Genotype X Environment Interaction for Grain Yield and Its Component Traits in Irrigated Rice

H.N. Subudhi, L.K. Bose, O.N. Singh and G.J.N. Rao

Central Rice Research Institute,
Cuttack - 753 006

Twenty popular rice varieties of Eastern India(110-135 days duration) were evaluated to study the genotype x environment(GXE) interaction and stability nature of different yield traits. The characters like plant height, Ear Bearing Tillers(EBT)/hill, panicle length, Days to fifty percent flowering and Grain yield were recorded in randomly selected plants for four different environments. It is revealed from the study that the varieties viz. Lalat and Saket-4 and PR-113 are stable across the environment for EBT/hill. The variety Daya is stable across the environment for panicle length. IR-72 is stable across the environment for days to fifty percentage flowering. For grain yield, Gouri, IR-8, Jaya and IR-36 exhibited higher yield than population mean with regression coefficient near unity and negligible deviation. Hence these varieties can perform better in all types of environment.

Key words: GXE interaction, stability studies, Yield traits, irrigated rice,Orissa

Rice (*Oryza sativa* L.) is the most important crop in India as well as Orissa. In Orissa, it is predominantly grown in 6.4 Mha. Rice is grown in diversified ecology ranging from high altitude to lowlands. So their phenotypic response varies greatly according to the environment. In Eastern India, the rice production is very low because of regular occurrence of natural calamities like flood, drought and submergence and lack of selection of proper stable varieties for different ecology. In most of the areas, the farmers are growing the traditional varieties which are low yielder.In irrigated areas, the high yielding varieties are grown but the varieties are susceptible to different biotic and abiotic stresses. So selection of stable and wider adaptable varieties is very important to increase the productivity. Breeders should take appropriate steps before development /release of the varieties. Genotype x Environment interaction studies should be conducted in different locations to find their degree of stability/adaptability. Farmers will adopt very quickly the stable varieties. Information regarding stability studies in rice is very meager and insufficient. Therefore the present study was aimed to evaluate some popular varieties for genotype and environment interaction and to find out better stable varieties for irrigated ecology.

Materials and Methods

Twenty popular high yielding varieties (110-135 days duration) were transplanted in CRRI farm during *kharif* 2006, 2007, 2008 and 2009 to study the nature of their stability and genotype and environment interaction for different yield attributes. The design was randomized block design with three replications The spacing was 15x20cm.The recommended agronomic practices were followed. The plot size was 12 m^2**.**The observations on plant height, panicle length, Days to fifty percentage flowering ,Ear Bearing Tillers(EBT)/hill were recorded in randomly selected plants and grain yield were recorded on plot basis. The mean value for different characters were analyzed for stability analysis(Eberhart and Russell,1966).

Results and Discussion

The analysis of variance showed significant difference among the genotypes and environment for all the traits studied Indicating very wide variability among the genotypes and environments. The GXE interaction was further partitioned into linear and nonlinear (pooled deviation) component. Mean squares for both these components were found highly significant. The GXE interaction was significant for majority of traits indicating that major portion of interaction was linear in nature and genotypes interacted considerably with the environment in expression of these traits at different locations. The analysis of variance was presented in Table 1.The genotypes x environment interaction was highly significant and both linear and nonlinear compounds are equally important in determining the stability of different characters(Zubair *et al.*2002)
.Considering all the parameter, it is revealed that both the linear and nonlinear components were significant for Days to fifty percent flowering (DFF), Plant height, and Panicle number. Similar finding

---

*Corresponding author email : dr_hatanath_subudhi@yahoo.co.in

Table 1. Pooled analysis of variance for stability analysis and its component traits in rice

Source of variation	DF	Mean sum of square				
		Plant height	EBT/hill	Panicle length	Yield	Days to 50% flowering
Replication within Env.	8	0.402	6.671	1.861	0.48727	0.5000
Varieties	19	401.701**	3.031	5.017	0.87444*	135.0772**
Env.+(Var.+ Env.)	60	98.909**	11.172**	2.988	0.63178	40.9777*
Environments	3	1184.751**	114.470**	1.79225	4.22036***	62.97050
Var.*Env.	57	41.760	5.735*	3.051	0.44291*	39.820*
Environments (Lin.)	1	3554.253**	343.409**	5.37733	12.66107**	188.911**
Var*Env.(Lin.)	19	26.775	6.125	2.99395	0.50768	71.342**
Pooled deviation	40	46.789**	5.264**	2.925546**	0.39000**	22.856**
Pooled error	152	0.981	1.044	0.47608	0.16001	0.0994
Total	79	171.733	9.214	3.47589	0.69014	63.60928

