

Assessment of Genetic Variability and Correlation Studies among Elite Sugarcane Genotypes Under Rainfed Conditions (*Saccharum Officinarum* L)

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Abstract: The present study evaluated the extent of genetic variability, correlation of traits among fifteen promising popular released and prerelease clones along with a standard CoA92081 were tested under rainfed situation at RARS, Anakapalle under rainfed conditions from 2020-21 to 2021-22. Additive gene action for NMC, stalk length, ccs yield and cane yield suggested for improvement through simple selection. Low to moderate GCV, PCV, heritability and GAM for traits like germination percent, brix percent, sucrose percent, purity percent, pol percent cane, fibre percent implies the narrow range of variability and importance of non-additive gene action in inheritance of the characters. Low to moderate estimates of GCV, PCV coupled with moderate heritability and GAM for traits of CCS %, Juice extraction percent, number of green leaves at 120 DAP, LAI at 120 DAP, SCMR at 120 DAP, stalk girth and single cane weight indicative of both additive and non-additive gene action in inheritance of characters. The correlation between Cane yield, NMC, Stalk length, stalk girth, single cane weight, brix, germination percent and CCS yield had positive significant correlation at both genotypic and phenotypic level. The elite clones identified *viz.*, CoA 11321, CoA 16321, CoA 17324, CoC 17337 and 2014A 224 can serve as valuable genetic resources for developing climate resilient sugarcane genotypes through targeted breeding efforts.

Keywords: Genetic Variability, GCV, PCV, Correlation, Rainfed conditions, Sugarcane

Sugar cane productivity is very low and stagnant in Andhra Pradesh state compared to neighboring states like Tamil Nadu, Karnataka, Maharashtra and Uttar Pradesh due to decrease in cane area in productivity lands, rainfed conditions and moisture stress during formative phase, non-adoption of recommended package of practices in plant and ratoon crops are major constraints of cane production (Lakshmikantham, 1972). Rainfed situation severely depress cane yield to the tune of 20-50% whereas the sucrose formation and sucrose recovery up to 6%. The most efficient way of managing water deficit

areas is the use of proper rainfed genotypes, their morpho-physiological studies besides agronomic manipulation. The extent of injury due to rainfed condition depends upon the cultivars, environmental conditions, stage of development and the duration of stress, understanding of the physiological phenomena of sugarcane to these conditions could help to develop strategies to sustain high yields under rainfed situation. Hence there is a need to develop rainfed tolerant varieties which possess inherent capabilities under water deficit conditions of most of the Sugarcane growing states

High tillering variety with rapid initial growth, deep root system, thin stalk with narrow, erect leaves can tolerate, moisture stress (Sundara,2002). Rainfed tolerant varieties recover faster on availability of moisture. Yield is the best measurement for measuring rainfed tolerance of genotypes under field conditions. Moisture stress affects tillering, leaf area, cane elongation, Stalk number, stalk height, Stalk yield and sucrose (Venkataramana, 2003).

Hemaprabha *et al* (2012) revealed that utilization of potential parents *viz.*, Co 740, Co 775, Co 6304, Co 6806 and Co 7201 could lead to evolving rainfed resistance varieties for improving sugarcane productivity in rainfed prone regions of India. Water relationship and photosynthetic responses to water deficit stress during this growth stage could therefore be useful in identifying rainfed genotypes (Silva *et al*, 2007)

Gomathi *et al* (2012) screened advanced varietal trail clones for rainfed tolerance and the clones Co 06022, Co 06010, Co 06013, Co 06015 and Co 06027 showed relatively higher photo chemical efficiency with better growth attributes *viz.*, leaf area index, leaf production, plant height, shoot population attributed to tolerance nature under rainfed.

