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RESEARCH ARTICLE

GENOTYPE X ENVIRONMENT INTERACTION AND ADAPTABILITY FOR PRODUCTIVE TRAITS IN SUGARCANE

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ABSTRACT

Fourteen sugarcane genotypes of early maturity group were grown in three different environments such as I plant, II plant and ratoon crops during 2007-08 to 2008-09 consecutive years. Eleven traits viz.-cane yields, CCS yield, CCS %, sucrose %, Brix %, Purity %, Number of milliable cane, Average cane weight, Milliable height, cane diameter, & Extraction%, were studied during present investigation. The variance of genotypes (G) & Environment (E) individually both shows highly significant at 1 % and 5% both at pooled error respectively, except extraction % and Milliable height .Which were found to be significant at 5% at pooled deviation only. The G X E interaction was found highly significant for all the traits except CCS % and Purity %. This had indicated that considerable variability among the genotypes with respect to productive traits in each (three) environment. The variance of environment liner was also found highly significant for all the productive traits at 1 % & 5 % at pooled deviation and pooled error except Milliable height which was found highly significant at only 5 % at pooled deviation.

INTRODUCTION

Genotypes (G) & Environment (E) interaction encountered in yield traits are a major challenge to plant breeder. Yield data & stability performance of genotypes across the contrasting environment are essential to enable a breeder to select high yielding and consistently performing genotypes. Liner regression technique has been extensively used by sugarcane breeders to judge the response to environment and to on the predict the stability performance. Several workers have criticised the regression technique as inadequate (Freeman and Perkins 1971 and Sukla 1972). Powel *et al*. (1986) observed that, the liner regression technique didn't adequately explain the Genotypes (G) & Environment (E) interaction and therefore suggested the use of genotype and phenotypic variance across environment to measure the stability. When incorporated in an analysis of variance over all environment Eberhart and Russells (1966) method was thought by Freeman and Perkins (1971) to result in a confusion about partitioning up degree freedom associate with environment liner item. Freeman and Perkins (1971) proposed independent estimate of environmental index, they divided the replication into group so that group may be used for measuring the average performance of verities in various environment and the other groups, averaging over the varieties is used for estimating the environmental index and also use one or more variety as check and asses the environmental index on the basis of their performance.

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The evolution of genotype under different climate condition provides information about the different stability parameter and the relative performance of the individual's genotypes. However cane yields and quality in sugarcane are dependent on several quantitative inherited traits which was influenced by environment .As the breeder have long been aware the problem of genotype – environment interaction for yields potential of sugarcane varieties but for juice quality and other productive traits information is very scarce. Therefore, the present investigation was carried out to determine the scarce magnitude of genotype x environment interaction and adaptability for productive traits in sugarcane.

MATERIALS AND THE METHODS

Fourteen early maturing sugarcane genotypes were tested in Advanced Varietals trials such as I plant, II plant and ratoon of I plants at Central Sugarcane Research Station Padegaon during 2007-08 to 2008-09 in *suru* season The present experiment was conducted in Randomized Block Design with three replication along with standards i.e. Co 85004, Co 94008, and CoC 671. Each plots consisted of eight row of eight meter length spaced at 90 cm. All recommended agronomic practices were followed for raising the plant cane and the ratoon crops. Data were recorded at harvest for cane yield, CCS yield, CCS %, sucrose %, Brix %, Purity%, Number of milliable cane (000/ha), Average cane weight (kg), Milliable height (cm), cane diameter (cm), & Extraction %. The phenotypic stability was assed by considering the mean performance over the environment (x) liner regression coefficient (bi) and the deviation from regression function (S^2di) as given by Eberhart and Russells (1966). An ideal genotype should have high mean performance (x), liner regression coefficient (bi) value should be near to unity or less and non significant deviation from regression function (S^2di). The stability parameters were estimated as par combined regression analysis of variance suggested by Freeman and Perkins (1971), Balwant Kumar *et al.* (1987) model of stability.

RESULT AND DISCUSSION

Pooled analysis of variance (Table 1) indicate that there were significant difference among the genotype, environment, genotype X environment, Environment linear for cane yields (t/ha), CCS yield (t/ha), sucrose %, Brix %, Number of milliable cane (000/ha), Average cane weight (kg), Milliable height (cm), cane diameter (cm), and Extraction% except CCS %, Purity %. For G X E interaction indicating high amount of variability among the genotype studied. This indicated that the responsiveness of the sugarcane genotype and there performance can be predicted with some reliance over the environment. Similar finding were reported by Singh (1995) and Patel *et al*. (1999) in sugarcane genotypes.

