Oryza Vol. 47. No.3, 2010 (206-210)

Phenotypic stability for grain yield and its components in upland rice genotypes

D.N. Bastia, T.K. Mishra* and S.R. Das

Department of Plant Breeding and Genetics, College of Agriculture, OUAT, Bhubaneswar-751003

ABSTRACT

Forty two early maturing rice genotypes were evaluated for yield performance over four diverse environments during dry and wet seasons. The stability analysis showed significance of linear component of variation for grain yield. The genotypes were grouped into four classes on the basis of their stability performance. The genotypes like Parijat, Suphala, Khandagiri, Badami, Ghanteswari, Annapurana, OR 1045-1-6, OR 929-3-2, OR 930-1-12, OR 1062-10-3, OR 1062-10-5, OR 929-3-11-3 and ORS 102-4 were found to possess high yield potential and stable performance over environments. The genotypes like Vanaprava and Udayagiri possess higher mean grain yield but low stability of performance indicating their suitability to favourable environments. The genotypes like Blackgora, N-22, Dular, Bhatta Sel. 2 had high level of stability but low yield potential indicating their adaptability to unfavourable environments. The stability yield performance of the genotypes was found to be associated with the stability of yield components like effective tillers m^{-2} and grains $panicle^{-1}$.

Key Words : *upland rice, genotype, yield stability, environment, interaction*

Rice is mainly grown in three ecological situations in Orissa *viz*. rainfed upland, favourable medium land and rainfed lowland. Early rice varieties are usually grown as direct seeded crop in rainfed upland during wet season and as transplanted crop during dry season under irrigated condition. Any genotype possessing considerable high yield potential coupled with stable performance in different environmental conditions has great value in plant breeding programme. Therefore, an attempt has been made in the present study to identify suitable rice genotypes under upland and for further use in breeding programme.

MATERIALS AND METHODS

The experimental material of the present investigation comprised of forty two early maturing rice genotypes. The genotypes were grown under two environments created through two cultural conditions (direct seeding and transplanting) over two seasons. The experiment was carried out in a randomized block design with three replications at the Central Research Station, Bhubaneswar. The gross plot size was 2.4 m^2 with row spacing of 15×20 cm. Recommended package of practices were followed for crop management. Observations were recorded on grain yield and five attributing characters like effective tillers m^{-2}, number of fertile grains $panicle^{-1}$, plant height, panicle length and flagleaf area. For computation of stability parameters, pooled analysis over environments was carried out following the regression approach of Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Pooled analysis of variance over environments indicated significant differences among varieties for all the characters under study, revealing the presence of significant variability in the genetic materials (Table 1). Significant mean sum of squares due to environment (linear) indicated that major portion of the variation was apparently due to linear regression (Reddy and Choudhury, 1991 and Mahapatra and Das, 1999). The significance of genotype×environment (linear) for grain

Table 1. Pooled analysis (mean squares) of variances for grain yield and its components in upland rice

Source	Genotype (G)	Environment (E) + G×E	E (Linear)	G×E (Linear)	Pooled deviation
d.f.	41	126	1	41	84
Grain yield	45.28**	161.78	17468.36**	34.62**	17.62**
Effective tillers m^{-2}	237..0**	237.7	17180.0**	136.8**	85.3**
Grains $panicle^{-1}$	320.8**	257.9	19940.3**	36.68**	21.83**
Plant height	588.6**	129.0	12577.9**	51.6**	18.5**
Panicle length	8.06**	3.46	313.2**	1.45**	0.76**
Flag leaf area	50.3**	37.9	3437.9**	7.1**	12.11**

** Significant at P= 0.01

yield (34.62**), effective tillers m^{-2} (136.80**), number of grains per panicle(36.68*), plant height (51.6**), panicle length (1.45**) and flag leaf area (7.1**) revealed that there were significant linear relationship in the expression of the above characters under growing condition and therefore, prediction of stability for these characters would be possible. The pooled deviation was highly significant indicating highly variable nature of the upland environment. This result was in agreement with findings of Roy and Panwar (1994); Mahapatra and Das (1999), Singh *et al.* (1995) and Arumugam *et al*. (2007).

Estimates of mean performance $(\bar{X})$, regression coefficient (bi) and deviation from regression (S^2di) of forty two genotypes for grain yield, effective tillers m^{-2} and grains $panicle^{-1}$ are presented in Table 2. On the basis of simultaneous considerations of these three parameters all the genotypes were classified into four groups (Table 3). The four genotypes included in group I had 'b' value less than one and non-significant S^2di values indicating below average stability of these genotypes. The two genotypes Vanaprava and Udayagiri of this group had high group had high mean grain yield indicating suitability of these genotypes for favourable environments only.

