

# Estimation of Variability Parameters in Early Generation General Collection Progenies of Sugarcane (*Saccharum* Species Complex)

Arvind Singh Negi\*, S.P. Singh, A.S. Jeena and M. Talha

Department of Genetics and Plant Breeding GBPUA & T, Pantnagar, U.S. Nagar, Uttarakhand.

\*Corresponding author email id: arvindnegi86@yahoo.com

**Abstract** – One hundred seventeen early generation clones of sugarcane including seven check varieties were planted in three blocks in an augmented block design II fashion at NBCRC, GBPUA & T, Pantnagar during autumn 2015-16. Data were recorded on fourteen different morphological character including juice quality parameter and yield attributes. Analysis of variance revealed highly significant differences among clones for the characters namely germination percentage, cane diameter, single cane weight, average inter-nodal length, juice brix percent, juice sucrose percent, CCS percent and significant difference for cane height. Statistical analysis revealed that, in general PCV were higher than GCV and ECV for all the characters studied. Germination percent exhibited highest GCV followed by single cane weight, CCS yield and cane diameter. Further, CCS yield exhibited highest PCV followed by germination percent and single cane weight. High variability at genotypic and phenotypic level offers more scope of selection in these characters. CCS yield and number of tillers exhibited highest ECV indicating higher environmental influences on these characters. It was revealed that juice sucrose percent exhibited highest heritability followed by juice brix percent, CCS percent, germination percent, cane diameter, average inter-nodal length, single cane weight and cane height. High genetic advance estimates were observed for germination percent followed by single cane weight, cane diameter and CCS yield. Characters *viz.* germination percent, single cane weight and cane diameter exhibited high heritability along with high genetic advance as percent of mean indicated that selection would be effective for these characters as there is preponderance of additive gene action in expression of these characters.

**Keywords** – Heritability, Saccharum, Sugarcane, Variability.

## I. INTRODUCTION

Sugarcane is a perennial, monocotyledonous crop plant which is cultivated in the tropical and sub-tropical regions of the world primarily for its ability to store high concentrations of sucrose or sugar in the inter-nodes of the stem. Sugarcane is an important cash crop of India. Sugar industry being the second largest agro-based processing industry after textile, contributes 2.0% of the gross domestic product. Among the five species of the genus *Saccharum*, *S. officinarum* ( $x = 10, 2n = 8x = 80$ ) is best represented by the two commercial hybrid varieties Co-205 and Co-285 which replaced the indigenous cultivated varieties of northern India. It represents cultivated sugarcane and is characterized by high sugar content, thick stalk, low fibre and low disease resistance. Sugar is the

major product of sugarcane and domestic demand of sugar

is rotating around 22-23 million tonnes annually, where as the production of sugar in India during last 5 years is rotating around 24.3 to 26.3 million tons. The total cane acreage for year 2015-16 was 4.95 million hectares and sugar production of 352.16 million tonnes [1].

The amount of variability present in breeding material plays an important role in the progress of improvement of crop plants through selection. Further, its expression is likely to be influenced by the environmental conditions. So, the information available at one location may not necessarily be applicable to another. Therefore, the knowledge of variability is desirable for a breeder before making any selection program. All the breeding methods and strategies for crop improvement are fundamentally based on the availability of genetic variability in the populations. Genetic variability and heritability are useful parameters that can help the breeder during different stages of crop improvement. The success of breeding program will depend largely on the extent of genetic variability and heritability for important economic traits in early generation populations. Since the estimate of heritability alone gives no indication of the amount of progress expected from selection, the heritability estimate along with genetic advance is needed in predicting resultant effect from selecting the best individuals [2].