Cane Yield

The result in Table. 2 revealed that the genotype CoVc 9982 (115.76 t/ha) recorded highest cane yield fowled by Co 0310 (114.02 t/ha) & Co 0314 (98.81 t/ha) & it was higher than the average cane yield (90.32 t/ha). The genotype CoVc 9982 (115.76 t/ha) recorded above the average cane yield with non significant S^2di & bi value near to unity indicating its good stability for cane yield with varying environmental condition . The S^2di value for genotype Co 0204, CoM 9902 & standard check CoC 671 were highly significant indicating their instability. The genotype Co 0314 (98.81 t/ha) exhibited higher mean cane yield above average and regression value near to unity and non significant S^2di value indicating its good stability under favourable or rich environment.

CCS yield (t/ha)

The genotype Co 0310 (16.54 t/ha), Co 0312 (15.35 t/ha), Co 0314 (15.01 t/ha), CoVc 9982 (15.33 t/ha) recorded higher CCS yield above the average (13.24t/ha).The genotype Co0310 (16.54t/ha) recorded highest CCS yield over the rest of other genotypes & above the average and its regression value (0.96) with lowest non significant value of S2di value indicating its good stability for rich or favourable environment. The genotype CoVc 9982 (15.33 t/ha) recorded the CCS yield above unity indicating its ability under unfavourable or poor environment condition. The genotype Co 0308, Co 0315, CoM 9903, CoM 0254 recorded highly significant S2di value, bi value, not near to unity indicating its poor adaptability to all environments.

CCS%

In respect of quality parameter for stability analysis the sugarcane genotype Co 0312 (16.04 %), Co 03149 (15.04 %) recorded highest CCS % above average, bi value near to unity (0.85) with non significant S^2di value indicates its most stability under rich or favourable environment. The genotypes Co 0315, CoM 9902 recorded highly significant S^2di value indicating its poor adaptability to all environmental condition.

Brix %

The highest brix % was recorded by the genotype Co 0312 (22.54 %) followed by Co0314 (22.10 %) and Co 0310 (21.93 %) above average brix %. The genotype Co 0312 (22.54 %) was recorded the highest brix % above average & bi value (0.89) near to unity with non significant S^2di indicating it adaptability to rich or favourable environment condition. The standard check Co 94008 & CoC 671 recorded the highly significant S^2di value indicating its poor adaptability to all environmental conditions.

Sucrose%

The sucrose % is one of the important quality parameter of sugarcane juice. The highest sucrose % was recorded by the genotype Co 0312 (21.87 %) with bi value near to unity (0.85) and non significant S^2di indicating it adaptability to rich or favourable environments. However, The standard check Co 94008 & CoC 671 recorded the highly significant S^2di value indicating its poor adaptability to all environmental conditions.

Purity %

The genotype Co 0312 (97.00 %) recorded highest purity % followed by Co 0308 (96.56 %) and CoM 0254 (96.42 %) above the average. The highest purity % was recorded by the genotype Co 0312 (97.00%) with bi value above unity and non significant S^2di indicating it adaptability to poor or unfavourable environment conditions. However, none of entries shows highly significant S^2di value indicating its good adaptability to all environments.

Number of Millable Canes (000/ha) at harvest

The number of millable cane recorded by the genotype Co 0312 (121.00) was highest and above average followed by CoVc 9982 (104.90) and Co 0204 (103.61). The genotype Co 0312 (121.00) was recorded highest number of millable cane with bi value near to unity along with non significant S^2di indicating its good stability to all environment conditions.

Average Cane Weight (Kg.)

The genotypes CoM 09903 (1.34 kg) recorded highest average cane weight and followed by Co 0209 (1.30 kg) and Co 0310 (1.28 Kg) above average. The highest average cane weight recorded by the genotype CoM 09903 (1.34 kg) with bi value lower than to unity indicating its good adaptability to poor or unfavourable environmental conditions. However, the genotype Co 0308 & CoVC 9982 shows highly significant S^2di value indicating its poor adaptability to all environmental conditions.

Height (cm.)

In respect of milliable height the sugarcane genotype Co 0310 (281.44 cm) recorded the highest cane milliable height followed by Co 0308 (281.33 cm) and CoM 0254 (280.77cm).

