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Studies on stability parameter and sustainability index for selecting stable genotypes of sugarcane (*Saccharum officinarum* L.)

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Abstract
A comparative studies on stability parameters and sustainability index for selecting stable genotypes of sugarcane was carried out according to Eberhart and Russell Model, with sustainability index model. Stability analysis was carried out with seven sugarcane genotypes for cane yield (t/ha), CCS (t/ha), CCS % juice, brix (%), sucrose (%) and single cane weight (kg) at maturity stage (300 Days) on three year data viz; 2010-11 to 2012-13. Based on the linear component (bi), non-linear response (s^2di) and high mean performance (X) the genotypeCoH07261 and Co 06032 were found stable for cane yield (t/ha) and CCS yield(t/ha), whereas Co 07025 was found stable for CCS % juice,brix %,sucrose % and single cane weight (kg.) and high sustainability index of more than 90 % indicated that these traits are least influenced by the environmental factors.
Keywords: Stability parameter, sustainability index, cane yield and *Saccharum officinarum* L.

Cane yield and its component traits are highly affected by the environments. With the statistical and biometrical techniques developed to estimate stability parameters, it would be possible to determine genotypic response for wider adaptability. Techniques for GE analysis based on linear regression can be informative when GE interaction has high linear association with the environmental index but when the non linear component is also significant. (Finley and Wilkinson 1963 and Varma *et al2007*). The analysis based on Eberhart and Russell model being relatively simple has been widely used for stability analysis. Estimation of GE interaction consists of complementary procedures classification and grouping the genotypes according to their response in different environments (Singh and Agrawal 2003). Genotype and environment interaction is important in understanding the stability in cane yield of a particular genotype before is being recommended for a given situation (Varma*et al* 2013). The present investigation was therefore conducted to find out the stability for cane yield and its component traits of promising sugarcane genotypes.

The experimental material consisted of seven sugarcane genotypes namely, Co 06032, Co 07023, Co 07025, CoH07261, CoLk07201,CoJ 64 &Co Pant 84211 (CoJ64 &Co-Pant84211 used as checks) andwere evaluated at Agricultural Research Station, Ummedganj, Kota, Rajasthan during 2010-11- to 2012-13 in randomized block design with three replications. Recommended package of practices were followed to raise good crops. The data were recorded on cane yield (t/ha), CCS (t/ha), CCS (%) juice,brix (%), sucrose (%) and single cane weight (kg). The cane yield was recorded on plot basis and was estimated in tonnes/ha. The three year data on each variety were used for estimation of stability parameters of different genotypes as per Eberhart and Russell model (1966). The sustainability index was estimated according to following formula used by other workers (Gangwar *et al*., 2004 and Verma *et al* 2013).

Sustainability index =Average performance of a genotype –Standard Deviation X 100
Best performance of a genotype in any year

The value of sustainability index were arbitrarily divided in to five group *viz*. very low (up to 45%), low (46– 60 %), moderate (61-75%), high (76-90) and very high (above 90%).

Pooled analysis of stability indicated that, genotype and environmental differed significantly for all the traits studied. Eberhart and Russel (1966) discussed the stability of a genotype depends on three parameters namely, genotypic mean (X), regression or linear response (bi) and deviation from the linearity (S^2di). According to this model an ideally stable genotype is one that confirms high mean value (>gi), unit regression or linear response (bi=1) and no deviation from the linearity (S^2di = 0). The estimates of mean performance (x), regression coefficient (bi) and deviation from regression ((S^2di) are presented in Table-1. Considering the stability of a genotype, the three parameters *viz*, grand mean over the environments(x), unit regression coefficient (bi=1) and squared deviation from the regression (S^2di = 0) were considered stable in performance. The

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genotype CoH07261 and Co 06032 were found stable for both cane yield (t/ha) and CCS (t/ha). None of the genotypes was found stable for CCS (%) juice.The genotype Co 07025 exhibited better performance with bi< 1.0 indicating bellow average responsiveness for poor environments.

For Brix (%) the genotype CoH07261 was also found stable, having unity regression and non-significant deviation from the regression, while the genotype CoLk07201 had regression less than unity but deviation from regression was non significant indicating that the genotypes might also be considered as stable for poor environments. For sucrose (%) and single cane weight (kg), the genotype Co 07025 and CoLk07201 were found stable with unity regression and non-significant deviation from regression. Similar results have been reported for stability in sugarcane yield by many workers (Kimberg *et al* 2009 and Tiwari *et al* 2011).

The estimates of sustainability index analysis of variance for cane yield and other related traits revealed significant genetic variability among the genotypes under study. The genotype CoH07261 recordedthe highest cane yield (84.62t/ha) with very high sustainability index of 94.20 % indicating the best performance of this genotype (Table-2). The best performance coupled with high value of sustainability index could be taken as the indication of close relationship between the best performance and the average performance over the years. The second best genotypes was Co 06032 recorded mean cane yield of 80.19 t/ha and sustainability index of 92.08 % indicating better performance. For CCS % juice the genotype Co 07025 hasthe highest mean value of 11.90 as well as sustainability index of 91.06 %. The other stable genotypes were CoH07062 and Co 06032. For Brix % sucrose % and single cane weight (kg) all the genotypes recorded higher sustainability index which indicated that, this character are least influenced by the environmental factors.

