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Variability, heritability and genetic advance for cane yield, its component traits and juice quality parameters over the environment

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Abstract
Analysis of variance in pooled over environments revealed significant genotypic differences for all the sixteen characters under study indicating presence of wide range of variation in the material for all the characters. The genotypic coefficient of variation was highest for germination % at 45 days, shoots at 240 days, tillers at 120 days, stalk height at 360 days and internodes/stalk at 360 days. High heritability coupled with high to moderate genetic advance was observed for germination % at 45 days, tillers at 120 days, shoots at 240 days, stalk diameter at 360 days, stalk height at 360 days, internodes/stalk at 360 days, NMC at harvest, cane yield and CCS (t/ha). Results indicated that these characters were governed by additive gene action so phenotypic selection for such traits may be useful in choice of best genotype.

Keywords: Variability, heritability, genetic advance, environment, yield, quality, sugarcane

Introduction
Cultivated sugarcane [*Saccharum* spp. Complex, 2n= 100-130] belongs to the genus *Saccharum* of the family poaceae. The genus is characterized by clonal propagation, complex aneupolyploidy and high levels of heterozygosity. Cultivated sugarcane is a derivative of interspecific crosses involving *S. officinarum* and *S. sponateum* (although minor contributions from *S. barberi* and *S. sinense* have also been observed).Crossing between cultivated and wild species was made to transfer disease resistance followed by back crossing for desirable agronomic traits resulted in mixture/complex of *Saccharum* species this is known as nobilization. The whole sugarcane plant is useful in various ways *viz*., cane for sugar, jaggery, *khandsari*, roots for fuel, tops for cattle feed and trash for roof, mulch and compost etc.
The character cane yield has a complex gene action. Many factors affecting the cane yield must be considered and evaluated with regards to their contribution to yield. A successful breeding programme for cane yield improvement through phenotypic selection is mainly dependent on the nature and magnitude of variation in the available material and part played by the environment in the expression of the plant characters *i.e.* phenotype. This requires the partitioning of the overall variability into its heritable and non-heritable components with the help of suitable genetic parameters such as genetic coefficient of variation, heritability and genetic advance.

Materials and Methods
Description of the study area
The field experiment was conducted at Main Sugarcane Research Station, Navsari Agricultural University, Navsari-396 450 (Gujarat) by creating four environments. The place is located 12 km away in the east from the great historical place "Dandi" on the Arabian seashore. Geographically, it is situated at 20°-57′N latitude and 72°-54'E longitude with an elevation of 10.0 meter above mean sea level on the western coastal belt of India. For this study, thirty genotypes of sugarcane obtained from Main Sugarcane Research Station, NAU, Navsari (Table-1) were used. Experiment was conducted in Randomized Block Design (RBD) with three replications. The gross plot size for each genotype was consisted of five rows each of six-meter length with row to row spacing of 90 cm and the net plot was consisted of middle 3 rows each of 5-meter length with row to row spacing of 90 cm (excluding 0.5 m ring line at both ends of the plot). The two budded sets of sugarcane were planted in rows keeping 12 buds per meter row length. The crop was raised under irrigated conditions following all

the recommended package of practices and fertilizer application for environment 1 and environment 3 (250 kg N + 125 kg P2O5 + 125 kg K2O per ha) while for environment 2 and environment 4 half dose of recommended fertilizer (125 kg N + 62.5 kg P2O5 + 62.5 kg K2O per ha) along with acetobacter treatment as a drenching @ 2.5 lit/ha for nitrogen fixation was followed.Observations were recorded on yield components and quality traits *viz.*, germination % at 45 days, tillers at 120 days (000/ha), shoots at 240 days (000/ha), stalk height at 360 days (cm), stalk diameter at 360 days (cm), internodes/stalk at 360 days, stalk weight at 360 days (kg), number of millable canes/ha (NMC) at 360 days (000/ha), cane yield at harvest (t/ha), juice brix % at 360 days, sucrose % juice at 360 days, juice purity % at 360 days, CCS % at 360 days, fibre % cane at 360 days, pol % cane at 360 days and sugar yield at 360 days (t/ha).

