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Using Different Statistical Techniques for Selection a Stable Varieties of Rice in Chhattisgarh State

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ABSTRACT

The objective of this study was to explore the effect of genotype and genotype x environment interaction on yield of 10 rice varieties in thirty different environments. Various statistical methods are available to analyze the data in MVATs. However, the information on these methods and their relative performance on evaluation of adaptability of rice varieties are limited. Therefore, in these studies was compare the statistical methods available for analysis of MVATs data of rice. It considered of yield data on performance of 10 varieties at 10 locations over 3 years. The statistical techniques such as ANOVA, stability parameters, ranking, multivariate techniques as a traditional method are used to approach were tested with the data. The result revealed that ANOVA method is not effective in describing pattern of G x E interaction but effective in describing main effects. Different stability methods consider different aspects of variability of varieties vary according to the parameter considered. Multivariate methods describe G x E interaction effectively with AMMI stability value that is easy to understand.

Key words: *Adaptability, AMMI, G x E Interaction, IPCA, Variety stability.*

INTRODUCTION

The promising varieties of rice are used in different agro-ecological regions in Chhattisgarh state to study the adaptability to varying climatic and soil conditions. These studies are commonly referred to as multi-location variety adaptability trials- MVATs defined the stability of a variety as a function of mean yield and yield stability across environments. Plant breeders need to a best stability analysis and variety selection tool, and have begun to incorporate it into their breeding programs[3,13,16,20]. Research focusing on stability, or genotype (G) x environment (E) interactions, is necessary for plant breeders to develop varieties that respond optimally and consistently across environments. GE interactions are said to exist when the responses of two genotypes to different levels of environmental stress fail to be parallel[1]. Numerous tools have been developed to measure the response of genotypes to changes in environment.

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Rice yield secondary data collected from the Chhattisgarh state in years 2011-12, 2012-13, and 2013-14 were analyzed. These data were balanced to obtain an equal number of genotypes in all environments. Varieties included Swarna, MTU-1010, MTU-1001, IR-36, IR-64, Mahamaya, Karmamasuri, Bamleswari, PKV-HMT and BPT-5204. These ten varieties were planted in three years at the Raigarh (E1, E2, E3), Janjgir-hampa (E4, E5, E6), Bilaspur (E7, E8, E9), Raipur (E10, E11, E12), Durg (E13, E14, E15), Rajnandgaon (E16, E17, E18), Mahasamund (E19, E20, E21), Dhamtari (E22, E23, E24), Kanker (E25, E26, E27) and Bastar (E28, E29, E30) yielding a total of 30 environments.

The data were analyzed using, Statistical Analysis System (SAS), MS Excel and SPSS software. The statistical methods given below were used to analyse the data. The NAOVA model given below was fitted for the data:

$$\textbf{Model}: Y_{ipqr} = \mu + B_r + G_i + L_p + S_q + (GS)_{iq} + (GL)_{ip} + (LS)_{pq} + (GLS)_{ipq} + e_{ipqr}$$

Where, μ is grand mean; G_i, L_p, S_q, represent the effect of the genotype, location, season, and $(GS)_{iq} + (GL)_{ip} + (LS)_{pq} + (GLS)_{ipq} + e_{ipqr}$ represent the genotype x season, genotype x location, location x season, genotype x location x season interactions, random error respectively. Others stability measures used in these particular analyses are; (i) The Variance of a variety across environments (S_i^2) (ii) Francis and Kannenberg[7] Coefficient of variance of varieties across environments. (iii) Wricke's[19] Ecovalance (W_i^2) parameter. (iv) Finlay and Wilkinson's[6] regression coefficient (b_i) (v) Eberhart and Russell's[5] deviation parameters(δ_{i}^{2}) (vi) Lin and Binns[12] Cultivar performance measure (Pi) (vii) Shukla's[18] stability variance parameter (σ_i^2) (viii) Freeman and Perkins[8] (ix) Non-parametric approach Nassar and Huhn[17] (x) Method of Ranking Yields for Selecting Varieties (xi) Multivariate Techniques

Principal Component Analysis (PCA), Factor Analysis will have employed for data arranged in a two-way table of environment and varieties that contained mean yield of each variety at different environments[4].

