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STABILITY ANALYSIS IN SUGARCANE (*SACCHARUM OFFICINARUM* L.)

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ABSTRACT

The current study on the stability analysis of cane yield, sugar yield, and related traits in sugarcane genotypes was conducted using the Eberhart and Russell Model. The results revealed significant differences in all traits, indicating substantial environmental variation and differing genotype responses. Most genotypes displayed significant divergence from regression, suggesting unpredictable responses and better adaptation to optimal conditions. Based on regression coefficient (bi), deviation from regression (Sd²), and overall mean performance (X), the genotype CoVSI 18121 was found to be stable for the number of millable canes, single cane weight and cane diameter and also performing well under favorable conditions for cane yield, commercial cane sugar, CCS %, and sucrose %. Environment-1 showed higher mean values and environmental indices for cane yield, commercial cane sugar, sucrose %, single cane weight, and cane diameter, while environment-3 had higher values for the number of millable canes. There was significant variability between sugarcane varieties and environmental conditions. The genotype CoVSI 18121 demonstrated high mean performance for cane and sugar yields, with a regression value below one for sugar yield and close to one (bi=1) for cane yield, alongside a non-significant deviation from regression (S^2di=0) for both traits across three environments, indicating its stability and adaptability to diverse conditions.

***Keywords*: G x E interaction, Environmental indices, Stability, Sugarcane**

Introduction

Sugarcane is a crucial global crop (Dagar *et al.*, 2002), with cane yield and its traits significantly influenced by environmental factors. Statistical and biometrical methods for estimating stability parameters allow for the evaluation of genotypic responses and adaptability. While techniques for G x E analysis using linear regression can be useful when G x E interactions correlate strongly with environmental indices, significant non-linear components also need consideration (Finley and Wilkinson, 1963; Varma *et al.*, 2007). The Eberhart and Russell model is popular for stability analysis due to its simplicity. Estimating G x E interactions involves complementary procedures based on how genotypes respond in various environments (Singh and Agrawal, 2003). Understanding G x E interactions is essential for assessing the stability of cane yield in genotypes before recommending them for specific conditions (Varma *et al.*, 2013). This study aims to evaluate the stability of cane yield and its traits in promising sugarcane genotypes. G x E interactions complicate the selection and testing of plant genotypes, especially across diverse environments. Measuring these interactions is vital for developing effective strategies for selecting genotypes suited to target environments (Romagosa *et al.*, 1993; De Lacy *et al.*, 1994).

Material and Method

The experimental study includes twelve sugarcane genotypes: CoVSI 13020, CoVSI 11001, VSI 12003, CoVSI 12025, CoVSI 18121, VSI 14050, PDN 13002, PDN 13011, CoM 12085, Co 09004, Co 12008, Co 12009, along with standards Co 86032, CoM 0265, MS 10001 and VSI 08005 and evaluated at three locations from Maharashtra state viz., Shree Tatyasaheb Kore Warana *Sahakari Sakhar Karkhana Limited*, Kolhapur, Vasandada Sugar Institute in Pune, and Karmayogi Ankushrao Tope Samarth *Sahakari Sakhar Karkhana*

Limited, Jalna, Maharashtra, during the season 2020-21 in randomized block design with two replications. The standard practices were implemented to ensure optimal crop growth. Data were collected on cane yield (t/ha), commercial cane sugar (t/ha), commercial cane sugar (%), sucrose (%), number of millable canes (000/ha), single cane weight (kg), and cane diameter (cm). The collected data for each variety were then analyzed to estimate stability parameters for different genotypes according to the Eberhart and Russell model (1966).

Result and Discussion

The pooled analyses of variance for various quantitative and qualitative traits across three locations are summarized in Table 1. The findings indicated significant differences among the tested genotypes at both the 5% and 1% levels of significance for all traits. The pooled deviation was significant for all traits except single cane weight, suggesting that the non-linear component of G × E interaction was dominant. Three stability parameters mean (X), regression coefficient (bi) and mean square deviation from the regression line (S^2di) were calculated for all seven traits with results presented in Table 1. Data on the seven quantitative and qualitative characteristics of sugarcane from the three locations E1: Shree Tatyasaheb Kore Warana *Sahakari Sakhar Karkhana Limited*, Kolhapur; E2: Vasandada Sugar Institute, Pune; and E3: Karmayogi Ankushrao Tope Samarth *Sahakari Sakhar Karkhana Limited*, Jalna were analyzed and the mean, range, and environmental indices for each trait (Table 2)

