

Original Research Article

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## Stability Analysis for Quantitative Traits in Sugarcane (*Saccharum officinarum*)

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### ABSTRACT

The experimental material comprising of seven varieties viz., Co 05009, CoH 05262, CoH 05265, CoLk 05201, CoPk 05191, CoJ64(s) and CoPant84211(s) were grown in randomized block design with three replications, in three environments at Agriculture Research Station Ummedganj, Kota North west zone, India during 2009 to 2011. Mean squares due to genotypes were highly significant for tillers population (ha), NMC (ooo ha), cane length (m), cane diameter (cm), single cane weight (kg), yield (t/ha), brix at 300 days, ccs (t/ha) and brix at 250 days. However, Extraction % and Sucrose % at 240 days were no significant. Variety CoPk 05191 was found stable for NMC (‘000 h), yield (t/ha) traits, except Tillers Population(ha), Cane Length (M), Cane Diameter (cm), Single Cane Weight (kg), Extraction (%), BRIX% at 240 Days, BRIX% at 300 Days, Sucrose % at 240 Days and CCS (t/ha), variety CoH 05265 was found stable for Cane Diameter (cm) and Single Cane Weight (kg) traits, except Tillers Population(ha), NMC (‘000 h), Cane Length (M), Extraction (%), yield(t/ha), BRIX% at 240 Days, BRIX% at 300 Days, Sucrose % at 240 Days and CCS (t/ha) while, variety CoH 05262, was also found stable for Cane Diameter (cm) except remaining traits. Hence, these CoPk 05191 CoH 05265 and CoH 05262, promising lines could be recommended for commercial cultivation or could be suitability used in further improvement programme.

#### Keywords

Stability, G x E interactions, Quantitative traits, Sugarcane (*Saccharum officinarum*).

#### Article Info

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### Introduction

The modern *Saccharum* spp. (cultivated sugarcane) is originated from complex hybridization events between *Saccharum officinarum*, *S. Spontaneum*, *S. barberi*, *S. sinense* and the related species (Sreenivasan *et al.*, 1987). India is the second last producer of sugar after Brazil. It is propagated vegetatively for commercial planting by stem cuttings called ‘sets’. Seed production of an elite sugarcane cultivar in sufficient quantity for planting in a vast area generally takes 10-15 years if multiplied through conventional

methods of seed multiplication. Sugarcane is grown extensively in India. The crop occupies over 50.55 lakh hectares in the country with a production of 3481.87 lakh tonnes, of which 66% is concentrated in the northern states. Sugarcane in India is processed in to sugar, jaggery and *khandsari*. It forms an important item of Indian diet as a sweetening agent. White sugar contains mainly sucrose (99.70%), where as jaggery has less sucrose (51.00%) but it contains protein (0.25%), glucose (21.20%) and minerals (3.40%) in

addition to traces of fats (0.02 to 0.03%), calcium (0.39%), vitamin A, vitamin B, phosphate. Sugarcane is an important and assured crop in tropical and subtropical India and the environment is always erratic in these tropics. This is need to breed genotypes for wide range of environments. Hence, knowledge of genotype x environment interactions is essential for such breeding programme, because potentiality of a genotype and stability of its performance can be judged by multi environmental test. Therefore, present experiment was undertaken to assess the stability of performance of varieties of sugarcane under three different environments (years).

### **Materials and Methods**

The experimental material comprising of seven varieties *viz.*, Co 05009, CoH 05262, CoH 05265, CoLk 05201, CoPk 05191, CoJ64(s) and CoPant84211(s) were grown in randomized block design with replicated thrice at Research Station Ummadganj, Kota North west zone, India during 2009 to 2011. Each treatment plot comprised 4 rows of 6 m length spaced at 75 cm apart. The recommended agronomic packages of practices were followed to raise good fresh as well as ratoon crops. The observations were recorded for tillers population (ha), NMC ('000 h), Cane Length (M), Cane Diameter (cm), Single Cane Weight (kg), Extraction (%), yield(t/ha), BRIX% At 240 Days, BRIX% At 300 Days, Sucrose % At 240 Days and CCS (t/ha). Phenotypic stability was estimated as per method given by Eberhart and Russells (1966).

