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Analysis of variance, range and mean for different characters in first clonal stage of sugarcane (*Saccharum officinarum* L.)

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Abstract
Understanding of various genetic parameters that govern a population under improvement is essential for proper planning and direction of plant breeding programme. Genetic variability and heritability are useful parameters that can help the breeding during different stages of crop improvement. The success of such programme will largely depend on the extents of genetic variability available in the base population and heritability of the characters under improvement. Therefore, a clear understanding of genetic parameters is of paramount importance to develop a breeding strategy. Genetic variability accumulated and conserved in the form of diverse plant types is immediately valuable for shaping new varieties. This forms the basic genetic wealth on which plant breeders could operate for reconstructing the existing genotypes.

Keywords: Sugarcane, range, genetic variability, heritability

Introduction
Sugarcane is a multipurpose crop that provides food, fodder, feed, fibre and fuel at an affordable price to the rural poor. Sugarcane has the unique and very useful characteristic of high sugar concentration accumulation. Hence, it is an important crop for sugar production. Its contribution to agricultural GDP is 10 per cent which is significant as the crop is grown by only 2.57 per cent of the gross cropped area in the country (Anon., 2017) [1].

Among the sugar crops, sugarcane, accounts for over 70 per cent of the world's sugar production (Anon., 2017) [1]. Sugarcane (*Saccharum* spp. hybrids) is a genetically complex crop of major economic importance in tropical and subtropical countries. Cane industry require high sugar producing varieties with other desired agronomic traits.

Globally, sugarcane is cultivated over an area of 24.10 m ha with an annual production of 1329.3 million tonnes and an annual productivity of 75.70 t/ha. In India, sugarcane is grown under diverse agro-climate situations covering an area of 5.2 m ha and production of 364.0 million tonnes of sugarcane with productivity of 70.39 t/ha (Anon., 2017) [1]. Principal sugarcane growing states are Karnataka, Tamilnadu, Maharashtra, Andhra Pradesh, Uttar Pradesh and Gujarat. In Karnataka sugarcane is grown in an area of 4.30 lakh hectare and production of 45.3 million tonnes of sugarcane with annual productivity of 93.80 t/ha (Anon., 2017) [2]. In Cauvery Command Area sugarcane is grown in an area of 0.61 lakh hectare with the production of 77.10 lakh tonnes of sugarcane and productivity of 101.80 t/ha (Anon., 2017) [2]. In India 24.39 million tonnes of sugar is produced, but the projected requirement of sugar by 2030 is 36 million tonnes which has to be achieved from the existing cane area through improved varieties and management for cane yield and sugar recovery as further expansion in area is not possible.

Genotypic coefficient of variability gives the magnitude of genetic variance present in the population. The heritability in broad sense is a measure of proportion of total genetic variance reflecting the performance repeatability and its appropriate estimate for clonally propagated crops like sugarcane. The genetic advance as per cent mean summarizes the information contained in the heritability and genotypic coefficient of variability. Hence, the information on these parameters is of paramount importance to sugarcane breeders.

The information on the nature and the magnitude of variability present in the genetic material is of prime importance for a breeder to initiate any effective selection programme. Genotypic and phenotypic coefficients of variation along with heritability as well as genetic advance are very essential to improve any trait because this would help in knowing whether or not the desired objective can be achieved from the material (Tyagi and Singh, 1998) [8].

Since, cane yield is a complex trait the association of different traits with it would be an important criterion for the development of high yielding, high sugared and mid-late maturing varieties in sugarcane.

Material and methods

First Clonal Generation (C_1) or Settling Nursery

Fifty five genotypes selected from 2308 seedling nursery based on evaluation were planted in *eksali* 2015. Each genotype was planted in two rows of 6.0 m length spaced at 90 cm apart (2R × 6m × 0.9m) with three budded setts per meter in augmented design with five blocks along with three checks *viz*., CoVC 99463, Co 86032 and Co 62175. All the recommended package of practices were adopted to raise the better crop stand. The details of the genotypes selected in seedling nursery and checks are furnished in Table 1.