*, **, significant at P=0.01 and P=0.05 respectively
*EBT: Ear Bearing Tiller

were reported in early duration rice varieties (Singh and Payasi,1999). A variety or genotype is considered to be more adaptive or stable if it has high mean value, but low degree of fluctuation when grown over diverse environments (Eberhart and Russell, 1966).They defined a stable variety as having unit regression over the environment (bi=1.0)and minimum deviation from regression (S^{2}di=0). Therefore, a variety with high mean value over the environment, unit regression coefficient (bi=1.0), deviation from regression as low as possibleS^{2}di=0 will be considered as a stable variety. The estimate on the stability parameter like mean performance (Xi), regression coefficient (bi) and deviation from regression (S^{2}di) for different traits are presented in Table 2. It is emphasized that the deviation from regression alone as a measure of stability where as linear regression is a varietal respose (Jatasar

Table 2. Estimate of different stability parameter for DFF, Plant height, EBT/hill, panicle length and grain yield in rice

Genotype	Plant height(cm)			EBT/Hill*			Panicle length(cm)			Yield(t/ha)			Days to 50% flowering		
	mean	bi	S^{2}di	mean	bi	S^{2}di	mean	bi	S^{2}di	mean	bi	S^{2}di	mean	bi	S^{2}di
IR-64	101.42	1.59	23.99**	11.6	1.07	-1.24	27.2	5.16	1.09	4.11	1.70	0.422*	94.5	4.6	14.03**
Lalat	98.15	1.47	52.68**	13.09	1.00	9.88**	27.47	3.7	1.58*	4.64	1.91*	-0.153	100.42	4.25	10.57**
Khitish	87.58	0.58	62.8**	11.09	-0.18	3.65*	25.07	5.77	3.24**	4.12	2.27	-0.035	90.58	-3.21*	3.09**
Satabdi	85.95	1.09	18.8**	11.73	-0.34	2.12	26.47	4.23	6.94**	3.83	0.89	-0.058	89.9	-0.99	6.98**
Ratna	86.24	0.71	28.8**	12.79	2.01*	-0.96	25.15	-1.85	-0.41	4.1	0.32	-0.021	92.75	0.84	1.57**
Saket-4	84.75	0.70	62.3**	13.46	1.05	3.54*	24.9	-1.07	-0.32	3.9	2.09	0.164	93.08	-0.85	2.87**
IR-72	99.7	1.21	40.8**	12.09	1.67*	-1.13	25.32	3.79	-0.02	4.19	-0.32	0.358	102.83	1.06	19.87**
Tapaswini	92.80	1.4	33.72**	12.30	1.33	-0.25	23.6	3.65*	-0.54	5.49	0.42	0.040	105.00	-0.76	19.82**
Uday	110.10	0.99	24.94**	11.97	1.41	1.44	24.52	-2.28*	-0.43	4.677	0.63	0.564*	98.75	1.87	0.66**
Naveen	108.55	1.07	28.42**	12.73	1.27	-0.60	26.42	2.92	1.83*	5.13	0.06	1.300**	97.16	2.14	16.03**
Radhi	119.38	0.58	5.01**	12.46	1.27	0.45	26.40	-0.94	0.22	4.35	0.24	1.029**	92.83	-0.06	3.03**
Indira	102.81	0.73	38.45**	11.87	0.85	0.28	27.05	-0.35	6.38**	4.36	1.90	0.793**	100.08	-1.32	8.03**
Gouri	100.8	1.53	266.66**	12.17	0.38	0.72	24.0	4.91	1.85*	4.56	0.71	-0.-0.024	107.66	1.95	12.9**
Daya	89.4	0.37	42.68**	12.03	1.79	3.70*	25.9	0.34	2.28**	4.30	0.047	-0.080	94.25	0.08	16.7**
IR-8	90.40	0.65	8.06**	10.75	0.75	1.77	24.70	-6.35	2.54**	5.43	0.88	-0.038	91.75	6.22	44.93**
IR-36	81.95	0.50*	1.16	12.6	1.39	0.66	24.77	-0.23	1.47*	4.65	-0.144	0.033	94.5	1.40	103.64**
IR-50	84.03	1.16	0.98	14.41	1.15	16.68**	24.76	3.57	0.46	3.92	0.477	-0.124	89.00	-0.47	41.07**
Jaya	94.7	0.87	148.10**	14.83	0.49	26.16**	24.78	0.14	3.8***	4.6	1.27	-0.142	90.54	-3.53	58.25**
PR114	89.0	1.22	16.66**	12.7	0.61	5.47**	23.94	-3.71	6.66**	4.42	2.056	-0.054	99.25	6.55*	9.44**
PR-113	89.06	1.57	11.63**	12.46	1.04	6.43**	25.35	-1.39	8.99**	4.71	2.53	0.300	107.41	0.18	61.10**
Mean	94.82			12.4			25.39			4.47			96.6		
SEM+	3.94			1.32			0.98			0.36			2.764		

