Genotype x environment interactions and stability analysis in pearl millet [Pennisetum glaucum (L.) R. Br.]

Amit Kumar, Dhirendra Singh, Sandeep Kumar Bangarwa and Mukesh Kumar Yadav

DOI: https://doi.org/10.22271/chemi.2020.v8.i1j.8338

Abstract
An experiment was conducted on eighteen hybrids of Pearl Millet (Pennisetum glaucum L.) over three artificial created environments by providing different levels of fertilizers, during kharij 2018 in RBD with three replications to estimate genotype x environment interaction. The environment indices of each character had wide difference for grain yield ranging from -2.85 in environment-III to 1.76 in environment-I as well as for other characters. The hybrids chosen widely varied in their mean grain yield, ranging from 23.17 (MARU-TEJ) to 30.73 (KBH-108). The highest yielding hybrid were MPMH-17, HHB-197 and RHB-177. Mean grain yield was linearly influenced by the environments it was lowest in the environment-III. Hybrids HHB-197 and MPMH-17 were found relatively stable for grain yield. HybridsRHB-223, HBB-299 and 9001 have below average stability for grain yield and suitable for better environmental conditions. HybridsRHB-233, HHB-67, GHB-744 and 9450 have above average stability for grain yield and suitable for poor environmental conditions.

Keywords: G x E interaction, stability, regression, fertilizer

Introduction
Pearl millet [Pennisetum glaucum (L.) R. Br.] locally known as bajra with 2n = 14 chromosome number belongs to the family Poaceae (Gramineae). It is an important coarse cereal crop of semi-arid tropics that does well on light textured soil with low moisture condition. It is believed to have originated in West Africa (Vavilov, 1950 and Murdock, 1959) from where it spread into India and other countries. Pearl millet is highly cross pollinated crop with protogynous condition. Pearl millet grain contains 8.5 to 15 per cent protein, 5.03 to 6.0 per cent fat, 1.05 to 1.7 per cent crude fibre and 65.5 to 70 per cent carbohydrates. As a food crop, pearl millet grain possesses the highest amount of calories per 100 gram (Burton et al., 1972) which is mainly supplied by carbohydrates, fats and proteins (Flech, 1981). Important quality aspects of pearl millet forage are high protein (11.6 per cent), low lignin, high dry matter yield, easy to digestible and possesses less oxalic acid which is an anti-nutritional factor (Hanna et al., 1999). Although, crude protein content (9.9-14 per cent) in pearl millet stover is less than sorghum, it is more than wheat and rice. The toxic component HCN is quantitatively less in green fodder of pearl millet in comparison to sorghum (Hanna et al., 1999). The realized productivity of pearl millet is below its potential. The main reasons of poor crop yield are low soil-moisture availability to crop usually at critical stages of growth during growing season and lack of proper nutrient management, and lack of instable varieties/hybrids. The phenotypic expression of a character is resultant of the interactions between genotype and environment. The estimates of genetic parameters obtained in one environment are biased due to the confounding of the G x E interaction effect with the genotype effects. It is therefore, necessary to take into account the G x E interaction while determining the estimates of various genetic parameters to have unbiased picture in the expression of various characters. Looking these facts, the need is to develop varieties that would give stable production from year to year and place to place even under moisture stress conditions. The term stability analysis is often associated with the analysis of variety trials.
It refers to a method of assessing the variations of each variety between the tested environments. The yield of a variety in each environment can be regressed linearly on the average yields of all varieties to determine its stability across to the tested environments. The resulting regression coefficient, or slopes, can be taken to indicate whether each variety is stable across environments or it is sensitive to the differences between them. The detection of significant genotype x environment (G x E) interaction indicates that phenotypic responses to changes in the environment are not the same for all genotypes. This means that the best genotype in one environment is not the best in another environment. If the interaction components are relatively large compared to the genotypic components, and if they are related to predictable environmental factors, the breeder searches for a cultivar that has general adaptability and universal performance over the range of environments (Abdelrahman and Abdalla, 2002) [1]. The present study was conducted to evaluate and identify the pearl millet hybrids with wider adaptation over a range of environments using stability analysis.

