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Short Communication

Estimation of genetic parameters in different environments and their implications in sugarcane breeding

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Knowledge of the genetic structure of breeding population and an understanding of the - relative importance of GE help in taking efficient and effective breeding programme decisions. Such knowledge includes accurate estimates of genetic variances and covariances of important traits. Estimating genetic variances under a limited range of environmental conditions may lead to biased genetic variance. Hence, this study was undertaken to determine genetic parameters on 30 clones of sugarcane grown under water stress, water logging, salinity and normal conditions as 2 plant and 1 ratoon crops. Experiments were conducted in randomized block designs with three replications. The plot size, in all experiments, was consisted of 2 rows of 4 m length spaced at 75 cm. Data on 8 traits of stalk yield and juice quality were recorded in 3 crops (12 experiments) following standard procedures. Data was analyzed following standard statistical procedures.

The clones showed maximum expression of sugar yield, stalk yield and SSW under saline condition as indicated by the maximum GCV (Table 1) and hence selection of superior clones based on these traits would be effective under saline condition. The maximum GCV was recorded for pol %, HR Brix, NMS and stalk length under water stress condition. This indicated that salinity and water stress are the ideal conditions for selection under which most of the traits showed their maximum expression. The GCV computed over stresses was the maximum in ratoon crop for sugar yield, stalk yield, NMS and stalk length, in 2nd plant crop for juice quality traits and SSW, and in 1st plant crop for stalk diameter (Table 1). Higher GCV in these crops for respective traits indicates better scope for selection. The GCV for HR Brix at 8m was higher than GCV for pol % at 12m indicating the potential for selection gain in juice quality of clones at an early crop age. Estimates of GCV over crops and stresses was the maximum for NMS (33.5%) followed by SSW (31.24%) which indicated that there was enough possibility to select clones for these traits. Variation in different GCV estimates (over crops, over stresses and over crops and stresses) was not observed for stalk diameter and SSW indicating their reliability as selection criteria under all conditions. Hence, stalk yield improvement may be brought about by selection through its important traits such as NMS, stalk diameter and SSW which would lead to improved sugar yield if pol % is maintained at economic acceptable level.

Data showed little difference in heritability among different environments (stresses) for stalk diameter and SSW, hence indicating their reliability as selection criteria under all environments. On the basis of highest heritability values, Ram *et al.* [1] concluded that normal and rainfed environments least influenced stalk diameter and SSW. The highest heritability values were observed in ratoon crop for sugar yield, stalk yield and NMS, and in 2nd plant crop for juice quality traits, stalk diameter, stalk length and SSW thereby indicating for their effectiveness in selection in respective crops. As the heritability values were higher in ratoon crop for sugar and stalk yields hence their selection would be more effective in ratoon crop. Estimates of heritability over crops and stresses were higher for HR Brix, NMS, stalk diameter and SSW but were moderate for other traits (Table 1) indicated that these traits can be used as selection criteria.

Higher GCV and heritability values for sugar yield, stalk yield and SSW under saline condition resulted in the highest GA for these traits (Table 1). For juice quality traits, NMS and stalk length, the maximum GA was observed under water stress condition. Stalk diameter alone showed the maximum GA under normal condition though the differences under different conditions were not much. These results also indicated that selection would be more effective under abiotic stresses. The GA computed over stresses was the maximum in ratoon crop for sugar and stalk yields and NMS, and in 2nd plant crop for juice quality traits, stalk diameter, stalk length and SSW. Hence, the selection would be effective for various traits in respective crops. The GA estimated over crops and stresses was the maximum for NMS and SSW. The GA estimates over crops, over stresses and over crops and stresses did not vary much for stalk diameter and SSW thereby indicating for their reliability as selection criteria. Stalk diameter was suggested as an efficient selection criterion by many earlier workers [2].