## II. MATERIAL AND METHODS

To estimate the genetic parameters for different morphological and juice quality characters, the present investigation was conducted at Sugarcane Breeding Block, Norman-E-Borlaug crop research center GBPUA & T Pantnagar, Distt. Udham Singh Nagar, Uttarakhand during autumn 2015-16. The experimental material comprised 117 clones of general collection progenies of sugarcane and 7 check varieties. Among check, Co 0238, Co Pant 03220, Co J 64 were belonging to early groups and Co Pant 97222, Co Pant 05224, Co S-767, Co S 8436 were from mid-late groups. The experiment was conducted in Augmented Block Design II in 3 blocks. Each entry was allotted to a single row plot measuring 3.0 m long and plot to plot spacing 0.90 m. Data were recorded on germination percent (45 days after planting), numbers of tillers at 120 days and numbers of millable canes at 300 days on net plot basis and converted to thousand per hectare. For cane characteristics, cane height (cm), cane diameter (cm), single cane weight (kg), average number of internodes and

average inter-nodal length (cm) were recorded at time of harvest. For juice characteristics, brix percent, sucrose percent in juice, juice purity percent and commercial cane sugar (CCS) percent were recorded at 12 months. Finally yield characters viz., cane yield (t/ha) and commercial cane sugar (CCS) yield (t/ha) per plot were recorded at time of harvest and calculated on hectare basis. The sucrose percent in juice was noted for corresponding values of the brix and pol reading using Schmitz table [3].

Juice purity percent was calculated at 12 months using formulae.

$$\text{Purity \%} = (\text{juice sucrose} / \text{juice brix}) \times 100$$

Commercial cane sugar (CCS) percent at 12 months and CCS yield (t/ha) at harvest stage was calculated using formulae.

$$\text{CCS \%} = [S - (B - S) \times 0.40] \times 0.73$$

Where,

S = Sucrose percent in juice.

B = Brix percent in juice.

CCS yield (t/ha) = [Available sugar (%) in cane x Cane yield (t/ha)] / 100.

#### Statistical Analysis:

The data obtained were subjected to statistical analysis as suggested for augmented design-II [4] and as described by [5]. Both genotypic and phenotypic coefficient of variability was computed for each character as per method suggested by [6]. Heritability ( $h^2_{bs}$ ) [7] and genetic advance as percent of means were estimated and categorized as low, moderate and high as suggested by [2].

### III. RESULTS AND DISCUSSION

For each fourteen characters comprising yield and quality attributes, analysis of variances were carried out as per standard procedure of Augmented Block Design- II [4], and the results are summarized in the Table 1. The variances (mean square) for germination percentage (53.71), cane diameter (0.11), single cane weight (0.07), average inter-nodal length (2.77), juice brix percent (3.53), juice sucrose percent (2.78), CCS percent (1.39) were highly significant and for cane height (1238.08) was significantly respectively. Results showed that there were highly significant differences among clones for the characters namely germination percentage, cane diameter, single cane weight, average inter-nodal length, juice brix percent, juice sucrose percent, CCS percent and significant difference for cane height.

The estimates of variability parameters that are coefficient of variation at genotypic (GCV), phenotypic (PCV) and environmental level (ECV), heritability (%) and genetic advance as percentage of mean are presented in Table 2. The estimated values of PCV were generally higher than GCV for all fourteen characters studied indicating role of environment on the performance of clones. Germination percent exhibited highest GCV (20.32%) followed by single cane weight (17.10%), CCS yield (t/ha) (15.30%) and cane diameter (11.66%). Moderate to high range of variation for germination percentage in sugarcane had earlier being reported by [8]. However, lower values of GCV were exhibited by juice

purity percent (1.60%) and average number of internodes (7.08%). CCS yield (23.70%) exhibited highest PCV followed by germination percent (22.54%) and single cane weight (kg) (21.34 %). Lower PCV was exhibited by juice purity percent (2.43 %) and juice brix percent (10.19 %). CCS yield (t/ha) exhibited highest ECV (18.11 %) followed by number of tillers (15.8 %). Lowest ECV were exhibited by juice purity percent (1.83 %) and juice sucrose percent (3.52 %).