**Materials and methods**

The present investigation was conducted at Research Farm, SKN College of Agriculture, Jobner (Rajasthan). Jobner is located at 26.97°N and 75.38°E. It has an average elevation of 400 metres (1312 feet). The materials for study consisted of eighteen hybrids of pearl millet taken from the R.A.R.I. Durgapura, Jaipur. The list of hybrids used in the study is presented in Table 1.

| Table 1: List of hybrids |
|-------------------------|
| S. No. | Number of Hybrids | S. No. | Number of Hybrids |
| 1 | RHB-173 | 10 | HHB-67 |
| 2 | RHB-177 | 11 | HHB-197 |
| 3 | RHB-223 | 12 | HHB-299 |
| 4 | RHB-233 | 13 | 9450 |
| 5 | RHB-234 | 14 | 9001 |
| 6 | GHB-538 | 15 | 86-M-86 |
| 7 | GHB-558 | 16 | MCPH-17 |
| 8 | GHB-744 | 17 | MARU-TEJ |
| 9 | GHB-905 | 18 | KBH-108 |

**Experimental method**

The experimental material were evaluated in randomized block design with 3 replications during kharif season 2018 in three artificially created environments by different dose of fertilizers as given below.

1. 150% Recommended dose of fertilizer (E1) i.e N₂@ 90 kg/ha, P₂O₅ @ 45 kg/ha, K₂O @ 45 kg/ha.
2. 100% Recommended dose of fertilizer (E2) i.e. N₂@ 60 kg/ha, P₂O₅ @ 30 kg/ha, K₂O @ 30 kg/ha.
3. 50% Recommended dose of fertilizer (E3) i.e N₂@ 30 kg/ha, P₂O₅ @ 15 kg/ha, K₂O @ 15 kg/ha.

In each environment/replication, each hybrid was sown in plot size 4.0 x 0.6 m² consisting two row of each hybrid. The row to row and plant to plant distances were kept 45 cm and 10 cm, respectively.

**Statistical analysis**

The data on each character for the varieties were subjected to standard statistical analysis of variance for each environment separately (Panse and Sukhatme, 1985) [6]. Later the data of each were subjected to pooled analysis of variance (Singh and Choudhary 1985) [7]. The source of variation, along with their degrees of freedom and expectations of mean squares for the joint analysis is given in Table 2.

| Source | d.f. | SS | EMSS |
|--------|------|----|------|
| Rep. within Env. | c(r-1) | | |
| Hybrids | (v-1) | MS1 | $\sigma^2c + r \sigma^2vs + s \sigma^2v$ |
| Environments | (s-1) | MS2 | $\sigma^2c + r \sigma^2vs + vr\sigma^2s$ |
| Var., x Env. | (v-1)(s-1) | MS3 | $\sigma^2c + r \sigma^2vs$ |
| Errors | (r-1)(v-1) | MS4 | $\sigma^2c$ |
| Total | (vsr-1) | | |

The environment wise analysis of variance was also conducted for each character.

**Stability analysis**

The stability analysis was done according to Eberhart and Russell (1966) [3]. The basic model employed is as follows:

$$Y_{ij} = \mu_i + \beta i + \delta ij$$

Where,

$Y_{ij}$ = Mean of the $i$th variety at $j$th environment,

$\mu_i$ = Mean of the $i$th variety over the environments

$\beta i$ = Regression coefficient of $i$th variety to varying environments indices.

**Joint Regression Analysis**

The table below gives the sources of the joint regression analysis along with the formulae used to obtained the sums of squares for each sources (Table 3) using the means over replication.