The ANOVA for yield of rice varieties are presented in Table1. The mean squares for locations, varieties, and locations x varieties were highly significant, indicating that the variety differed in their pattern of response relative to each other in the various locations of Chhattisgarh state. Partitioning of the variance component indicated that 12.42 % due to varieties, 65.92 % due to varieties and locations, 18.31 % due to varieties and years, 3.14 % varieties x locations x years and 0.20 % due to error. The large contribution of variance due to varieties, GEI, varieties and years, indicates the significant influence of GEI in evaluation rice yield performance in Chhattisgarh state. Similarly, huge contribution of G x E interaction was also reported by Mohammadi *et al*[14]., in which they indicated that GEI accounted for larger proportion. This interaction is illustrated in figure 1 which is not described adequately in conventional ANOVA method.

Table 1: Combined ANOVA for rice yield and SS% in used environments over a periods 2011-12 to 2013-14

Source	DF	SS	SS%	MS	F- value	P<0.01
Years	2	227.72	1.24	113.86	426.73	**
Locations	9	897.79	4.91	99.75	373.86	**
Years x Locations	18	500.84	2.74	27.82	104.28	**
Varieties	9	9254.82	50.67	1028.31	3.85	**
Varieties x Years	18	264.96	1.45	14.72	55.17	**
Varieties x Locations	81	5510.77	30.17	68.03	254.98	**
Varieties x Years x Locations	162	1524.85	8.35	9.41	35.27	**
Residual	300	80.04	0.43	0.26		
Total	**599**	**18261.82**				

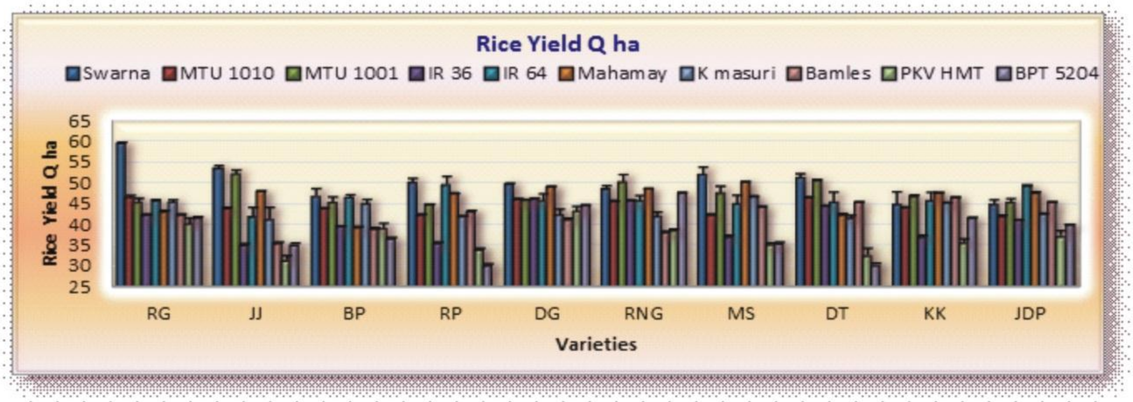

Fig. 1: Performance of genotypes over seasons at different locations for 10 rice varieties

The results of the methods using ranks are shown in table 2. The results indicate that the overall adaptability of MTU-1010 is superior compared to that of other varieties according to the ranking method. The problem in this method is that the highest mean score is not associates with the lowest variance of score and vice versa. Therefore, whether to consider mean score or variance of score or both measures simultaneously is a problem in selecting a genotype.

Finlay and Wilkinson[6] considered linearity of regression as a measure of stability. Eberhart and Russell[5], however, emphasized that both linear (bi) and nonlinear components of G × E interaction should be considered in judging the phenotypic stability of a particular genotype.