Heritability as an index of transmissibility of character from the parents to their offspring plays a predictive role, expressing the reliability of the phenotypic value. For character having large heritability percentage is considered to be highly heritable and if it's small, environment is correspondingly prominent in the expression of the character [9]. Genetic advance is the improvement in the genotypic value of the new population in contrast to the base population, which is very useful. Juice sucrose percent (88.40%) exhibited highest estimated heritability (broad sense) value followed by juice brix percent (87.50%), CCS percent (86.70%), germination percent (81.30%), cane diameter (72.80%), average inter-nodal length (68.80%), single cane weight (64.20%) and cane height (60.20%). Higher estimate of heritability for juice sucrose was also reported by [10]-[11]-[12]. Moderate heritability estimates were obtained for juice purity percent (43.10%), CCS yield (41.70%), NMC (38.60%) and cane yield (34.30%), however low heritability estimate were observed for average number of internodes (26.20%) and number of tillers (19.80%). The genetic advance as percent of mean for different characters varied from 2.16 % for juice purity percent to 37.76 % germination percent. High genetic advance estimates were observed for germination percent (37.76%) followed by single cane weight (28.21%), cane diameter (20.50%) and CCS yield (20.34%). High estimates of heritability along with high genetic advance (% of mean) for germination percentage had been reported by various workers [13]-[14]. Further high expected genetic gains for cane weight had been reported earlier by [15]-[8].

### IV. CONCLUSION

In present investigation, characters viz. germination percent, single cane weight and cane diameter exhibited high heritability along with high genetic advance as percent of mean. Germination percent exhibited highest GCV followed by single cane weight, CCS yield and cane diameter in present investigation. Further, CCS yield exhibited highest PCV followed by germination percent and single cane weight. High variability at genotypic and phenotypic level offers more scope of selection in these characters. CCS yield and number of tillers exhibited highest ECV indicating higher environmental influences on these characters. It was revealed that Juice sucrose percent exhibited highest heritability followed by juice brix percent, CCS percent, germination percent, cane diameter, average inter-nodal length, single cane weight and cane height. High genetic advance estimates were observed for germination percent followed by single cane weight, cane diameter and CCS yield. Character viz., germination percent, single cane

weight and cane diameter exhibited high heritability along with high genetic advance as percent of mean indicating that selection would be effective for these characters as there is preponderance of additive gene action in expression of these characters.

### ACKNOWLEDGEMENT

The author acknowledges the help and cooperation of Directorate of Experiment Station, GBPUA&T-Pantnagar, for providing all the necessary facility (land, labors etc) during experiment. Further, author acknowledge the kind support of his guide and PI, AICRP-Sugarcane breeding, GBPUA&T-Pantnagar for providing necessary field and lab facilities during the conduct of experiment.

### REFERENCES

- [1] India. Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare. *Agriculture Statistics at a Glance*. Delhi, Controller of Publication. 2016. 489p.
- [2] Johnson, H.W., Robinson, H.F. and Comstock, R. E. (1955). Estimates of genetic and environmental variability in soybeans. *Agronomy Journal*, 47 (7): 314-318.
- [3] Spencer, G. L. and Meade, G.P. Sugarcane Hand Book, John Wiley & Sons, London, 1955.
- [4] Federer, W.T., "Augmented (or hoonuiaku) designs" in Hawaiian Planters' Record LV, 1956 (2): 191-208.
- [5] Federer, W.T. and Raghavarao, D. (1975). On Augmented Designs. *Biometrics*, 31(1): 29-35.
- [6] Burton, G.W. and DeVane, E.W. (1953). Estimating heritability in tall Fescue (*Festuca arundinacea*) from replicated clonal material. *Agronomy Journal*, 45: 478-81.
- [7] Lush, J.L. (1940). Intra-class correlations or regression of offspring on dam as a method of estimating heritability of characteristics. *Am. Soc. Anim. Prod.*, 33: 293-301.
- [8] Bora, G.C., Goswami, P.K. and Bordoloi, B.C. (2014). Studies on variability and character association in sugarcane (*Saccharum spp.*) under rain-fed condition of North Eastern India. *Dir. Res. J. of Agri. and Food Sci.*, 2 (5): 55-59.
- [9] Lush, J.L. Animal Breeding Plans. Iowa State College Press, Ames, Iowa. 1943.
- [10] Tyagi, V.K., Sharma, S. and Bhardwaj, S.B. (2011). A study on the nature and magnitude of variations in different traits in sugarcane. *Electronic J. of Plant Breed.*, 2 (3): 334- 341.
- [11] Masri, M.I. and Amein, M. M. M. (2015). Yield potential and ratooning ability of some sugarcane genotypes. *J. of plant breed. and crop sci.*, 7(8): 262-274
- [12] Priya, M.S., Reddy, K. H. P., Kumar, M.H., Rajarajeswari, V. and Naidu, G.M. (2015). Variability and heritability studies for cane yield and quality traits in sugarcane (*Saccharum spp.*). *Bioinfolet*, 12 (2a): 436 – 439.
- [13] Singh, J.R.P., Kamat, D.N. and Kumar, A. (2002). Variability in sugarcane under saline condition. *Ind. Sugar.*, 52(4): 265-267.
- [14] Patil, P.P., Patel, D.U., Mali, S.C. and Lodam, V.A. (2014). Genetic variability in sugarcane (*Saccharum spp. Complex*). *Trends in Bio sciences*, 7(13): 1388-1391.
- [15] Ebid, M. H. M., Khalil, H.A. and Fergany, M.A. (2015). Heritability and genotypic and phenotypic correlations among sugar cane yield and some agronomic traits. *Egypt J. Plant Breed.*, 19(1): 159 – 171.