The significance of the variance due to varieties, environments, varieties x environments interaction,
environmental (linear), varieties x environments (linear) was tested against pooled error. But the pooled deviation was tested against the pooled error for testing the pooled deviation which was derived by the following formula:

\[
Pooled \text{error for testing pooled deviation } MS = Pooled \text{ error } MSS \setminus r
\]

Where,
\[
r = \text{number of replications}
\]

**Stability parameters**

According to Eberhart and Russell (1966) [3] model the stability of genotype is judged on the basis of mean, \((x)\) regression coefficient \((b)\) and deviation from the regression \((S^2_d)\). These parameters were measured for each variety as follows:

\[
\text{Mean}(x) = \frac{\sum_i Y_{ij}}{stv}
\]

where,
\[
s = \text{no. of environment}, \ v = \text{no. of varieties}, \ r = \text{no. of replications}
\]

**Regression coefficient** \((b)\):

\[
\frac{\sum Y_{ij} I_j}{\sum I_j^2}
\]

\(Y_{ij}\) an \(I_i;\) refers to the performance of \(i^{th}\) variety at \(j^{th}\) environment and index, respectively as explained earlier.

**Table 3: Joint regression analysis of variance (Eberhart and Russell, 1966) [3]**

| Source                      | d.f. | S.S. | M.S.  |
|-----------------------------|------|------|-------|
| Hybrids (v)                 | (v-1)| \((1/s)\sum Y_{ij}^2\) - C.F. | \(MS1\) |
| Env. + (Var. x Env.)        | v(s-1)| \(\sum (\sum Y_{ij} - \sum Y_{ij}/s)^2\) | \(MS2\) |
| Env. (Linear)               | 1    | \(1/s(\sum Y_{ij})^2 / \sum I_j^2\) | \(MS3\) |
| Var. x Env. (Linear)        | v-1  | \(\sum (\sum Y_{ij}^2 / \sum I_j^2) - \text{Env. (linear) SS}\) | \(MS4\) |
| Pooled deviation            | v-(s-2)| \(\sum (\sum Y_{ij}^2 - \sum I_j^2 / s) - \sum (\sum Y_{ij} I_j^2) / \sum I_j^2\) | \(MS5\) |
| Pooled Error                | s(r-1)-(v-1)| \(\sum Y_{ij}^2 / \sum I_j^2\) | \(MS6\) |

\(Y_{ij}\) an \(I_i;\) refers to the performance of \(i^{th}\) variety at \(j^{th}\) environment and index, respectively as explained earlier.

The mean days to 50 per cent flowering ranged from 44.56 (RHB-177) to 57.11 days (KBH-108). The regression coefficient ranged from 0.19 (GHB-558) to 1.64 (HHB-299). The \(S^2_d\) values of all the hybrids were non-significant (Table 6). The environmental indices ranged from -3.50 to 3.01 days (Table 4), indicating wide difference among the environments for this character. The mean days to maturity ranged from 79.73 (RHB-177) to 92.00 days (KBH-108). The regression coefficient ranged from 0.02 (GHB-558) to 1.60 (HHB-299). The \(S^2_d\) estimates of all the hybrids were non-significant (Table 6). The environmental indices ranged from -3.5 to 2.99 days. The mean value of plant height ranged from 133.66 (RHB-177) to 3.03 (9001). The regression coefficient ranged from -0.29 (MPMH-17) to 2.99 (RHB-233). The \(S^2_d\) estimates of most hybrids were non-significant except HHB-299 (\(S^2_d=151.17\)) (Table 7). The mean number of tillers per plant ranged from 2.31 (86-M-86) to 3.31 (9001). The regression coefficient ranged from -0.22 (KBH-108) to 1.95 (HHB-197). The \(S^2_d\) estimates of most hybrids were non-significant except RHB-173, GHB-744, GHB-558, HHB-67, HHB-197, 9001, MMPH-17, MARU-TEJ (Table 7). The average mean of panicles length ranged from 18.94 (MARU-TEJ) to 25.27 cm (RHB-233). The regression coefficient ranged from -0.29 (MPMH-17) to 2.99 (RHB-233). The \(S^2_d\) estimates of most of hybrids was non-significant except GHB-558, HHB-299, 9001, 9450 and KBH-108, (Table 8). The weight of 1000 grain varied from 86.69 (RHB-173) to 10.61 (GHB-744). The regression coefficient ranged from -0.55 (9001) to 2.61