MATERIALS AND METHODS

The present study was taken up with objective of Screening and evaluation of water use efficient cultivars for rainfed situation and Study of morpho-physiological parameters under rainfed conditions. Fifteen promising popular released and prerelease clones *viz.*, 2004A107, Co A 16321, Co C 16336, Co C 16337, 2014 A 224, Co A 17324, Co A 11321, Co Or 18346, Co C 17337, 2012 A 249, 2012 A 319, 2012 A340, 2014 A 210 and 2014A224 along with a standard CoA92081 were tested under rainfed condition from 2020-21 to 2021-22 at RARS, Anakapalle. The experiment was carried out in Randomized Block Design with three replications. Gross plot size of 6mt X

0.9mt X 10R = 54.00m² and Net plot size of 6mt X 0.9mt X 8R= 43.20 m², 80 cm between rows. Fertilizers applied 100 kg P₂O₅ + 120 kg K₂O / ha at the time of planting are applied as basal dressing. Nitrogen @ 60 kg N/ha in the form of urea will be applied in two split doses, 30% at ten days after transplanting and the remaining 70% at 60 days after transplanting. Data on physiological parameters, number of millable canes, length of stalk, Stalk girth, single cane weight and cane yield per plot were recorded at harvest. Juice sucrose was determined at harvest following the standard procedure (Meade and Chen, 1977). Juice extraction percent and fibre per cent was calculated before harvest. Estimated CCS yield was determined based on CCS per cent and cane yield. Statistical analysis was performed as per the procedure of Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Analysis of variance showed there is significant variability among the characters studied. (Table 1) Germination%, Number of millable canes (NMC) Brix%, Sucrose%, juice extraction

Table 1: Estimates of Genotypic Mean sum of squares and Error Mean Sum of squares Significance

Character	Genotypic Mean sum of squares	Error Mean Sum of squares
Germination %	65.02 **	22.20
Number of millable canes (NMC)	178.36 **	32.86
Brix %	3.82 **	1.00
Sucrose %	3.93**	0.06
CCS %	3.81**	0.06
Purity %	2.82	0.95
Pol % cane	2.40	1.83
Juice Extraction % (JE %)	24.03**	10.85
Fibre %	2.70	1.12
CCS yield (t/ha)	12.82**	2.08
Cane yield (t/ha)	68.35**	3.67
Number of green leaves at 120DAP(NGL at 120DAP)	9.02**	1.22
LAI at 120 DAP	1.85	0.68
SCMR at 120DAP	22.18**	3.12
Stalk length(m)	2.52	0.06
Stalk girth (m)	3.31**	0.04
Single cane weight (Kg)	5.53**	1.81

% CCS%, CCS yield, Cane yield, Number of green leaves at 120DAP, SCMR, Stalk girth and single cane weight showed significant variability. Whereas Pol/% cane, fibre per cent, purity per cent, LAI at 120DAP and stalk length showed non-significant variability

Based on the classification given by Sivasubramanian and Menon(1973) revealed that all the traits were differed significantly. The values of range, mean performance, phenotypic coefficient of variance (PCV), Genotypic coefficient of variance (GCV), heritability and Genetic advance as per cent of mean of the genotypes studied were given in Table 2. The mean for germination percent was 59.52 with a range from 55.58 to 61.22 (2012A 319 & CoA 17324). Variation for NMC with a range of 75.23 (2012A 319) to 100.67 (CoA 17324). The quality parameters of brix, sucrose, ccs and purity percent ranged from 19.20%, 17.89, 15.08% and 84.12%_{ss} to 22.03%, 20.01%, 16.02% and 90.08% respectively with mean values of 18.43, 15.93, 14.22 and 89.09 respectively in the experiment. Juice extraction percent was lower in 2014A 210 and higher in CoA 16321. Variation for fibre was 13.13 with a range from 12.32 (2014A 210) to 14.02 (2012A 319). Cane and ccs yields were ranged from 89.08 & 12.32 ((2012A 340) to 105.66 & 14.64 (CoA 17324) with a mean value of 78.33 t/ha and 13.13 t/ha respectively at harvest. Physiological parameters like number of green leaves, LAI and SCMR were higher in 2004A 107 and lower in 2012A 319 with a mean of 11.65, 1.68 and 45.50 respectively at 120 days after planting. The yield components *viz.*, stalk length (1.63), stalk girth (2.53) and single cane weight (1.13) recorded by the genotype CoA 17324 which indicated maximum variability exists in the genotypes.

