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Stability of yield in relation to components traits in rice under rainfed low land c ondition

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Abstract : Twenty rainfed low land rice genotypes were evaluated for their stability to grain yield and its component traits under three predictable environments created by changing the method of sowing and date of transplanting *viz.* direct sowing, normal transplanting and delayed transplanting. The pooled analysis of variance indicated that the mean differences due to genotypes and genotype x environment interaction were significant indicating that the genotypes differ in their adaptability and stability. The pooled deviations were also significant for all the characters studied, suggested that these genotypes differed in their deviation from linearity. Most of the characters were influenced by non-linear components of G x E interaction, but magnitude of linear components were greater than non-linear types. On the basis of linear components characters, the genotypes RAU 1401-12-2, Satyam, Kishori expressed average response and relative stability under different environment for yield and yield components. Stability for grain yield and its components were also exhibited by the genotypes TTB 517-16-SBIR 70149-33 and Satyam under favourable environment whereas, genotypes RAU 1305-6-3-2-3 had higher stability under poor environmental condition. The genotypes RAU 1401-12-2 and RAU 1314-3-3-3 were found to be stable under average environment for grain yield per plant. These genotypes are suitable for the rainfed low land condition which will also serve as good parents for the development of high yielding stable lines.

Key words : Rice, Stability, Rainfed, Lowland, Yield.

Introduction

The ultimate aim of any Plant breeding programme is to evolve the cultivars with high yield potential, with consistent performance over diverse environments. Productivity of a population is the function of its adaptability while, the later is a compromised of fitness (stability) and flexibility. Stability of a genotype depends on the ability to retain certain morphological and physiological characters steadily and allowing others to vary, resulting in predictable G x E interaction for yield. A population that can adjust its genotypic and phenotypic state in response to environmental fluctuation in such a way to give high and stable yield is termed "well buffered". In the present study an attempt has been made to isolate genotypes with high grain yield adaptability and stability under rainfed low land condition.

Materials and Methods

The experimental material comprised of 20 promising rice genotypes. The elite lines/ rice genotypes were grown in three predictable environments created through method of sowing and date of transplanting *viz.* direct sowing (E_I), normal transplanting (E_{II}) and delayed transplanting (E_{III}). The field trial was conducted in randomized block design with three replications in *Kharif* 2002 at experimental research farm, RAU, Pusa. The plot size was 5.0 x $1.5m^2$ with a row spacing of 20cm both under direct seeding and transplanting. In the latter case 25 day-old seedlings were transplanted 15cm apart with one seedling/hill. Recommended package of practices were followed to raise the crop.

Observations on five random competitive plants from each plot were recorded for plant height,

Table 1. Pooled analysis of variance for seven characters in rice under rainfed low land condition

Source	d.f.	Mean sum of square						
		Days to 50% flowering	Plant height (cm)	Panicle length (cm)	No.of tillers/hill	No.of fertile spiklets/panicle	1000-grain weight	Grain yield/ plant
Genotype (G)	19	444.79**	937.46**	6.26*	1.70	1309.59**	11.48**	153.63**
Environment (E)	2	21711.19**	8242.69**	6.30	19.10**	8663.91**	67.91**	826.19**
G x E	38	162.93**	275.95**	2.44**	1.10**	575.04**	4.03**	39.52**
E + (G x E)	40	21874.12	8518.64	8.74	20.2	9338.95	71.94	865.71
E (Linear)	1	43422.43**	16485.40**	12.60*	38.02**	17327.83**	135.48**	1652.86**
GxE (Linear)	19	139.70**+	113.91+	2.36+	1.07+	889.75**+	6.14**+	60.65**+
Pooled deviaton (non-linear)	20	44.07**	416.08**	2.40**	1.07**	247.32**	1.83**	17.48**
Pooled error	114	2.33	3.20	0.35	0.22	93.72	0.33	3.29

* and ** : Significant at 5% and 1%, respectively.

+ : Significance of G x E (Linear) component at 1%, against pooled error.

panicle length, number of tillers/hill, fertile spiklets/panicle, 1000-grain weight and grain yield/plant. Days to 50 per cent flowering was recorded on the plot basis. Stability analysis for grain yield and six component traits was carried out following Eberhart and Russel (1966) model.