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The Sd estimates were all the hybrids were non-
significant (Table 9). The environmental indices ranged from
-0.57 to 0.84 (Table 4), indicating differences among the
environments. The mean biological yield per plant ranged
from 71.44 (MARU-TEJ) to 81.44 g (S6-M-86). The
regression coefficient ranged from 0.21 (RHB-233) to 1.81
(KHB-108) (Table 9). The environmental indices ranged from
-6.17 to 7.04 (Table 4). The Sd estimates of most hybrids
were non-significant except HHH-197, 9450, MARU-TEJ.
The mean harvest index ranged from 30.13 (RHB-173) to
36.93 % (RHB-233). The regression coefficient ranged from
1.12 (RHB-234) to 3.68 (9001) (Table 10). The
environmental indices ranged from -1.93 to 1.82 (Table 4).
The Sd value were non-significant except 9450, HHH-197,
RHH-538, GHB-558, RHB-173 (Table 10), indicating that
most of the hybrids were instable for this character. Thus,
mean and regression coefficient was considered for the
grading of hybrids for their stability. The mean grain yield per
eight plant ranged from 23.17 (RHB-173) to 30.73 g (KHB-
108). The regression coefficient ranged from -0.49 (RHB-
173) to 2.14 (S6-M-86) (Table 4.10). The environment indices
ranged from -2.85 to 1.76 (Table 4), indicating wide
differences among the environments. The Sd associated with
most of hybrids were non-significant except HHH-67, GHB-
744, RHB-538. (Table 10). Hybrids RHB-177, HHH-197 and
MPMH-17 were found relatively stable for grain yield per
plant. Most of these hybrids were also found stable and
desirable for one or other yield components e.g. HHH-197
was stable for tillers per plant, biological yield per plant and
harvest index. MPH-17 was stable for tillers per plant and
panicle length.

Significant genotype x environment interaction were observed
for all characters except days to 50% flowering, days to
maturity, plant height (cm) and panicle length (cm). Hybrids
RHB-177, HHH-197 and MPH-17 were found stable for
most of the characters which will be suitable for changing
environmental conditions. The environment + (genotypes x
environment) interaction was significant for most of the
characters except plant height (cm), panicle length (cm),
panicle diameter (cm). (Table 5).

### Table 4: Environment indices for different characters of pearl millet hybrids

| Environments | Days to 50% flowering | Days to maturity | Plant height (cm) | Tillers per plant | Panicle length (cm) | Panicle diameter (cm) | 1000 grain weight (g) | Biological yield/plant (g) | Harvest index (%) | Grain yield/plant (g) |
|--------------|-----------------------|------------------|-------------------|-------------------|---------------------|-----------------------|-----------------------|--------------------------|-----------------|-----------------------|
| Environment-I (150% R.D.F.) | -3.5 | -3.5 | 8.72 | 0.59 | 1.96 | 0.09 | 0.84 | 7.04 | -0.117 | 1.764 |
| Environment-II (100% R.D.F.) | 0.48 | 0.53 | 6.61 | -0.03 | -0.72 | 0.06 | -0.27 | -0.87 | 1.821 | 1.088 |
| Environment-III (50% R.D.F.) | 3.01 | 2.99 | -15.34 | -0.56 | -1.24 | -0.16 | -0.57 | -6.17 | -1.938 | -2.853 |
| Grand mean | 50.06 | 85.00 | 156.67 | 2.88 | 21.23 | 2.39 | 9.88 | 76.36 | 33.33 | 26.05 |