Genetic parameters, heritability and GAM (GCV, PCV, h^2 and GAM)

Analysis of genotypic coefficient of variance (GCV) and Phenotypic Coefficient of Variance

(PCV) of different characters were presented in Table 2, Table 3 and Fig. 1. The results indicated that the PCV values were slightly greater than GCV values for most of the traits which indicated the traits under study were less influenced by the environment.

Moderate phenotypic and genotypic coefficient of variation coupled with high heritability and genetic advance as percent of mean (GAM) were observed for NMC, stalk length, ccs yield and cane yield suggested predominance of additive gene action in governing these characters amenable for improvement through simple selection. In contrast low to moderate GCV, PCV, heritability and GAM for traits like germination, brix percent, sucrose percent, purity percent, pol percent cane, fibre percent in the present study implies the narrow range of variability and importance of non-additive gene action in inheritance of the characters.

Low to moderate GCV, PCV coupled with moderate heritability and GAM for traits CCS %, Juice extraction percent, number of green leaves at 120 DAP, LAI at 120 DAP, SCMR at 120 DAP, stalk girth and single cane weight recorded low GCV and PCV but high heritability with low to moderate GAM indicative of both additive and non-additive gene action in inheritance of characters.

Similar results estimated on GCV, PCV, heritability and GAM were also reported by El-Hinnawy and Mersi (2009), Mali & Patel (2013), Esayas *et al*, 2016), Alam *et al* (2017), Kumar *et al* (2018), Japheth *et al* (2019) Pooja kumari *et al* (2020), Barreto *et al* (2021) and Guljar *et al* (2022) in Sugarcane.

Correlation Studies

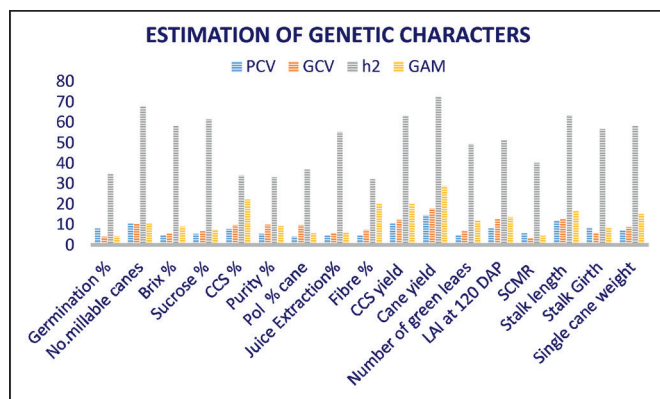
The correlation coefficient is a statistical parameter that quantified the degree and strength of association between two interrelated variables which may arise from genetic linkages, pleiotropism or a combination of both effects. In the experiment,

Table 2: Estimates of Genetic Components of Variance, Heritability and GAM of Sugarcane Genotypes Evaluated at M/S Etikoppaka Sugar Factory Site

Character(s)	Min	Max	Mean	PCV	GCV	h^2	GAM
Germination %	55.58	61.22	59.52	8.05	4.02	35.00	4.15
No.millable canes	84.28	100.67	75.23	10.24	10.09	67.87	10.46
Brix %	19.20	22.03	18.43	4.72	5.58	58.32	8.82
Sucrose %	17.89	20.01	15.93	5.53	6.92	61.30	7.63
CCS %	15.08	17.02	14.22	7.83	9.62	34.12	22.16
Purity %	84.12	90.08	89.90	5.31	9.85	33.08	9.12
Pol % cane	14.14	15.78	13.00	4.12	9.58	36.80	5.68
Juice Extraction%	53.02	60.12	48.06	4.54	5.98	55.08	6.31
Fibre %	12.32	14.02	10.52	4.52	7.18	32.08	20.28
CCS yield	12.32	14.64	13.13	10.61	12.12	63.12	20.18
Cane yield	89.08	105.66	78.33	14.62	17.80	72.82	28.80
NGL at 120DAP	14.89	16.55	11.65	4.62	7.10	49.22	11.92
LAI at 120 DAP	2.18	2.80	1.68	8.13	12.62	51.08	13.56
SCMR at 120DAP	42.36	56.32	45.50	5.58	3.32	40.12	4.58
Stalk length	1.13	1.63	0.84	11.78	12.63	63.33	16.67
Stalk girth	19.72	2.53	0.98	8.56	5.96	56.55	8.12
Single cane weight	1.04	1.13	0.82	7.20	8.63	58.23	15.14