Results and Discussion

Pooled analysis of variance for stability parameters (Table 1) showed that the mean differences between the genotypes were highly, significant for all the seven characters studied except number of tillers per hill. The environments and interaction (G x E), environments (linear) were also significant in respect of all the seven characters with the exception to the environmental effects for panicle length. Highly significant G x E interaction component in all the characters indicated differential reaction of the genotypes to the environment. The pooled deviation (non-linear) in the present study were significant for all the characters and suggested that the genotypes differed in their deviation from linearity. The genotype x environment (linear) components was highly significant for the characters, days to 50 per cent flowering, fertile spiklets per panicle, 1000-grain weight and grain yield per plant when tested against pooled deviation. The G x E (non-linear) components were also significant for all the characters studied, when tested against pooled error. High magnitude of environmental (linear) effect was observed for all the characters in comparison to G x E (linear) effect which may be responsible for high adaptation in relation to yield attributing traits in rice. The pooled analysis of variance revealed that both linear and non-linear components of G x E interaction were significant for days to 50 per cent flowering, number of fertile spiklets per panicle and grain yield per plant indicated the predominance of G x E interaction for those traits was of linear type. These findings

Table 2. Stability parameters for seven component traits of 20 genotypes in rice under rainfed low land condition

Genotypes	Days to 50% flowering			Plant height (cm)			Panicle length (cm)			Number of tillers/hill		
	$\overline{X}$	b_i	S^2d_i	$\overline{X}$	b_i	S^2d_i	$\overline{X}$	b_i	S^2d_i	$\overline{X}$	b_i	S^2d_i
Vaidehi	157.55	0.97	75.79**	173.86	1.80++	0.23	23.43	-0.82	1.07*	7.15	0.56	0.68*
Sudha	157.33	0.95	60.80**	167.06	1.77	646.34**	21.17	1.15	0.61	6.97	0.74	1.64**
Rajshree	144.22	0.87++	-0.65	117.83	0.82	492.16**	23.04	2.44	1.91*	7.88	2.15	0.73*
Satyam	156.00	0.99	-1.67	124.23	0.97	-2.18	24.24	1.82+	-0.236	8.57	0.53+	-0.11
Kishori	155.66	0.99	-1.88	139.40	0.76	101.60**	25.68	0.001	1.80*	9.75	0.75	3.06**
TCA 88-55	155.00	0.98	37.05**	167.62	0.73	364.07**	24.46	-2.32	1.36*	7.46	1.09++	0.04
PSR1209-2-3-2	157.44	0.97	45.78**	145.40	0.97	657.71**	21.75	2.33	0.60	6.53	0.74	2.86**
RAU 1305-6-2-3	156.77	1.00	20.77**	147.06	0.98	453.84**	23.71	-0.98	0.68	8.64	2.41	1.78**
RAU 1306-4-3-2-2	138.11	0.85	145.98**	125.35	0.25	57.98**	24.57	0.26	5.80**	6.96	0.58++	-0.13
RAU 1314-3-3	151.33	1.32	80.70**	129.12	1.23	750.32**	25.73	-1.40	14.78**	7.88	2.63+	0.86*
RAU 1326-94-69	156.44	0.89	34.60**	136.20	1.16	317.06**	22.86	-1.15	0.20	7.23	0.31	-0.06
RAU 1 326-29-2-5	148.22	1.25	20.37**	133.13	1.09	969.28**	26.10	0.89	0.21	8.34	0.20	0.72*
RAU 1326-94-2	157.22	1.00	53.67**	153.13	0.74	122.27**	24.25	0.55	0.79	7.24	-0.22	2.41**
RAU 1392-5-3-7-2B	152.66	1.01	17.87**	128.26	1.09	1090.21**	24.33	1.06	1.89*	7.22	1.72++	-0.08
OR 1898-17	146.33	1.20	33.65**	119.80	0.57+	30.08**	25.28	4.17	0.88	8.28	0.94	-0.22
TTB517-16-SBIR 70349-33	155.88	0.94++	-1.18	136.15	1.15	101.17**	27.28	5.82++	-0.29	8.10	0.75	0.51
RAU 676	157.55	0.97++	-2.29	129.93	1.25	1515.50**	24.95	1.91	3.02**	7.44	0.33	1.35**
RAU 1401-12-2	148.55	0.79++	10.18*	154.80	1.07	242.41**	24.68	0.85	-0.04	8.38	1.42	0.30
RAU 13 14-3-3-3	141.55	0.98	148.91**	111.76	0.52	278.38**	23.93	2.52	4.58**	8.04	0.91	-0.70*
Bakol	158.33	0.97	56.30**	155.21	1.00	68.93**	23.43	1.35	1.27*	7.65	1.34	0.63
Mean	152.60			139.33			24.24			7.78		

