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Genotype x Environment Interaction and Stability Analysis in Pearl Millet (*Pennisetum americanum* L.)

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ABSTRACT

The genotype x environment interaction and stability parameters were studied for 9 genotypes of pearl millet screened under four weed management treatments (created environments) during the *kharif* seasons of the years 1991, 1992 and 1993 at GAU, Anand and significant G x E interaction for yield and its attributes were revealed. Differential response of genotype to environment was observed in individual year as well as in pooled analysis for yield and its attributes. The mean grain yield and two stability parameters viz., regression coefficient (bi) and deviation from regression (S^2d) were obtained to access the superior genotype. An ideal genotype is one that combines high yield, unit regression and least deviation from regression. Genotype GHB 229 was noticed high yielding and stable in 'no weeding' and 'hand weeding' environments whereas MH 179 appeared high yielding and stable under herbicide applications.

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INTRODUCTION

The genotype x environment interaction is of great importance to plant breeder when he is testing genotypes over a series of environments (viz., seasons, years, locations and artificially created environments) for developing improved varieties/hybrids. The presence of such G x E interactions causing problem in ordering and relative ranking of the genotypes when tested under varying environments. An ideal genotype is one that combines high yield and stability in performance (Eberhart and Russel, 1966). The literature on stability analysis for comparing genoypes of various crops tested over space and time is available in plenty. But such information is not available very specifically for genotypes of any crop tested under varying weed management aspects. The present study, therefore, was undertaken to ascertain whether the different genotypes of pearl millet differ in their response to environments created artificially through weed management treatments.

MATERIALS AND METHODS

An experiment was conducted on pearl millet (*Pennisetum americanum* L.) at Weed Control Research Project, GAU, Anand during *kharif* season of the years 1991, 1992 and 1993. The trial was laid out in split plot design with four replications. Four weed management treatments viz., unweeded (E1), hand weeding (E2), atrazine @ 0.75 kg. a.i./ha. (E3) and

atrazine 1.25 kg. a.i. kg/ha (E4) were relegated to main plot which were considered as four created environments and nine pearl millet hybrids/varieties (hereafter referred to as genotypes) viz., GHB 227 (G1), GHB 30 (G2), GHB 32 (G3), GHB 181 (G4), GHB 183 (G5), GHB 184 (G6), GHB 229 (G7), MH 179 (G8) and B.K. 560 (G9) to sub plot. The genotypes were sown in the first week of July every year, the seed rate being 4.00 kg/ha. Atrazine herbicide was applied as pre-emergence treatment next day after seeding.

The net plot size comprised three rows each of 5 m. length, the intra and inter row spacings were 10 cm and 45 cm respectively. All recommended agronomic practices in vogue were followed throughout the crop season. Every year observations were recorded on plant stand, plant height (cm), earhead length (cm), weed counts, grain yield (kg/plot) and straw yield (kg/plot). The statistical model proposed by Prabhakaran and Jain (1984) was employed for genotype x environment interaction analysis. The stability parameters were obtained as outlined by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

The data generated through this investigation for all the characters were analysed for invididual year as well as pooled over years and are presented in Table 1 and Table 2 respectively.

TABLE 1

Year-wise test of significance for genotype (G), environments (E) and G x E interaction effects.

Characters	*1990*			*1991*			*1992*		
	G	*E*	*G x E*	*G*	*E*	*G x E*	*G*	*E*	*G x E*
Plant stand	**	NS	NS	**	*	*	**	NS	NS
Plant height	**	NS	*	**	**	*	**	NS	*
Earhead length	**	NS	*	**	NS	*	**	NS	*
Grain yield	**	**	*	**	**	**	**	**	**
Dry fodder yield	**	**	*	**	**	**	**	**	**
Weed counts	NS	**	NS	NS	**	NS	NS	**	NS

Legend : * = Significant at 0.05 probability level.
** = Significant at 0.01 probability level.
NS = Not Significant.

TABLE 2

Test of significance based on pooled analysis for different characters.

Characters	*Y*	*E*	*Y x E*	*G*	*Y x G*	*G x E*	*Y x G x E*
Plant stand	**	NS	NS	NS	**	NS	NS
Plant height	**	*	NS	**	**	**	NS
Earhead length	**	*	NS	**	**	**	NS
Grain yield	**	**	NS	**	**	**	NS
Dry fodder yield	**	**	NS	**	**	**	NS
Weed counts	**	*	NS	*	NS	*	NS

Legend : * = Significant at 0.05 probability level.
** = Significant at 0.01 probability level.
NS = Not Significant.

The results (Table 1) revealed that the differences in performances due to genotypes were significant for all the characters except weed counts in all the years. The variation due to environments (weed management treatments) was significant for grain yield, straw yield and weed counts in all the years. However, G x E interaction significantly influenced with all the characters except weed counts.

Pooled analysis (Table 2) showed that genotype, environment and G x E interaction significantly influenced that genotypes and environments were not independent in causing variation for all the attributes. Thus the presence of G x E interaction signified for the present study. The existence of G x E interaction (under artificial created environments) was reported in peral millet by Singh and Murty (1974); Machanda and Mehta (1980); Pethani and Kapoor (1985) and Das *et al.* (1985). The presence of such interaction creating difficulties in demostrating significant superiority of any genotype. Hence stability was carried out using yield data only.