Table 1: List of selected clones from fluffs of different cross combinations used under study with their parentage and salient features in first clonal stage of sugarcane

S. No.	Clones	Parentage	Features
01	Co VC 14-62-31	Co 8318 GC	High Brix per cent juice and high pol per cent
02	Co VC 14-12--30	Co 8371 × Co86011	High sucrose per cent, easy detrashing and more NMC
03	Co VC 14-12--02	Co 8371 × Co86011	High sucrose per cent, easy detrashing and more NMC
04	Co VC 14-01--03	Co 86002 × Co1148	High sucrose per cent and more number of tillers.
05	Co VC 14-06--03	Co 8371 × CoT8201	High Brix per cent juice and high pol per cent
06	Co VC 14-12--03	Co 8371 × Co86011	High sucrose per cent, easy detrashing and more NMC
07	Co VC 14-02--04	Co 85002 × Co 62174	High Brix per cent juice and high pol per cent
08	Co VC 14-06--04	Co 8371 × CoT8201	High sucrose per cent and more number of tillers.
09	Co VC 14-09--04	Co 740× Co775	High Brix per cent juice and high pol per cent
10	Co VC 14-12--05	Co 8371 × Co86011	High sucrose per cent and more number of tillers.
11	Co VC 14-02--08	Co 85002 × Co 62174	High Brix per cent juice and high pol per cent
12	Co VC 14-02--09	Co 85002 × Co 62174	High Brix per cent juice and high pol per cent
13	Co VC 14-06--09	Co 8371 × CoT8201	High sucrose per cent and more number of tillers.
14	Co VC 14-12--09	Co 8371 × Co86011	High sucrose per cent and more number of tillers.
15	Co VC 14-02--10	Co 85002 × Co 62174	High sucrose per cent and more number of tillers.
16	Co VC 14-02--12	Co 85002 × Co 62174	High Brix per cent juice and high pol per cent
17	Co VC 14-12--14	Co 8371 × Co86011	High sucrose per cent and more number of tillers.
18	Co VC 14-02--15	Co 85002 × Co 62174	High sucrose per cent and more number of tillers.
19	Co VC 14-12--23	Co 8371 × Co86011	High sucrose per cent and more number of tillers.
20	Co VC 14-12--24	Co 8371 × Co86011	High sucrose per cent and more number of tillers.
21	Co VC 14-12--25	Co 8371 × Co86011	High sucrose per cent and good number of tillers.
22	Co VC 14-12--27	Co 8371 × Co86011	High Brix per cent juice and high pol per cent
23	Co VC 14-06--12	Co 8371 × CoT8201	High Brix per cent juice and high pol per cent
24	Co VC 14-13--01	CoM 0265 × Co 775	High Brix per cent juice and high pol per cent
25	Co VC 14-13--02	CoM 0265 × Co 775	High Brix per cent juice and high pol per cent
26	Co VC 14-25--01	ISH 100 × Co 0240	High sucrose per cent and more number of tillers
27	Co VC 14-26--02	ISH 100 × Co 62198	High Brix per cent juice and high pol per cent
28	Co VC 14-29--02	Co 86002 × Co 62198	High sucrose per cent and more number of tillers
29	Co VC 14-31--03	Co 8371 × Co 99006	High Brix per cent juice and high pol per cent
30	Co VC 14-31--05	Co 8371 × Co 99006	High sucrose per cent and more number of tillers.
31	Co VC 14-35--01	Co 98010 × Co 775	High Brix per cent juice and high pol per cent
32	Co VC 14-35--02	Co 98010 × Co 775	High Brix per cent juice and high pol per cent
33	Co VC 14-35--05	Co 98010 × Co 775	High sucrose per cent and good number of tillers.
34	Co VC 14-35--08	Co 98010 × Co 775	High sucrose per cent and more number of tillers
35	Co VC 14-35--12	Co 98010 × Co 775	High sucrose per cent and more number of tillers.
36	Co VC 14-35--15	Co 98010 × Co 775	High Brix per cent juice and high pol per cent
37	Co VC 14-42--03	ISH 100 PC	High Brix per cent juice and high pol per cent
38	Co VC 14-42--04	ISH 100 PC	High sucrose per cent and more number of tillers.
39	Co VC 14-42--05	ISH 100 PC	High sucrose per cent and more number of tillers.
40	Co VC 14-45--02	COA 7602 PC	High Brix per cent juice and high pol per cent
41	Co VC 14-45--03	COA 7602 PC	High Brix per cent juice and high pol per cent
42	Co VC 14-61--02	CoSnk 05103 GC	High Brix per cent juice and high pol per cent
43	Co VC 14-61--14	CoSnk 05103 GC	High sucrose per cent and more number of tillers
44	Co VC 14-61--18	CoSnk 05103 GC	High Brix per cent juice and high pol per cent
45	Co VC 14-62--02	Co 8318 GC	High Brix per cent juice and high pol per cent
46	Co VC 14-62--04	Co 8318 GC	High sucrose per cent and more number of tillers
47	Co VC 14-62--05	Co 8318 GC	High Brix per cent juice and high pol per cent
48	Co VC 14-62--20	Co 8318 GC	High sucrose per cent and more number of tillers.
49	Co VC 14-62--21	Co 8318 GC	High sucrose per cent and good number of tillers.
50	Co VC 14-62--22	Co 8318 GC	High Brix per cent juice and high pol per cent
51	Co VC 14-62--24	Co 8318 GC	High sucrose per cent and more number of tillers.
52	Co VC 14-62--26	Co 8318 GC	High Brix per cent juice and high pol per cent
53	Co VC 14-62--27	Co 8318 GC	High sucrose per cent and more number of tillers.
54	Co VC 14-62--28	Co 8318 GC	High Brix per cent juice and high pol per cent
55	Co VC 14-62--32	Co 8318 GC	High Brix per cent juice and high pol per cent
Standard Checks			