Table 1. ANNOVA (Mean sum of square) for stability Parameters for growth and yield contributing characters in Sugarcane

.No.	Source of Variation	d.f	Cane Yield (t/ha)	CCS Yield (t/ha)	CCS %	Brix %	Sucrose %	Purity %	NMC (000/ha)	Av. Cane Wt. (kg)	Height (cm)	Diameter (cm)	Extraction %
								at harvest					
1	Genotype (G)	16	526.3 ** ##	10.02 ** ##	1.26 * ##	2.22 ** ##	2.26 ** ##	3.63 ** ##	501.6 ** ##	0.07 ** ##	953.7 ** ##	0.11 ** ##	9.45 #
2	Environment (E)	2	2511.62 ** ##	62.26 ** ##	5.41 ** ##	15.94 ** ##	17.4 ** ##	22.96 ** ##	3840.44 ** ##	0.34 ** ##	439.2 #	3.11 ** ##	150.93 ** ##
3	G X E	32	89.12 ##	2.75 ##	0.36	0.31 ##	0.43 ##	1.20	109.75 ** ##	0.018 * ##	271.1 ##	0.017 * ##	8.8 ##
4	E + V X E	34	231.6 ** ##	6.25 ** ##	0.66 ##	1.23 ** ##	1.43 * ##	2.48 ** ##	329.19 *	0.03 ** ##	2839.14 ** ##	0.19 ** ##	17.16 * ##
5	Environment Linear	1	5023.23 ** ##	124.5 ** ##	10.82 ** ##	31.87 ** ##	34.81 ** ##	45.87 ** ##	7680.68 ** ##	0.69 ** ##	878.5 ##	6.22 ** ##	301.8 ** ##
6	G X E Linear	16	117.4 ##	3.05 ##	0.24	0.16	0.23	1.53	57.97 ##	0.02 ** ##	282.7 ##	0.027	9.19 #
7	Pooled Deviation	17	57.18	2.31	0.45	0.44	0.6	0.82	152.01	0.007	244.2	0.0081	7.91
8	pooled Error	96	17.76	0.39	0.15	0.16	0.24	0.97	19.46	0.005	124.9	0.004	4.57

#, # # : Significant at 5 % and 1 % against pooled deviation , respectively.
*,** : Significant at 5 % and 1 % against pooled error , respectively.

Table 2. Performance and Stability Paramenters for growth and yield in Sugarcane

S.No.	Genotype	Cane Yield (t/ha) at harvest			CCS Yield (t/ha) at harvest			CCS (%) at harvest			Brix (%) at harvest		
		Mean (X)	bi	S^2di	Mean (X)	bi	S^2di	Mean (X)	bi	S^2di	Mean (X)	bi	S^2di
1	Co-0204	98.26	0.64	102.01 *	13.73	0.91	3.68	13.94	1.36	-0.13	20.60	1.23	-0.16
2	Co 0205	74.41	0.63	26.93	11.15	0.68	0.98	14.96	0.81	0.13	21.65	0.97	0.02
3	Co 0209	89.95	1.18	-12.79	13.32	1.25	0.006	14.92	1.38	-0.10	21.77	1.05	-0.03
4	Co 0302	87.20	1.00	7.24	12.93	1.00	-0.03	14.82	1.33	-0.14	21.54	0.97	-0.08
5	Co 0306	67.58	0.85	-17.71	9.71	0.85	-0.33	14.34	0.73	-0.12	21.71	0.72	-0.15
6	Co 0308	93.33	-0.29	44.26	13.72	-0.12	4.4**	14.67	1.06	0.0006	20.99	0.98	-0.17
7	Co 0310	114.02	1.36	-2.95	16.54	0.96	-0.36	14.56	0.94	0.48	21.93	1.07	0.03
8	Co 0312	95.71	0.66	20.52	15.35	0.76	0.67	16.04	0.85	-0.025	22.54	0.89	-0.06
9	Co 0314	98.81	0.76	11.83	15.01	0.77	-0.13	15.20	0.24	-0.14	22.10	1.32	-0.10
10	Co 0315	71.86	2.10	19.49	10.84	2.11	5.76 **	14.91	0.59	0.89 *	21.43	0.28	0.13
11	CoM 9902	95.08	1.41	103.27*	13.55	0.92	0.41	14.41	1.53	0.78 *	20.93	1.32	-0.10
12	CoM 9903	87.72	1.09	30.43	13.24	1.06	2.65 *	15.04	0.31	0.04	21.27	0.55	0.05
13	CoM 254	96.97	1.92	63.66	14.64	1.96	5.71 **	15.01	0.85	0.41	21.43	0.70	1.20
14	Co Vc 9982	115.76	1.20	-17.46	15.33	1.18	-0.27	13.22	1.22	-0.14	18.65	1.24	-0.13
	Standards												
15	Co 85004 ©	76.44	1.73	153.25	11.46	1.75	0.84	15.00	0.41	-0.07	21.77	1.08	0.57
16	Co 94008 ©	87.47	-0.08	-15.88	11.89	-0.48	0.93	13.58	0.47	2.69 **	20.43	1.43	1.4 **
17	CoC 671 ©	84.88	0.76	153.93 **	12.62	1.37	7.71 **	14.69	2.84	0.54	21.21	1.12	2.16 **
	G.Mean	90.32	1.00	22.20	13.24	1.00	0.53	14.67	1.00	0.05	21.29	1.00	0.07

