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Variability for Cane Yield, Sugar Yield and Yield Components at Three Stages of Sfelection in Sugarcane (*Saccharum officinarum* L.)

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ABSTRACT

Moderate estimates of genotypic and phenotypic coefficients of variation coupled with high heritability and genetic advance over mean (GAM) were recorded for number of millable canes, single cane weight, cane yield and cane volume indicating the operation of additive gene action while low estimates of GCV and PCV coupled with high heritability and low GAM were observed for cane length, cane diameter and HR brix indicating the operation of non-additive gene action in seedling nursery. Moderate values of GCV and PCV coupled with high heritability and GAM for shoot population at 90 DAP, cane volume, number of millable canes per plot and CCS yield in clonal stages revealed the importance of additive gene action in inheritance of these characters. Low to moderate estimates of GCV and PCV along with low to moderate estimates of heritability and GAM for number of green leaves at 60 and 120 DAP, leaf area index at 60 and 120 DAP, brix, sucrose, purity per cent and cane diameter suggested the operation of non-additive gene action in governance of characters. Low to moderate estimates of GCV and PCV coupled with moderate to high estimates of heritability and GAM for CCS per cent, shoot population at 120, 180, 240 DAP, number of millable canes at 300 DAP, single cane weight, cane length and cane yield suggested the importance of both additive and non additive gene action for these characters. The differential modes of gene action for the characters in seedling and clonal generations could be due to differences in the estimates of GCV, PCV, heritability and GAM due to sample size and environmental variation.

Key words : Clonal Stages, Gene Action, Genetic Parameters, Seedling, Sugarcane.

Knowledge on the magnitude of variability coupled with heritability in the breeding material gives an idea on the possibility of effective genetic improvement through selection. The success of genetic advance under selection depends on genetic variability, heritability and selection intensity. Simple selection can be practiced if high heritability coupled with high genetic advance are recorded for a character. Thus, the nature of gene action and inheritance of characters is essential so as to adopt a suitable breeding methodology in crop improvement. The information available on the inheritance of characters is scanty in sugarcane. The present study was carried out in sugarcane to access the variability for yield components, cane yield, sugar yield and to study the genetic parameters at seedling and clonal stages.

MATERIAL AND METHODS

The present investigation involving genotypes derived from 38 bi-parental crosses and 18 GCs was carried out at RARS, Anakapalle from 2007 to 2010 in seedling, first and second clonal generations. A total of 17,311 seedlings in 18 blocks along with four standards *viz.,* Co 6907, 87A 298 (early), Co 7219 and Co 86249 (mid late) were evaluated in 10 m rows by adopting at 80 x 40 cm spacing in ARCBD during April, 2007. A total of 520 genotypes selected in the seedling generation were planted during 2008-09 in two rows of 2.5 m, row length spaced at 80 x 40 cm spacing in ARCBD along with four standards. One hundred and fourteen genotypes were selected in the first clonal generation for further study in second clonal generation. Each clone was planted in four rows of five meters row length spaced at 80 cm during the third week of April, 2009 in ARCBD with four standards *viz.,* Co 6907, 87A 298, Co 7219 and Co 86249. All the recommended package of practices were followed to raise a healthy crop. Data were recorded on number of canes per clump, cane yield, single cane weight, cane length, cane diameter, HR brix per cent and cane volume in seedling nursery, while number of green leaves and leaf area index at 60 and 120 DAP, shoot population at 90, 120, 180 and 240 DAP, number of millable canes at 300 DAP and at harvest, cane yield, Single cane weight, cane length, cane diameter, cane volume in clonal stages and juice quality parameters *viz.,* brix and sucrose were determined in clonal stages as per the standard

Table 1 Mean, range and genetic parameters for cane yield and yield components in seedling nursery of sugarcane

S.No	Character(s)	Mean	Range		GCV (%)	PCV (%)	Heritability (h^2)	Genetic advance(GA)	GA over mean
			Minimum	Maximum					
1.	Number of canes clump^{-1}	3.72	2.00	6.13	20.33	20.69	96.47	1.53	41.13
2.	Single cane weight (kg)	1.20	0.87	1.69	11.52	12.04	91.55	0.27	22.70
3.	Cane length (cm)	254	179	306	5.40	6.72	63.77	22.38	8.83
4.	Cane diameter (cm)	2.45	2.05	3.05	5.04	5.94	72.00	0.22	8.81
5.	Cane volume (cm^3)	4.39	2.03	7.32	19.71	21.72	83.02	1.63	37.13
6.	Cane yield (kg)	4.32	2.00	7.80	18.50	19.05	90.76	1.54	35.63
7.	HR Brix (%)	19.60	18.00	22.24	3.17	3.85	67.53	1.05	5.36

procedures. Estimates of CCS, purity and CCS yield carried out as suggested by Meade and Chen (1977) and Srivastava *et al*. (1988).