56	CoVC 99463	Co 6806 PC	High cane yield, high sucrose content with improved juice quality
57	Co 86032	Co 62198XCoC 671	High sucrose and quality.
58	Co 62175	Co 951 × Co 419	High cane yield.

Where,
GC = General Crosses, PC = Poly Crosses, SC = Station Crosses

Data Recorded in First Clonal Generation (C_1) Crop

Observations were recorded on the following traits for each genotype before and at the time of harvest in the settling nursery (C_1) crop.

1. Number of tillers/plot
2. Number of millable canes /plot
3. Millable cane length (cm)
4. Cane diameter (cm)
5. Number of internodes
6. Internode length (cm)
7. Single cane weight (kg)
8. Pol per cent juice
9. Brix per cent juice
10. CCS per cent
11. CCS cane yield
12. CCS yield (t/ha)
13. Purity per cent
14. Cane yield (t/ha)
15. HR Brix Yield (t/ha)

Results and Discussion

Analysis of Variance

The analysis of variance was performed individually for each character and total variation was partitioned into different sources of variation. The results are presented in Table 2.

Analysis of variance revealed significant mean sum of squares due to blocks and entries for eleven characters viz., number of tillers/plot at 120 DAP, NMC at harvest, internode length, millable cane length, cane stalk diameter, pol per cent, Brix per cent, CCS per cent, purity per cent, HR Brix yield and cane yield and shows non significant for single cane weight, number of internodes per cane, CCS cane yield. The mean sum of squares due to entries were significant for fourteen characters viz., number of tillers/plot at 120 DAP, NMC at harvest, internode length, millable cane length, pol per cent, Brix per cent, CCS per cent, purity per cent, HR Brix yield and cane yield, single cane weight, number of internodes per cane, CCS cane yield, CCS yield except cane stalk diameter. The mean sum of squares due to checks was significant for number of internodes per cane, internode length, pol per cent, Brix per cent, CCS per cent, CCS yield, HR Brix yield and cane yield.

The mean data recorded on fifteen characters for 55 genotypes along with the best check data corrected with block effect, Range, Mean and number of Genotypes showing higher performance than the best check for fifteen characters in first clonal stage of sugarcane in 55 genotypes are presented in table 3.

Mean, Range, and number of Genotypes showing higher performance than the best check for Different Characters in First Clonal Stage

1. Number of tillers/plot

Seven genotypes recorded significantly higher tiller number at 120 DAP than the best check Co 99463. The tiller number at 120 DAP ranged from 35.00 (CoVC 14-62-05) to 125.00 (CoVC 14-02-15) with a general mean of 77.36.

2. Number of Millable Canes per Plot

Number of millable canes per plant varied from 23.00 (CoVC 14-62-05) to 94.00 (CoVC 14-02-15) with a general mean of 59.69. Twelve genotypes recorded significantly higher number of millable canes per plot compared to the best check Co 99463.