Data analysis

The data recorded for all the characters were subjected to analysis of variance with the usual standard statistical procedure outlined by Panse and Sukhatme (1978)[14].Phenotypic and genotypic variance, phenotypic and genotypic coefficient of variation, range and mean of five tagged randomly selected canes were used to estimate the variability in the population. Thus, phenotypic and genotypic coefficients of variation were estimated according to the method suggested by Burton and Devane (1953) [3].Broad sense heritability expressed as the percentage of the ratio of the genotypic variance (σ2g) to the phenotypic variance (σ2p) and was estimated on genotype mean basis as described by Allard (1960) [1]. According to Johnson *et al*. (1955) [7], genetic advance expected under selection and genetic advance in percent of the mean were calculated at 5% selection intensity

Results and Discussion

The extent of inherent variation is the most crucialelement in any breeding material. Therefore, the occurrence of genetic variability is pre-requisite for any crop improvement programme as it provides a wider scope for selection. Accordingly, sugarcane genotypes were evaluated for their genetic potential in a response of cane yield, its components and juice quality parameters over the environment.

Range of phenotypic variation

A perusal of range of phenotypic variation in pooled analysis (Table-3) revealed that genotypes possessed the highest magnitude of variability for stalk height at 360 days (227.16 to 310.67) followed by tillers at 120 days (144.45 to 211.30) and shoots at 240 days (125.68 to 191.78). High range of phenotypic variation was reflected by the traits such as number of millable canes at harvest (107.98 to 133.70), cane yield (107.27 to 137.24) and germination % at 45 days (46.56 to 74.80). This indicated an ample scope of exploitation of the characters under study. All the sixteen characters had a wide range of variability (on pooled bases). Similar results were reported by Hapase and Hapase (1990) [5], Verma *et al*. (1999) [22], Singh *et al.* (2002b) [18], Hapase and Repale (2004) [6], Patel *et al.* (2006a) [15], Rahman and Bhuiyan (2009) [17], Anbanandan and Saravanan (2010) [2] and Tyagi *et al.* (2011) [21]. Wider adaptability facilitates better chances of improvement.

Genotypic, phenotypic and environmental components of variance

In pooled analysis, the values of genotypic and phenotypic variances were highest for the stalk height at 360 days (413.09 and 758.98) followed by tillers at 120 days (291.79 and 431.35), shoots at 240 days (215.35 and 354.55) and cane yield (t/ha) (46.91 and 96.10).Similar results were reported by Kumar *et al.* (2010a) [12], Anbanandan and Saravanan (2010) [2] and Pawar *et al.* (2011) [16] for most of the cane yield and its contributing traits. The character NMC at harvest (38.39 and 94.09) and germination % at 45 days (53.84 and 71.40) exhibited moderate genotypic and phenotypic variances.Such results were also observed by Kadian *et al.* (1997) [8], Doule and Balasundaram (1997) [4], Verma *et al.* (1999) [22] and Murthy (2007) [13]. The lowest estimates of genotypic and phenotypic components of variances were associated with characters such as stalk weight at 360 days (kg), stalk diameter at 360 days and fibre % cane at harvest.Hapse and Hapse (1990) [5] and Khan *et al*. (1991) [10] obtained lowest estimate for single cane weight followed by stalk diameter at 360 days. Singh *et al*. (1996) obtained lowest estimates of cane diameter. Doule and Balasundaram (1997) [4] also obtained such type of results as obtained in present study. Tyagi and Singh (2000) [20] found lowest estimates of genotypic and phenotypic variance for stalk girth at 360 days. Singh *et al.* (2002a) [18] reported such results for stalk girth followed by stalk weight. Similar results were akin to the findings of Rahman and Bhuiyan (2009) [17].

A perusal of the estimates of environmental component of variance in relation to their genotypic counterpart revealed that the estimates of σ2g were higher than σ2e for most of the characters in individual as well as pooled over environments. The higher magnitude of genotypic variance suggested little influence of environments in the expression of genetic variability.

Genotypic and phenotypic coefficients of variation

The estimates of genotypic and phenotypic components of variance described in the previous section reflected the amount of variability present in the population for different traits. However, such estimates cannot be utilized for comparing relative degree of variability for various characters as these estimates are associated with squared unit of measurement for certain characters. This comparison can be achieved by estimating genotypic coefficient of variation (GCV %) and phenotypic coefficient of variation (PCV %). The genotypic and phenotypic coefficients of variation for all the traits in pooled over environments are summarized in Table-3.