The CR values were greater than predicted response to direct selection for stalk yield under water

Table 1. Estimates of genotypic coefficient of variation (GCV), heritability (h^2) and genetic advance (GA) in 3 crops under 4 abiotic stresses in sugarcane

Environments/crops	Variance	Sugar yield (kg/plot)	Stalk yield (kg/plot)	Pol % (12m)	HR Brix (8m)	NMS/plot	Stalk diameter (cm)	Stalk length (cm)	SSW (kg)
Over crops									
Normal	GCV	17.42	13.27	6.80	7.37	36.07	15.32	7.69	30.00
	h^2	0.21	0.14	0.45	0.45	0.66	0.74	0.28	0.67
	GA	16.50	10.20	9.42	10.20	60.41	27.22	8.33	51.01
Water stress	GCV	24.86	22.94	7.34	8.69	36.28	14.19	9.21	30.12
	h^2	0.29	0.34	0.50	0.62	0.69	0.72	0.37	0.68
	GA	25.13	27.63	10.72	14.08	62.12	24.88	11.52	51.19
Water logging	GCV	16.75	16.25	4.46	7.38	33.00	14.40	7.34	30.85
	h^2	0.19	0.20	0.21	0.57	0.70	0.72	0.25	0.66
	GA	15.08	14.96	4.21	11.49	56.93	25.10	7.51	51.75
Salinity	GCV	27.16	24.86	5.68	7.67	24.93	14.97	8.08	31.80
	h^2	0.41	0.38	0.41	0.42	0.52	0.76	0.31	0.72
	GA	35.93	31.65	7.50	10.25	37.06	26.85	9.30	55.75
Over stresses									
1st plant crop	GCV	20.51	18.04	5.63	7.87	29.53	15.08	7.37	31.94
	h^2	0.36	0.34	0.34	0.57	0.74	0.72	0.40	0.68
	GA	25.45	21.83	6.75	12.21	52.34	26.45	9.55	54.07
Ratoon	GCV	46.80	44.81	6.95	7.05	53.17	14.65	11.00	28.75
	h^2	0.68	0.65	0.46	0.48	0.83	0.72	0.37	0.64
	GA	79.25	74.49	9.71	10.03	99.95	25.60	13.86	47.27
2nd plant crop	GCV	27.68	22.62	8.07	9.75	26.07	14.88	10.07	34.50
	h^2	0.64	0.55	0.70	0.63	0.72	0.80	0.53	0.83
	GA	45.70	34.40	13.87	15.96	45.69	27.38	15.16	64.82
Over crops and stresses									
Population	GCV	23.61	21.40	6.35	7.92	33.50	14.81	8.34	31.24
	h^2	0.34	0.32	0.41	0.52	0.66	0.72	0.32	0.69
	GA	28.46	24.77	8.40	11.74	56.05	25.95	9.70	53.56

stress conditions, for stalk diameter and SSW under water logging conditions, for SSW under saline condition, and for SSW in 1st plant crop (Table 2). Under these situations indirect selection for respective trait would be better than direct selection for sugar yield. Of these traits, indirect selection for stalk diameter under water logging condition is of particular interest as measurements on this trait could be recorded in situ and that too much prior to harvesting. The superiority of indirect selection for sugar content over direct selection has also been reported in sugarcane earlier [3].

Results indicated that selection for juice quality traits would be easier if selection is practiced at an early stage of crop age as higher GCV, heritability and GA values were observed at 8m crop age. The improvement in sugar yield will be faster if sugarcane clones are selected for stalk yield traits namely NMS, SSW and stalk diameter in comparison to selection for juice quality traits. Ram & Hemaprabha [4] also concluded that sugar yield potential of sugarcane clones could be increased by improving the stalk yield maintaining the sucrose % at an acceptable level. The results also indicated the significant importance of stalk diameter and SSW as potential selection criteria.

Table 2. Estimates of correlated response (CR) and response to direct selection for sugar yield in sugarcane

Environments/crops	Response to direct selection	Response to indirect selection through						
		Stalk yield	Pol % (12m)	HR Brix (8m)	NMS/plot	Stalk diameter	Stalk length	SSW
Over crops								
Normal	0.99	0.73	0.64	0.74	−0.42	0.90	0.69	0.93
Water stress	1.20	1.21	0.57	0.37	0.35	0.30	1.00	0.86
Water logging	0.77	0.76	0.27	0.19	−0.36	0.92	0.63	0.98
Salinity	2.04	1.92	0.69	−0.06	−0.37	1.94	1.16	2.25
Over stresses								
1st plant crop	1.49	1.37	0.72	0.48	−0.66	1.43	1.14	1.53
Ratoon	3.34	3.21	0.74	−0.64	2.65	−0.07	2.00	1.00
2nd plant crop	2.79	2.45	1.78	1.32	−1.21	2.08	1.68	2.47
Over crops and stresses								
Population	1.53	1.40	0.73	0.36	0.04	1.04	1.04	1.34

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