### Table 5: Joint regression analysis (Eberhart and Russel, 1966) for different characters tested over three environments

| Source | d.f. | Days to 50% flowering | Days to maturity | Plant height (cm) | Tillers per plant | Panicle length (cm) |
|--------|------|-----------------------|------------------|-------------------|-------------------|---------------------|
| Hybrids | 17 | 56.89** | 56.41** | 865.21** | 0.23** | 9.12 |
| Env. + (Gen.x Env.) | 36 | 15.36* | 15.32* | 242.02 | 0.53** | 6.20 |
| Env. (Linear) | 1 | 388.68** | 383.72** | 6395.41** | 12.05** | 107.20** |
| Gen. x Env. (Linear) | 17 | 4.04 | 3.47 | 94.42 | 0.24** | 2.41 |
| Pooled deviation | 18 | 5.32 | 6.05 | 39.56 | 0.16** | 4.17** |
| RHB-173 | 1 | 6.26 | 6.71 | 100.52 | 0.93** | 0.20 |
| RHB-177 | 1 | 0.89 | 0.60 | 55.53 | 0.05 | 0.19 |
| RHB-223 | 1 | 1.04 | 0.76 | 3.79 | 0.04 | 0.52 |
| RHB-233 | 1 | 0.02 | 0.03 | 0.08 | 0.02 | 0.02 |
| RHB-234 | 1 | 4.80 | 3.96 | 0.01 | 1.00 |
| RHB-538 | 1 | 11.29 | 10.90 | 22.83 | 0.01 | 0.66 |
| GHB-558 | 1 | 10.11 | 14.73 | 0.18 | 0.13** | 14.56** |
| GHB-744 | 1 | 18.38 | 19.14 | 15.00 | 0.14* | 2.95 |
| GHB-905 | 1 | 0.58 | 0.71 | 24.05 | 0.01 | 1.79 |
| HHH-67 | 1 | 10.58 | 11.10 | 8.79 | 0.16* | 3.78 |
| HHH-197 | 1 | 2.38 | 2.71 | 147.48 | 0.43** | 1.80 |
| HHH-299 | 1 | 11.88 | 11.55 | 193.50* | 0.12 | 6.70* |
| 9450 | 1 | 6.36 | 5.89 | 9.71 | 0.06 | 6.76* |
| 9001 | 1 | 2.63 | 2.40 | 73.52 | 0.24** | 16.36** |
| 86-M-86 | 1 | 5.07 | 4.65 | 9.30 | 0.04 | 1.22 |
| MPH-17 | 1 | 2.68 | 10.25 | 5.24 | 0.14* | 1.13 |
| MARU-TEJ | 1 | 0.12 | 1.90 | 0.09 | 0.22** | 0.32 |
| KHH-108 | 1 | 0.61 | 0.83 | 42.44 | 0.03 | 15.04** |
| Pooled error | 102 | 15.52 | 15.61 | 127.01 | 0.10 | 4.26 |
| Total | 53 | 28.68 | 28.50 | 441.91 | 0.43 | 7.14 |

| Source | d.f. | Panicle diameter (cm) | 1000 grain weight (g) | Biological yield/plant (g) | Harvest index (%) | Grain yield/plant (g) |
|--------|------|------------------------|-----------------------|--------------------------|-----------------|-----------------------|
| Hybrids | 17 | 0.19* | 1.14** | 27.90** | 14.94* | 14.91** |
| Env. + (Gen. x Env.) | 36 | 0.08 | 0.97* | 57.90** | 19.24** | 13.49** |
| Env. (Linear) | 1 | 0.70** | 19.72** | 1549.19** | 127.57** | 223.89** |
| Gen. x Env. (Linear) | 17 | 0.04 | 0.79* | 15.26* | 19.34** | 10.89** |
| Pooled deviation | 18 | 0.07** | 0.11 | 12.83* | 13.12** | 4.25* |
Table 6: Mean values and stability parameters (b and $S^2_a$) of the Pearl millet hybrids for days to 50% flowering and days to maturity

