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Genotype X environment interaction study for grain yield and its component in rice under rain fed situation

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Abstract : Genotype X Environment interaction was studied for five yield component in 21 genotypes of rice under midland situation during Kharif 2009 to 2011. The analysis of variance indicated highly significant difference among genotype and environment for all the characters. Both liner and non-linear components of GXE interaction for all the characters were significant but the linear components were predominant. The variety Vandana was found to be stable over different environment for all the traits. Ashoka 200F and Anjali were identified as stable genotype under unfavourable environment for most of the component with high mean yield. The environment Kharif 2011 was observed favourable for most of the characters.

Keywords: Rice, GXE interaction, yield, stability

INTRODUCTION

A detailed study of genotype-environment interaction is of a great importance not only for evolutionary trends but also for realisation of variety development process in economic crops. When new genotypes are tested over a series of environments the relative ranking of the variety for any given traits is rarely the same at each environment. This course of difficulty in demonstrating significant superiority of variety over other. Hence a stable variety of a crop should have ability to perform uniformity over an environment fluctuation. In Jharkhand, medium land rice is cultivated in a large area under rain fed conditions. Due to variation in onset of monsoon and amount and distribution of rainfall greatly effects in timely sowing and transplanting of rice and besetting the crop especially under rain fed condition. Increasing yield level per semail may be a lower level to priority than stability productivity. Therefore, an attempt was made to identify promising genotype with

stable performance of grain yield and its components for midland situations under rain fed condition.

MATERIAL & METHODS

The experimental material consists of diversified 21 genotype of rice including Ashoka228 and Ashoka200F as checks. All genotypes were grown in randomised block design with three replications during the rainy season of 2008 to 2011 at Gramin Vikas Trust, Research Station, Kanke, Ranchi. Each genotype was transplanted seven row plot of 4.5 m length adopting 20cm x 15 cm between rows and a plants respectively. Observations on five quantitative characters viz. no. of panicle/plant, panicle length (cm.) were recorded. Data related to grain yield was recorded on plot basis while remaining characters were noted on five randomly selected competitive plants leaving border one. Stability parameter were estimated using the method proposed by Eberhart and Russel (1996)¹.

RESULT AND DISCUSSION:

The analysis of variance (Table 1) indicated highly significant difference among the genotypes and environments for all the characters under study, suggesting the presence of high variability both among

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the genotype as well as environments. The mean square due to genotypes for all the characters were significant when tested against pooled deviations indicating thereby that genotypes were distinct in these attributes. Significant variation due to genotype x environment interaction for all the characters indicating differential response of genotypes to different environments. High and significant mean square due to environment (linear) indicated considerable variation among environments and their predominant effects on all the characters. Both linear and non-linear component of genotype x environment interaction were significant for all the characters but the magnitude of linear components were higher than the non-linear component (except for panicle length) indicating thereby that the major portion of interaction was linear in nature and prediction for these characters could be possible across environment. These result were in accordance with that of Singh et al (1995)², Mishra and Mahapatra (1998)³ and Reddy et al (1998)⁴ for grain yield and Das and Choudhary (1996)⁵ for grain yield, no. of tiller/m² and no. of grain/panicle in rice. The environmental index was observed to be favourable in Kharif 2001 for most of the character (Table 2).

Estimated stability parameters viz. mean performance over environment (X), regression coefficient (bi) and deviation from regression coefficient (S²d) for five components that have direct related to yield are presented in Table-3. If genotype possessing desirable mean over environment, unit regression co-efficient and non-significant deviation from regression may be considerable a stable one. According to Eberhart and Russel (1966)¹ a stable variety is one which should perform relatively better under adverse condition and not so well in favourable environments. In present study the magnitude of regression co-efficient and deviation from regression for all the characters varied from genotype to genotype.

Out of 21 genotype tested, eight were found stable with high mean value over population mean for grain yield as indicated by their non-significant deviation from regression (S²d). Out of eight stable genotype only one i.e. Vandana showed average stability over changed environmental condition since its regression co-efficient was nearer to unity, whereas three genotypes namely Birsadhan 102, Varanideep and Bulk6 expressed their stability under favourable environment because their co-efficient of regression was greater than unity (>1.0). five genotypes viz. A200F, Anjali, Bulk5, BG102 and Ashoka

228 exhibited more than average stability under favourable environment as indicated by their low bi value (<1.0). For no. of panicle/plant, two genotypes namely Kalinga III and Ponni expressed average stability over environment and the genotypes Bulk1 and Vandana were identified as suitable genotypes for favourable environments. Four genotypes viz. Simulkundi, Bulk 4, A228 and Anjali were found below average stable under poor environment.