For cane yield (t/ha), E1 had the highest mean value at 72.19, followed by E3 at 68.51 and E2 at 65.44. The environmental indices varied from -3.27 to 3.48, with cane yield ranging from 66.32 to 107.37 t/ha in E1, 54.45 to 97.53 t/ha in E2, and 61.71 to 103.74 t/ha in E3. In terms of commercial cane sugar (CCS) (t/ha), E1 recorded the highest mean at 10.87 followed by E3 at 9.58 and E2 at 9.06. The environmental indices ranged from -0.77 to 1.03, with CCS values ranging from 9.02 to 16.68 t/ha in E1, 7.68 to 13.71 t/ha in E2 and 8.61 to 15.46 t/ha in E3. For CCS%, significant variation was noted between environments with environmental indices ranging from -0.23 to 0.41 and means from 7.40 to 8.03. The CCS% varied from 9.37 to 10.98% in E1, 8.71 to 9.68% in E2 and 8.10 to 10.14% in E3. Regarding sucrose %, environmental indices ranged from -0.25 to 0.42 and the means spanned from 10.44 to 11.12%. The sucrose % varied from 13.01 to 15.12% in E1, 12.42 to 13.66% in E2 and 11.51 to 14.11% in E3. For the number of millable canes (000/ha), environmental indices and means ranged from -1.25 to 1.18 and 39.55 to 41.97 (000/ha), respectively. The number of millable canes ranged from 44.02 to 56.22 (000/ha) in E1, 40.39 to 56.93 (000/ha) in E2, and 49.11 to 56.62 (000/ha) in E3. The variation in single cane weight (kg) was observed across different environments with environmental indices ranging from -0.03 to 0.05 and means varying from 0.87 kg to 0.95 kg. The range for this trait was 0.98 to 1.37 kg in E1, 0.92 to 1.31 kg in E2, and 0.85 to 1.40 kg in E3.

