Mysore J. Agric. Sci., 51 (1) : 98-101, 2017

AMMI Model for Stability and Adaptability of Finger Millet (*Eleusine coracana*) Genotypes

H. R. Chaithra, K. N. Krishnamurthy, P. Ravishankar and G. B. Mallikarjuna
Department of Agricultural Statistics, Applied Mathematics and Computer Science
College of Agriculture, UAS, GKVK, Bengaluru - 560 065

Abstract

Stability in performance is one of the most desirable properties of a genotype to be released as a variety for varied regions. Genotype x environmental interactions and stability were investigated on grain yield with 16 finger millet genotypes in 33 environment. The ANOVA for grain yield revealed highly significant difference ($p<0.01$)for genotypes (G), environment (E) and their interactions (G x E). The first four principle components were significant ($p<0.01$) and cumulatively contributed 60.28 per cent of the total G x E interaction. The biplot technique used to identify appropriate genotypes across environments showed that the genotypes KOPN 933, VL 149, VR 708 and GPU 78 had moderate grain yield with low interaction and hence considered as stable genotypes.

The genotype x environment interaction has a direct effect on genotypes stability and adaptability in different environmental conditions. In this sense, plant breeders look for genotypes that has general adaptability, or they look for genotypes that have specific adaptability for specific environment.The crop varieties show wide fluctuations in their yielding ability when grown over varied agro-climatic conditions. Hence, there is a persistent demand for identifying suitable genotypes which can with stand environmental variations and ensure reasonably good yields. Testing breeding lines or advanced generation progenies under different conditions forms an integral part of breeding programme aimed at identifying stable genotypes which can perform well under different growing situations.The performance of a genotype mainly depends on environmental interaction. The evaluation of genotype-environmental interaction gives an idea of the buffering capacity of the population under study. The low magnitude of genotype environmental interactions indicates consistent performance of a population over variable environments.

The AMMI model is a hybrid analysis that incorporates both the additive and multiplicative components of the two-way data structure. The linear regression model combines the additive and multiplicative components and thus analyse main effects and their interaction. AMMI biplot analysis considered to be an effective tool to diagnose GEI patterns graphically. The additive portion is separated from interaction by analysis of variance. The principal component analysis (PCA), which provides a multiplicative model, is applied to analyze the interaction effect from the additive AMMI model. The biplot display of PCA scores plotted against each other provides visual inspection and interpretation of GEI components. The integration of biplot display and genotypic stability statistics enables genotypes to be grouped on the basis of similarity in performance across diverse environments.The analysis of G x E interaction of multi-location yield data through AMMI model have been reported by Kulusum *et al.* (2013), Mukherjee *et al.* (2013) and Bose *et al.* (2014) for Rice, Misra *et al.* (2009), Adugna *et al.* (2011), Fentie *et al.* (2013) and Dagnachew *et al.* (2014) for finger millet, Srinivasa Rao *et al.* (2012) for Sorghum and Sabaghpour *et al.* (2012) for Chickpea. All these workers found significant GXE interaction for grain yield and stressed the usefulness of AMMI analysis for selection of promising genotypes for specific environmental conditions.The present study in finger millet was undertaken to analyse the G x E interaction using AMMI model and to evaluate stability and adaptability of genotypes in different environments.

Material And Methods

The material for this study was taken from a multi-locational trial on 16 finger millet (*Eleusine *coracana*) genotypes in 11 locations (*viz.,* Bengaluru, Coimbatore, Hanumanamatti, Jagdalpur, Mandya, Paiyur, Perumalapalli, Ranchi, Rewa and Vizianagaram) conducted under All India Coordinated varietal trials in different testing Centre's in India during the k*harif* seasons of 2010 to 12, together representing 33 environments. The list of finger millet genotypes along with their origin are shown in Table I.

TABLE I

List of finger millet genotypes and their origin

Geno-types	Origin	Geno-types	Origin
VR959	Vizianagaram	VL 149	Almora
VL352	Almora	BR 7	Jagadalpur
BBM10	Ranchi	BBM 11	Ranchi
VL353	Almora	GPU 79	Bengaluru
PRM9002	Ranichauri	GPU 75	Bengaluru
KOPN 933	Kolhapur	BR 4	Jagadalpur
GN-4	Waghai	GPU 78	Bengaluru
VR 708	Vizianagaram	PR 202	Peddapuram

The AMMI model

The mathematical model for AMMI is,

$$Y_{ij} = \mu + G_i + E_j + \sum_{n=i}^{N} \lambda_n \, y_{in} \, \delta_{jn} + e_{ij}$$

where, Y_{ij} is the yield of i^{th} genotype in j^{th} environment, μ is the overall mean, G_i is the genotypic (i^{th}) main effect, E_j is the environmental (j^{th}) main effect, $ë_n$ is the singular value of n^{th} PCA axis., y_{in} is the genotypic eigen vector values for n^{th} PCA axis, $ä_{jn}$ is the environmental eigen vector values for n^{th} PCA axis and e_{ij} is the residual.