#, # # : Significant at 5 % and 1 % against pooled deviation , respectively.
*,** : Significant at 5 % and 1 % against pooled error , respectively.

Table 3. Performance and Stability Paramenters for growth and yield in Sugarcane

S.No.	Genotype	Sucrose (%) at harvest			Purity (%) at harvest			NMC (000/ha) at harvest			Av. Cane Wt (kg) at harvest		
		Mean (X)	bi	S^2di	Mean (X)	bi	S^2di	Mean (X)	bi	S^2di	Mean (X)	bi	S^2di
1	Co-0204	19.28	1.24	-0.24	93.58	1.65	-0.97	103.61	0.99	-13.77	1.09	1.40	-0.0023
2	Co 0205	20.58	0.81	-0.11	95.05	0.56	0.59	89.50	1.17	-16.28	0.95	1.07	-0.0047
3	Co 0209	20.79	1.08	-0.19	95.41	0.83	-0.97	80.19	0.42	-12.15	1.30	1.76	-0.0045
4	Co 0302	20.51	1.07	-0.15	95.23	1.07	-0.87	93.97	1.11	-0.91	1.17	0.92	-0.0028
5	Co 0306	20.20	0.70	-0.08	93.61	1.50	-0.46	85.75	0.95	-2.84	0.85	0.82	-0.0020
6	Co 0308	20.27	0.98	-0.15	96.56	1.29	-0.89	90.36	0.53	25.47	1.11	-0.31	0.0247 *
7	Co 0310	20.67	0.75	-0.14	94.33	0.94	1.25	94.33	0.77	-18.69	1.28	2.31	0.0043
8	Co 0312	21.87	0.85	-0.24	97.00	1.59	-0.71	121.00	1.01	-18.23	0.79	1.06	-0.0002
9	Co 0314	21.11	1.21	0.05	95.51	0.39	-0.89	88.40	1.10	15.82	1.10	-0.03	-0.0035
10	Co 0315	20.37	0.50	0.15	94.99	0.86	-0.65	72.92	1.27	-9.46	1.03	1.01	-0.0039
11	CoM 9902	20.17	1.27	-0.12	96.33	1.09	-0.96	88.19	1.94	632.2 **	1.18	1.76	-0.0038
12	CoM 9903	20.46	0.56	-0.18	96.18	1.18	-0.96	71.54	0.81	-13.27	1.34	0.48	0.0001
13	CoM 254	20.66	0.58	0.69	96.42	-0.11	1.65	97.81	1.24	447 **	1.10	-0.66	-0.0020
14	Co Vc 9982	17.94	1.63	-0.15	95.52	1.20	2.97	104.90	1.15	-1.27	1.18	0.87	0.0328 *
	Standards												
15	Co 85004 ©	20.61	0.88	0.60	94.72	0.66	-0.96	81.84	1.13	600.38 **	0.94	0.67	-0.0052
16	Co 94008 ©	19.04	1.16	3.06 **	93.22	-0.59	1.08	85.63	0.47	664.7 **	1.08	1.36	0.0021
17	CoC 671 ©	20.33	1.63	3.24 **	95.68	2.84	-0.75	70.63	0.87	-15.29	1.34	2.44	-0.0054
	G.Mean	20.29	0.99	-0.02	95.26	1.00	-0.15	89.45	1.00	-6.22	1.11	1.00	0.00

#, # # : Significant at 5 % and 1 % against pooled deviation , respectively.
*,** : Significant at 5 % and 1 % against pooled error , respectively.