For cane diameter (cm), the highest mean value of 1.69 cm was recorded in E1, followed by E2 at 1.65 cm and E3 at 1.64 cm. Environmental indices for this trait ranged from -0.02 to 0.03 which ranges of 1.81 to 2.29 cm in E1, 1.85 to 2.21 cm in E2, and 1.89 to 2.31 cm in E3. Environment 1 showed higher mean values and environmental indices for cane yield (t/ha), commercial cane sugar (t/ha), sucrose %, single cane weight (kg), and cane diameter (cm), while the number of millable canes (000/ha) had higher means and indices in E 3. Pooled analysis of stability revealed significant differences in genotypes and environments for all traits studied. According to Eberhart and Russell (1966), genotype stability is based on three parameters: genotypic mean (X), regression or linear response (bi), and deviation from linearity (S^2di). An ideally stable genotype exhibits a high mean value (>gi), a unit regression coefficient (bi=1), and no deviation from linearity ($S^2di=0$). The estimates for mean performance (X), regression coefficient (bi), and deviation from regression (S^2di) are presented in Table 3. For stability assessment, the three parameters viz., grand mean across environments (X), unit regression coefficient (bi=1) and squared deviation from regression ($S^2di=0$) were used to identify stable performance. The stability parameters for both quantitative and qualitative traits are detailed in Table 3. For cane yield (t/ha), among the 16 varieties tested across three locations, CoM 0265 had the highest yield at 102.15 t/ha, followed by CoVSI 18121 at 100.23 t/ha and Co 12009 at 100.14 t/ha. The average yield across the environments was 68.71 t/ha. Varieties CoVSI 12025, MS 10001, and VSI 14050 showed mean values above the grand mean with regression coefficients less than one (bi=1) and non-significant deviations from regression, indicating stability in less favorable environments. In contrast, varieties like Co 12008 (bi=1.1), VSI 08005 (bi=1.12), CoM 0265 (bi=1.462), CoVSI 18121 (bi=1.463), Co 09004 (bi=1.567) and CoM 12085 (bi=1.983) had bi values greater than one and performed better in favorable conditions though three showed significant deviations from regression. For commercial cane sugar (CCS) (t/ha), Co 12009 recorded the highest at 14.92 t/ha, followed by CoVSI 18121 at 14.82 t/ha and CoM 0265 at 13.70 t/ha, with an average of 9.84 t/ha. The varieties MS 10001 and Co 12008 had mean values above the grand mean, with regression coefficients less than one, suggesting they are stable in less favorable conditions. Conversely, CoVSI 12025 (bi=1.348), CoVSI 18121 (bi=1.597), CoM 12085 (bi=1.801), and Co 09004 (bi=1.923) performed well in favorable conditions with bi values greater than one, though five showed significant deviations from regression. For CCS%, CoVSI 12025 led with 10.18%, followed by MS 10001 at 10.12%, Co 09004 at 10.01% and CoVSI 18121 with an average of 7.62%. Varieties CoVSI 13020 and PDN 13011 had higher mean values than the grand mean, with regression coefficients below one, indicating stability in unfavorable environments. On the other hand, CoVSI 12025 (bi=1.999), CoVSI 18012 (bi=1.433), Co 09004 (bi=2.247), and Co 12008 (bi=1.015) were expected to perform well in favorable conditions with eight varieties showing significant deviations from regression. For sucrose % in juice, CoVSI 12025 had the highest at 14.18%, followed by MS 10001 at 14.10%, CoVSI 18121 at 13.71%, and CoM 12085 at 13.42%. The varieties CoVSI 13020 and Co 12008 had mean values above the grand mean with regression coefficients below one, indicating stability in less favorable conditions. Meanwhile, CoVSI 18121 (bi=1.487) and CoM 12085 (bi=1.578) performed well in favorable environments, with nine varieties showing significant deviations from regression. For the number of millable canes (000/ha), Co 86032 had the highest count, followed by Co 12009 and PDN 13002 with an average of 40.80 (000/ha). The varieties PDN 13002, PDN 13011, CoVSI 18121, VSI 14050, CoM 0265, and MS 10001 showed higher mean values than the grand mean with regression coefficients below one, indicating stability in unfavorable environments. Conversely, VSI 08005 (bi=2.099), CoM 12085 (bi=2.455), Co 12008 (bi=2.222), Co 09004 (bi=3.375), CoVSI 12025 (bi=3.943) and CoVSI 13020 (bi=5.156) had higher mean values and performed well in favorable conditions. For single cane weight (kg), CoM 0265 had the highest weight at 1.35 kg followed by CoVSI 18121 at 1.32 kg and VSI 08005 at 1.30 kg with an average of 0.91 kg. The varieties CoVSI 18121, CoM 12085, VSI 14050, and PDN 13011 showed higher mean values than the grand mean with regression coefficients less than one, indicating stability across environments. In contrast, Co 09004 (bi=1.312), Co 12008 (bi=1.402), MS 10001 (bi=1.433), VSI 08005 (bi=1.469), and PDN 13002 (bi=2.654) performed better in favorable conditions, with six varieties exhibiting significant deviations from regression. For cane diameter (cm), among the 16 varieties tested across three locations, CoVSI 18121 recorded the highest measurement at 2.26 cm, followed by CoM 0265 at 2.19 cm and VSI 08005 at 2.16 cm. The average diameter across the environments was 1.66 cm. Varieties CoVSI 18121 and MS 10001 had mean values above the grand mean, with regression coefficients below one (bi=1) and non-significant deviations from regression, indicating stability in unpredictable locations and better performance in unfavorable environments. In contrast, CoVSI 12025 (bi=1.379), PDN 13002 (bi=1.506), VSI 08005 (bi=2.115), and CoVSI 13020 (bi=3.524) had bi values greater than one, suggesting they would perform well in favorable conditions, although deviations from regression were significant for six varieties.

These findings align with previous research by Falconer (1966), Pollock (1975), Ruschel (1978), Galvez (1980), Tai *et al.* (1982), Kang and Miller (1984), Kumar *et al.* (2004), Kimberg *et al.* (2009), Tiwari *et al.* (2011), Imtiaz *et al.* (2013), Mohammad *et al.* (2013), Guddaamath *et al.* (2014), and Koli *et al.* (2016) regarding various sugarcane genotypes.

Tables 1: Pooled analysis of variance for stability of seven qualitative and quantitative characters related to yield in sugarcane over locations

Source	df	CY (t/ha)	CCS (t/ha)	CCS%	Sucrose%	NMC	SCW	CD
Genotypes	19	4125.78**	85.82**	46.46**	91.22**	1341.58**	0.69*	2.19*
Environment	2	228.37**	17.28**	2.49**	2.72**	29.56**	0.03*	0.01*
E+(V x E)	40	29.82**	1.71**	0.24**	0.31**	8.51**	0.00*	0.01*
Variety x Environment	38	19.37**	0.89**	0.12*	0.18**	7.40**	0.00*	0.01*
Environment (linear)	1	456.74**	34.55**	4.99**	5.44**	59.13**	0.07*	0.03*
Variety x Environment (linear)	19	14.38**	0.94**	0.16*	0.19**	11.70**	0.00*	0.01*
Pooled Deviation	20	23.14**	0.80**	0.08*	0.16*	2.95	0.00*	0.01*
Pooled error	114	11.11	0.26	0.01	0.02	4.35	0.00	0.00