RESULTS AND DISCUSSION

AMMI analysis of variance for grain yield (Kg/ha) in 16 genotypes tested over 33 environment across the years. The results presented in Table II showed that the main effects of genotype(G), environment (E) and G x E interaction were found to be highly significant ($p < 0.01$). Further, the breakdown of G x E interaction in to 5 PCA's (PCA I to PCA V)

TABLE II

AMMI analysis of variance of 16 finger millet genotypes for grain yield tested in 33 environments across years

Source of variation	df	Mean square	F ratio	p value
Genotypes	15	1418152.03	3.333	<0.01
Environments	32	11297390.16	26.55	<0.01
G * E interaction	480	425465.27		
PCAI	46	845400.90	2.488	<0.01
PCA II	44	746017.35	2.196	<0.01
PCA III	42	652589.52	1.921	<0.01
PCA IV	40	599843.85	1.765	<0.01
PCA V	38	579669.11	1.706	
Residual	200	149327.36	0.439	
Pooled residual	390	339769.55		
	Variance (%)	Cum.variance (%)	Residual variance	
contribution of PCA I	19.04	19.04	165318600	
contribution of PCA II	16.07	35.12	32492600	
contribution of PCA III	13.42	48.54	214738400	
contribution of PCA IV	11.75	60.28		
contribution of PCA V	10.79	71.07		

accounted for 19.04, 16.07, 13.42, 11.75 and 10.79 per cent of variation, respectively. Thus, the 5 principal components obtained by singular value decomposition of environments explained 71.07 per cent of the total G x E variation for finger millet grain yield.

Ammi 1 Biplot Analysis : The scatter of genotype points in AMMI1 biplot (Fig.1) showed 4 adaptive groups of genotypes. The genotypes VR 959, VL 353 and BR 7 formed an adaptive group with high yield and high main (additive) effects showing high positive interaction. The genotypes VL 352 and GPU 75 formed an adaptive group having high mean yield with moderately negative interaction. While, the genotypes BR 4, PR 202 and GPU 79 formed an adaptive group with high mean but with high negative interaction. The genotypes PRM 9002, BBM 10 and VL 149 had low mean with moderate positive interaction. The genotypes KOPN 933, GPU 78 and VR 708 had relatively negligible interaction. The genotype GN 4 was scattered singly in the biplot with high positive interaction.

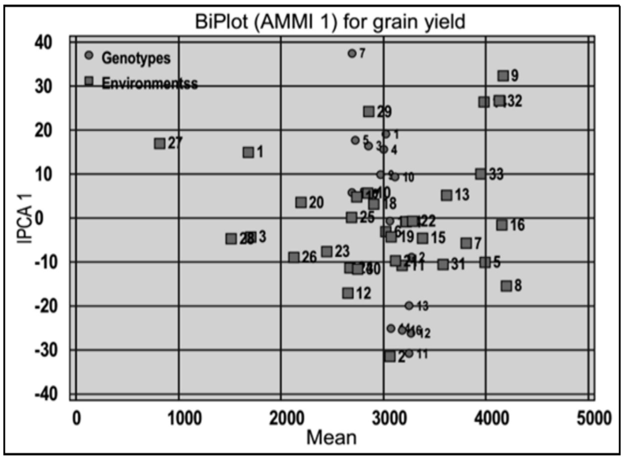

Fig. 1: AMMI 1 biplot of main effects and G x E interaction of 16 finger millet genotypes for grain yield in 33 environment

Thus, from the analysis, the genotypes KOPN 933, VL 149, VR 708 and GPU 78 had moderate grain yield with low interaction and hence considered as stable genotypes.