| Hybrids | Days to 50% flowering | Days to maturity |
|---------|-----------------------|-----------------|
|         | Mean | b   | $S^2_a$ | Mean | b   | $S^2_a$ |
| RHB-173 | 52.44 | 1.21* | 1.09 | 87.44 | 1.21* | 1.51 |
| RHB-177 | 44.56 | 0.43* | 4.20 | 79.33 | 0.54** | -4.61 |
| RHB-223 | 45.11 | 0.79** | 6.14 | 85.56 | 0.46** | -5.18 |
|         | 50.56 | 0.45** | 5.53 | 85.56 | 0.46** | -5.18 |
| RHB-905 | 49.11 | 1.05** | 4.59 | 84.11 | 1.06** | -4.50 |
| HBB-67  | 44.78 | 1.09 | 5.41 | 79.78 | 1.08 | 5.89 |
| HBB-197 | 44.89 | 1.44** | 2.79 | 79.89 | 1.44** | -2.49 |
| HBB-299 | 53.67 | 1.64** | 6.71 | 88.56 | 1.60* | 6.34 |
| 9450    | 54.67 | 1.30* | 1.19 | 89.67 | 1.31* | 0.69 |
| 9001    | 56.22 | 0.97* | 2.54 | 91.22 | 0.98* | -2.80 |
| 86-M-86 | 55.56 | 1.29* | 0.10 | 90.56 | 1.31* | -0.55 |
| MPMH-17 | 48.22 | 1.63** | 2.49 | 82.11 | 1.18 | 5.04 |
| MARU-TEJ| 44.38 | 0.57** | 0.05 | 80.89 | 1.04** | -3.30 |
| KBB-108 | 57.11 | 0.53** | 4.56 | 92.00 | 0.49* | -4.38 |
| S.Em+   | 1.63 | 0.49 | 1.74 | 0.53 | 1.00 |
| Pop. Mean | 50.60 | 1 | 85.00 | 1 |

*, ** = significant at 5% and 1% levels, respectively

Table 7: Mean values and stability parameters (b and $S^2_a$) of the pearl millet hybrids for plant height (cm) and productive tillers per plant

| Hybrids | Plant height (cm) | Tiller per plant |
|---------|------------------|------------------|
|         | Mean | b   | $S^2_a$ | Mean | b   | $S^2_a$ |
| RHB-173 | 156.11 | 0.80 | 58.18 | 3.03 | 1.36 | 0.90** |
| RHB-177 | 171.63 | 1.40** | 13.19 | 2.64 | 0.74* | 0.02 |
| RHB-223 | 144.07 | 1.99** | 38.54 | 2.84 | 1.95** | 0.01 |
| RHB-905 | 168.31 | 1.52** | 42.26 | 3.18 | 0.30 | -0.02 |
| HBB-67  | 146.78 | 0.95** | 42.33 | 3.00 | 0.50 | 0.04 |
| HBB-197 | 155.10 | 0.96** | 19.49 | 3.07 | 1.05** | -0.02 |
| 9450    | 143.99 | 1.10** | 42.16 | 2.47 | 0.67 | 0.09* |
| 9001    | 167.23 | 1.73** | 27.34 | 2.80 | 1.02* | 0.11* |
| 86-M-86 | 136.78 | 0.67* | 18.28 | 3.01 | 1.50** | -0.02 |
| MPMH-17 | 141.93 | 1.10** | 33.54 | 3.31 | 1.58** | 0.13* |
| KBB-108 | 156.61 | 2.01** | 105.14 | 3.00 | 1.95* | 0.39** |
| S.Em+   | 146.73 | -0.20 | 151.17* | 2.78 | 1.59 | 0.08 |
| RHB-299 | 148.91 | 0.91** | 32.63 | 2.96 | 0.45 | 0.02 |
| 9001    | 178.11 | 1.27* | 31.18 | 3.31 | 1.19 | 0.21** |
| 86-M-86 | 181.98 | 0.77** | 33.03 | 2.31 | 0.39 | 0.01 |
| MARU-TEJ| 140.83 | 0.24 | 37.10 | 2.93 | 1.02* | 0.11* |
| KBB-108 | 133.66 | 0.56** | 42.25 | 2.71 | 0.89 | 0.19** |