*Significant at $P \leq 0.05$ level of significance, **Significant at $P \leq 0.01$ level of significance

CY- cane yield (t/ha), CCS (t/ha)- commercial cane sugar (t/ha), CCS % - commercial cane sugar percent, sucrose %- sucrose percent in juice, NMC- number of millable canes (000/ha), SCW- Single cane weight (kg) and CD- Cane diameter (cm)

Table 2: Summary of mean, range and environment index values in respect of seven traits across three environments in 16 sugarcane genotypes

Characters	Mean			Range			Enviromental index		
	Env. 1	Env. 2	Env. 3	Env. 1	Env. 2	Env. 3	Env. 1	Env. 2	Env. 3
CY(t/ha)	72.19	65.44	68.51	66.32 -107.37	54.45-97.53	61.71-103.74	3.48	-3.27	-0.21
CCS (t/ha)	10.87	9.06	9.58	9.02 -16.68	7.68-13.71	8.61 -15.46	1.03	-0.77	-0.26
CCS%	8.03	7.40	7.44	9.37 –10.98	8.71-9.68	8.10 -10.14	0.41	-0.23	-0.18
Sucrose %	11.12	10.52	10.44	13.01 -15.12	12.42-13.66	11.51-14.11	0.42	-0.17	-0.25
NMC	40.87	39.55	41.97	44.02 -56.22	40.39-56.93	49.11-56.62	0.07	-1.25	1.18
SCW	0.95	0.90	0.87	0.98 –1.37	0.92-1.31	0.85 -1.40	0.05	-0.01	-0.03
CD	1.69	1.65	1.64	1.81 –2.29	1.85-2.21	1.89 -2.31	0.03	-0.01	-0.02

CY- cane yield at harvest (t/ha), CCS (t/ha)- commercial cane Sugar (t/ha), CCS % - commercial cane sugar percent at harvest, sucrose %- sucrose Percent in juice, NMC- number of millable canes (000/ha), SCW- single cane weight (kg) and CD- cane diameter (cm)

Env.1- Shree Tatyasaheb Kore Warana *Sahakari Sakhar Karkhana Limited*, Kolhapur **Env.2-** Vasandada Sugar Institute, Pune **Env.3**- Karmayogi Ankushrao Tope Samarth *Sahakari Sakhar Karkhana Limited*, Jalna.

Table 3 : Stability parameters for qualitative and quantitative characters related to yield in sugarcane over locations

Genotypes	Cane yield(t/ha)			CCS (t/ha)			CCS%		
	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
CoVSI 13020	66.13	1.597	198.909**	9.55	0.77	4.758**	9.62	0.625	-0.008
CoVSI 11001	90.97	1.634**	15.186	12.31	1.397**	-0.051	8.98	0.967**	-0.007
VSI 12003	76.35	2.316*	32.228	10.94	1.472*	1.200**	9.54	0.929*	0.001
CoVSI 12025	69.08	0.938	-11.054	10.58	1.348	-0.229	10.18	1.999	0.075*
CoVSI 18121	100.23	1.463	-10.731	14.82	1.597	-0.209	9.84	1.433	-0.011
VSI 14050	76.42	-0.354	-11.105	9.49	-0.546	-0.085	8.27	-0.705	0.151**
PDN 13002	93.75	2.086	81.257**	13.56	1.889	2.455**	9.60	1.207	0.066*
PDN 13011	79.28	0.594	32.921*	10.92	1.005	3.610**	9.13	1.674	0.734
CoM 12085	99.97	1.983	-10.951	14.17	1.801	-0.113	9.50	1.663	0.025**
Co 09004	84.13	1.567	-10.710	12.67	1.923	-0.227	10.01	2.247	0.015
Co 12008	64.14	1.1	-3.823	9.11	0.992	-0.158	9.45	1.015	-0.013
Co 12009	100.14	1.389**	-8.773	14.92	1.804**	-0.070	9.91	1.842**	0.046*
MS 10001(std.)	87.07	0.511	-8.423	13.21	0.893	-0.257	10.12	1.053	0.069*
Co 86032(std.)	84.85	0.596**	-6.596	12.02	1.191**	-0.127	9.44	1.661**	-0.010
CoM 0265(std.)	102.15	1.462	-10.976	13.70	1.226	0.023	8.97	1.169	0.105**
VSI 08005(std.)	99.60	1.12	17.679	14.77	1.235	1.357*	9.87	1.224	0.131**
Pooled Mean	68.71			9.84			7.62		