### **Results and Discussion**

The pooled analysis of variance for phenotypic stability (Table 1) revealed that the mean squares due to genotypes were highly significant for tillers population (ha),

NMC (ooo ha), cane length (m), cane diameter(cm), single cane weight (kg), yield (t/ha), brix at 300 days, ccs (t/ha) and brix at 250 days. However, Extraction % and Sucrose % at 240 days were non significant indicating the presence of variability in the genotypes for the traits under study. The genotype x environment interaction was significant for cane length(m), yield (t/ha) and ccs (t/ha), while remaining traits were non significant. Queme *et al.*, (2005) also reported that variance due to environment, genotype and GxE interactions were highly significant for cane yield, sucrose (%) and sugar yield.

The environment linear components of variance were highly significant for all the traits, except the Sucrose % at 240 days was non significant indicating that macro environmental differences were present under all the three environments. The mean squares due to linear component *i.e.* genotype x environment linear were significant for tillers population (ha), Cane length (M), cane diameter (cm), single cane weight (kg), yield (t/ha) and highly significant for ccs (t/ha) the traits. Mean squares due to pooled deviations (non-linear) were non significant for tillers population (ha), NMC (oooha), cane length (M), cane diameter (cm), single cane weight (kg), yield (t/ha), brix at 240 days, brix at 300 days, ccs (t/ha) and Extraction % traits. However, it was highly significant for Sucrose % at 240 days.

This suggested that both linear and non-linear components played important role in building up of total genotype x environment interactions for these traits. The significant mean squares due to pooled deviations for Sucrose % at 240 days trait indicated that genotypes differed considerably with respect to their stability and the prediction for this trait would be difficult. Kumar *et al.*, (2007) reported significant GxE (linear) for cane yield and sugar yield.

**Table.1** Pooled analysis of variance for genotype x environment interactions for different traits in sugarcane

Source of variation	d.f	Mean Sum of Squares										
		Tillers Population (000 ha)	NMC ('000 ha)	Cane Length (M)	Cane Diameter (cm)	Single Cane Weight (kg)	Extractio n (%)	Yield (t/ha)	BRiX% At 240 Days	BRiX% At 300 Days	Sucrose %At 240Days	CCS (t/ha)
Rep within Env.	6	21.32	16.02	41.43	0.001	0.003*	0.37	13.63	0.05	0.02	0.03	0.21*
Varieties	6	103.86**	131.56**	1093.40**	0.04**	0.03**	0.81	262.05**	0.16*	0.28**	0.26	4.16**
Env.+ (Var.x Env.)	14	814.25**	305.55**	2210.09**	0.12**	0.05**	1.03	513.39**	0.14*	0.08	0.16	8.07**
Environments	2	5580.87**	2070.54**	13820.45**	0.84**	0.34**	3.15*	3496.35**	0.71**	0.28**	0.37	55.10**
Var.x Env.	12	19.81	11.38	275.03*	0.005	0.002	0.68	16.23*	0.04	0.04	0.12	0.23*
Environments (Lin.)	1	11161.73**	4141.07**	27640.89**	1.67**	0.68**	6.31**	6992.70**	1.43**	0.56**	0.74	110.21**
Var.x Env.(Lin.)	6	31.55*	5.55	464.09*	0.007*	0.003*	0.79	27.27*	0.04	0.05	0.07	0.40**
Pooled Deviation	7	6.92	14.76	73.69	0.002	0.001	0.48	4.45	0.03	0.03	0.15**	0.04
Pooled Error	36	38.87	22.15	71.05	0.003	0.003	0.39	13.76	0.03	0.04	0.02	0.18
<b>Total</b>	<b>20</b>	<b>601.13</b>	<b>253.35</b>	<b>1875.09</b>	<b>0.09</b>	<b>0.04</b>	<b>0.97</b>	<b>437.99</b>	<b>0.14</b>	<b>0.14</b>	<b>0.19</b>	<b>6.89</b>