The phenotypic and genotypic coefficients of variation were estimated by using the formulae given by Burton (1952). Heritability in broad sense and GAM were determined according to Hanson (1963) and Allard (1960).

RESULTS AND DISCUSSION

Estimates of genetic parameters (GCV, PCV, heritability, GAM) for cane and sugar yield, yield components, juice quality in seedling nursery and two clonal stages are presented in Tables 1 to 3.

Analysis of variance revealed that significant differences for all the characters studied at all the three stages of selection *viz.,* seedling, first and second clonal generations indicating existence of variability among the genotypes for the characters studied *viz.,* number of green leaves, leaf area index at 60 DAP, shoot population at 90, 120, 180, 240 DAP, NMC at 300 DAP, single cane weight, cane length, cane volume, NMC per plot, cane yield and sugar yield.

Moderate estimates of GCV, PCV coupled with high heritability and GAM were recorded for number of millable canes, single cane weight, cane volume and cane yield indicating the importance of additive gene action in the governance of these characters. Similar results of GCV, PCV heritability and GAM were also reported for number of millable canes and cane yield (Sabitha and Prasada Rao, 2008 and Sabitha *et al.,* 2009); single cane weight (Navneeth Kumar *et al*., 2010), cane volume (Madhavi and Reddy, 1992). Low estimates of GCV, PCV, high heritability and low GAM recorded for cane diameter and HR brix indicating the importance of non additive gene action in the inheritance of these characters (Table 1). Similar results were observed for GCV, PCV, heritability and GAM in sugarcane by Sabitha *et al.* (2009) for cane length, cane diameter by Singh and Singh (2001) for HR brix per cent in seedling nursery.

Moderate estimates of GCV and PCV and moderate to high estimates of heritability and GAM were recorded in the present study for shoot population at 90 DAP, number of millable canes, sugar yield and cane volume suggests the importance of additive gene action (Table 2 & 3). Similar results of moderate estimates of GCV, PCV and moderate to high estimates of heritability and GAM were also reported by Sabitha *et al*. (2009) for shoot population, number of millable canes and sugar yield; Madhavi and Reddy (1992) for cane volume in sugarcane.

Low to moderate estimates of GCV, PCV, heritability and GAM recorded for number of green leaves at 60 and 120 DAP, leaf area index at 60 and 120 DAP, brix, sucrose, purity per cent and cane diameter in the present study implies the narrow range of variability and importance of non additive gene action in inheritance of the characters. Similar results were also reported for number of green leaves and leaf area index at 60 and 120 DAP (Rahman and Bhuiyan, 2009), brix and sucrose per cent (Gagandeep *et al*., 2004), purity per cent and cane diameter (Sabitha *et al., 2009)* in sugarcane.

Low to moderate GCV, PCV and notables moderate to high heritability and GAM recoded for CCS per cent, shoot population at 120, 180, 240 DAP, number of millable canes at 300 DAP, single cane weight, cane length and cane diameter indicating the importance of both additive and non additive gene action in the inheritance of these characters. Similar results of low to moderate GCV

Table 2. Mean, range and genetic parameters for cane yield, sugar yield and yield components in first clonal stage (Settling Nursery) of sugarcane.

S.No	Character(s)	Mean	Range		GCV (%)	PCV (%)	Heritability (h^2)	Genetic advance (GA)	G A over mean
			Minimum	Maximum					
1	Number of green leaves at 60 DAP	7.68	5.26	11.11	7.32	11.59	39.89	0.73	9.52
2	Number of green leaves at 120 DAP	14.31	9.82	17.52	7.05	10.00	49.70	1.46	10.21
3	Leaf area index at 60 DAP	1.09	0.76	1.96	9.65	13.45	51.50	0.16	14.27
4	Leaf area index at 120 DAP	2.12	1.63	2.99	4.75	6.92	47.26	0.14	6.73
5	Brix per cent at harvest	18.98	13.06	24.46	6.95	8.59	65.47	2.20	11.59
6	Sucrose per cent at harvest	16.92	10.58	22.30	9.06	10.15	79.56	2.81	16.64
7	CCS per cent at harvest	12.08	7.15	16.70	10.25	11.49	79.60	2.26	18.84
8	Purity per cent at harvest	89.08	73.17	99.98	3.56	4.76	55.79	4.87	5.47
9	Shoot population at 90 DAP	117.61	70.90	194.91	10.16	13.82	54.11	18.31	15.39
10	Shoot population at 120 DAP	167.27	89.45	241.70	9.22	12.43	55.02	23.57	14.09
11	Shoot population at 180 DAP	138.12	87.26	214.27	9.88	13.32	55.01	21.21	15.09
12	Stalk population at 240 DAP	123.03	91.98	195.73	9.22	11.81	60.83	18.46	14.80
13	NMC at 300 DAP	111.32	90.12	156.37	9.51	11.39	69.71	18.21	16.36
14	Single cane weight(kg)	1.09	0.57	1.54	10.34	11.00	88.36	0.22	20.18
15	Cane length (cm)	262.70	197.66	338.92	10.06	11.49	76.63	47.64	18.14
16	Cane diameter(cm)	2.26	1.72	2.96	5.39	6.59	66.77	0.20	9.07
17	Cane volume (cm^3)	111.71	54.99	215.03	13.57	15.89	72.89	26.55	23.86
18	NMC/plot(kg)	105.28	89.24	139.49	12.66	14.73	73.86	23.60	22.41
19	Cane yield(kg $plot^{-1}$)	115.40	48.00	184.53	8.14	9.95		21.08	18.26
20	CCS yield(kg $plot^{-1}$)	13.98	4.48	25.17	13.35	17.21		3.00	21.34