*, **, significant at P=0.01 and P=0.05respectively *EBT : Ear Bearing Tiller

and Paroda,1980).

For grain yield, the varieties viz. Lalat, Tapaswini,Uday,Naveen,Gouri,IR - 8,IR - 36, Jaya,PR113 produce more yield than mean value but deviation from regression are significant for varieties like Uday, Naveen,. So Naveen and Uday

are unpredictable and sensitive to environment and other varieties viz. Lalat, Tapaswini, Gouri,IR-8,IR-36,Jaya,PR113 are having non significant deviation from regression hence stable across the environment. The varieties viz. Tapaswini, Naveen Uday,Gouri and IR-8 showed higher mean yield and regression coefficient less than unit. So these varieties perform better in unfavorable condition. The varieties Lalat ,Jaya and PR-113 are having more grain yield and regression coefficient more than unit. Hence these varieties perform better in favorable condition. The genotype x environment interaction for grain yield and other traits was studied in rice (Kishore *etal.*2002, Reddy and Choudhary, 1991). Stability studies in upland rice was reported (Subudhi *et al.*2008).

For plant height, all the tested genotypes have significant deviation from regression except IR-8 and IR-36, hence these varieties are sensitive to environmental change for plant height. The mean value is higher in IR-64, Lalat, IR-72,Tapaswini, Naveen, Gouri and regression coefficient is more than unit hence these genotypes perform better in favorable condition. The varieties viz. Uday, Radhi, Indira have more value than mean but regression coefficient is less than unit. hence better for unfavorable condition.

For EBT, the varieties viz. Naveen, Radhi, IR-36,Jaya, IR-50 PR-114,PR-113,are having higher mean values but significant deviation from regression was observed in Lalat, Saket-4,IR-50, Jaya,PR-113and PR-114.So the later varieties are sensitive to environment and perform better in favorable environment. The varieties like Lalat and Saket-4 and PR-113 are stable across the environment.

For panicle length, the varieties viz. IR-64,Lalat, Satabdi,Naveen,Radhi, Indira and Daya are having more mean value and significant regression from

deviation was observed in Lalat, Satabdi, Naveen, Indira and Daya. So these varieties respond according to the environmental conditions.IR-64 and Radhi are less sensitive to environment .The variety Daya is stable across the environment(bi =0.337).For Days to fifty percent flowering, the varieties viz. Lalat,IR-72, Tapaswini, Uday, Naveen, Indira, Gouri and PR113 are having more mean value and all genotypes have significant deviation from regression, so these are sensitive to environment change. IR-72 is stable across the environment.

Based on the individual stability characters, the varieties viz. Gouri, IR-8 Jaya and IR-36 exhibited higher yield than population mean with regression coefficient near unity and negligible deviation. Hence these varieties can perform better in all types of environment and recommended for cultivation in Orissa as well as Eastern India.

References

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

Jatasar, P.S. and Paroda, R.S. 1980. Phenotypic adaptability of characters related to productivity of wheat cultivars. *Indian. J. Genet.*, **40**: 132-139.

Kishore, K. and Singh, N.K., Niraj Kumar and Thakur, R. 2002. Genotype x Environment interaction and stability analysis for grain yield and some associated traits in boro rice. *Oryza.* **39**: 12-14.

Reddy,J.N. and Choudhary, D. 1991. Stability for grain yield and its components in rice. *Oryza.,* **28**: 295-299.

Singh, S.K. and Payasi,S.K.1999. Stability assessment in early duration genotypes of rice. *Crops Res.***180**: 133-136.

Subudhi,H.N., Meher, J. and Bose, L.K. 2008.Stability analysis for grain yield in some rice varieties. *Environ. Ecol.,* **26**: 2199-2201.

Zubair M., Anwar M., Haqqani, A.M. and Zahid,M.A. 2002.Genotype-Environment interaction for grain yield in mash(*Vigna mungo* L.Happer).*Asian J. Plant Sci.*, **1**: 128-129