AMMI 2 Biplot Analysis : From AMMI 2 biplot analysis (Fig. 2), we observed that the genotypes PRM 9002, GN 4, VR 708 and BBM 11 were more responsive since they were away from the origin,

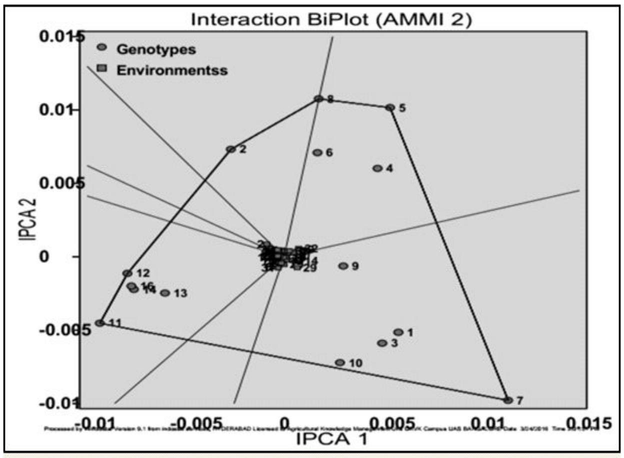

Fig. 2: AMMI 2 biplot of G x E interaction of 16 finger millet genotypes for grain yield across 33 environments.

whereas, genotype GPU 78 was close to the origin and hence the genotype GPU 78 is non- sensitive to environmental interaction forces.The remaining genotypes scattered away from the origin in the biplot indicating that the genotypes are more sensitive with specific environmental conditions.

The AMMI analysis for grain yield involving 33 environments across years showed high significant difference between genotypes, environments and G x E interactions indicating the stability of some of the genotypes across the environments. The 5 principal components obtained by singular value of decomposition of environments explained 71.07 per cent of the total G x E variation for finger millet grain yield.

Further, it was observed that the genotypes KOPN 933, VL 149, GPU 78 and VR 708 had high grain yield with low interaction as they are scattered very near to origin. Thus, these genotypes indicates wider adaptability and hence considered as stable genotypes.

In order to find the association between PCA1 and PCA2, AMMI 2 biplot analysis was carried out. From this analysis, it was observed that, only genotype GPU 78 was found to be stable as it was closer to the origin indicating non sensitivity to environmental conditions.

References

Adugna, Tesfaye Tesso, Erenso Degu, Taye Tadesse, Feyera Merga, Wasihum Legesse, Alemu Tirfessa, Haileselassie Kidane, Andualem Wole and Chemeda Daba, 2011, Genotype-by-environment interaction and yield stability analysis in finger millet (*Elucine coracana L. Gaertn*) in Ethiopia. *Amer. J. Pl. Sci.,* **2** : 408 - 415.

Bose, L. K., Jambhulkar, N. N. and Singh, O. N., 2014, Additive main effects and multiplicative interaction (AMMI) analysis of grain yield stability in early duration rice. *J. Anim. Pl. Sci.,* **24**(6) : 1885 - 1897.

Dagnachew Lule, Masresha Fetene, Santie De Villers, and Kassahun Tesfaye, 2014, Additive main effects and multiplicative interactions (AMMI) and genotype by environment interaction (GGE) biplot analyses aid selection of high yielding and adapted finger millet varieties. *J. Appl. Bio Sci.,* **76** : 6291 - 6303.

Fentie Molla, Alemayehu Assefa and Ketema Belete, 2013, AMMI analysis of yield performance and stability of finger millet genotypes across different environments. *World J. Agril. Sci.*, **9**(3) : 231 - 237.

Kulusum, U. M., Hassan, J. M., Akter, A., Rahman, H. and Biswas, P., 2013, Genotype-environment interaction and stability analysis in hybrid rice: An application of additive main effects and multiplicative interaction. *Bangladesh J. Bot.*, **42** (1) : 73 - 81.

Mukherjee, A. K., Mohapatra, N. K., Bose, L. K., Jambhulkar, N. N. and Nayak, P., 2013, Additive main effects and multiplicative interaction (AMMI) analysis of G x E interactions in rice-blast pathosystem to identify stable resistant genotypes. *African J. Agril. Res.,* **8** (44) : 5492 - 5507.

Sabaghpour, S. H., Razavi, F., Danyali, S. F., Tobe, D. and Ebadi, A., 2012, Additive main effect and multiplicative interaction analysis for grain yield of chickpea (*Cicer arietinum* L.) in Iran. *Intl. Scholarly Res. Network (ISRN) Agron.,* pp. 1-6.

Srinivasa Rao, Sanjana Reddy, Abhishek Rathore, Belum Vs Reddy and Sanjeev Panwar, 2011, Application GGE biplot and AMMI model to evaluate sweet sorghum (*Sorghum bicolor*) hybrids for genotype x environment interaction and seasonal adaptation. *Indian J. Agril. Sci.,* **81** (5) : 438 -444.

(*Received :* November, 2016   *Accepted :* February, 2017)