On the basis of best performance and high sustainability index the genotypes CoH07261, Co 06032 and CoLk07025 were found to be consistence over the years and quality traits are least affected by the environmental factors. Similar findings were earlier reported by Imtiaz *et al (*2013), Kumar et al (2004) and Guddadamath *et al* (2014) in sugarcane.

The comparative study ofEberhart & Russell model and sustainability index model indicated that, the genotypes CoH07261 and Co 06032 were found to be stable for cane yield based on the linear components (bi), non-linear response (S^2di), high mean values and high sustainability index. These genotypes may be considered for cultivation so that sugarcane productions can enhanced in the South-Eastern Plain Zone of Rajasthan for realizing higher yield.

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Table 1- Estimates of stability parameters of cane yield and its components in sugarcane.

Genotype	Cane yield (t/ha)			CCS (t/ha)			CCS (%) Juice			Brix (%)			Sucrose (%)			Single cane weight (kg)		
	Mean	bi	$S^{-2}di$	Mean	bi	$S^{-2}di$	Mean	bi	$S^{-2}di$	Mean	bi	$S^{-2}di$	Mean	bi	$S^{-2}di$	Mean	bi	$S^{-2}di$
Co 06032	80.19	0.81	-0.8	9.65	1.11	-0.1	11.80	0.46	-1.0	19.76	0.79	0.00	17.22	0.78	0.0	0.98	0.58	0.0
Co 07023	73.57	2.57*	2.5	8.14	1.47*	-0.1	9.99	2.44*	-0.3	18.80	1.26*	-0.1	16.31	1.11	0.0	0.91	0.46	0.0
Co 07025	79.98	1.46	1.7	9.51	-0.15	1.1	11.90	0.24	-0.8	20.09	1.68*	0.0	17.39	0.91	0.1	1.06	1.00	0.0
CoH07261	84.62	1.21	0.7	10.39	0.92	0.1	11.75	0.62	-1.1	20.28	1.16	0.2	17.29	1.15	0.1	1.10	1.07*	0.0
CoLk07201	79.06	-1.59	5.0*	9.37	1.28	-0.1	1.86	0.24	-0.7	19.94	-0.47	-0.1	17.31	1.04	0.0	1.06	0. 23	0.0
CoJ64	69.74	3.95*	2.9	7.96	2.27*	-0.1	10.35	2.63*	0.4	19.51	1.95*	0.3	16.78	0.90	0.1	0.858	1.67*	0.0
CoPant84211	73.49	-1.42	5.5*	8.68	0.09	0.4	11.60	0.35	-0.7	19.67	0.61	-0.1	16.97	1.08	0.0	0.961	1.32*	0.0
Pooled mean	77.24			9.10			11.32			19.72			17.04			0.992		
Standard Error	1.27			0.36			0.48			0.24			0.17			0.01		

*= Significant at 0.05 probability

Table: 2- Estimates of sustainability index of cane yield and its components in sugarcane.

Genotype	Cane yield (t/ha)				CCS (t/ha)				CCS (%) Juice			
	Mean	Õn	Y_M	Sustainability index (%)	Mean	Õn	Y_M	Sustainability index (%)	Mean	Õn	Y_M	Sustainability index (%)
Co 06032	80.19	2.52	84.35	92.08	9.65	0.767	10.45	85.05	11.80	0.52	12.98	86.95
Co 07023	73.57	3.68	79.84	87.54	8.14	0.572	9.24	81.96	9.99	3.37	12.26	54.11
Co 07025	79.98	1.67	87.25	89.75	9.51	0.525	10.95	82.07	11.90	0.49	12.54	91.06
CoH07261	84.62	4.23	85.34	94.20	10.39	0.851	11.00	86.79	11.75	0.72	13.12	84.08
CoLk07201	79.06	3.46	84.51	89.45	9.37	0.462	10.96	81.72	11.86	0.53	12.92	87.71
CoJ64	69.74	4.36	77.05	84.86	7.96	0.882	9.67	73.23	10.35	3.59	13.02	51.95
CoPant84211	73.49	3.01	79.45	88.71	8.69	0.531	10.01	81.01	11.60	0.45	12.28	90.85
Pooled mean	77.24				9.10				11.32			

Genotype	Brix (%)				Sucrose (%)				Single cane weight (g)			
	Mean	Õn	Y_M	Sustainability index (%)	Mean	Õn	Y_M	Sustainability index (%)	Mean	Õn	Y_M	Sustainability index (%)
Co 06032	19.76	0.55	20.5	93.74	17.22	0.44	18.1	92.73	0.98	0.06	1.05	87.86
Co 07023	18.80	0.50	19.53	93.74	16.31	0.51	17.42	90.69	0.91	0.07	1.02	82.62
Co 07025	20.09	0.42	20.7	95.08	17.39	0.51	18.12	93.15	1.06	0.06	1.15	87.72
CoH07261	20.28	0.84	22.19	87.61	17.29	0.57	18.55	90.17	1.10	0.10	1.21	82.97
CoLk07201	19.94	0.29	20.34	96.62	17.31	0.60	18.45	90.59	1.06	0.06	1.15	86.85
CoJ64	19.51	0.61	20.2	93.57	16.78	0.52	17.94	90.68	0.86	0.07	0.96	82.39
CoPant84211	19.67	0.39	20.2	95.48	16.97	0.49	17.63	93.50	0.96	0.06	1.05	85.71
Pooled mean	19.72				17.04				0.99			