\*, \*\* Significance at 5% and 1% levels of probability respectively

**Table.2** Stability Parameters of 11 traits in sugarcane (Eberhart and Russell's model 1966)

Genotypes	Tillers Population (000 ha)			NMC ('000 ha)			Cane Length (M)			Cane Diameter (cm)			Single Cane Weight (kg)		
	Mean	bi	s <sup>2</sup> di	Mean	bi	s <sup>2</sup> di	Mean	bi	s <sup>2</sup> di	Mean	bi	s <sup>2</sup> di	Mean	bi	s <sup>2</sup> di
Co 05009	126.27	1.00	-23.04	97.59	1.06	-5.37	192.75	1.25	-50.73	2.21	0.79	0.000	0.86	1.12	-0.003
CoH 05262	128.17	0.92	-36.16	87.20	0.96	-5.89	168.10	0.95	17.38	2.29	0.93	0.003	0.84	1.24	-0.001
CoH 05265	136.13	1.10	-34.64	88.33	1.18	-16.49	171.88	1.02	-37.36	2.32	0.94	-0.002	0.87	0.97	-0.003
CoLk 05201	128.20	0.73*	-36.15	86.95	0.89	-19.66	171.09	1.12	-5.79	2.29	0.80	-0.002	0.80	0.99	-0.003
Co Pk 0 5191	142.77	1.15	-3.38	101.07	0.92*	-21.26	199.18	1.44	152.02	2.26	1.23	-0.001	0.98	1.04	-0.003
Co J 64 (S)	134.00	1.04**	-36.36	84.85	0.98	-0.17	145.05	0.37	35.88	2.06	1.13	-0.002	0.68	0.86	-0.003
Co Pant 84211(S)	129.05	1.03	-36.34	83.97	0.98	23.24	155.42	0.81	-63.29	2.03	1.14	0.000	0.69	0.75*	-0.003
Population Mean	132.10			89.99			171.90			2.21			0.82		
SE (mean)	1.9			2.72			6.10			0.03			0.02		
SE of bi		0.1			0.16			0.1			0.09			0.08	

**Table 2. Conted....**

Genotypes	Extraction (%)			Yield (t/ha)			BRiX% At 240 Days			BRiX% At 300 Days			Sucrose % At 240 Days			CCS (t/ha)		
	Mean	bi	s <sup>2</sup> di	Mean	bi	s <sup>2</sup> di	Mean	bi	s <sup>2</sup> di	Mean	bi	s <sup>2</sup> di	Mean	bi	s <sup>2</sup> di	Mean	bi	s <sup>2</sup> di
Co 05009	51.81	1.10	-0.15	74.13	1.09*	-13.72	17.72	1.73	-0.003	19.99	1.58	-0.04	15.31	1.40	0.03	8.58	1.11*	-0.18
CoH 05262	52.01	0.21	0.57	71.03	1.24**	-13.74	18.18	0.30	-0.02	20.02	0.44	-0.03	15.29	-0.20	0.49**	8.47	1.23*	-0.18
CoH 05265	52.15	0.89	-0.26	75.01	1.09	-6.40	17.83	0.62	0.01	20.04	1.91	-0.04	15.07	1.04	-0.02	8.83	1.11	-0.07
CoLk 05201	52.42	0.42	-0.34	68.92	0.97	-12.70	18.37	1.07	0.01	19.88	1.27	-0.04	15.37	0.86	-0.02	8.14	0.99	-0.13
Co Pk 0 5191	51.72	0.05	-0.31	82.94	0.97	-4.43	18.23	1.05	-0.02	20.53	-0.46	0.09	16.02	0.20	0.11*	9.79	0.91	-0.12
Co J 64 (S)	52.86	2.77	0.02	55.06	0.73	-2.40	18.00	1.31	-0.01	19.59	1.42	0.01	15.49	1.77	0.21**	6.31	0.77	-0.11
Co Pant 84211(S)	53.09	1.53	1.17	60.52	0.87	-11.60	17.92	0.88	0.04	19.68	0.82	-0.02	15.43	1.90	0.12**	6.92	0.86	-0.18
Population Mean	52.30			69.67			18.04			19.97			15.43			8.15		
SE (mean)	0.49			1.49			0.12			0.12			0.27			0.15		
SE of bi		0.73			0.07			0.39			0.60			1.19			0.05	

\*, \*\* Significance at 5% and 1% levels of probability respectively

In the present investigation, both predictable (linear) and unpredictable (deviation) component were significant and shared the genotype x environments interaction. However, predictable component was predominant for some of the traits, while unpredictable component was predominant for some other traits.

