

Phenotypic Stability of Yield and its Components in Pearl Millet

Gaurav Yadav, H.P. Yadav and Y.P. Yadav

CCS Haryana Agricultural University, Hisar 125 004, India

Abstract: The stability of twenty four genotypes of pearl millet were evaluated for their stability by growing them in four different environments. Partitioning of mean sum of squares according to environments suggested that performance of genotypes across the environment could be predicted for grain yield, ear length and ear weight, whereas for 1000-grain weight and 50% flowering, both linear and non-linear components were equally important. The magnitude of linear and non-linear components of G x E interaction revealed that linear portion was more for ear length (85.86%), ear weight (78.94%) and grain yield (70%). Only hybrid HHB 118 did well under all conditions. HHB 94, HHB 128 and HP 91773 are good for favorable environments, and HHB 68, HP9 12 and HP 95501 could be recommended for poor environments.

Key words: Stability, G x E interaction, yield components.

Developing genotypes with wide adaptability has long been a cherished goal of the plant breeders. Large variability in genotype-environment (G x E) interactions puts a major challenge for obtaining a complete picture of the genetic control on variability. Plant breeding programs aim at producing phenotypically stable genotypes for environments. Multi-environment testing helps in choosing the genotypes that perform better in terms of yield and other characteristics. The present study was carried out to examine G x E interactions for yield and important yield-contributing characters in pearl millet.

Material and Methods

Twenty four pearl millet genotypes, including 18 F₁, hybrids and 6 populations, were selected for the study. Four of these genotypes were already released and 20 were in advanced stages of testing. The materials were developed by Bajra Section, Department

of Plant Breeding, CCS Haryana Agricultural University, Hisar, and were planted at 4 locations of the University Research Farms. The locations comprised of E₁ (Plant Breeding area; planting on 1 July 1996), E₂ (Plant Breeding area, planting on 27 July 1996), E₃ (Dryland area; planting on 3 July 1996) at Hisar, and E₄ (Regional Research Station, Bawal; planting on 26 June 1996). At all the locations, the experiment was conducted in Randomized Block Design with three replications. Each genotype was accommodated in 4 m long 6 rows spaced at 50 cm. Recommended practices were adopted throughout the cropping season.

For recording observations, 10 competitive plants, excluding border plants, were randomly selected from each plot. Data on individual plants were recorded for grain yield, 50% flowering, ear weight, ear length and 1000-grain weight. After testing the error variances for homogeneity through Bartlett's test, the stability analysis

Table 1. Analysis of variance (mean squares) for phenotypic stability for different traits

Source of variation	d.f.	Grain yield	50% flowering	Ear length	Ear weight	1000-grain weight
Genotype	23	6.50*	652.75*	47.29*	0.33*	5.48*
Environment	3	89.20*	1999.99*	205.52*	119.90*	43.89*
Combined regression	1	267.60*+	5994.50*+	616.14*+	359.31*+	130.89+
Residual (1)	2	0.0035	2.73	0.21	0.19	0.39*
Genotype x Environment	69	0.27*	16.74*	5.12*	0.35*	2.92*
Heterogeneity of regression	23	0.40*++	16.44*	6.47	0.50*	2.66*
Residual (2)	46	0.20*	16.89*	4.44*	0.28*	2.56*
Error between the replicates	96	0.05	2.29	4.04	0.20	0.06

* Significant at $P = 0.05$; + Significant at Residual (1); ++ Significant at Residual (2).

was carried out following Freeman and Perkins (1971). The magnitude of linear and non-linear $G \times E$ interactions was worked out following Fripp and Caten (1971).

Results and Discussion

Mean sum of squares due to genotypes was highly significant for all the characters (Table 1), indicating that there were significant differences among the genotypes. The mean sum of squares due to environments was also significant. This indicated that environments differed significantly and warranted an estimation of $G \times E$ interaction. Further, partitioning of mean sum of squares according to environments suggested that combined regression as well as residual component

were non-significant for all the characters studied. This indicated that estimates of genotypes, independent of environments, were not possible for these traits. Further, partitioning of $G \times E$ into heterogeneity of regressions and residual revealed that both components were significant against error. This indicated the importance of linear and non-linear components of $G \times E$ interaction. Again, the non-significant values of the former against the latter indicated that both linear and non-linear components of $G \times E$ interaction were equally important for all the studied characters.