Table 1. Analysis of variance for different morphological and juice quality characters in General collection progenies of sugarcane

Source of Variation	d. f.	Germination Percent	No. of Tillers ('000/ha)	No. of millable canes ('000/ha)	Cane height (cm)	Cane diameter (cm)	Cane Weight (kg)	No. of inter-nodes
Blocks	2	316.97**	158.08	92.55	7343.06**	0.22**	0.22**	24.35*
Entries	123	53.71**	340.35	151.59	1238.08*	0.11**	0.07**	7.32
Checks	6	22.13	310.66	122.56	3438.78**	0.08	0.09*	7.79
Varieties	116	53.98**	331.06	148.86	1204.66**	0.12**	0.07**	7.43
Checks vs Vars.	1	211.47**	1596.48*	641.50*	-8089.18	-0.18	-0.20	-8.66
Error	12	8.89	257.12	86.02	436.78	0.03	0.02	5.26

  

Source of variation	d.f	Inter-nodal length (cm)	Juice brix %	Juice sucrose %	Juice purity %	CCS %	Cane yield (t/ha)	CCS yield (t/ha)
Blocks	2	8.91**	20.39**	18.38**	6.49	9.41**	1815.81**	90.23**
Entries	123	2.77**	3.53**	2.78**	5.45	1.39**	267.95	9.69
Checks	6	9.36**	1.21*	1.87**	14.96**	1.28**	155.07	5.01
Varieties	116	2.57**	3.51**	2.76**	4.84	1.38**	267.07	9.17
Checks vs Vars.	1	-13.50	19.71**	9.89**	19.54**	3.75**	1047.53*	97.79**
Error	12	0.72	0.38	0.28	2.57	0.16	166.21	5.01

\* Significant at 5% level of significance

\*\* Significant at 1% level of significance

Table 2: Variability and heritability estimates for different characters in General collection progenies of sugarcane

S. No.	CHARACTERS	GCV%	PCV%	ECV%	H <sup>2</sup> <sub>(b)</sub> in %	GA as % of mean
1	Germination percent	20.32	22.54	9.73	81.30	37.76
2	No. of tillers ('000/ha)	7.86	17.65	15.80	19.80	7.20
3	NMC ('000/ha)	10.28	16.55	12.97	38.60	13.15
4	Cane height (cm)	11.37	14.65	9.25	60.20	18.16
5	Cane diameter (cm)	11.66	13.66	7.12	72.80	20.50
6	Single cane weight (kg)	17.10	21.34	12.78	64.20	28.21
7	Average number of inter-nodes	7.08	13.82	11.87	26.20	7.47
8	Average inter-nodal length (cm)	10.70	12.90	7.21	68.80	18.28
9	Juice brix Percent	9.53	10.19	3.61	87.50	18.36
10	Juice sucrose percent	9.71	10.33	3.52	88.40	18.80
11	Juice purity percent	1.60	2.43	1.83	43.10	2.16
12	CCS percent	9.87	10.60	3.87	86.70	18.92
13	Cane yield (t/ha)	11.37	19.49	15.74	34.30	13.71
14	CCS yield (t/ha)	15.30	23.70	18.11	41.70	20.34