttar Pradesh, Punjab, Haryana, Rajasthan, Bihar, Tamil Nadu, Karnataka, Maharashtra, Andhra Pradesh and West Bengal. Being a long duration crop, sugarcane is prone to water logging, adversely affecting cane productivity and quality. Higher water table during active growth phase adversely affects stalk weight and plant population resulting yield loss at the rate of about one ton per acre for one-inch increase in excess water [1], although sugarcane is a relatively tolerant to high water tables and flooding [2,3]. According to Lush (1949) [4] heritability is the transmissibility of characters from parents to offspring. Although estimates of heritability are useful to plant breeder as they provide fundamental basis for selection on phenotypic performance. However, for more reliable conclusions, heritability estimates coupled with genetic gain should also be considered [5]. In any crop breeding programme, selection for yield and component characters plays a vital role in identification of superior genotypes for different qualitative and quantitative characters. For development of improved clones, information on the variability on yield and quality characters is needed. For the purpose genotypic and phenotypic coefficient of variation are required to be determined. The extent of variation which is due to genetic/genotypic causes as compared to total variation that is, heritability (h^2) is also required to be determined for deciding the selection programme. Heritability gives an idea of the heritable portion of the genotypic variation. If the heritability for a particular character is very high (>0.8), the selection for that character will be easy otherwise in case, if heritability is very low (<0.4), the selection for the character will be difficult. Heritability and genetic advance are used for predicting the gain from selection. The present investigation was, therefore, undertaken to determine genetic variability and heritability and genetic advance for yield and quality parameters in sugarcane.

Materials and Methods

The present investigation was carried out at the Sugarcane Breeding Experimental Block of Norman Borlaug Crop Research Centre, Gobind Ballabh Pant University of Agriculture and Technology, Pantnagar, India, during 2010-2011. The experimental material was consisted of eighteen clones or genotypes including four water logging tolerant checks viz. CoS 97264, CoSe 96436, BO 91 and UP 9530, planted in randomized block design with two replications. The genotypes/clones taken were from the different origins and are listed in the [Table-1]. The plot size for each entry represented 4 rows of 5-meter length spaced at 90 cm apart. Twenty sets of three buds each were planted in each row. The plant crop was waterlogged twice, first for three days during July 18-20, 2010 at 60 cm water depth and then for four days from 18 to 21 August, 2010 with the water depth of 69.5 cm. Data were recorded on 14 characters. The morphological characters includes germination percent, number of tillers, number of millable canes (NMC), cane height (m), cane thickness (cm), single cane weight (kg), juice weight (kg), cane yield (tonnes per hectare), commercial cane sugar yield (CCS yield) (tonnes per hectare) and quality traits were as juice brix percent, sucrose percent, juice purity percent, juice extraction percent, commercial cane sugar percent (CCS %). Standard procedure had been used during collection of data on morphological and quality traits.

Estimation of variability parameters

Coefficient of variation: Genotypic, phenotypic and environmental coefficients of variation were calculated as the ratio of their standard deviation to the mean of the character expressed in percentage.

Phenotypic coefficient of variation: $PCV\% = \sigma P_i / X_i \times 100$

Genotypic coefficient of variation: $GCV\% = \sigma G_i / X_i \times 100$

Environmental coefficient of variation: $ECV\% = \sigma E_i / X_i \times 100$

Heritability

Heritability in broad sense (h^2b) was estimated as the ratio of genotypic variance to the phenotypic variance [6].

Table-1 Details of sugarcane genotypes used in the experiment

Clones	Origin	S.N.	Clones	Origin
CoS 767	Shahjahanpur	10	Co 1148	Coimbatore
CoPant2218	Pantnagar	11	CoPant 84211	Pantnagar
CoPant 90223	Pantnagar	12	CoK 16/05	Kashipur
CoPant 3230	Pantnagar	13	CoPant 5224	Pantnagar
CoPant 5222	Pantnagar	14	CoJ 64	Jalandhar
CoPant 97222	Pantnagar	15	CoS 97264 (Check)	Shahjahanpur
CoPant 3219	Pantnagar	16	CoSe 96436 (Check)	Seorahi
CoS 96268	Shahjahanpur	17	UP 9530 (Check)	Uttar Pradesh
CoPant 99214	Pantnagar	18	BO 91 (Check)	Bihar