In combined analysis over environments the values of genotypic and phenotypic coefficient of variation were high for germination % at 45 days (12.19 and 14.10) followed by shoots at 240 days (9.09 and 11.86), tillers at 120 days (9.08 and 11.22), stalk height at 360 days (7.84 and 10.51) and internodes/stalk at 360 days (5.99 and 8.67).Similar results were reported by Kumar *et al.* (2010a) [12], Anbanandan and Saravanan (2010) [2] and Pawar *et al.* (2011) [16] for most of the cane yield and its contributing traits. Moderate estimates of genotypic and phenotypic variances were observed for NMC at harvest and germination % at 45 days. Such results were also observed by Kadian *et al.* (1997) [8], Doule and Balasundaram (1997) [4], Verma *et al.* (1999) [22] and Murthy (2007) [13].

The characters *viz*., juice purity % at 360 days (0.90 and 1.68), fibre % cane (1.96 and 3.08) and pol % cane (2.61 and 4.68) expressed low degree of genotypic and phenotypic coefficient of variation (Table-3).Verma *et al.* (1999) [22] and Hapse and Hapse (1990) [4] obtained similar result for juice purity per cent. In present study the difference between PCV and GCV was less for most of the characters suggesting that characters were not much influenced by environment, their improvement by phenotypic selection is possible.

Heritability and Genetic advance pooled over environments

In crop improvement, only the genetic component of variation is important since only that component is transmitted to the next generation. Heritability indicates the effectiveness with which selection of genotypes would be based on phenotypic performance. In present investigation, characters, *viz*., germination % at 45 days, tillers at 120 days, shoots at 240 days showed high heritability coupled with high genetic advance (Table-3) indicated that these characters were governed by additive gene action and selection would be effective for improvement of these traits. Hapse and Repale (2004) [6] reported high heritability coupled with high genetic advance for number of tillers at 120 days, germination percentage, total height and millable height of cane. Kumar *et al.* (2004) [11] observed same trend for number of tillers at 240 days, cane height and number of internodes/stalk. Similar results were obtained by Rahman and Bhuiyan (2009) [17], Kumar *et al.* (2010a) [12] and Pawar *et al*. (2011) [16] for the traits like stalk height and other yield contributing characters.

While, other characters *viz*., stalk diameter at 360 days, stalk height at 360 days, internodes/stalk at 360 days, NMC at harvest, cane yield (t/ha) and CCS (t/ha) showed high to moderate heritability with high to moderate genetic advance (Table-3).Moderate heritability with low genetic advance observed for traits like juice brix % at 360 days, sucrose % juice at 360 days, commercial cane sugar % (CCS %), fibre % cane and pol % cane. The moderate to high heritability is being exhibited due to favorable influence of environment rather than genotype. Same result was obtained by Hapse and Hapse (1990) [5] for sucrose per cent juice. Singh *et al.* (1996) [19] and Singh *et al.* (2002a) [18] reported the same results for both brix per cent and sucrose per cent. Moderate to high heritability coupled with high genetic advance for number of millable canes, single cane weight and cane yield was also reported by Kamat and Singh (2001) [9],Murthy (2007) [13] found moderate heritability with low genetic advance for cane diameter. Anbanandan and Saravanan (2010) [2] reported similar trend for the characters internodal length, brix per cent, sucrose per cent, cane length, cane thickness and purity % showed high heritability with low genetic advance.

Low heritability with low genetic advance was observed for stalk weight at 360 days and juice purity % at 360 days. It indicated that the character is highly influenced by environmental effects and selection would be ineffective for this trait.

