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AMMI Analysis for Stability of Grain Yield in Rice (*Oryza sativa* L.)

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Abstract: Six short duration rice genotypes were tested over fifteen environment in different blocks of Ramanathapuram district of Tamil Nadu. Grain yield data were subjected to the Additive main effects and multiplicative interaction (AMMI) analysis. Results indicated a significant genotype × environment interaction (GEI) that influenced the relative ranking of the varieties across the environments. It was evident from AMMI analysis that genotype, environment and the first principal component of interaction effect accounted for 95.20% of the treatment sum of squares and the first three principal component of interaction effect were significant. As per the AMMI model, three genotypes RM 96019, AD 00119 and AD 99111 were identified as having general adaptability.

Key words: *Oryza sativa*, AMMI analysis, GEI structure, PCA, biplot analysis

INTRODUCTION

The genotype × environment interaction structure is an important aspect of both plant breeding programme and the introduction of new crop cultivars (Freeman, 1985). ANOVA which is an additive model is effective in partitioning the total sum of squares into i) the genotype main effect ii). The environment main effect and iii) the GEI, but it does not provide insight into GEI structure. To study the underlying the interaction component, more advance techniques such as principal component analysis are required. The AMMI model is a hybrid model involving both additive and multiplicative components of two way data structure. The AMMI model separates the additive variance and then applies Principal Component Analysis (PCA) to the interaction portion to extract a new set of co-ordinate axis which explain in more detail the interactions pattern. The effectiveness of AMMI procedure has been clearly demonstrated by various authors viz., in soybean Zobel *et al.* (1988) in maize Crossa *et al.* (1990), Nitch *et al.* (1992) and Crossa *et al.* (1991) in wheat, Shinde *et al.* (2002) in pearl millet and Zaval-Garcia *et al.* (1992) in rice, respectively using multi locational data.

Using the AMMI analysis and biplot facility therefrom, the pearl millet yield trial data were analysed to determine the nature and magnitude of G × E interaction effects on grain yield in diverse production environments, to identify high yielding, stable genotypes adapted to diverse production environments and to determine the areas where rice genotypes would be adapted and produce economically competitive yields.

MATERIALS AND METHODS

Six short duration rice varieties viz., RM 96019, AD 00119, AD 99111, CB 17 664, CB 17837 and NILs 17 were evaluated at 15 locations in Ramanathapuram district of Tamil Nadu, India representing all types of soils under rainfed conditions. The trial was laid out during October 2005 and the crop has harvested during January 2006. The observations on 50% flowering, number of panicles m^{-2}, grains/panicle and grain yield.

RESULTS AND DISCUSSION

Bioplot analysis is the most powerful interpretive tool for AMMI model. There are two AMMI biplots, the AMMI 1 biplot where the main effects (genotype mean and environment mean) and IPCA 1 scores for both genotypes and environments are plotted against each other and the AMMI 2 biplot where scores for IPCA 1 and IPCA 2 are plotted (Table 1).

In AMMI 1 biplot, the usual interpretation of a biplot assay is that if a genotype or an environment has a IPCA 1 score of nearly Zero, it has small interaction

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Table 1: Stability parameters for grain yield

Env/Gen	RM 96019	CB 17664	CB 17837	AD 00119	AD 99111	NILs 17	Enviorn	IPCAI	IPCA2
AT	4740.00	3740.00	3100.00	5010.00	3710.00	3910.00	3868	-0.59	-3.71
PP	5005.00	2810.00	3150.00	4918.00	3725.00	4100.00	3951	9.16	-0.05
PE	4850.00	2710.00	2980.00	4826.00	3625.00	3950.00	3824	6.92	-4.22
SD	4825.00	2620.00	2860.00	4910.00	3660.00	3850.00	3788	3.05	-3.35
MD	5050.00	2860.00	2850.00	4926.00	3550.00	3860.00	3849	10.87	5.28
SI	4760.00	2750.00	3015.00	5050.00	3575.00	3925.00	3846	0.60	2.95
MI	4950.00	2810.00	3620.00	5100.00	3500.00	3610.00	3923	7.82	5.56
PB	4900.00	2690.00	3125.00	5080.00	3820.00	2750.00	3894	1.04	-6.00
AM	4525.00	2640.00	2960.00	5065.00	3750.00	3790.00	3792	-9.41	-4.62
VK	4710.00	2720.00	2990.00	5075.00	3720.00	4000.00	3869	-3.91	-1.55
RT	4615.00	2760.00	3110.00	4960.00	3820.00	3950.00	3869	-4.71	-8.89
JV	4710.00	2800.00	3115.00	5020.00	3430.00	3853.00	3821	2.64	6.40
PE	4625.00	2725.00	2815.00	5150.00	3540.00	3720.00	3762	-6.27	7.99
KM	4595.00	2740.00	2820.00	5200.00	3525.00	3975.00	3809	-7.90	9.83
CD	4525.00	2715.00	2780.00	5035.00	3710.00	3816.00	3764	-9.51	-0.66
Genotype mean	4739.00	2740.00	3090.00	5022.00	3644.00	3891.00	3842		
IPCA1	18.64	0.20	4.37	-13.62	-9.68	0.09			
IPCA2	1.84	7.17	-5.39	12.05	-15.71	0.04			

