RESEARCH PAPER

ADVANCE RESEARCH JOURNAL OF
CROP IMPROVEMENT
Volume 6 | Issue 2 | December, 2015 | 119-123
e ISSN-2231-640X

DOI : 10.15740/HAS/ARJCI/6.2/119-123
Visit us: *www.researchjournal.co.in*

Estimation of g x e interactions in exotic germplasm of pearl millet (*Pennisetum glaucum* L.)

OM VIR SINGH AND A.K. SINGH[1]

AUTHORS' INFO

Associated Co-author :
[1]National Bureau of Plant Genet Resources, Regional Station, CAZRI Campus, JODHPUR (RAJASTHAN) INDIA

Author for correspondence:
OM VIR SINGH
National Bureau of Plant Genet Resources, Regional Station, CAZRI Campus, JODHPUR (RAJASTHAN) INDIA

ABSTRACT : Twenty seven accessions of pearl millet germplasm of African origin along with check HHB 67 were evaluated in eight environments for eight quantitative traits and data were subjected to regression analysis and also analysed to detect the presence of crossover and non-crossover interactions. Seven accessions namely, EC 539227, EC 539241, EC 468904, EC 539254, EC 539259, EC 468900, and EC468896 were identified to be promising based on regression analysis, whereas accessions EC 539299, EC 541536, EC 468904, EC 539227, EC 468898, EC 541540 and EC 539251 were identified as potential ones by using crossover and non-crossover interactions concepts against standard check HHB 67. Of these accessions EC 468904 was identified as high yielding accession having specific adaptability and responsiveness to higher nitrogen regimes both by regression analysis and crossover and non-crossover interactions concept.

KEY WORDS : Pearl millet, Genotype x environment interaction, Crossover and non-crossover interaction, Regression analysis

How to cite this paper : Singh, Om Vir and Singh, A.K. (2015). Estimation of g x e interactions in exotic germplasm of pearl millet (*Pennisetum glaucum* L.). *Adv. Res. J. Crop Improv.,* **6** (2) : 119-123.

Paper History : **Received :** 17.10.2015; **Revised :** 27.10.2015; **Accepted :** 12.11.2015

Pearl millet [*Pennisetum glaucum* (L.) R.Br.], the world's hardiest crop, is an important food and fodder crop in Africa and Asia and forage in America. India is the largest‘ producer of pearl millet in Asia, both in terms of area (about 8.1 million ha) and production (9.6 million tons) with an average productivity of 1186 kg/ha (Yadav, 2015). Its grain is a staple food of people living in arid regions of India and also has a high feed value for livestock, poultry and fish (Yadav, 2015). The low grain yield of pearl millet invites attention for systematic and concerted efforts to develop cultivars having high yield potential with stability at a specific location over the years or stable performance across the locations (Steel and Torrie, 1980). The pearl millet germplasm is the store house of useful genes for yield, drought tolerance, diseases and insect pests tolerance/ resistance (Yadav and Weltzein, 2000) and it has been used in breeding programme worldwide (Andrews and Kumar, 1996) as well as traits for improving grain and fodder quality (Kelley *et al*, 1996). To enhance the productivity of pearl millet breeders look for location specific accession that should be responsive to input intensive agriculture. The regression technique describes the response pattern of individual accession without differentiating the kind of g x e interaction involving change in magnitude of response or direction among the accessions (Allard and Bradshaw, 1964; Finlay and Wilkinson, 1963;Eberhart and Russell, 1966 and Perkins and Jinks, 1968). Baker (1988) described a test initially purposed by Gail and Simon (1985) and illustrated its application to test the kind of interaction in crop plants. The concept of cross over and non-cross over interactions is important in decision making related to crop improvement strategies (Yates and Cochran, 1938; Virk and Mangat, 1991) as the presence of crossover interaction is a substantial evidence in favour of breeding for specific adaptation. The accessions exhibiting crossover interaction against a standard variety can be said to have specific adaptability and can replace that standard variety in the specific environments. In view of these facts, the present investigation was carried out with 27 accessions of African origin in eight environments created by manipulating the fertility status of soils over four years to identify a stable and high nitrogen responsive accession using regression analysis (Baker, 1988; Virk and Mangat, 1991) and crossover and non-crossover interactions concept (Gail and Simon, 1985). Information on this aspect on germplasm of pearl millet is scanty.