The genotypes like Blackgora, N-22, Dular and Bhatta Sel-2 were included in Group II with 'b' values less than one and non-significant S^2di value indicating their high stability of performance over environments. All these genotypes are local land races and had low mean grain yield indicating their adaptability to unfavourable environment. Group III included 21 genotypes with unit 'b' value and $S^2di = 0$, which are considered to posses average stability. Out of these twenty one genotypes, twelve had high mean yield. So these are considered as the suitable ones to be grown over environments for their better stability of performance. Among these genotypes ORS 102-4 was found to be the highest yielder. Other promising genotypes in this group are OR 1062-10-5, OR 930-1-1-2, Annapurna, Ghanteswari, Badami, OR 1062-10-3 and OR 1045-1-6.

Simultaneous consideration of the three characters studied revealed that the genotypes like Parijat, Khandagiri, OR 1045-1-6, OR 929-3-2, OR 1062-10-3 and OR 1062-10-5 (Table 2) had high mean performance with unit regression for all these characters. But the genotypes like ORS 102-4, Ghanteswari, OR 930-1-1-2 and Badami had high mean performance and unit regression for grain yield and effective tillers m^{-2}.

Based on the present investigation, it was found that the local varieties like Blackgora, N-22, Dular and Bhatta Sel-2 have inherent low yield potentiality and do not respond to environmental changes *i.e*. these are highly adaptable to low yielding environments. The varieties like Vanaprava and Udayagiri with high mean grain yield and low stability of performance are found to be suitable for favourable environment like transplanted condition. A good number of genotypes like Parijat, Khandagiri, Ghanteswari, Annapurna, OR 1045-1-6, OR 929-3-2, OR 930-1-2, OR 1062-10-3, OR 1062-10-5, OR 929-3-11-3 and ORS 102-4 are found to have high mean yield performance and posses

Table 2. Stability parameters for grain yield and its components in upland rice genotypes