Genotypes	No.of fertile spikelets/panicle			1000-grain weight			Grain yield / plant		
	$\overline{X}$	b_i	S^2d_i	$\overline{X}$	b_i	S^2d_i	$\overline{X}$	b_i	S^2d_i
Vaidehi	90.31	1.54	-1.43	24.77	1.37	0.38	19.48	0.78	2.69
Sudha	78.40	1.73	320.42*	22.66	-1.00++	0.64	18.18	0.58++	-3.25
Rajshree	109.54	0.14	1286.09**	23.44	1.45	9.73**	20.54	0.95	11.73*
Satyam	100.87	3.72	305.47*	25.00	0.614	0.16	22.07	1.41++	-3.25
Kishori	135.90	-1.17+	58.16	26.00	0.510	2.92**	30.30	1.37	105.21**
TCA 88-55	109.63	0.42	21.16	23.33	0.738	2.32**	17.28	1.34	-0.048
PSR1209-2-3-2	124.11	0.004+	-68.30	22.00	1.56	0.24	17.31	0.93	1.20
RAU1305-6-2-3	121.48	-1.7+	138.33	25.00	0.61	-0.16	21.47	0.81++	-3.05
RAU1306-4-3-2-2	132.63	-0.43++	-62.79	24.55	0.47++	-0.19	19.02	0.45++	-1.92
RAU1314-3-3	144.73	1.9	850.93**	25.66	1.75++	-0.11	20.95	0.65	42.29**
RAU1 326-94-69	116.12	-0.42	122.26	24.66	0.64++	-0.33	20.25	0.22++	0.36
RAU1 326-29-2-5	158.96	1.86++	-68.83	25.88	1.40	4.90**	20.88	0.72	53.32**
RAU1 326-94-2	138.29	0.26++	-86.94	25.33	0.87	0.27	18.61	0.32	8.22
RAU1392-5-3-7-2B	121.64	3.56++	-77.87	23.77	2.26	5.79**	16.51	1.43++	-2.65
OR.1898-17	152.08	2.83++	-93.59	26.00	1.59	1.17*	22.07	0.76	33.42**
TTB517-16-SBIR70149-33	141.74	3.50	456.63*	25.44	1.75	1.71*	21.85	1.79++	-3.29
RAU676	134.28	0.076++	-75.93	24.66	0.94	1.03*	23.13	0.46	32.71**
RAU1401-12-2	134.94	2.03	-43.70	25.00	1.07**	-0.33	23.84	1.58	3.05
RAU 1314-3-3-3	142.92	3.51++	44.47	24.66	-0.29++	0.89	22.87	1.31	9.46
Bakol	137.27	0.36	46.82	24.44	1.63++	-0.29	21.62	2.05++	2.57
Mean	126.29			24.61			20.91		

* and ** : Significant at 5% and 1%, respectively.

+ and ++ : Significant against deviation from unity at 5% and 1%, respectively.

are in corroboration with the result of Vivekanandan and Subramanian (1994), Singh *et al.* (1995), Singh and Payasi (1999), Kulkarni *et al.* (2000) and Senapati *et al.* (2002).

Finlay and Wilkinson (1963) reported linear regression as a quantitative measure of phenotypic stability to denote varietal adaptability over a range of environments. But, Eberhart and Russel (1966) suggested that both linear (bi) and non-linear components (S^2di) of the genotypes environment interaction should be considered while, evaluating the phenotypic stability of a genotype. According to Langer *et al.* (1979), the regression coefficient is a measure of response to varying environments and the mean square for deviation from linear regression is a true measure of productive stability. A genotype with high mean, unit regression coefficient and least deviation from regression was considered as the ideal and widely adapted stable genotype. All three parameters of stability the mean ($\overline{X}$), regression coefficient (bi) and deviation from regression (S^2di) for all the characters are presented in Table 2. According to Eberhart and Russel (1966), an ideal genotype must have high performance unit regression on coefficient (b=l) and the deviation not significantly different from zero (S^2di). They further pointed out that the varieties exhibiting high regression coefficient ($bi > 1$) could be considered as below average in stability. Such varieties will perform better only in favourable environment while, their performance will be poor in unfavourable environments. The varieties with low regression coefficient ($bi < 1$) are adapted specifically to poor environment.