Research Procedure

Twenty seven accessions of African origin of pearl millet germplasm, along with most popular pearl millet hybrid HHB 67 were raised in the Randomized Complete Block Design with three replications in eight environments in the hot arid climate at Crop Research Centre of National Bureau of Plant Genet Resources, Regional Station, Jodhpur. Environments were created by manipulating the fertility levels of soil by applying two doses of nitrogen *i.e.* 120kg/ha and 160kg/ ha over four years. Thus, eight environments were created, *i.e.* two during *Kharif* 2012 *i.e.* Env. I (120 kg N/ha), Env. II (160 kg N/h), Similarly, Env. III and Env. IV were created during *Kharif* 2013, Env. V and Env. VI during *Kharif* 2014 and Env. VII and Env. VIII during *Kharif* 2015. The plot size consisted of 4 rows of 3 meter length at 45 cm spacing and plant to plant distance within the row was kept 15 cm. All standard recommended package of practices were followed to raise good experiments. The initial soil fertility status of each environment with respect to available N, P and K was worked out and found to be similar. Half of the nitrogen dose was applied at the time of seedbed preparation and remaining half was side dressed at the stage of 25 days old plants. The observations were recorded on five randomly taken plants in each replication. The data were recorded on days to 50 per cent flowering, plant height (cm), number of tillers per plant, number of leaves per plant, panicle length (cm), panicle diameter (cm), test weight (gm), and grain yield per plant (g). Data were analysed separately for each environment. Adjusted progeny means were used for the combined analysis for the traits exhibiting the presence of gxe interaction. Regression analysis and analysis to detect the presence of crossover and non-crossover interactions were carried out as per Eberhart and Russell (1966) and Perkins and Jinks (1968) and Gail and Simon (1985).

Research Analysis and Reasoning

Analysis of variance revealed significant differences among accessions for the eight traits in all eight environments. The combined analysis revealed the presence of g x e interaction for grain yield/plant, number of fertile tillers per plant, plant height (cm), panicle length (cm), panicle diameter (cm), number of leaves per plant, 1000-seed weight (test weight) and days to 50 per cent flowering. Regression analysis enables breeders to select desirable accessions with respect to the responsiveness and stability in different environments (Gupta and Ndoye, 1991; Pethani and Kapoor, 1985 and Benti *et al.*, 1996). In the present study, the accessions EC 539241,EC 468904, EC 539254EC 539259, EC 468900 and EC468896 had above average performance and responsiveness with respect to grain yield/plant (Table 1). Among these high yielding accessions, EC 539241, EC 539254, EC 539259, EC 468900 and EC468896 can be designated as stable ones with average responsiveness. Though the accession EC 468904 is an above average yielder and also had shown above average responsiveness coupled with instability, it was the highest yielder in Env. II (year 2012, 160kg N/ha) followed by EC 539241, EC 539259, EC 468900, EC 539254, and EC468896 which were significantly superior to the best check. The accession EC 468904 showed above average performance and instability for 1000-grain weight, being the best performer for these traits again in Env. VII. The accession EC 539241 and EC468896 showed average performance along with stability for panicle diameter and number of tillers per plant. The existence of prior scientific basis to explain crossover interaction is crucial (Peto, 1982). Thus, it is advantageous to define the varietal combinations among which one has to look for qualitative interaction in advance. There will be enormous multiplicity of all possible varietal pairs for detection of crossover interaction if there is no prior basis for comparison. Such

Table 1 : Heterogeneity (H) test of response for the comparison of mean grain yield/ plant (g) against the standard variety HHB 67 along with Q^+ and Q^- value for cross over interaction and adaptability parameters for the accessions