Moreira *et al*[15]., defined desirable genotypes as high yielding ones with broad adaptability and phenotype stability. The stability describes the variability of yields among environments. The varieties with minimum variability across environments are referred as stable genotypes. The results of stability analysis are shown in table 2. The variance indicates the variability in yields from mean yields of the particular genotype. The genotype with comparatively smaller variance is considered as stable. Hence, the variety Karmamasuri (G7) is the most stable variety according to variance criteria. The results of CV are appropriate to compare variability of different varieties. Linn Binns'[12](Pi) cultivar performance, Shukla's[18] stability variance, Wricke's[19] ecovalence, Finlay Wilkinson's[6], Eberhart and Russell's[5] and ASV shows the most stable genotype as a MTU-1010 (G2) and according to non-parametric approaches S1 and S2[17] provide most stable variety are Swarna (G1). Whereas, Freeeman and perkins estimated MTU-1001 (G3) stable in all environments but S1 and S2 shows unstable. BPT-5204 (G10) un-stable shown by Linn & Binns[12], Shukla's[18], Wricke[19], Perkins & Jink's, Eberhart & Russell[5], Freeman & perkins[8] along with ASV. Based on ranking total minimum value are shown MTU-1010 (G2) as a stable from all methods followed by IR-64 (G5).

Table 2: Results from various stability analysis approaches with ranks[11] (Leon, 1986)

S	Varieties	MY	MY	CV	P_i	σ^2_i	W_i	b_i	$\overline{S^2_{di}}$	β_i	FP	S1	S2	ASV	RT
1	Swarna	50.25	1	8	7	8	8	10	10	9	2	1	1	8	73
2	MTU1010	44.36	5	2	1	1	1	4	1	1	7	2	3	1	**29**
3	MTU1001	47.49	2	7	5	7	4	6	5	5	1	10	10	7	69
4	IR36	40.49	8	6	8	6	6	5	6	6	8	3	4	5	71
5	IR64	46.08	4	4	3	3	3	1	3	2	3	6	7	4	**43**
6	Mahamaya	46.34	3	5	4	4	7	8	7	7	4	5	5	2	61
7	KMasuri	43.41	6	1	2	2	2	2	2	3	5	8	8	3	44
8	Bamleswari	42.09	7	3	6	9	9	9	8	8	6	7	6	9	87
9	PKVHMT	36.79	10	10	9	5	5	3	4	4	9	9	9	6	83
10	BPT5204	38.45	9	9	10	10	10	7	9	10	10	4	2	10	100

Where; R= Rank, RT= Rank Total, Pi= Lin Binns[12] cultivar performance, σ^2_i = Shukla's[18] stability variance, Wi= Ecovalance[19] (Wricke's), bi=Regression coefficient[6] (Finlay Wilkinson's) and S_{di}^2= Deviation parameter from the regression[5] (Eberhart and Russell's).

The comparison of results of stability analysis suggested that description of stability of a genotype vary with the method employed to test the stability (Table 3). The selection of a best method is a problem as a standard is not available for comparison of different methods. Therefore, further studies on development of indicator to evaluate the efficiency of stability methods are required. Indicators based on power and robustness of different methods would be a sensible indicator statistically and hence the attention should be focused on this line.

To compare the different stability parameters, Spearman's rank correlation was computed among stability measures and mean yield. Taking the yield over locations as the first measures; variety Swarna (G1), MTU-1010 (G2), MTU-1001 (G3), IR-36(G4), IR-64 (G5), Karmamasuri (G7) and Mahamaya (G6) produced higher yield than grand mean yields (43.57 q/ha). Whereas, variety Bamleshwari (G8), PKV-HMT (G9) and BPT-5204(G10) produced lower yield than grand mean yield. The results of stability measures and mean yield are given in Table 3.

Spearman's rank correlations between mean yield and stability measures are presented in Table 3. Mean yield was significantly (P<0.01) positively associated (0.927) with Freeman and Perkins[8] (β_i). Rest of the stability measures shows non-significant association with the yield.

Francis & Kannenberg's[7] coefficient of variation (CV %) found the significance (P<0.01) along with positively associated with Lin and Binns's (P_i) (0.855). Remaining stability measures not shows significant association with CV (%).

Lin and Binns's[12] (P_i) procedure observed significantly positive—association (P<0.01) with Francis & Kannenberg's[7] coefficient of variation (0.855), Shukla's[18] stability variance (0.794) and the ASV (0.770) procedure from the AMMI model. The stability measure showed significantly (P<0.05) positive association along with Wricke's[19] ecovalence (0.758), Eberhart and Russell's[5] models (0.685) and Perkins and Jinks (0.709).