Table 3: Contd.…

Genotypes	Sucrose %			NMC(000/ha)			SCW		
	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
CoVSI 13020	13.45	0.615	0.006	45.84	5.156	2.953	0.98	0.777	0.004*
CoVSI 11001	12.65	0.819**	-0.008	51.44	-1.198**	-2.421	1.21	1.658**	0.006**
VSI 12003	13.40	1.049*	0.036	50.59	4.052*	3.712	1.03	2.811*	0.000
CoVSI 12025	14.18	2.124	0.208**	45.04	3.943	-4.330	1.03	1.889	0.013**
CoVSI 18121	13.71	1.487	-0.022	51.92	0.579	-3.739	1.32	0.824	-0.001
VSI 14050	11.82	-0.79	0.557**	50.26	-1.566	-1.587	1.07	-0.248	0.000
PDN 13002	13.48	1.188	0.102*	55.58	0.17	-2.500	1.13	2.654	0.000
PDN 13011	12.88	1.89	1.201**	53.28	-1.478	5.362	1.03	0.024	0.001
CoM 12085	13.42	1.578	-0.012	54.04	2.455	1.625	1.24	1.006	0.000
Co 09004	13.96	2.355	0.082*	49.98	3.375	-2.675	1.12	1.312	0.003*
Co 12008	13.25	0.853	-0.022	46.77	2.222	-3.980	0.93	1.402	0.002*
Co 12009	13.92	1.88**	0.067*	55.85	1.602**	6.136	1.20	2.269**	0.001
MS 10001(std.)	14.10	0.963	0.113*	48.23	-0.116	0.826	1.22	1.433	0.000
Co 86032(std.)	13.21	1.775**	-0.012	55.96	-0.778**	-4.348	1.01	0.733**	0.000

CoM 0265(std.)	12.65	1.148	0.287**	51.00	-0.517	-1.273	1.35	-0.014	0.009**
VSI 08005(std.)	13.80	1.07	0.274**	50.15	2.099	-4.318	1.30	1.469	0.001
Pooled Mean	10.69			40.80			0.91		

Table 3: (Contd.)…

Genotypes	Diameter (cm)		
	Mean	bi	S^2di
CoVSI 13020	2.05	3.524	-0.002
CoVSI 11001	2.15	3.834**	0.007
VSI 12003	2.07	4.798*	0.000
CoVSI 12025	2.00	1.379	0.001
CoVSI 18121	2.26	-0.426	0.003
VSI 14050	2.04	-0.15	0.026**
PDN 13002	2.09	1.506	0.007
PDN 13011	2.05	1.864	0.008*
CoM 12085	2.00	1.9	0.028**
Co 09004	2.00	0.859	0.018**
Co 12008	1.90	-2.024	0.009*
Co 12009	2.13	1.641**	-0.002
MS 10001(std.)	2.04	-5.274	0.006
Co 86032(std.)	2.04	2.98**	-0.002
CoM 0265(std.)	2.19	1.474	0.010*
VSI 08005(std.)	2.16	2.115	0.005
Pooled Mean	1.66		

Conclusion

There was significant variability among the sugarcane varieties and their environments with considerable interaction between the varieties and environmental conditions. Based on the regression coefficient (bi), deviation from regression (Sd^2), and overall mean performance (X), the genotype CoVSI 18121 was found to be stable in terms of the number of millable canes, single cane weight, and cane diameter. It also performed well under favorable conditions for cane yield (t/ha), commercial cane sugar (t/ha), CCS%, and sucrose% in juice at harvest, indicating its effectiveness across different environments. To identify sugarcane genotypes with superior yield and desirable traits across varied conditions, a breeding program should incorporate stability analysis, testing of advanced breeding materials and evaluation of G × E interactions.

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References

Dagar, P., Pahuja, S.K., Kadian, S.P. and Singh, S. (2002) Evaluation of phenotypic variability in sugarcane using principal factor analysis. *Indian Journal of Sugarcane Technology* **17**:95-100.

De Lacy, I.H., Fox, P.N., Corbett J.D., Crossa, J., Raaram, S., Fischer, R. A., Van Ginkel, M. (1994) Long-term associations of locations for testing spring wheat. *Euphytica* 72:95- 106.