Accession	Adaptability parameters			Against HHB 67		
	$\mu + d_i$	β±SE	$\sigma^2 d_i$	H	Q+	Q^-
EC 539241	252.32*	0.85*±0.07	0.14	285.54#	300.25	104.63
EC 539299	85.65	0.99.*±0.20	0.34*	98.58#	221.04@	97.50@
EC 541536	102.57	0.91*±0.06	0.12	168.71#	98.65	110.43
EC 468904	298.24*	1.04*±0.11	0.35*	258.29#	175.48@	187.24
EC 539227	204.38*	0.78*±0.21	0.42*	264.34#	142.06	113.20@
EC 539254	225.17*	0.88*±0.02	0.08	59.18#	94.55	187.57
EC 539259	267.30*	0.97*±0.0.8	0.17	247.02#	200.57	75.17
EC 468900	240.24*	0.93*±0.12	0.09	175.55#	110.82	98.62
EC 539271	108.65	0.68*±0.08	0.28*	105.90#	186.37@	107.54@
EC468896	202.13*	.87*±0.04	0.10	201.48#	280.17	94.13
EC 468898	105.40	-1.08*±0.10	0.62*	185.54#	183.37@	140.02
EC 539295	106.21	0.49*±0.01	0.26*	67.28#	85.94	85.66
EC 541540	100.15	1.22*±0.78	0.31*	101.44#	208.63	72.25@
EC 539251	104.30	0.89*±0.34	0.35*	214.08#	306.22@	108.33@
EC 468902	110.35	-0.78*±0.18	0.5*	191.82#	87.71@	201.20
EC 541539	109.87	-1.08*±0.27	0.23*	98.94#	109.30	122.98@
EC 541543	101.21	0.87*±0.08	0.35*	207.85#	67.18	65.07@
EC 539243	113.26	1.07*±0.50	0.52*	91.10#	201.69@	147.82

Grand mean (µ) 116.39±10.57 HHB 67 256.14±08.39 *significant at P<0.05, # was significant against χ^2 0.05 at s-1df, where is the number of environments, @minimum of either Q^+ OR O^- was significant against "C" value given by Gail and Simon (1985).

Table 2 : Accessions exhibiting signifant " # H (heterogeneity of response) and Q^+ and Q^-against standard hybrid HHB 67

Characters	H	Q^+ and Q^-
Grain yield/ plant (g)	Twenty accessionsEC 539241, EC 539299, EC 541536,EC 468904,EC 539227, EC 53925,EC 539259, EC 468900, EC468896, EC 468898, EC 541540, EC 539251, EC 468902, EC 541543, EC 539243, EC 541542, EC 541538, EC 539300, EC 539240, EC 539226,	EC 539241, EC 539299, EC 541536, EC 468904, EC 539227, EC 53925,EC 539259, EC 468900, EC468896, EC 468898, EC 541540, EC 539251, EC 468902, EC 541543, EC 541542, EC 539300 (sixteen accessions)
No. of tillers/plant	All accessions except EC 541539, EC 539243	EC 539299, EC 541536, EC 468904, EC 539227, EC 468900, EC 539271, EC 541540, EC 539251, EC 468902, EC 541543, EC 541542, EC 541533, EC 539240 (ten accessions)
Plant height (cm)	All accessions except EC 539241, EC 468904, EC 539251, EC 539243	EC 539241, EC 468904,EC 53925,EC 539259, EC468896, EC 468898, EC 541540, EC 539251, EC 541543, EC 539243, EC 541542, EC 541538, EC 539300, EC 539240, EC 539226, EC 541536, EC 539227, EC 539271,EC 468902, EC 541543, EC 539225, EC 468900, EC 541539 (twenty three accessions)
Panicle length (cm)	All accessions except EC 541536, EC 539227, EC 539251	EC 539299, EC 468904, EC 539259, EC 468900,EC 539271,EC 468898,EC 541540,EC 539251,, EC 541539, EC 539243, EC 539225, EC 541542, EC 541538,EC 539240, ,EC 468902,EC 541543 (sixteen accessions)
Panicle diameter (cm.)	All accessions except EC 468898, EC 539227, EC 539271, EC 541539	EC 539241, EC 468904, EC 539271, EC 468898, EC 541536, EC 541539,EC 539259, EC 468900, EC 539227, EC 539251, EC 539295, EC 468903, EC 539256, EC 468902, EC 539255 (fifteen accessions)
Number of leaves/ plant	All accessions except EC 468900, EC 539271	EC 539241, EC 468904, EC 539271, EC 468896, EC 468899, EC 539225, EC 468902, EC 539227, EC 539251, EC 539252, EC 539256, EC 539258, EC 539254, EC 539260, EC 468898, EC 541535, EC 541539 (Seventeen accessions)
Test weight (g)	All accessions except EC 539227, EC 539254, EC 468900,EC 539251	EC 539241, EC 468904, EC 539271, EC 468896, EC 468898, EC 4688900, EC 468902, EC 468901, EC 539226 EC 539240, EC 539227, EC 539252, EC 539254, EC 539256, EC 539271, EC 539259, EC 539255 EC 539253, EC 539242 (nineteen accessions)
Days to 50% flowering	All accessions except EC 541536, EC 539227	EC 539299, EC 468904EC 539259, EC 468900,EC 539271,EC 468898,EC 541540,EC 539251, EC 541539, EC 539243, EC 468897, EC 468901, EC 468903, EC 539240, EC 539258, EC 539225, EC 539299, EC 539258, EC 539253, EC 541538, EC 541543, EC 539295 (twenty two accessions)