Table 1: List of genotypes used in the study

1. Co 85004	11. Co 07012	21. CoSnk 07104
2. Co 86032	12. Co 07015	22. CoSnk 07105
3. Co 94008	13. Co 07017	23. CoJn 07092
4. Co 99004	14. Co 07020	24. CoJn 07093
5. Co 07003	15. CoN 95132	25. CoJn 07094
6. Co 07006	16. 2005 N 699	26. PI 07131
7. Co 07007	17. CoN 07072	27. PI 07132
8. Co 07008	18. CoN 07073	28. MS 07081
9. Co 07009	19. CoSnk 07101	29. CoM 07083
10. Co 07010	20. CoSnk 07103	30. CoVC 07061

Table 2: Analysis of variance showing mean square for sixteen characters in Sugarcane (Pooled)

Source	d.f.	Germination % at 45 days	Tillers at 120 days (000/ha)	Shoots at 240 days (000/ha)	Stalk height (cm) at 360 days	Stalk diameter (cm) at 360 days	Internodes /stalk at 360 days
Environment	3	641.04**	9603.00**	7683.33**	6072.66**	0.117**	97.21**
Treatment	29	663.43**	3641.08**	2723.49**	5302.98**	0.1742**	32.71**
E x T	87	40.49**	465.44**	341.16**	111.51	0.009	6.98**
Error	232	17.56	139.56	139.20	345.89	0.01	2.33
S.Em±		1.71	4.82	4.81	7.59	0.04	0.62
C.V. %		7.08	6.59	7.61	7.00	4.77	6.26

Source	d.f.	Stalk weight (kg) at 360 days	NMC at harvest (000/ha)	Cane yield (t/ha)	Juice brix % at 360 days	Sucrose % juice at 360 days
Environment	3	1.124**	2370.33**	3661.33**	9.39**	8.72**
Treatment	29	0.076**	516.48**	612.22**	5.53**	4.52**
E x T	87	0.011**	107.45**	87.00**	1.31**	1.12**
Error	232	0.004	55.70	49.19	0.578	0.564
S.Em±		0.02	3.04	2.86	0.31	0.30
C.V. %		5.34	6.32	5.64	3.58	3.83

Source	d.f.	Juice purity % at 360 days	CCS %	Fibre % cane	Pol % cane	CCS (t/ha)
Environment	3	2.08	4.50**	1.41**	4.95**	51.85**
Treatment	29	10.23**	2.28**	1.30**	2.43**	14.73**
E x T	87	4.97**	0.63**	0.27**	0.65**	2.69**
Error	232	1.72	0.32	0.12	0.32	1.34
S.Em±		0.53	0.23	0.14	0.23	0.47
C.V. %		1.42	4.09	2.36	3.88	6.74

Table 3: General mean, phenotypic range, variance components, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance of 30 sugarcane genotypes (Pooled over environments)

Characters/ Parameters	General Mean	Range (Phenotypic)	Genotypic variance	Phenotypic variance	Environmental variance	GCV (%)	PCV (%)	H^2 (b) (%)	G.A.
Germination % at 45 days	59.11	46.56-74.80	53.84	71.40	17.56	12.19	14.10	75.41	22.21
Tillers at 120 days (000/ha)	179.30	144.45-211.30	291.79	431.35	139.56	9.08	11.22	67.65	16.14
Shoots at 240 days (000/ha)	154.66	125.68-191.78	215.35	354.55	139.20	9.09	11.86	60.74	15.23
Stalk height (cm) at 360 days	265.40	227-16-310.67	413.09	758.98	345.89	7.84	10.51	54.43	11.64
Stalk diameter (cm) at 360 days	2.48	2.26-2.68	0.014	0.02	0.01	4.73	6.72	70.00	8.22
Internodes /stalk at 360 days	24.42	21.23-27.08	2.53	4.86	2.33	5.99	8.67	52.06	9.68
Stalk weight (kg) at 360 days	1.23	1.14-1.47	0.0006	0.005	0.004	5.96	8.00	12.00	1.42
NMC at harvest (000/ha)	117.90	107.98-133.70	38.39	94.09	55.70	4.95	8.03	40.80	6.92
Cane yield (t/ha)	124.20	107.27-137.24	46.91	96.10	49.19	5.32	7.76	48.81	7.94
Juice brix % at 360 days	21.19	19.56-22.53	0.45	1.03	0.578	2.80	4.55	43.69	4.31
Sucrose % juice at 360 days	19.60	18.04-20.85	0.33	0.89	0.564	2.71	4.70	37.08	3.68
Juice purity % at 360 days	92.50	90.82-93.82	0.70	2.42	1.72	0.90	1.68	28.93	1.00
CCS %	13.85	12.73-14.77	0.18	0.50	0.32	2.68	4.89	36.00	3.79
Fibre % cane	14.90	14.11-15.48	0.09	0.21	0.12	1.96	3.08	42.86	2.72
Pol % cane	14.72	13.65-15.66	0.17	0.49	0.32	2.61	4.68	34.69	3.40
CCS (t/ha)	17.20	14.58-20.09	1.11	2.45	1.34	5.82	8.91	45.31	8.49