Table 2: Analysis of variance for fifteen characters in first clonal stage of sugarcane

S. No.	Characters	Mean squares			
		Block	clones	Checks	Error
		df = 4	df =57	df = 2	df = 8
1.	Tiller number	292.82**	772.26**	38.07	11.23
2.	NMC	125.31**	476.14**	6.67	7.25
3.	Millable cane length (cm)	840.91**	520.70**	43.80	13.97
4.	Cane diameter (cm)	0.12*	0.08	0.02	0.03
5.	Number of internodes	3.89	6.96*	6.82*	1.53
6.	Internode length (cm)	21.27**	5.88*	17.93**	1.30
7.	Single cane weight (kg)	0.03	0.08**	0.04	0.01
8.	Pol per cent juice	8.28**	3.22**	4.08**	0.13
9.	Brix per cent juice	6.71**	1.83**	4.76**	0.13
10.	CCS per cent	1.65**	4.85**	3.12**	0.11
11.	CCS cane yield	0.001	0.002**	0.001	0.00
12.	CCS yield (t/ha)	1.04	23.69**	3.01*	0.38
13.	Purity per cent	11.17**	40.68**	2.68	0.86
14.	Cane yield (t/ha)	47.99*	1118.54**	51.37*	9.46
15.	HRB Yield (t/ha)	4.93**	44.37**	6.56**	0.43

* Significant at 5% probability level
** Significant at 1% probability level

Table 3: Range, Mean and Number of Genotypes showing higher performance than the best check for different characters in first clonal stage in sugarcane

S. No.	Characters	Range		Mean	Best check	No. of superior genotypes over best check
		Min	Max			
1.	Tiller number	35.00	125.00	77.36	Co99463 (107.20)	7
2.	NMC	23.00	94.00	59.69	Co99463 (76.80)	12
3.	Millable cane length (cm)	157.00	257.00	207.49	Co 62175 (222.20)	11
4.	Cane diameter (cm)	2.40	3.80	3.03	Co86032 (3.10)	19
5.	Number of internodes	13.70	23.70	18.24	Co86032 (20.76)	10
6.	Internode length (cm)	7.70	19.00	12.33	Co 62175 (15.22)	5
7.	Single cane weight (kg)	0.64	2.13	1.13	Co 62175 (1.36)	9
8.	Pol per cent juice	14.66	21.30	17.91	Co86032 (17.46)	40
9.	Brix per cent juice	16.00	22.00	19.76	Co86032 (21.28)	5
10.	CCS per cent	9.68	18.15	13.33	Co86032 (15.36)	1
11.	CCS cane yield	0.06	0.27	0.15	Co 62175 (0.19)	5
12.	CCS yield (t/ha)	2.55	16.61	8.66	Co86032 (13.30)	7
13.	Purity per cent	79.90	98.67	90.80	Co86032 (82.03)	44
14.	Cane yield (t/ha)	21.52	126.22	64.43	Co 62175 (91.15)	15
15.	HRB Yield (t/ha)	3.75	24.92	12.78	Co 62175 (18.68)	9

3. Millable cane length (cm)
Millable cane length varied from 157.00cm (CoVC 14-35-15) to 257.00 cm (CoVC 14-62-04) with a general mean of 207.49cm. Eleven genotypes recorded significantly higher values for Millable cane length compared to the best check Co 62175.

4. Cane diameter (cm)
Cane diameter ranged between 2.40cm (CoVC 14-62-02) and 3.80 cm (CoVC 14-35-05) with a general mean value of 3.03cm. Nineteen genotypes showed more stalk diameter than the best check Co 86032.

5. Number of internodes
Ten genotypes exhibited significantly more number of internodes per cane than the best check Co 86032. The number of internodes per cane varied from 13.70 (CoVC 14-12-05) to 23.70 (CoVC 14-02-04, CoVC 14-09-04, CoVC 14-26-02) with a general mean value of 18.24.

6. Internode length (cm)
The length of the internodes ranged from 7.70cm (CoVC 14-35-15) to 19.00 cm (CoVC 14-62-02) with a general mean of 12.33cm. Five genotypes showed significantly more internode length than the best check Co 62175.

7. Single cane weight (kg)
Single cane weight ranged from 0.64 kg (CoVC 14-01-03) to 2.13 kg (CoVC 14-62-28) with a general mean value of 1.13 kg. Nine genotypes recorded significantly higher cane weight than the best check Co 62175.

8. Pol per cent juice
Pol per cent ranged from 14.66 (CoVC 14-62-04) to 21.30 (CoVC 14-06-03) with a general mean value of 17.91. Fourty genotypes recorded significantly higher pol per cent than the best check Co 86032.

9. Brix per cent juice
Five genotypes recorded significantly higher Brix than the best check Co 86032. The Brix per cent varied from 16.00 (CoVC 14-62-05) to 22.00 (CoVC 14-02-12, CoVC 14-12-03, CoVC 14-06-03) with a general mean of 19.76.