Table 3: Estimation of Genetic Parameters, Heritability and GAM of Genotypes

Character(S)	PCV	GCV	Heritability	GAM
Germination %	Low	Low	Low	Low
No.millable canes	Moderate	Moderate	High	Moderate
Brix %	Low	Low	Moderate	Low
Sucrose %	Low	Low	Moderate	Low
CCS %	Low	Low	Moderate	Moderate
Purity %	Low	Low	Moderate	Low
Pol % cane	Low	Low	Moderate	Low
Juice Extraction%	Low	Low	Moderate	Moderate
Fibre %	Low	Low	Moderate	Low
CCS yield	Moderate	Moderate	High	High
Cane yield	Moderate	Moderate	High	High
NGL at 120DAP	Low	Low	Moderate	Moderate
LAI at 120 DAP	Low	Moderate	Moderate	Moderate
SCMR	Low	Moderate	Moderate	Moderate
Stalk length	Moderate	Moderate	High	Moderate
Stalk girth	Low	Moderate	Moderate	Moderate
Single cane weight	Low	Low	Moderate	Moderate

**Figure 1**

correlation coefficient analysis evaluates the inter relationship between various traits.

Simple phenotypic correlation coefficients between cane yield, agronomic traits, morphophysiological traits were presented in Table 4. The data revealed that positive and significant correlation with cane yield recorded for ccs yield (0.8952**), single cane weight (0.4602**), stalk girth (0.4620**), stalk length (0.1903*), CCS % (0.1232**), brix % (0.0828*), NMC (0.8893*) and germination percent

(0.1134*). Quality parameters viz., brix, sucrose, CCS and purity percent showed significant positive correlation among themselves in the trial. LAI at 120 DAP and number of green leaves and SCMR values were found to be positive and significant which indicated the effect of biomass production also contributed for cane yield in the experiment. Similar reports had been reported by Anshuman *et al.* (2002), Chaudhary and Joshi (2005), Terzi *et al.* (2009), Mohana Krishna *et al.* (2009), Mali *et al.* (2013), Esayas *et al.* (2016), Barreto *et al.* (2021) and Rajendra *et al.* (2022) also reported similar kind of findings in Sugarcane.

CONCLUSION

Based on the estimates of GCV, PCV, heritability and Genetic advance as per cent of mean, it was concluded that NMC, stalk length, CCS yield and cane yield suggested predominance of additive gene action in governing these characters amenable for improvement through simple selection and heritable. In contrast low to moderate GCV, PCV, heritability and GAM for traits like germination, brix percent, sucrose percent, purity percent, pol percent cane, fibre percent implies the narrow range of variability and importance of non-additive gene action in inheritance of the characters. Low to moderate GCV, PCV coupled with moderate heritability and GAM for traits like CCS %, Juice extraction percent, number of green leaves at 120 DAP, LAI at 120 DAP, SCMR at 120 DAP, stalk girth and single cane weight indicative of both additive and non-additive gene action in inheritance of characters.

The nature and extent of correlation among various traits differs from each other. The correlation between Cane yield, NMC, Stalk length, stalk girth, single cane weight, brix, germination percent and CCS yield had positive significant correlation at both genotypic and phenotypic level. These traits should be regarded as important selection criteria for cane yield improvement program

The elite clones identified viz., CoA 11321, CoA 16321, CoA 17324, CoC 17337 and 2014A 224 can serve as valuable genetic resources for developing climate resilient sugarcane genotypes through targeted breeding efforts.

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