*, ** = significant at 5% and 1% levels, respectively
### Table 8: Mean values and stability parameters (b_i and s^2_{ai}) of the pearl millet hybrids for panicle diameter and panicle length (cm)

| Hybrids | Panicle length (cm) | Panicle diameter (cm) |
|---------|---------------------|-----------------------|
|         | Mean    | b_i     | S^2_{ai} | Mean    | b_i     | S^2_{ai} |
| RHB-173 | 23.09   | 0.89**  | -1.22    | 2.34    | 2.15    | 0.04     |
| RHB-177 | 20.22   | 0.72**  | -1.23    | 2.16    | 0.52    | 0.03     |
| RHB-223 | 20.09   | 0.79*   | -0.90    | 2.48    | 1.47**  | -0.02    |
| RHB-233 | 25.27   | 2.29**  | -1.40    | 2.55    | 0.90    | 0.01     |
| RHB-234 | 20.91   | 1.48*   | -0.42    | 2.34    | 0.17    | 0.05     |
| RHB-538 | 19.80   | 1.59**  | -0.76    | 2.21    | 1.51**  | -0.02    |
| GHB-558 | 21.10   | 0.96    | 13.14**  | 2.41    | -0.08   | 0.02     |
| GHB-444 | 20.84   | 1.16    | 1.54     | 2.27    | 0.85    | 0.02     |
| GHB-905 | 22.39   | 1.16    | 0.37     | 2.33    | 0.75    | 0.05     |
| HBB-67  | 19.51   | 1.70*   | 2.36     | 1.98    | -0.46   | 0.20**   |
| HBB-197 | 21.01   | 1.20*   | 0.38     | 2.47    | 2.50**  | 0.01     |
| HBB-299 | 19.32   | 0.49    | 5.28*    | 2.59    | 1.20    | 0.19**   |
| 9450    | 23.48   | 1.09    | 5.34*    | 2.57    | 1.44    | 0.10*    |
| 9001    | 22.30   | 0.15    | 14.94**  | 2.56    | 3.03**  | 0.01     |
| 86-M-86 | 23.34   | -0.20   | -0.20    | 2.94    | 0.08    | 0.01     |
| MPMH-17 | 19.60   | -0.29   | -0.29    | 2.22    | 1.87**  | -0.02    |
| MARU-TEJ| 18.94   | 1.21**  | -1.10    | 1.88    | -1.20   | 0.22**   |
| KBH-108 | 22.89   | 1.43    | 13.62**  | 2.65    | 1.22    | 0.05     |
| S.Emk   | 1.44    | 0.83    | 0.19     | 1.36    |         |          |

* ** = significant at 5% and 1% levels, respectively

### Table 9: Mean values and stability parameters (b_i and s^2_{ai}) of the pearl millet hybrids for biological yield (g) and 1000 grain weight (g)

| Hybrids | 1000 grain weight (g) | Biological yield (g) |
|---------|-----------------------|-----------------------|
|         | Mean    | b_i     | S^2_{ai} | Mean    | b_i     | S^2_{ai} |
| RHB-173 | 8.69    | 2.34**  | -0.27    | 79.78   | 1.34**  | -0.70    |
| RHB-177 | 9.39    | 1.22**  | -0.27    | 79.56   | 0.99**  | -0.62    |
| RHB-223 | 9.56    | 2.61**  | -0.14    | 78.33   | 1.39**  | -0.51    |
| RHB-233 | 8.95    | 1.47    | 0.41     | 73.89   | 0.21    | 1.72     |
| RHB-234 | 9.43    | 1.06    | 0.03     | 73.11   | 1.07**  | 2.64     |
| RHB-538 | 10.31   | 1.10*   | -0.10    | 76.56   | 1.34**  | -2.33    |
| GHB-558 | 10.07   | 0.58**  | -0.27    | 71.78   | 0.45**  | -6.81    |
| GHB-744 | 10.61   | 0.39    | -0.23    | 73.78   | 0.75**  | -6.74    |
| GHB-905 | 10.56   | 1.10*   | -0.10    | 79.44   | 0.78**  | -6.80    |
| HBB-67  | 10.16   | 0.76**  | -0.24    | 76.44   | 1.60**  | 3.65     |
| HBB-197 | 10.17   | 0.22**  | -0.27    | 76.67   | 0.83    | 53.05**  |
| HBB-299 | 10.09   | 0.68**  | -0.22    | 76.33   | 0.37**  | -6.16    |
| 9450    | 10.27   | 1.61**  | -0.27    | 78.11   | 0.94    | 41.17**  |
| 9001    | 9.51    | -0.55   | -0.21    | 78.70   | 1.60**  | 0.24     |
| 86-M-86 | 10.51   | 1.25**  | -0.24    | 81.44   | 1.03**  | -1.93    |
| MPMH-17 | 8.85    | 1.45    | 1.04     | 72.00   | 1.12**  | -1.36    |
| MARU-TEJ| 10.14   | 1.37**  | -0.25    | 71.44   | 0.97    | 43.28**  |
| KBH-108 | 10.51   | 1.26**  | -0.27    | 78.78   | 1.84**  | 11.80    |
| S.Emk   | 0.23    | 0.31    | 2.532    | 0.38    |         |          |