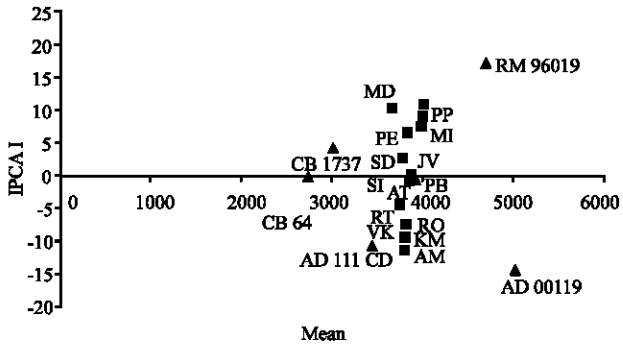

Fig. 1: AMMI I- Biplot for grain yield in rice cultures

effects and when a genotype and an environment have the same sign on the PCA axis, their interaction is positive, if different, their interaction is negative. The AMM 1 biplot (Fig. 1) clearly indicated that all the six genotypes studied were differed from each other and not only for mean yields, but also for their interaction effects. However, the environments studied were differed only for their interaction effects and they exhibited less difference for the main effect.

The locations AT and SI had IPCA 1 score near zero and hence had small interaction effects indicating that all the genotypes performed well in these locations. Thus, these two locations were considered as the favourable environment for all the genotypes studied. Similarly, the genotypes CB 17664 and NILs 17 had zero score on the first IPCA 1 indicating that these varieties were less influenced by the environments. Among these two genotypes, CB 17664 was found to have below average yield. On the otherhand, the genotype NILs 17 registered above average yield along with the IPCA 1 score close to zero, it was adjudged as the stable genotype and had general adaptation to all the environments.

Similar signs of IPCA 1 score for both genotype and environment implies positive interaction and thus higher yield of the genotype at that particular location. The location viz., PP, MD, SI, MA and PB among the environments and RM 96019 among the genotypes had positive IPCA 1 score and registered above average yield, hence the genotypes RM 96019 was identified as specifically adapted culture to the above mentioned environments and these environments were considered as the suitable environments for this genotype. Likewise, the genotype AD 00119 and the environments VK and RT had above average yield and negative IPCA 1 score and thus the environments VK and RT were found to have favourable environments for the genotype AD 00119.

In AMMI II biplot (Fig. 2) the environmental scores are joined to the origin by site lines. Sites with short spokes do not exert strong interactive forces. Those with long spokes exert strong interaction. The environments AT, MA and VK had short spokes and they do not exert strong interactive forces.

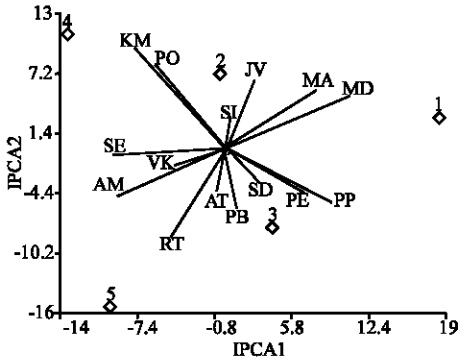

Fig. 2: Interaction Biplot for the AMMI2 Model

In Fig. 2 genotypes occurring close together on the plot will tend to have similar yields in all environments, while genotypes far apart may either differ in mean yield or show a different pattern of response over the environments. The genotypes near the origin are non sensitive to environmental interaction and those distant from the origins are sensitive and have large interaction. In the present study, the genotypes RM 96019, AD 00119 and AD 99111 had large interaction since they were away from the origin where as the genotypes CB 17664, CB 17837 and NILs 17 were close to the origin and hence they were non- sensitive to environmental interactive forces.

Similarly the environments close together exert similar pattern of interaction for e.g., the environments PB, SD PE and PP grouped close together on the plot and they found to have similar interaction pattern on the genotypes. The RM 96019 culture had evolved exclusively for rainfed upland conditions and this variety had performed very well in all the locations irrespective of soil types and this is the first report on this variety. Since AMMI analysis for rainfed rice is very limited this will added the data.

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