Shukla's[18] procedure found that the significant association (P<0.01) along with (Pi) procedure (0.794), ecovalence (W_i) (0.782), Eberhart and Russell's[5] (0.879), Perkins and Jinks (0.891) and AVS (0.952) were approximately equivalent for ranking purposes.

Wricke's[19] (W_i) stability parameter showed positively significant (P<0.01) association with Shukla's[18] (0.891), Frinlay and Wilkinsons[6] (0.782), Eberhart and Russell's[5] (0.952) and Perkins and Jink's (0.964) stability variance.

Finlay and Wilkinson's[6] procedure found positively associated with significance (P<0.01) with Wricke's[19] (W_i) ecovalence (0.782), Eberhart and Russell's[5] (0.867) and Perkins & Jink's (0.842). Remaining others stability measures not found significance association with the others.

Eberhart & Russell's[5] ($\overline{S^2_{di}}$) found positively correspondence along with significance (P<0.01) of Shukla's[18] variance (0.879), Wricke's[19], ecovalence (0.952), Perkins and Jinks',(0.842) Finlay and Wilkinsons[6] (0.867). Stability model Perkins and Jinks' (β_i) observed (P<0.01) significantly positive association with Shukla's[18] variance (0.891), Finlay and Wilkinson[6] (0.842), Wricke's[19] ecovalence (0.964) and Eberhart and Russell's[5] (0.976).

Freeman and Perkins[8] procedure were significantly positively associated (P<0.01) with mean yields (0.927). Remaining others stability procedure found non-significant association to other methods. S (1) and S (2) methods were found significant (P<00.1) only to each other (0.92) and AVS found significantly positive—association (P<0.01) with Lin and Binns[12] (P_i) (0.770), Shukla's[18] variance (0.952) and Wricke's[19] ecovalance (0.770).

Table 3: Spearman's rank correlation from all the stability parameters for rice

	MY	CV	P_i	σ^2_i	W_i	b_i	$\overline{S^2_{di}}$	β	FP	S1	S2
MY	*										
CV	0.200	*									
P_i	0.503	0.855**	*								
σ^2_i	0.139	0.600	0.794**	*							
Wi	0.176	0.527	0.758*	0.891**	*						
b_i	-0.297	0.285	0.382	0.709*	0.782**	*					
$\overline{S^2_{di}}$	-0.091	0.539	0.685*	0.879**	0.952**	0.867**	*				
β	0.030	0.515	0.709*	0.891**	0.964**	0.842**	0.976**	*			
FP	0.927**	0.212	0.479	0.115	0.224	-0.152	-0.018	0.103	*		
S1	0.176	0.018	-0.030	-0.030	-0.212	-0.358	-0.309	-0.248	-0.139	*	
S2	0.079	-0.091	-0.200	-0.261	-0.442	-0.515	-0.503	-0.479	-0.236	0.952**	*
ASV	0.212	0.588	0.770**	0.952**	0.770**	0.527	0.745*	0.758*	0.127	0.091	-0.139

Thus, the first two principal component analysis (PCA's) altogether explains 50.71% of the variability in the performance of 10 varieties in 30 environments. Hence, first two PCAs were used to study the G x E interaction[9,10]. The size and sign of variable (environments) determines the scores of a variety for a given PC. It indicates that all the environments (locations x years) contribute equally for PCA1. This implies that PCA1 describes the overall adaptability component. The result suggested that a genotype with a higher score according to PCA1 has higher broad adaptability characters than other varieties[2].

Table 4: The Eigen analysis of the Correlation Matrix of PCA analysis

IPCA Axis	Variance	G x E Explained	Cumulative
PCA I	1101.43	29.84%	29.84%
PCA II	770.17	20.87%	50.71%
PCA III	680.95	18.45%	69.16%
PCA IV	455.31	12.34%	81.49%
PCA V	245.06	6.64%	88.13%
PCA VI	208.76	5.66%	93.79%

The information in table 2 indicates that different statistical methods identify different varieties as the most adaptable variety. Therefore, as solution, the variety identified by the majority of statistical methods could be declared as the most adaptable variety. In this study, the variety MTU-1010 (G2) and IR-64 (G5) has identified as most stable variety in different methods. Finally, it should be remembered that for traits like disease resistance or quality, the application of the dynamic concept of stability is not justified.