a practice will greatly increase the experiment wise error rate. In the present case, the accessions were, therefore, compared with the standard check HHB 67 for detection of crossover interaction since the aim was to find better alternative to HHB 67. The H (heterogeneity of response) and Q+ and Q- (for the presence of crossover interaction) against the standard variety HHB 67 were estimated for all the 27 accessions for the traits exhibiting the presence of g x e interaction *i.e.* grain yield/plant, number of fertile tillers per plant, plant height (cm), panicle length (cm), panicle diameter (cm), number of leaves per plant, 1000-seed weight (test weight) and days to 50 per cent flowering and their significance was tested (Eberhart and Russell, 1966; Virk *et al.*, 1985 and Witcombe, 1988). The accession exhibiting either significant H or Q+ and Q- are given in Table 2. For grain yield/plant, H was significant for the 20 accessions against HHB 67. The presence of cross over interaction was observed for 26 accessions for grain yield/plant against HHB 67. The 10 accessions exhibited the presence of crossover interaction for number of tillers per plant, 23 accessions for plant height and 16 accessions for panicle length, 19 accessions for 1000-grain weight and 15 accessions showed the presence of it for panicle diameter, 17 accessions had the presence of g x e interaction for number of leaves/ plant and 22 accession had exhibited the presence of gxe interaction for days to 50 flowering. All the accessions failed to exhibit crossover interaction for all traits against HHB 67 thus, presence or absence of crossover interaction was accession and trait specif (Kumar, 1989 and Sharma, 1995). The accessions EC 539241, EC 468904, EC 539227, 1023, 1025 and EC 539251 in environment IV had significantly higher grain yield/plant than check HHB 67.

The conclusion drawn from regression analysis and crossover and non-crossover interactions concepts about accessions having specific adaptability differ considerably. The accessions EC 539241, EC 468904, EC 539254, EC 539259, EC 468900 and EC468896 identified as potential yielder having specific adaptability for environment II on the basis of regression analysis failed to exhibit significant min (Q+ or Q-) against standard variety HHB 67 except EC 468904 which had significant min (Q+ or Q-) against HHB 67. On the other hand seven accessions EC 539299, EC 541536, EC 468904, EC 539227, EC 468898, EC 541540 and EC 539251 identified as potential yielders having specific adaptability to higher fertility level. On the basis of crossover and non-crossover interaction concepts, these accessions failed to exhibit stable above average performance and responsiveness for grain yield/ plant except EC 468904. A mention may be made of the accession, EC 468904 that has been identified as a high yielding accession having specific adaptability both by using regression analysis and crossover and non-crossover interactions concept. EC 468904 gave significantly higher mean grain yield/plant than the standard variety HHB 67. However, in environments I, III, V, and VII it had lower grain yield than HHB 67. Thus accession, EC 468904 had specific adaptation to high yielding environment *i.e.* high nitrogen regimes rather than possessing general adaptation (Sharma,1995).