10. Commercial cane sugar per cent (CCS %)
None of the genotypes recorded significantly higher Brix than the best check Co 86032. The CCS per cent varied from 9.68 (Co 62175, Co 99463) to 18.15 (Co 86032) with a general mean of 13.33.

11. CCS cane yield
CCS Cane yield ranged from 0.06 (CoVC 14-01-03) to 0.27 (CoVC 14-62-28) with a general mean of 0.15. Five genotypes showed significantly higher cane yield than the best check Co 62175.

12. CCS yield (t/ha)
CCS yield (t/ha) ranged from 2.55 (CoVC 14-62-05) to 16.61 (CoVC 14-31-03) with a general mean of 8.66. Seven genotypes showed significantly higher cane yield than the best check Co 86032.

13. Purity per cent (%)
Forty four genotypes recorded significantly higher Brix than the best check Co 86032. The purity per cent varied from 79.90 (Co 62175) to 98.67 (Co VC 14-45-03) with a general mean of 90.80.

14. Cane yield (t/ ha)
Cane yield (t/ha) ranged from 21.52 (t /ha) (Co VC 14-02-12) to 126.22 (t ha) (Co VC 14-62-28) with a general mean of 64.43 t ha^{-1}. Fifteen genotypes showed significantly higher cane yield than the best check Co 62175.

15. HR Brix yield (t/ ha)
Nine genotypes recorded significantly more HR Brix yield than the best check Co 62175. The HR Brix yield ranged from 3.75 t ha^{-1} (Co VC 14-62-05) to 24.92 t ha^{-1} (Co VC 14-31-03) with a general mean value of 12.78 t ha^{-1}.

The scope for improvement through selection is enhanced by the range of variability in the population. The comparison of results showed higher range of variations for number of tillers/plot, number of millable canes/plot, millable cane length(cm), number of internodes, internode length(cm), single cane weight, CCS per cent, CCS yield (t/ha), CCS cane yield, cane yield (t/ha), HR Brix yield (t/ha) and while narrow range of variations were observed in cane diameter, pol per cent juice, Brix per cent juice and purity per cent. Similar results were noticed by Gupta *et al.*, (2002) [3], Patel *et al.*, (2006) [6], Guruprasad Hiremath (2012) [4], Suresh Jaganur (2014) [7] and kasayya (2016) [5].

Conclusion

Wide range of variation was recorded for all the characters studied. Analysis of variance revealed significant mean sum of squares due to blocks and entries for eleven characters viz., tiller number, NMC at harvest, internode length, millable cane, cane stalk diameter, pol per cent, Brix per cent, CCS per cent, purity per cent, HR Brix yield and cane yield. The mean sum of squares due to entries was significant for fourteen characters viz., tiller number, NMC at harvest, internode length, millable cane length, pol per cent, Brix per cent, CCS per cent, purity per cent, HR Brix yield and cane yield, single cane weight, number of internodes per cane, CCS cane yield, CCS yield except cane stalk diameter. The mean sum of squares due to checks was significant for number of internodes per cane, internode length, pol per cent, Brix per cent, CCS per cent, CCS yield, HR Brix yield and cane yield.

References

1. Anonymous. 2017, http//www. faostat. com
2. Anonymous. 2017, http//www. indiastat. com
3. Gupta RK, Animesh Chatterjee, Chatterjee A. Study on some genetic parameters and its implication in selection of Sugarcane. Cooperative Sugar, 2002; 33(10):823-826.
4. Guruprasad Hiremath. Morphological traits and DNA markers assay based diversity in selected clones of sugarcane. M.sc. (Agri). Thesis, Univ. Agric. Sci., Bangalore, 2012, 197p.
5. Kasayya. Genetic investigation in mid-late maturing sugarcane (*Saccharum officinarum*) clones isolated for cauvery command area, M. Sc(Agri). Thesis, Univ. Agric. Sci., Bangalore, 2016, 107p.
6. Patel KC, Patel AI, Mali SC, Patel DU, Vashi RD. Variability, correlation and path coefficient analysis in sugarcane (*Saccharum spp*). Crop Res. 2006; 32(2):213-218.
7. Suresh Jaganur. Evaluation of elite clones of sugarcane (*Saccharum officinarum*) for cane yield, quality traits and rationing ability. M.Sc (Agri). Thesis, Univ. Agric. Sci., Bangalore, 2014, 85.
8. Tyagi SD, Singh DN. Studies on genetic variability for stalk characters in sugarcane. Indian Sugar. 1998; 40(8):259-262.