REFERENCES

1. Allard, R.W. and Bradshaw, A.D., Implications of genotype-environmental interactions in applied plant breeding. *Crop Sci.*, **4:** 503-507 (1964).
2. Bhardwaj, R.K., Saxena, R.R., Gautam, S.S. and Singh, D.P., Assessment of genotype x environment interaction and adaptation of wheat using multivariate statistical analysis. *Green Farming* ,**7(5):** 1220-1223 (2016).

3. Blanche, S.B., Myers, G.O., Akash, M. and Jiang, B., Transgene effect on the stability of cotton cultivars in Louisiana. *In* Proc. Beltwide Cotton Conf., Atlanta, GA. 9- 13 Jan. 2002. Natl. Cotton Counc. Am., Memphis, TN (2002).
4. Broschat, D.K., Principal Component Analysis in Horticulturar research. *Hortscience*, **14(2):** (1979).
5. Eberhart, S.A. and Russell, W.A., Stability parameters for comparing varieties. *Crop Sci*., **6:** 36-40 (1966).
6. Finlay, K.W. and Wilkinson, G.N., The analysis of adaptation in a plant breeding prochickpeame. *Aust. J. Agric. Res*., **14:** 742-754 (1963).
7. Francis, T.R. and Kannenberg, L.W., Yield stabilitystudies in short-season maize. I. A descriptivemethod for grouping genotypes, *Can J. Plant Sci*., **58:** 1029–1034 (1978).
8. Freeman, G.H. and Perkins J.M., Environmental andgenotype-environmental components of variabilityVIII.Relations between genotypes grown indifferent environments and measures of theseenvironments. *Heredity*, **27:** 15–23 (1971).
9. Galinski, T., Czajka, S. and Kaczmarek, Z., A model for the analysis ol a series of experiments repeated at several places over a period of years. IL Example. Biuletvn Oceny Odmian **XII:** 35—71 (1987b).
10. Galinski, T., Czajka, S. and Kaczmarek, Z., A model for the analysi.s of a series of experiments repeated at several places over a period of vears. I. Theory. Biuietyn Oceny Odmian **XII:** 7—33 (1987a).
11. Leon, J., Methods of simultaneous estimation of yield and yieid stability. In: Biometrics m Plant Breeding. Proc. 6th Meeting EUCARPIA Section Biometrics in Plant Breeding, Birmingham, UK, 299—308 (1986).
12. Lin, C.S. and Binns, M.R., A superiority measure of cultivar performance for cultivar x location data. *Can. J. Plant Sci*., **68:** 193-198 (1988).
13. Lubbers, E.L., Evaluation of cotton breeding test environments in the southeast United States. p. 791-807. *In* Proc. Beltwide Cotton Conf., Nashville, TN. 6-10 Jan. 2003. Natl. Cotton Counc. Am., Memphis, TN (2003).
14. Mohammadi, R. and Amri, A., Genotype x environment interaction and genetic improvement for yield and yield stability of rainfed durum wheat in Iran. *Euphytica,* **192:** 227-249 (2013).
15. Moreira, J.A.N., Santos J.W. and Costa J.N., Preliminary results of classification of locals and cotton genotypes.1. Regional tests –1988/89. CNPA, EMBRAPA, Research Document, Brasília-DF, Brazil. 13 p (1990).
16. Myers, G.O., Biplot analysis of the National Cotton Variety Test. *In* Proc. Beltwide Cotton Conf., Atlanta, GA. 9-13 Jan. 2002. Natl. Cotton Counc. Am., Memphis, TN (2002).
17. Nassar, R. and Huhn, M., Studies on estimation of phenotypic stability: Tests of significance for nonparametric measures of phenotypic stability. *Biometrics,* **43:** 45-53 (1987).
18. Shukla, G.K., Some statistical aspects of partitioning genotype environmental components of variability. *Heredity*, **29:** 237-245 (1972).
19. Wricke, G., Über eine Methode zur Erfassung der ekologischen Streubreite in Feldversuchen Z. Pflanzenzücht, **47:** 92-96 (1962).
20. Yan, W., GGE Biplot- A Windows application for graphical analysis of multi-environment trial data and other types of two-way data. *Agron. J.*, **93:** 1111-1118 (2001).