and PCV coupled with moderate to high heritability and GAM were also reported for CCS per cent (Singh *et al*., 2006); shoot population, single cane weight (Singh *et al*., 2002), cane length (Gagandeep *et al*., 2004) and cane diameter (Jain *et al*., 2001) in sugarcane.

Based on the estimates of GCV, PCV, heritability and GAM, it is concluded that the number of millable canes, single cane weight, cane volume and cane yield are controlled by additive gene action while cane length, cane diameter and HR brix per cent are under the influence of non additive gene action in seedling nursery. Shoot population at 90 DAP, number of millable canes, cane volume and sugar yield are governed by additive gene action. While number of green leaves at 60 and 120 DAP, leaf area index at 60 and 120 DAP, brix, sucrose, purity and cane diameter are conditioned by non additive gene action. The characters *viz.,* CCS per cent, shoot population at 120, 180, 240 DAP, number of millable canes at 300 DAP, single cane weight, cane length and cane yield are governed by both additive and non additive gene action in sugarcane.

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Table 3. Mean, range and genetic parameters for cane yield, sugar yield and yield components in second cloned stage (Selection nursery) of sugarcane

S.No	Character(s)	Mean	Range		GCV (%)	PCV (%)	Heritability (h^2)	Genetic advance (GA)	GA over mean
			Minimum	Maximum					
1	Number of green leaves at 60 DAP	7.85	5.51	10.13	7.24	10.45	48.23	0.81	10.38
2	Number of green leaves at 120 DAP	14.32	11.63	16.23	4.89	6.90	50.18	0.15	7.13
3	Leaf area index at 60 DAP	1.12	0.86	1.48	8.84	12.58	49.43	0.14	12.51
4	Leaf area index at 120 DAP	2.15	1.79	2.71	4.72	6.58	51.45	0.15	6.97
5	Brix per cent at harvest	19.89	17.89	23.51	5.72	7.52	57.86	1.80	8.96
6	Sucrose per cent at harvest	17.91	15.74	21.88	5.02	6.76	55.14	1.39	7.68
7	CCS per cent at harvest	12.86	11.09	16.21	8.19	9.25	78.40	1.93	14.93
8	Purity per cent at harvest	90.04	80.15	99.45	3.52	4.77	54.46	4.81	5.35
9	Shoot population at 90 DAP	134.42	71.00	232.00	17.30	18.77	85.00	42.27	32.86
10	Shoot population at 120 DAP	187.39	126.00	292.00	12.23	14.60	70.18	38.71	21.11
11	Shoot population at 180 DAP	160.96	105.00	252.00	13.12	15.16	74.92	36.59	23.40
12	Stalk population at 240 DAP	143.50	103.00	218.00	9.37	11.12	71.01	22.69	16.27
13	NMC at at 300 DAP	130.76	92.00	208.00	6.16	7.48	67.87	12.76	10.46
14	Single cane weight (kg)	1.16	0.95	1.86	8.20	8.52	92.62	0.20	16.26
15	Cane length (cm)	246.25	180.00	321.00	8.90	10.30	74.70	40.94	15.85
16	Cane diameter (cm)	2.46	2.00	3.30	4.90	5.35	83.97	0.23	9.25
17	Cane volume (cm^3)	141.72	75.03	277.92	13.49	13.82	95.26	38.03	27.12
18	NMC/plot(kg)	119.88	88.00	193.00	12.44	14.08	78.06	22.64	20.15
19	Cane yield (kg $plot^{-1}$)	138.33	94.94	223.31	8.29	9.16	81.84	20.96	15.45
20	CCS yield (kg $plot^{-1}$)	17.86	12.58	29.55	10.57	11.78	80.48	3.43	19.53

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