Eberhart, S.A. and Russell, W.L. (1966) Stability parameters for comparing varieties. *Crop Sci*. **6**:36-40.

Falconer, D.S. (1966) Comments o heritability and repeatability. *Int.Soc. Sugar Cane Technol*. Sugarcane Breed. Newsl. **18**: 15-17

Finley, K.W and Wilkinson G.E. (1963) The analysis of adaptation in a plant breeding programme. *Australian J. of Agric. Res.* **14**: 742-54.

Galvez, G. (1980) The genotype-environment interaction in experiments of sugarcane variety trials (*Saccharum* spp.): comparision of three stability methods. Pp. 1152-1160. In M. B. Lopez and C. M. Madrazo (ed.) Proc. XV11 Congr. *Int. Soc. Sugar Cane Technol.*, Manila, Philippines. 1-11 Feb. 1980. Int. Soc. of Sugar Cane Technol.

Guddaamath, S.G., Patel, S.B. and Khadi, B.M. (2014) Stability and regression analysis in elite genotypes of sugarcane (S. spp. varieties complex). *African J. of Agric. Res.* **9** (37): 2846-2853.

Imtiaz, A.K., Nighat, S., Raza, S., Yasmine, S. and Sajida, B. (2013) Environmental interaction of sugarcane genotype and yield stability analysis of sugarcane. *Pak. J. of Bot.* **45** (5): 1617-1622.

Kang, M.S. and Miller J.D. (1984) Genotype X Environment Interactions for Cane and Sugar Yield and their implications in Sugarcane Breeding. *CROP SCIENCE*, vol. 24, May-June 1984

Kimberg, C. A., Zhoul, M. M. and Dasiuva, J.A. (2009) Genotype X environment interaction and resources allocation in sugarcane yield traits in the Rio-Grande valley region of *Texas.J. of American Society* of Sugarcane technologist **29:**11-24.

Koli, N.R., Bagri, R.K., Meena, B.S. and Kumhar, B.L. (2016) Studies on stability parameter and sustainability index for selecting stable genotypes of sugarcane (Saccharum officinarum L.). *Electronic Journal of Plant Breeding* **10**.5958/0975-928X.2016.00018.1

Kumar, S, Sigh PK, Singh J and Swapna M. G x E interaction analysis for quantitative traits in sugarcane. *Indian Sugar*. 2004 **13** (10): 813-818.

Mohammad, T., Hidayatur, R., Amjad, A., Sajjad, A. and Mohammad, K. (2013) Assessment of Genotype x Environment Interaction and Stability of Promising Sugarcane Genotypes for Different Agronomic Characters in Peshawar Valley. *American journal of Experimental Agriculture* **3**(1): 142-151.

Pollock, J.S. (1975) Selection consequences of differential performance of standard clones across environment. *Int. Soc. Sugar Cane Technol*. Sugarcane Breed. Newsl **35**: 36-39.

Romagosa, I., Fox P.N., Garcia, del Moral, L.F., Ramos, J.M., Garcia, del Mora, B., Roca de Togores, F., Molinacano, J.L. (1993) Integration of statistical and physiological analyses of adaptation of near-isogenic barley lines. *Theor. Appl. Genet*. 86: 822-826.

Ruschel, R. (1978) Phenotypic stability of some sugarcane varieties (*Saccharum* spp.) in Brazil. *Int. Soc. Sugar Cane Technol.*

Singh, P. and Agarwal, D.K. (2003) Sustainability index as an aid for determining the genotypic stability in diploid cotton. *Journal of Cotton Research and Development* **17** (1): 90-2.

Tai, P.Y., Rice, E. R. and Miller, J.D. (1982) Phenotypic stability analyses of sugarcane cultivar performance tests. *Crop Sci.* **11**: 184-190.

Tiwari, D.K., Panday, P., Singh, R.K., Singh, S.P. and Singh, S.B. (2011) Genotype x environment interaction and stability analysis in elite clones of sugarcane (*S. officinarum* L.).*International J. of Plant Breeding & Genetics* **5** (1): 93-98.

Verma, S.K, Tuteja, O.P., Koli, N.R., Singh, J., Niwas, R, and Monga, D. (2007) Assessment of genotype x environment interaction for diverse set of cotton (*G. arboretum* L.) of various eco-geographic regions evaluated under North Indian conditions. *Indian J. of Agric.Sci.* **77** (4): 258-60.