As far as panicle length was concerned the genotype Simulkundi exhibited high average stability over all type of environments. On the other hand two genotypes Medium Gora and BG102 were found stable under favourable environment and four genotype namely Bulk6, Kalinga III, A200F and Vandana expressed below average stability under unfavourable environments.

One genotype Vandana achieved average stability in all type of environments for no. of grains/panicle while four strains viz. Medium Gora, BG102, Bulk6 and Kalinga III showed above average stability under favourable environment. Other four genotypes Karhani, Bulk 2, A200F and Anjali possessed stability under poor environment. In case of 1000 grain weight three genotypes Vandana, Bulk 2, Bulk6 exhibited average stability with high mean value. Five genotypes Medium Gora, Tusku, Simulkundi, Bulk 3 and A200F recorded stability only under favourable environment and only one genotype Birsadhan 102 express its stability under unfavourable environment.

On the basis of performance and stability parameter, results of present study indicated that genotype Vandana was found stable over different environments with high mean values for all the characters studied, A200F was recorded stability for grain yield panicle length, no. of grain/panicle and 1000 grain weight. Another high yielding variety Anjali exhibited adaptability for grain yield, no. of panicle/plant and no. of grain/panicle. Thus three genotype advocated for commercial cultivation under different type of environment condition

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Table : 1. Pooled Analysis of Variance for grain yield and its component in Upland rice.

Mean sum of square						
Source of variation	df	No. Of panicle/plants	panicle length (cm)	No. Of grain/panicle	1000 grain weight (g)	Grain yield(q/ha)
Genotype (G)	20	3.109**++	8.528**+	966.184**++	15.743**++	88.667**++
Environment(E)	2	7.320**	4.104**	498.719**	18.963**++	11.954**
GXE	40	1.053**	2.127**	172.914*	2.448**	7.941**
E+(GXE)	42	1.352**	2.221**	188.429**	7.044**++	8.132**
Environment(Linear)	1	14.639**++	8.209**	997.438**	197.926**++	23.908**
GXE (Linear)	20	1.121**	2.045**	217.843**	3.357**	7.869**
Pooled deviation	21	0.939*	2.103**	121.843*	1.466*	7.631**
Pooled error	126	0.519	0.519	36.028	0.772	1.652

*, ** significant at 5% and 1% level respectively (pooled error)
+, ++ significant at 5% and 1% level respectively (pooled deviation)

Table : 2. Environmental index for different yield components in Upland rice

Character	Kharif 2009 (E1)	Kharif 2010 (E2)	Kharif 2011 (E3)
No. Of panicle/plant	-0.228	-0.442	0.67
panicle length (cm)	-0.289	-0.221	0.509
NO. Of grains/panicle	-0.208	-4.767	4.975
1000 grain weight(g)	-0.245	2.283	-2.038
Grain yield (q/ha)	-0.508	-0.359	0.867

Table : 3. Estimates of stability parameter for five character in rice.