Literature Cited

Allard, R.W. and Bradshaw, A.D. (1964). Implications of genotype-environment interactions. *Crop Sci.*, **4** : 503-507.

Andrews, D.J. and Kumar, A. K. (1996). Use of the West African pearl millet landrace in India in cultivar development. *Plant Genet. Resour. Newslett.*, **105** : 15–22.

Baker, R.J. (1988). Test for crossover genotype x environmental interaction. *Can. J. Plant Sci*., **68** : 405-410.

Benti, T., Gezahen, B. and Assefa, A. (1996).Genotype by environment interaction and yield stability of maize cultivar. *Ethiopian J. Agric. Sci*., **15** : 1-7.

Eberhart, S. A. and Russell, W. A. (1966). Stability parameters for comparing varieties. *Crop Sci.*, **6** (1) : 36-40.

Finlay, K.W. and Wilkinson, G.N. (1963). The analysis of adaptation in plant breeding programmes. *Australian J. Agric. Res.*, **14** (6) : 742-754.

Gail, M. and Simon, R. (1985). Testing for quantitative interaction in *Schizophyllum commune*. I. Analysis and character. *Heredity*, **27**: 361-372.

Gupta, S.C. and Ndoye, A.T. (1991). Yield stability analysis of promising pearl millet genotypes in Senegal. *Mayda*., **36** (1) : 83-86.

Kelley, J.D., Parthasarathy, R.P., Weltzein, R.E. and Purohit, M.L. (1996). Adoption of improved cultivars of pearl millet in an arid environment: Straw yield and quality considerations in Western Rajasthan. *Environ. Agric.*, **32** (2) : 161–172.

Kumar, K.A. (1989). Pearl millet: Current status and future potential. *Outlook Agric.*, **18** : 46–53.

Perkins, J.M. and Jinks, J.L. (1968). Environmental and genotype-environmental components of variability IV. Non linear interaction for multiple inbred lines. *Heredity.*, **23** : 525-535.

Pethani, K.V. and Kapoor, R.L. (1985). Phenotypic stability for grain yield in pearl millet. *Indian J. Genet*., **45** : 362-367.

Peto, R. (1982). Statistical aspects of cancer traits pp. 867-871. In: E. E. Hainan (ed.), *Treatment of cancer.*, Chapman and Hall, London, U.K.

Sharma, R.K. (1995). Breeding lentil for response to additional nitrogen application. *Crop Improv*., **22** (2) : 1139-1419.

Steel, R.G. and Torrie, J.H. (1980). *Principles and procedures of statistits*. McGraw-Hill Book Co. New York, U.S.A..

Virk, D.S., Chahal, S. S. and Pooni, H.S. (1985). Repeatability of stability estimators of downy mildew in pearl millet. *Theor. Appl. Genet*., **70** : 102-106.

Virk, D.S. and Mangat, B. K. (1991). Detection of crossover genotype x environment interaction in pearlmillet. *Euphyta*, **52** (3) : 193-199.

Witcombe, J.R. (1988). Estimate of stability for comparing varieties. *Euphyta.*, **39** : 11-18.

Yadav, H.P. (2015). Pearl millet news. All India Coordinated Research Project on Pearl Millet. PP 1.

Yadav, O.P. and Weltzein, R.E. (2000). Differential response of pearl millet landrace based population and high yielding varieties in contrasting environments. *Ann. Arid Zone*, **39** : 39–45.

Yates, F. and Cochran, W.G. (1938). The analysis of groups of experiments. *J. Agric. Sci. Cambridge*, **28** : 556-580.

6th Year
★★★★★ of Excellence ★★★★★