In the present investigation, normal June sowing and July transplanting with recommended doses of NPK fertilizers were considered as the most favourable environment for maximum yield, whereas, the June sowing and August transplanting (delayed transplanting) and direct seeding in April were considered as less favourable environments. Adaptability of twenty rice genotypes under diverse environments are presented in Table 3. In the present investigation, diverse environments are characterized in three-groups, average environment (mean $> \mu$, $b_i = 1$, S^2di = NS), favourable environment (mean $> \mu$, $b_i > 1$, S^2di = NS) and poor environment (mean $> \mu$, $bi = 1$, S^2di = NS). The genotypes, Kishori and Satyam were found to be more stable under average environment whereas, the genotypes TTB517-16-SBIR70149-33 and RAU 676 were found to be more stable under poor environment for days to 50 per cent flowering. Variety Vaidehi was found to more stable for plant height under good environment. The genotypes OR 98-17, TTB 517-16-SBIR 70149-33 and RAU 1401-12-2 were stable under average environment for number of tillers per hill. The variety Satyam was found to be stable under poor environment for number of tillers per hill. The genotypes exhibited stability for number of fertile spiklets per panicle were RAU 1401-12-2 and Bakol under average environment. The genotypes OR 1898-17 and RAU 1314-3-33 were stable under good environment for fertile spikelets per panicle. Similarly the genotypes, RAU 1326-26-2-5 and Kishori exhibited stability under poor environment for fertile spikelets per panicle. For 1000-grain weight, the variety Vaidehi, Satyam and elite lines RAU 1305-6-3-2-3 and RAU 1326-94-2 were stable under average environment. The genotypes RAU 1314-3-3 and RAU 1401-12-2 exhibited stability under good environment and the genotype RAU 1314-3-3-3 showed stability under poor environment for 1000 grain weight. The genotypes RAU 1401-12-2 and RAU 1314-3-3-3 showed stability under average/good environment and TTB 517-16-SBIR 70149-33 and variety Satyam exhibited stability under favourable environment for grain yield per plant. The genotypes RAU 1305-6-3-2-3 exhibited stability for grain yield per plant under poor environment. Therefore, the above findings are in accordance with Kulkarni and Eswari (1994). Mishra and Mahapatra (1998)

Table 3. Adaptability of rice genotypes under diverse environments

Sl. No.	Characters	Genotypes stable under		
		Average environment (Mean> μ, b_i=1, S^2d_i=NS)	Favourable environment (Mean > μ, b_i=1, S^2d_i=NS)	Poor environment (Mean > μ, b_i=1, S^2d_i=NS)
1.	Days to 50% flowering	Kishori and Satyam		TTB 517-16-SBIR 70149-33 and RAU 676
2.	Plant height		Vaidehi	
3.	Panicle length	RAU 1326-29-2-5, OR 1898- 17 and RAU 1401-12-2		
4.	Number of tillers per hill	OR 1898- 17, TTB 517-16-SBIR 70149-33 and RAU 1401-12-2		Satyam
5.	Number of fertile spikelets per panicle	RAU 1401-12-2 and Bakol	OR 1898- 17 and RAU 1314-3-33	RAU 1326-94-2, RAU 1326-29-2-5 and Kishori
6.	1000-grain weight	Vaidehi, Satyam, RAU 1305-6-3-2-3 and RAU 1326-94-2	RAU 1314-3-3 and RAU 1401-12-2	RAU 1314-3-3-3
7.	Grain yield per plant	RAU 1401-12-2 and RAU 1314-3-3-3	TTB 517-16-SBIR70149-33 and Satyam	RAU 1305-6-3-2-3

and Mishra *et al.* (2000) who have reported stable performance to different characters in different genotypes under changing environment.

Thus, the results of the present study revealed that the genotypes RAU 1401-12-2 and RAU 1314-3-3-3 had relatively higher stability under varying environments for yield and yield components followed by Kishori and Satyam. Stability for grain yield and its components were also shown. The genotypes TTB 517-16-SBIR 70149-33 and Satyam were found stable for grain yield and its components under favourable environments, the genotype RAU 1305-6-3-2-3 under poor environmental conditions. The exploitation of these genotypes in breeding programmes will help in improving the productivity of semi-dry areas.