Table-2 Variability parameters of different characters in sugarcane

S	Characters	Mean $\pm$ SE	GCV %	PCV %	ECV %	$h^2_{(b)}$ in %	Genetic advance (GA)	GA as % of mean
1	Germination %	26.35 $\pm$ 1.19	14.26	15.63	6.39	83.27	7.06	26.79
2	No of tillers	152.25 $\pm$ 7.03	15.26	16.60	6.41	84.53	44.02	28.91
3	NMC	85.05 $\pm$ 3.85	9.54	11.49	6.41	68.87	13.87	16.31
4	Cane height	2.45 $\pm$ 0.06	8.63	9.34	3.56	85.42	0.40	16.33
5	Cane thickness	1.82 $\pm$ 0.06	7.77	9.10	4.72	73.06	0.25	1374
6	Cane weight	1.03 $\pm$ 0.03	5.95	7.63	4.78	60.79	0.09	8.74
7	Juice weight	2.11 $\pm$ 0.09	11.83	13.34	6.15	78.72	0.45	21.33
8	Juice brix %	20.56 $\pm$ 0.51	2.26	4.22	3.56	28.67	0.51	2.48
9	Juice sucrose %	16.36 $\pm$ 0.30	2.23	3.43	2.60	42.55	0.49	3.00
10	Juice purity %	79.67 $\pm$ 1.32	3.99	4.63	2.34	74.33	5.65	7.09
11	CCS percent	10.72 $\pm$ 0.21	4.32	5.19	2.88	69.18	0.79	7.37
12	Juice extraction %	40.75 $\pm$ 1.06	9.27	9.98	3.70	86.24	7.22	17.72
13	Cane yield	87.56 $\pm$ 3.43	5.32	7.69	5.55	47.86	6.64	7.58
14	CCS yield	9.40 $\pm$ 0.48	8.11	10.87	7.24	55.64	1.17	12.45
Range of variability parameters			2.23-15.26	3.43-16.60	2.34-7.24	28.67-86.24	0.09-44.02	2.48-28.91

The heritability estimates were calculated as follows:

$$h^2_b = \sigma^2_g / \sigma^2_p \times 100$$

Expected genetic advance

Expected genetic advance was estimated as suggested by Allard (1960) [6].

$$GA = K \times \sigma_P \times h^2_b$$

Where,

GA = Expected genetic advance

K = Selection differential expressed in standard unit

σ_P = Phenotypic standard deviation calculated as square root of phenotypic variance

h^2_b = Heritability in broad sense

Genetic advance expressed as percent of population mean was calculated from the method given by Johnson et al. (1955).

$$\text{Genetic advance as mean (\%)} = \text{Genetic advance} / \text{General mean of population (Gm)} \times 100$$

For categorizing the magnitude of variability parameters, limits used are given below:

Variability Parameters	High	Moderate	Low
PCV and GCV	>20 %	15-20 %	<15 %
Heritability (h^2_b)	>80 %	50-80 %	<50 %
Genetic advance as percent of mean	>40 %	25-40 %	<25 %

Results and Discussions

Analysis of variance for all the characters revealed significant differences among the clones included in the investigation. This indicates that there was significant amount of phenotypic variability present and all the clones differed from each other with regard to characters studied. The estimates of variability parameters that are coefficient of variation at genotypic (GCV), phenotypic (PCV) and environmental level (ECV) and heritability (%) and genetic advance as percentage of mean are presented in table 2 and discussed briefly as below.

Coefficients of Variation

The estimated values of PCV were higher than GCV for all the characters studied. 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 juice brix, juice sucrose percent and cane yield where environmental variation contributes a slightly high in total phenotypic variation. Number of tillers (000/ha) exhibited

highest GCV (15.26%), followed by germination percentage (14.26%), and juice weight (11.83 %). The lowest GCV (2.23%) was observed for juice sucrose percent. PCV was recorded highest for number of tillers (16.60 %) followed by germination percentage (15.63) and juice weight (11.83 %). The lowest phenotypic coefficient of variation (3.43 %) was observed for juice sucrose percent. The range for environmental coefficient of variation (ECV) was observed from 2.34 % for juice purity percent to 7.24 % for CCS yield. The high values of GCV and PCV were obtained for germination percent and number of tillers followed by juice weight and number of millable canes. These results were similar to those reported by Gosh and Singh (1996) [7] for germination percent, number of tillers and NMC. In general, morphological traits had recorded higher values of GCV and PCV and juice quality characters had lower values for these parameters. These findings were similar to that observed by Singh and Singh (1999) [8], Gosh and Singh (1996) [7].

Heritability

The highest estimated heritability (broad sense) value was obtained for juice extraction percentage (86.24 %) followed by cane height (85.42 %), number of tillers (84.53 %) and germination (83.27 %). Heritability estimates in broad sense was moderate for the characters, namely, NMC (68.87 %), cane thickness (73.06 %), cane weight (60.79 %), juice weight (78.72 %), juice purity (74.33 %), CCS percent (69.18 %) and CCS yield (55.64 %), while the estimates were low for juice brix (28.67 %), juice sucrose (42.55 %) and cane yield (47.86 %). The high heritability estimates in broad sense for juice extraction percent, cane height, number of tillers and germination percent were in agreement with the results of Gosh and Singh (1996).

Genetic Advance

The genetic advance for various characters varied from 0.09 for cane weight to 44.02 for number of tillers. When genetic advance was computed as percent of mean, it was observed moderate for germination (26.79 %) and number of tillers (28.91 %) while other characters showed the low genetic advance with lowest value for juice brix (2.48 %). Gosh and Singh (1996) [7], Hapase and Repale (2004) [9] reported higher genetic advance as percent of mean for number of tillers and germination percent. The heritability and genetic advance were found low for cane yield, the similar result was reported earlier by Reddy and Somarajan (1993) [10]. This finding was in agreement with Singh and Singh (1999).

Application of research: It was observed from the results, that morphological characters recorded moderate to high estimates for heritability and genetic advance, suggesting that selection of these morphological characters would be effective for developing water logging tolerant clones.

Research Category: Genetics and Plant Breeding

Abbreviations: CCS- Commercial Cane Sugar, ECV- Environmental Coefficient of Variation, GCV- Genotypic Coefficient of Variation, NMC- Number of Millable Canes, PCV- Phenotypic Coefficient of Variation

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Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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