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STABILITY OF GRAIN YIELD IN PEARL MILLET (*PENNISETUM AMERICANUM* L. LEEKE)

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ABSTRACT

Four male steriles, 20 inbreds, and 80 F_1 hybrids of pearl millet (*Pennisetum americanum* L. Leeke) were evaluated under five environments. Highly significant genotype x environment interactions were recorded, though the linear portion was significantly higher than the nonlinear portion in parents and their hybrids, the hybrids being more stable than parents.

Key words: Stability, pearl millet, G x E interaction.

Pearl millet (*Pennisetum americanum* L. Leeke) is one of the important cereal crops in India. Several hybrids have been successfully released and found superior with respect to stability and productivity. Advancement in diversification of parents and their hybrids in pearl millet is a continuous process [1], thus in heterosis breeding, information on stability of newly developed parents and behaviour of hybrids under different environments is quite important. The present study provides information on the stability behaviour of new male sterile and inbred parents of bajra and their hybrids, and its utility in breeding programme.

MATERIALS AND METHODS

Four male sterile lines (MS 5054A, 5141A, L_{111}A and 1260_2A) were mated with 20 inbred lines in line x tester design. The resulting 104 entries were sown in randomised block design replicated thrice. The experimental material was sown in five environments, viz., Jamnagar: early kharif, normal spacing; Jamnagar: late kharif, wide spacing; Junagadh: kharif; Rajkot: kharif; and Jamnagar: summer. Stability parameters were estimated as per standard procedure [2].

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RESULTS AND DISCUSSION

In the present study linear regression (b) is simply regarded as a measure of response of a particular genotype, whereas the deviation from the regression line ($\bar{S}^2_d$) is considered as a measure of stability. Genotype with lowest or nonsignificant standard deviation being the most stable and vice versa.

An examination of the two parameters b and $\bar{S}^2_d$ for the individual parents and hybrids revealed that only in 10 males and 66 hybrids regression mean squares were significant (Table 1). This showed that linear regression alone accounted for almost entire G x E interactions in these genotypes. However, 5 males and 4 hybrids had only significant remainder mean square which makes their perform- ance unpredictable under changed environments. The remaining genotypes, i.e. 3 females, 3 males and 8 F_1 hybrids had significant regression mean square as well as remainder mean square, indicating the presence of both linear as well as nonlinear portions of G x E interactions in respect of these genotypes (Table 1). The individual analysis confirmed the information obtained from the analysis of variance for stability parameters where both the components of G x E interactions, i.e. linear as well as nonlinear were found to be important (Table 2).

Table 1. Distribution of parents and F_1 hybrids on the basis of individual G x E interaction components for grain yield in pearl millet

Parameter	Females	Males	Hybrids
Predictable			
G x E absent:			
(both b and $\bar{S}^2_d$ nonsignificant)	1	2	2
G x E present:			
(only b significant)	—	10	66
Unpredictable (G x E present)			
Both b and $\bar{S}^2_d$ significant	3	3	8
Only $\bar{S}^2_d$ significant	—	5	4

A simultaneous consideration of all adaptation parameters ($\bar{X}$, b and $\bar{S}^2_d$) for individual parents indicated that amongst the females, L_{111}A, 5141A and 5054A were unstable and highly responsive to environmental change (b > 1), whereas MS 126D_2A was less responsive (b < 1) and highly stable genotype. However, grain yield of MS L_{111}A was the highest (61.38 g/plant) among all the female parents.

Among the pollinators, J 2236 (53.9 g/plant) was the highest grain yielding genotype with high response (b > 1) to the environmental changes and unstability of performance. J 264 (43.1 g) and J 437 (43.1 g) were also high yielders with average responsiveness (b~1) and high stability.

Table 2. Analysis of variance for stability parameters of parents and hybrids of pearl millet

Source	Parents		Hybrids	
	d.f.	M.S.S.	d.f.	M.S.S.
Genotypes (G)	23	607.9*+	79	579.2*+
Environment (E) (linear)	1	26908.3*+	1	261458.7*+
G x E (linear)	23	431.3*+	79	607.1*+
Pooled deviation	72	82.0*	340	63.2*
Pooled error	230	20.5	790	46.1

*Significant against pooled error at $P \leq 0.05$.