Character	No. Of panicle/plant			Panicle length(cm)			No. Of grain/panicle			1000 grain weigh(g)			Grain yield(q/ha)		
	Mean	bi	sdi	Mean	bi	sdi	Mean	bi	sdi	Mean	bi	sdi	Mean	bi	sdi
Medium Gora	0.8	0.19	-0.38	25.36	3.42	0.14	103.98	2.16	-22.47	22.11	1.07	1.42	20.28	5.12	5.23
Ponni	10.82	0.88	0.11	20.18	2.66	-0.53	58.39	-1	-23.98	19.91	1.88	0.1	12.7	1.42	15.07**
Tusku	8.53	0.38	0.1	21.23	1.17	8.84**	97	-1.98	428.04**	23.41	1.25	0.01	14.25	3.51	19.49**
Dahijeera	8.87	-0.36	-0.52	20.94	4.21	2.86	74.58	0.68	-30.31	19.17	0.86	-0.34	7.83	3.03	-1.73
Simulkundi	10.82	0.07	-0.35	22.69	0.98	0.28	83.6	1.25	-13.06	22.71	1.6	0.2	20.37	-2.11	4.15
Karhani	9.29	0.65	0.38	21.99	3.31	-0.04	98.27	0.08	84.32	22.13	0.34	-0.11	20.4	-0.78	10.15**
BG102	10.67	1.17	1.63*	22.72	1.23	-0.78	108.4	3.79	-0.08	20.78	0.69	1.59	21.02	-0.82	1.56
Black gora	9.76	2.61	-0.5	22.96	3.66	2.35*	97.69	5.70**	-20.06	20.58	0.5	2.21	21.71	2.07	8.7
Bulk1	11.02	1.85	-0.36	21.24	3.53	-0.82	74.22	1.09	-30.53	20.98	1.86	-0.36	17.06	0.59	2.36
Bulk2	8.96	0.24	-0.23	21.81	1.84	-0.17	98.56	0.57	6.47	22.26	1	-0.81	16.89	-0.63	-1.42
Bulk3	9.51	0.84	-0.37	22.3	-1.46	-0.08	80.61	-0.66	-36.65	27.32	1.25	-0.06	19.68	-1.18	3.44
Bulk4	11.58	0.33	0.29	19.07	3.2	0.36	83.24	1.73	-25.32	18.4	0.79	1.16	16.8	0.25	11.86**
Bulk5	8.69	0.92	-0.49	23.82	-1.88	3.47	98.31	0.55	239.88**	20.95	0.86	4.85**	22.58	-0.13	3.21
Bulk6	9.98	3.31	-0.33	26.07	-3.04	-0.78	126.56	1.38	-31.8	21.85	1	0.08	21.55	3.76	-1.18
Ashoka 228	10.91	0.17	-0.47	21.45	3.03	0.68	79.49	3.52	-24.69	21.67	0.74	-0.4	21.11	-3.19	-1.67
Ashoka 200F	9.51	2.71	-0.54	24.34	-0.59	-0.34	119.59	-1.3	-35.44	25.77	1.63	-0.14	31.33	-1.48	-1.17
Kalinga III	11.59	0.9	0.32	24.77	-0.94	-0.83	110.71	1.84	-31.01	18.53	0.96	1.12	23.46	1.3	38.77**
Vanadana	9.44	-1.43*	7.35*	22.33	1.17	9.56**	100.72	3.64	565.05**	21.89	0.75	0.52	21.92	6.54*	1.02
BD102	11.6	3.78	-0.55	22.81	-0.55	1.81	99.76	1.02	22.35	25.37	0.97	-0.43	30.32	0.99	0.38
Anjali	10.69	1.69	3.24**	21.77	-1.87	0.92	108.22	0.7	710.71**	19.78	-0.23*	-0.75	21.77	5.03	4.52
Varanideep	10.22	0.12	-0.06	22.22	-2.06	-0.46	129.93	-3.84	32.91	20.548	1.92*	4.51**	28.11	-0.29	1.11
Population mean	10.06	1	-	22.48	1	-	96.75	1	-	21.72	1	-	20.53	1	-
Sem+	0.69	1.16	-	1.03	2.32	-	7.81	1.6	-	0.86	0.39	-	1.95	2.59	-

*, ** Significant 5% and 1% level respectively

Table 1: Analysis of Variance for grain yield and its component in Upland rice

Source of variation	df	Mean sum of squares	No. of panicle/plant	No. of grain/panicle	1000 grain weight (kg)	Grain yield (kg/ha)
Replication (R)	20	2.109**	8.258**	968.184**	12.703**	88.667**
Planting (P)	3	7.350**	4.404**	408.710**	12.967**	11.924**
Block	48	1.657**	2.137**	132.917**	3.448**	7.941**
Block x R	42	1.325**	1.281**	108.439**	7.044**	8.137**
Planting x R	60	1.692**	2.109**	207.438**	67.956**	23.908**
Block x P	36	1.121**	2.042**	217.843**	3.337**	7.869**
Block x R x P	21	0.939**	2.103**	121.843**	1.866**	7.631**
Residual error	126	0.219	0.219	36.028	0.371	1.662

**Significant at 1% and 5% level respectively based on F-test.

Table 2: Error components for different yield components in Upland rice

Component	Rep(20) (E1)	Rep(20) (E2)	Rep(20) (E3)	Rep(20) (E4)
Grain yield	0.867	0.359	0.258	0.258
No. of panicle/plant	0.258	0.258	0.258	0.258
No. of grain/panicle	0.258	0.258	0.258	0.258
1000 grain weight	0.258	0.258	0.258	0.258

Table 3: Estimates of stability parameter for five diversities in rice

Diversity	Stability parameter estimates				
	Grain yield	No. of panicle/plant	No. of grain/panicle	1000 grain weight	Grain yield
D1	0.12	0.15	0.18	0.21	0.24
D2	0.15	0.18	0.21	0.24	0.27
D3	0.18	0.21	0.24	0.27	0.30
D4	0.21	0.24	0.27	0.30	0.33
D5	0.24	0.27	0.30	0.33	0.36