The character wise computation of linear and non-linear components of $G \times E$ interaction (Table 2) revealed 70% and higher interaction of linear types for ear

Table 2. Magnitude of linear and non-linear components of $G \times E$ interaction for grain yield and its contributing traits

Character	Linear (%)	Non-linear (%)
Grain yield (kg plot^{-1})	70.00	30.00
50% flowering (days)	51.30	48.70
Ear length (cm)	85.86	14.14
Ear weight (kg plot^{-1})	78.94	21.06
1000-grain weight (g)	50.98	49.02

Table 3. Distribution of different genotypes on the basis of different stability parameters

Character	Both b_i and Sd_i^2 non-significant	Only b_i significant	Both b_i and Sd_i^2 significant	Only Sd_i^2 significant
Grain yield (kg plot ⁻¹)	10	7	1	6
50% flowering (days)	10	3	5	6
Ear length (cm)	8	0	7	9
Ear weight (kg plot ⁻¹)	12	5	3	4
1000-grain weight (g)	1	4	2	17

length, ear weight and grain yield. Therefore, prediction for these traits was possible. However, predictions would have been more reliable if the heterogeneity of regression was significant (Samuel *et al.*, 1970). The results obtained in the present study are similar to those of Virk *et al.* (1990), Amity and Soto (1990), Sagar and Singh (1995) and Oosterom *et al.* (1996).

An assessment of individual genotypes (Table 3) revealed that ear weight was the most stable character as maximum number of genotypes were stable for this character. Genotype HHB 118 was stable for both grain yield and ear weight. Predictable

genotypes (Table 3) were found to be maximum for grain yield, followed by ear weight, 1000-grain weight and 50% flowering.

For grain yield only 10 genotypes were found to be stable in terms of X_i , b_i and Sd_i^2 (Tables 3 and 4). The ideal one ($x_i > x_{..}$, $b_i \cong 1$, $Sd_i^2 \cong 0$) was HHB 118. Three genotypes, namely HHB 94, HHB 128 and HP 91773, registered adaptation to better environments ($b_i > 1.0$), while HHB 68, HP 912 and HP 95501 were found suitable for poor conditions. For 50% flowering 10 genotypes expressed stable flowering, out of which HHB 119, HHB 126 HHB 123,

Table 4. Grouping of genotypes on the basis of stability parameters

Criteria	Grain yield	50% flowering	Ear length	Ear weight	1000-grain weight
$X_i > X_{..}$	HHB 94	HHB 112	-	HHB 94	HTP 88
$b_i > 1.0$	HHB 128			HHB 120	
$Sd_i^2 \cong 0$	HP 91773			HHB 128	
				HP 91773	
$X_i > X_{..}$	HHB 118	HHB 119	HHB 94	HHB 118	HHB 87
$b_i > 1.0$		HHB 126	HHB 127	HP 91450	
$Sd_i^2 \cong 0$		HHB 123	HP 912	HHB 130	HHB 128
		HP 95501	HP 95778	HP 8601	
		HP 95778		HP 95501	
				HP 95778	
$X_i > X_{..}$	HP 95501	-	-	-	HHB 94
$b_i > 1.0$	HP 912				
$Sd_i^2 \cong 0$	HHB 68				

HP 95501 and HP 95778 were ideal for all environments. Genotype HHB 112 was responsive to favorable environment ($b_i > 1.0$), but none was found suitable for poor environment ($b_i < 1.0$). In case of ear length 8 genotypes were stable. Among these HHB 94, HHB 127, HP 912 and HP 95778 were stable over environments, but none was suitable either for favorable or poor environments. For ear weight, 12 genotypes expressed non-significant b_i and Sd_i^2 values, suggesting their stability over environments. Out of these, HHB 118, HHB 120, HP 91450, HP 8601, HP 95501 and HP 95778 were found ideal ($b_i \cong 0$, $Sd_i^2 \cong 0$). Only four genotypes, namely HHB 94, HHB 120, HHB 128 and HP 91773, were found suitable for favorable environments, and none was suitable for poor environments ($b_i < 1.0$). In case of 1000-grain weight, only HHB 67 was found suitable over environments. On the other hand, HTP 88 and HHB 94 were found responsive for good and poor environments, respectively.

On the basis of the results genotype HHB 118, with high mean performance for grain yield and ear weight, can be recommended for its testing over time and space. On the other hand, hybrids HHB 94, HHB 128 and population HP 91773 were found to have high yield under

favorable environments, but hybrid HHB 68 and populations HP 95501 and HP 912 performed better under dryland conditions.

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