References

1. Allard RW. Principles of Plant Breeding. John Willey and Sons, Inc., New York, 1960, 85-95.
2. Anbanandan V, Saravanan K. Genetic variability in interspecific and intergeneric progenies in sugarcane. Plant Archives. 2010; 10(2):627-632.
3. Burton CW, Devane RW. Estimating heritability in tall fescue from replicated clonal material. Agron. J. 1953; 4:78-81.
4. Doule RB, Balasundaram N. Variability, heritability and genetic advance for yield and quality attributes in sugarcane. Indian Sugar. 1997; 47(7):499-502.
5. Hapase RS, Hapase DG. Genetic variability studies in late maturing sugarcane varieties. Bhartiya Sugar. 1990; 15(10):13-16.
6. Hapse RS, Repale JM. Variability studies of some quantitative and qualitative characters in sugarcane varieties. Indian Sugar. 2004; LIV (3):205-210.
7. Johnson HW, Robinson HF, Comstock RE. Genotypic and phenotypic correlation in soyabeans and their implication in selection. Agron. J. 1955; 47:477-483.
8. Kadian SP, Chander K, Sabharval PS. Genetic variability and heritability in sugarcane. Indian Sugar. 1997; 46(12):937-975.
9. Kamat, DN, Singh JRP. Variability in sugarcane under rainfed condition. Sugar Tech. 2001; 3(1&2):795-797.
10. Khan MI, Chattergee A, Bargale M. Genetic variability and character association analysis for yield and its attributes in sugarcane. Co-operative Sugar. 1991; 23(1):29-33.
11. Kumar K, Singh PK, Singh JRP. Genetic variability and character association in subtropical clones of sugarcane (Saccharum complex hybrid). Indian Sugar. 2004; LIV(3):189-198.
12. Kumar N, Singh T, Kumar V. A study on genetic parameters, repeatability and predictability in plant and ratoon crops of sugarcane (*Saccharum officinarum* L.). Indian Sugar. 2010a; LX (2):23-27.
13. Murthy N. Genetic variability and character association for yield and quality parameters in sugarcane. J Maharashtra Agric. Univ. 2007; 32(3):343-346.
14. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. ICAR, New Delhi. 1978.
15. Patel KC, Patel AI, Mali SC, Patel DU, Vashi RD. Variability, correlation and path analysis in sugarcane (*Saccharum* spp.). Crop Res. 2006a; 32(2):213-218.
16. Pawar DS, Hapse RS, Repale JM, Deshmukh RB. Studies on genetic variability, heritability and genetic advance in different sugarcane genotypes. Proc. Of 10th Joint Conv. Of STAI and DSTA. 2011; pp: 206-215.
17. Rahman MM, Bhuiyan MSR. Variability, heritability and genetic advanced for cane yield and its components in some indigenous and exotic promising clones of sugarcane (*Saccharum officinarum* L.). Indian Sugar. 2009; LIX(2):35-41.
18. Singh A, Bhatnagar PK, Khan AQ, Shrtria PK. Variability and heritability for cane yield, its components and quality characters in sugarcane (*Saccharum* spp. complex). Indian Sugar. 2002b; 51(1):717-719.
19. Singh AP, Chattergee A, Nema GK. Genetic variability in sugarcane. Crop Res. 1996; 12(2):162-164.
20. Tyagi SD, Singh DN. Correlation and heritability studies in sugarcane. Indian Sugar. 2000; 50(5):305-308.
21. Tyagi VK, Sharma S, Bhardwaj SB. A study on the nature and magnitude of variations in different traits in sugarcane. Electronic J Plant Breeding. 2011; 2(3):334-341.
22. Verma PS, Pal S, Karma NK. Genetic variability and correlation studies in sugarcane. Indian Sugar. 1999; 49(2):125-128.