Table 4. Performance and Stability Paramenters for growth and yield in Sugarcane

S.No.	Genotype	Height (cm) at harvest			Diameter (cm) at harvest			Extraction (%) at harvest		
		Mean (X)	bi	S^2di	Mean (X)	bi	S^2di	Mean (X)	bi	S^2di
1	Co-0204	255.11	1.29	3.94	3.22	1.19	-0.0039	49.74	1.48	-1.89
2	Co 0205	232.11	0.87	525.51 *	3.11	1.26	-0.0040	50.98	0.77	4.10
3	Co 0209	252.11	1.15	-121.24	3.47	0.95	-0.0014	50.26	0.41	62.31 **
4	Co 0302	275.22	1.20	347.93	3.11	0.67	-0.0010	47.52	1.14	-2.50
5	Co 0306	222.33	0.94	-27.84	2.80	1.05	-0.0034	47.23	-0.70	-1.60
6	Co 0308	281.33	0.98	785.95 *	3.07	0.57	0.0312	51.36	0.67	8.52
7	Co 0310	281.44	1.03	208.92	3.43	1.42	0.0026	49.01	1.83	2.08
8	Co 0312	251.22	0.64	-103.04	2.78	1.01	-0.0038	47.03	1.24	-4.57
9	Co 0314	263.88	0.96	-52.26	3.06	1.05	-0.0008	48.64	1.16	-4.49
10	Co 0315	233.77	0.99	-123.73	3.33	0.78	0.0062	48.22	0.51	1.00
11	CoM 9902	265.22	0.62	-118.46	3.35	1.19	0.0099	52.00	2.31	-3.25
12	CoM 9903	262.44	1.24	-122.91	3.24	0.78	0.0236 *	49.82	1.21	-3.80
13	CoM 254	280.77	0.78	-118.28	3.04	0.83	-0.0018	46.69	0.51	-3.48
14	Co Vc 9982	275.44	1.04	487.49	3.16	0.93	0.0116	50.24	1.41	-4.07
	Standards									
15	Co 85004 ©	248.88	1.32	484.85	2.98	0.65	0.0069	45.51	0.34	-3.61
16	Co 94008 ©	264.77	0.60	-114.89	3.18	1.56	-0.0040	48.66	2.14	16.13
17	CoC 671 ©	265.66	1.26	85.52	3.29	1.04	-0.0043	48.71	0.16	-4.15
	G.Mean	259.51	0.99	47.73	3.15	1.00	0.00	48.92	0.98	-0.35

#, # # : Significant at 5 % and 1 % against pooled deviation , respectively.
*,** : Significant at 5 % and 1 % against pooled error , respectively.

However, the genotype Co 0310(281.44 cm) showed the highest cane milliable height above average with bi value near to unity and Non significant S^2di value indicating its good adaptability to all environmental conditions.

Diameter (cm) at harvest

Among all the genotypes tested, the sugarcane genotype Co 0209 (3.47 cm) shows the highest cane diameter above average with bi value near to unity along with non significant S^2di value indicating its good adaptability to all environmental conditions. Among all the genotypes tested for the cane diameter the sugarcane genotype Co 0209 (3.47 cm) found most stable. The genotype CoM 9903 shows the highly significant S^2di value indicating its poor adaptability to all environmental conditions. Under rich or favourable condition the genotype Co 0310 (3.43 cm) rank second in case of diameter.

Extract ion % at harvest

Among all the fourteen genotypes along with three best standard the sugarcane genotype CoM 9902 recorded the highest extraction % (52.00 %) followed by Co 0308 (51.36 %) and Co 0205 (50.98 %). The sugarcane genotype CoM 9902 (52.00 %) recorded the highest extraction % with bi value more than unity along with non significant S^2di value indicating its poor adaptability to unfavourable environmental conditions.

REFERENCES

Balwant Kumar, S.S. Pandey and D.N. 1987. Kamat Interaction for yield and yield attributes in sugarcane. Indian J. Agric. Sci., 57 (3):309-313.

Singh, S.P. and Khan, A.Q.1997. Selection of sugarcane genotypes for different environments, Sugar Cane, 5:10-12.

Simmonds, N.W. 1981. Genotype (G), environment (E) and GE components of Crop Yields. Exp.Agric. 17: 355-362.

Sharma, H.L. and Bhardwaj. T.S.1983. Adaptability studies for quality traits in sugarcane (Saccharum spp.) Sugarcane Breeder Newsletter No. 45: 86-92.

Shukla, G.K. 1972. Some statical aspects of partitioning genotype environment component of variability. Heredity 29: 237-245.

Tyagi, S.D. Singh, D.N. and Nand K. 2001. The effect of genotype environment interaction on varieties for sugarcane. Indian Sugar, 3:171-174.

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