A perusal of phenotypic stability parameters (Table 2) for Tillers Population / ha, NMC ('000 h), Cane Length (m), Cane Diameter (cm), Single Cane Weight (kg), yield (t/ha), Extraction (%), BRIX% at 240 Days, BRIX% at 300 Days, Sucrose % at 240 Days and CCS (t/ha) (Table 2.) revealed that only three varieties namely CoPk 05191 CoH 05262, and CoH 05265 were exhibited  $S^2_{di}$  (deviation from regression) non-significant and regression coefficient (bi) equal to unity ( $bi \approx 1$ ) with mean value higher than the population mean. Similar results have been reported earlier Tahir et al.(2013) an Guddadamath *et al.*, (2014) for cane yield and Tiawari *et al.*, (2011) for NMC. These varieties were therefore, considered suitable and stable under variable environmental conditions, variety CoPk 05191 for NMC ('000 h), yield (t/ha), variety CoH 05262, for Cane Diameter (cm) and variety CoH 05265 for Cane Diameter (cm) and Single Cane Weight (kg) traits. Variety CoH 05262 was also found suitable and stable under unfavorable environment for BRIX% at 240 Days and BRIX% at 300 Days. All seven varieties were exhibited  $S^2_{di}$  (deviation from regression) non-significant, regression coefficient (bi) greater than unity ( $bi > 1$ ) with mean value higher than the population mean. All these varieties were considered suitable and stable under favourable environmental conditions for NMC ('000 h), Cane Length (m), Single Cane Weight (kg), yield (t/ha), CCS (t/ha, Co 05009), Single Cane Weight (kg), yield (t/ha), and CCS (t/ha, CoH 05262), tillers population(ha), yield (t/ha) BRIX% at

300 Days and CCS (t/ha CoH 05265), BRIX% at 240 Days (CoLk 05201), tillers population(ha), Cane Length (M), Cane Diameter (cm) Single Cane Weight (kg), BRIX% at 240 Days (CoPk 05191), Extraction (%) and Sucrose % at 240 Days (CoJ64(s) and CoPant84211(s), while the three varieties namely, (CoLk 05201), CoH 05262 and (CoPk 05191), were exhibited  $S^2_{di}$  non-significant, regression coefficient less than unity ( $bi < 1$ ) with mean value higher than the population mean, thereby indicating its stability and suitability under unfavorable environmental conditions for Cane Diameter (cm) and Extraction (%) CoLk 05201). BRIX% at 300 Days (CoH 05262) and Sucrose % at 240 Days (CoPk 05191). Variety CoPk 05191 was found stable for NMC ('000 h), yield (t/ha) traits, except Tillers Population (ha), Cane Length (M), Cane Diameter (cm), Single Cane Weight (kg), Extraction (%), BRIX% at 240 Days, BRIX% at 300 Days, Sucrose % at 240 Days and CCS (t/ha), variety CoH 05265 was found stable for Cane Diameter (cm) and Single Cane Weight (kg) traits, except Tillers Population (ha), NMC ('000 h), Cane Length (M), Extraction (%), yield(t/ha), BRIX% at 240 Days, BRIX% at 300 Days, Sucrose % at 240 Days and CCS (t/ha) while, variety CoH 05262, was also found stable for Cane Diameter (cm) except remaining traits. Therefore, these promising CoPk 05191 CoH 05265 and CoH 05262, lines could be recommended for commercial cultivation or could be suitability used in further improvement programme.

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