The mean grain yield and two stability parameters regression coefficient (bi) and deviation from regression (S) of nine genotypes tested under four environments (weed management treatments) pooled over three years are given in Table 3. The results (Table 3) showed that mean of genotypes ranged from 1.86 kg (G3) to 3.03 kg (G7) with grand mean 2.38 kg for E1; the difference being significant. For E2 it varied from 2.42 kg (G3) to 3.54 kg (G7) with ground mean 2.94 kg, the difference being significant. In case of G3 it varied from 2.01 kg (G1 to 3.10 kg (G8) with overall mean 2.56 kg with significant difference and 1.27 kg (G1) to 2.79 kg (G8) with general mean 2.03 kg under E4 and the difference was significant. The pooled mean over four environments ranged from 2.4 kg (G3) to 3.15 kg (G7) with grand mean 2.48 kg, the mean difference being significant. The regression coefficient (bi) varied from 0.62 (G3) to 1.24 (G1) while mean square deviation (S^2d) varied from -0.23 (G8) to 0.28 (G1). The stable

TABLE 3

Average grain yield and stability parameters for nine genotypes tested under four environments.

Genotypes	*Environments*				*Average*	*bi*	S^2d
	E1	*E2*	*E3*	*E4*			
G1	2.18	2.80	2.01	1.27	2.07	1.24*	0.28*
G2	2.21	2.93	2.42	2.09	2.41	1.15	0.22*
G3	1.86	2.42	2.02	1.85	2.04	0.62*	0.02
G4	2.63	3.49	2.87	2.44	2.85	1.04	0.02
G5	2.47	2.81	2.64	1.92	2.46	1.34*	0.04
G6	2.50	2.97	2.80	2.40	2.67	0.52	-0.06
G7	3.03	3.54	2.59	1.88	2.76	1.01	0.02
G8	2.53	3.04	3.10	2.79	2.86	1.10	-0.23
G9	1.96	2.47	2.55	1.63	2.15	1.04	0.20*
Average	2.37	2.94	2.56	2.03	2.48	—	—
C. D. 0.05	0.66	0.41	0.56	0.68	0.46	—	—

Legend : * Significant at 0.05 probability level.

TABLE 4

Environment-wise mean grain yield and stability parameters for nine genotypes.

Genotype	E1			E2		
	$\bar{Yi}$	*bi*	$S^{-2}d$	$\bar{Yi}$	*bi*	$S^{-2}d$
G1	2.18	1.43	0.15**	2.80	1.04**	0.90**
G2	2.21	1.64*	-0.03	2.93	0.78**	0.09*
G3	1.86	0.54*	-0.05	2.42	0.31*	0.09*
G4	2.63	1.02	-0.03	3.49	1.00	0.01
G5	2.47	0.91	0.38**	2.81	0.58	-0.02
G6	2.50	-0.23	0.03	2.97	0.84	-0.04
G7	3.03	0.91	-0.02	3.54	0.94	-0.11
G8	2.53	1.31*	0.62**	3.04	1.16**	-0.41*
G9	1.96	1.07	0.49**	2.47	2.35**	-0.05
Mean	2.37			2.94		
C. D. 0.05	0.66			0.41		

Genotype	E3			E4		
	$\bar{Yi}$	*bi*	$S^{-2}d$	$\bar{Yi}$	*bi*	$S^{-2}d$
G1	2.01	1.19*	0.05**	1.27	0.78	0.62**
G2	2.42	1.80*	-0.01	2.09	1.69*	0.07*
G3	2.02	0.16	-0.03	1.85	0.82	0.20**
G4	2.87	1.09	-0.08	2.44	1.02	-0.04
G5	2.64	1.26*	0.20**	1.92	1.02	-0.03
G6	2.80	0.91	-0.03	2.40	0.54*	0.32**
G7	2.59	0.57*	-0.01	1.88	0.71	0.07
G8	3.10	1.06	-0.01	2.79	1.04	-0.04
G9	2.55	0.76	-0.03	1.63	0.96	-0.05
Mean	2.56			2.03		
C. D. 0.05	0.56			0.68		

Legend : * Significant at 0.05 probability level.
** Significant at 0.01 probability level.

genotype is one that combines high yield and stability in performance. For this investigation genotypes G4 (GHB 181), G7 (GHB 229) and G8 (MH 179) showed high grain yield, regression coefficient near unity and lower deviation from regression. Hence were considered as stable genotypes. Among which G4 and G8 were suited to better environments (bi > 1) while G7 exibited suitability under poor environments.

Environment-wise stability analysis was carried out to screen environment specific genotype using grain yield data pooled over three years showed significant differences among genotypes (Table 4). The mean grain

yield and two stability parameters (bi and Sd) obtained for four environments (weed management treatments) revealed that genotype G7 (GHB 229) was found stable under E1 (no weeding) and E2 (hand weeding) while genotype G8 (MH 179) exibited superiority in E3 and E4 (herbicide application) environments.

Use of herbicide for controlling weed is a labour saving practice. However, its application requires great care and finance. Herbicide causes pollution problems also. Due to industrialization in the country, farmers are facing acute shortage of labour for agriculture. This problem could be solved partly if genotype tolerance to weedy conditions are developed.

Thus results leads to the conclusion that `like no tillage' (cost saving agronomic practice) `no weeding and no herbicide application' in pearl millet could be advocated as cost saving practice without affecting yield potential, if genotypes like GHB 229 are developed and made available to the farmers. This practice takes care of pollution problem due to herbicide use also.

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