+ Significant against pooled deviation at $P \leq 0.05$.

Most of the hybrids from the crosses of MS $126D_2A$ had low grain yield potential, while hybrids of MS 5141A were mostly high yielding. The hybrids 5141A x J 487 (80.7 g), 5141A x J 380 (75.7 g), 5141 x J 1188 (73.6 g) and 5141 x J 1262 (70.7 g) were top yielders in this study, although highly responsive ($b > 1$) to changing environments. However, only hybrid 5141A x J 380 was unstable which makes its behaviour unpredictable. These hybrids gave better yield under suitable environment and poor yield in unfavourable environments. But it can be said that yield of these hybrids will increase substantially with improvement in environment at a rate well above the average yield of the total population under favourable environment as they have above average responsiveness ($b > 1$). Hybrid 5141A x IP 233 (70.4 g/plant) was also high yielder with average response ($b \sim 1$), but unstable.

Highly significant mean square due to environment (linear) indicated that yield differences under different environments were considerable and were highly influenced by environments. This indicates that larger differences between environments and a greater part of genotypic response was a linear function of environments. On comparing the relative magnitude of the linear component of environments between parents and hybrids, it was found that its proportion was higher for hybrids. This means that the hybrids were more responsive to environmental changes in respect of yield.

The G x E interaction sum of squares were partitioned into the linear (predictable) and pooled deviation (nonlinear) components. Both these components were significant in both the parental as well as hybrid populations. The variance due to G x E (linear) was significantly higher as compared to pooled deviation for both parents and hybrids. Thus, the major portion of interactions was linear in nature and prediction would still be possible. Almost similar observations were reported earlier [1–3].

The study of G x E interactions leads to meaningful evaluation of individual genotype which are summarised in Table 1. It showed that in spite of existence of the unpredictable portion prediction could still be made in respect of many genotypes. With regard to the distribution of parents and F_1 hybrids based on individual G x E interaction components, 68 F_1 and 13 parents revealed predictable nature, whereas only 12 F_1 and 11 parents showed unpredictable behaviour. This clearly indicated that the heterozygotes (F_1) possess relatively low nonlinear sensitivity and exhibited higher stability and environmental response than the homozygous genotypes (inbred parents).

The information on stability is important for the newly developed parents at least for hybrid seed production and understanding the behaviour of parents under various environments. The adaptation parameters ($\overline{X}$, b and $\overline{S}^2_d$) of the male sterile parents showed that MS 126D_2A was highly stable. MS L_{111}A line, although higher grain yielder, was highly responsive and unstable. Amongst the pollinator parents, J 2236 with high performance was highly responsive but unstable. J 437 gave high mean grain yield with average response and also showed high stability.

Based on the adaptation parameters, the cross 5141A x J 487 gave highest yield performance (80.7 g), high responsiveness ($b > 1$) and stability index ($\overline{S}^2_d = 10.98$). Hybrid 5141A x J 380 with more or less similar grain yield (75 g) was also highly responsive ($b > 1$) but was unstable ($\overline{S}^2_d$ significant). With almost same level of grain yield (73.6 g), hybrid 5141A x J 1188 was highly responsive ($b > 1$) and stable.

The adaptability of parental lines involved in the high yielding cross combinations was also studied. For responsiveness, a few cross combinations which were of high x high, medium x medium and low x low combiners, provided hybrids with high, medium and low responsiveness, respectively. Most crosses showed dominance and epistatic type of gene interaction. Likewise, stable hybrid combinations were obtained when both parents had high stability. The genotype studied in the present investigation did not exhibit uniform pattern of stability and environmental response (linear). These two attributes appear to be specific for individual genotypes. This means that even with varying levels of responsiveness high proportion of additive gene interactions may be involved in determining high stability. The parents expressed greater range of both b and $\overline{S}^2_d$ for grain yield, which may be due to fixation of additive gene effects resulting from homozygosity and complementary gene action. From such a gene complex, genotypes can be isolated with the desired level of responsiveness and stability of performance.

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