* ** = significant at 5% and 1% levels, respectively

### Table 10: Mean values and stability parameters (b_i and s^2_{ai}) of the pearl millet hybrids for harvest index (%) and grain yield per plant (g)

| Hybrids | Harvest index (%) | Mean    | b_i     | S^2_{ai} | Grain yield per plant (g) | Mean    | b_i     | S^2_{ai} |
|---------|-------------------|---------|---------|----------|--------------------------|---------|---------|----------|
| RHB-173 | 30.13             | -1.05   | 45.92** | 23.71    | -0.49                    | 1.23    |
| RHB-177 | 33.90             | 2.07**  | -3.87   | 27.09    | 1.89**                   | -2.49   |
| RHB-223 | 34.71             | 3.17**  | 5.20    | 27.86    | 2.10**                   | -9.87   |
| RHB-233 | 36.93             | -0.73   | -4.68   | 28.84    | -0.32                    | -2.36   |
| RHB-234 | 32.88             | -1.12   | 10.20   | 23.80    | 0.01                     | -2.01   |
| RHB-538 | 31.99             | 1.64    | 39.32** | 24.65    | 0.49                     | 10.80*  |
| GHB-558 | 31.22             | -1.06   | 26.75** | 23.61    | 0.54                     | 9.60*   |
| GHB-744 | 33.30             | -0.27   | -5.20   | 24.51    | 0.47                     | -0.55   |
| GHB-905 | 32.15             | -0.71   | -4.59   | 25.51    | 0.33                     | 3.78    |
| HBB-67  | 30.24             | -0.31   | 0.46    | 24.26    | 0.54                     | 9.77*   |

* 674 *
|        | 34.91 | 1.24 | 15.50* | 27.99 | 1.78* | 4.97 |
|--------|-------|------|--------|-------|-------|------|
| HHB-197 | 34.47 | 2.91 | 12.66  | 26.59 | 2.09**| -2.44|
| HHB-299 | 33.06 | 0.52 | 24.78* | 25.78 | 0.11  | 0.18 |
| 9001   | 36.82 | 3.68**| 0.40  | 28.28 | 2.05* | 7.00 |
| 9450   | 34.96 | 2.36**| -4.38 | 28.36 | 2.14**| -2.03|
| 86-M-86| 31.44 | 3.17**| -3.86 | 24.19 | 1.69**| 1.35 |
| MPMH-17| 30.33 | 1.00 | -0.56  | 23.17 | 0.63**| -2.41|
| MARU-TEJ| 36.58 | 1.49 | -1.14  | 30.73 | 1.96**| -1.79|
| KBH-108| 2.561 | 1.360|       | 1.458 | 0.584 |      |
| S.Em+  |       |      |        |       |       |      |
| Pop. Mean | 33.33 | 1    |        | 26.05 | 1     |      |

*, ** = significant at 5% and 1% levels, respectively

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