Sl.	Variety	Grain yield in g ha^{-1}			Effective tiller m^{-2}			Grains $panicle^{-1}$			Plant height			Panicle length			Flag leaf area		
		$\bar{X}$	bi	S^2_{df}	$\bar{X}$	bi	S^2_{df}	$\bar{X}$	bi	S^2_{df}	$\bar{X}$	bi	S^2_{df}	$\bar{X}$	bi	S^2_{df}	$\bar{X}$	bi	S^2_{df}
1	Rudra	24.16	1.26	-2.65	66.30	1.29	27.92	52.63	0.85	37.99	73.40	0.65	33.12**	17.73	0.76	0.50	14.49	0.52	3.04
2	Shankar	28.04	1.45	18.47*	62.2	1.37	10.72	58.45	0.46	-22.26	73.60	0.56	47.34**	17.20	0.44	0.47	14.56	0.75	5.54
3	Zhu11-26	27.74	1.47	66.57**	54.13	0.89	-6.71	62.03	0.73	146.69**	68.86	0.61	35.17**	18.68	0.90	0.49	16.63	0.88	-0.28
4	Heera	19.05	1.06	13.58	54.87	1.13	12.88	64.10	0.95	102.21**	72.61	0.50	-0.97	20.92	0.52	0.78	16.10	0.81	-1.10
5	Kalinga-III	27.42	1.30	21.81**	68.57	1.07	137.32**	55.88	0.87	7.82	102.67	0.69	15.53*	22.38	0.46	-0.24	14.63	0.79	2.84
6	Subhadra	23.09	1.48	-1.00	59.30	1.47	112.86**	59.57	0.49	-4.96	70.71	0.79	1.49	17.46	0.72	-0.25	22.94	1.54	4.14
7	Vanaprava	26.41	1.29	7.27	63.38	1.33	98.80**	73.42	0.04	260.83**	106.58	0.83	7.89	22.96	0.43	-0.22	17.38	0.63	-1.43
8	Sneha	22.89	1.22	44.46**	65.43	1.33	255.66**	61.57	0.72	-20.53	67.09	0.83	16.71*	18.83	0.96	-0.26	16.12	1.08	4.03
9	Vandana	21.85	0.96	16.21*	54.20	1.30	-23.60	65.09	0.93	46.53*	108.23	0.96	19.51**	21.07	0.47	2.14**	21.73	0.82	152.84**
10	Dhala Heera	20.08	0.94	2.59	61.08	0.44	41.59	59.45	0.64	-22.59	73.67	0.75	-4.11	20.82	1.01	-0.11	18.42	1.17	-2.33
11	Parijat	25.84	1.04	-4.46	74.50	0.76	4.83	64.19	0.85	12.09	76.80	0.68	12.53*	20.00	0.76	0.30	16.60	0.69	-4.10
12	Suphala	24.85	1.00	-3.12	73.37	1.14	58.05*	83.07	1.67	-8.50	67.44	0.66	-3.68	18.96	0.84	-0.29	17.37	0.80	0.64
13	Pathara	24.64	1.06	-4.48	56.50	0.84	-23.48	64.35	1.25	-17.81	82.48	1.11	2.29	20.78	0.94	-0.20	23.07	1.40	20.45**
14	Khandagiri	26.65	0.79	-3.52	68.58	0.76	70.16*	63.37	0.82	-7.34	78.53	0.84	-3.62	18.98	0.68	0.20	16.74	0.58	-2.72
15	Nilagiri	30.60	0.86	23.60**	61.88	0.99	161.47**	73.35	1.62	-7.39	79.86	1.02	-3.57	22.89	1.46	0.11	22.68	1.32	2.03
16	Badami	26.70	0.96	-2.04	60.23	0.90	85.68**	69.31	1.38	-3.24	73.98	0.81	0.17	21.52	1.34	0.40	18.72	0.97	8.53
17	Ghanteswari	27.48	0.95	6.31	65.03	1.08	80.44*	70.42	1.55	130.26**	74.89	1.01	14.78*	21.32	1.17	1.38**	18.77	0.92	0.88
18	Lalitgiri	24.40	0.92	3.73	59.43	0.69	24.13	73.20	0.81	156.41**	78.43	0.95	5.77	20.07	0.69	-0.22	19.90	0.97	-1.80
19	Udayagiri	28.08	1.24	-0.84	62.87	0.99	-8.87	77.72	1.68	13.12	76.78	1.16	11.08	21.23	1.50	0.15	19.81	1.82	0.19
20	Neela	19.27	0.82	28.67**	58.23	0.46	96.35**	68.93	1.22	107.99**	76.98	0.90	5.74	21.17	1.08	0.18	17.19	1.15	-4.32
21	Annapurna	28.66	1.02	-2.37	64.58	0.52	63.02*	70.38	1.50	45.87*	72.68	0.81	7.51	21.86	1.08	0.75*	19.56	0.90	18.44**
22	Annada	23.71	23.71	0.86	-1.96	57.08	52.66	78.27	1.46	58.77*	74.77	0.86	4.03	20.83	1.13	-0.04	19.36	0.77	7.41
23	Aditya	21.01	1.06	103.43**	49.17	0.50	329.15**	58.64	0.73	63.04**	7966	1.19	18.03**	19.37	0.97	0.53	15.65	0.50	3.65
24	OR 1045-1-6	27.00	0.75	11.69	71.23	1.06	-19.20	63.18	1.39	4.73	77.63	1.05	-1.14	21.83	1.24	-0.19	16.93	0.72	-0.30
25	OR 929-3-2	30.73	0.98	-3.69	63.52	0.70	-12.20	70.28	1.20	10.44	74.92	0.81	5.48	22.05	1.14	-0.24	18.26	0.99	16.54**
26	OR 930-1-12	29.62	0.81	6.14	70.43	1.08	-7.98	59.95	1.52	42.28	74.62	1.10	0.30	21.56	1.40	1.11**	15.88	0.77	0.34
27	OR 1062-10-3	27.31	0.84	1.85	71.07	1.03	2.36	65.66	1.07	27.41	77.55	0.72	6.64	19.52	0.82	0.85*	18.53	0.75	-0.95
28	OR 1062-10-5	31.19	1.10	-2.67	71.07	1.16	-4.86	63.45	0.45	3.68	70.62	0.81	-2.62	19.10	0.61	-0.12	17.14	0.86	2.49
29	OR 929-3-11-3	26.22	1.10	-3.56	56.83	0.86	27.14	70.97	1.26	181.55**	74.85	1.23	8.49	21.50	1.63	0.63	18.35	1.36	1.38

Table 2 Contd...

Sl.	Variety	Grain yield in g ha^{-1}			Effective tiller m^{-2}			Grains panicle^{-1}			Plant height			Panicle length			Flag leaf area		
		$\bar{x}$	bi	S^2_{df}	$\bar{x}$	bi	S^2_{df}	$\bar{x}$	bi	S^2_{df}	$\bar{x}$	bi	S^2_{df}	$\bar{x}$	bi	S^2_{df}	$\bar{x}$	bi	S^2_{df}
30	OR 1509-6	26.21	0.84	31.81**	61.57	0.85	73.94*	74.82	1.22	131.39 **	86.52	1.34	17.31**	20.72	1.36	-0.17	23.22	1.35	6.69
31	OR 1513-3	26.84	0.90	49.01**	63.83	0.75	143.69**	63.70	1.68	84.72**	85.23	1.17	-0.39	21.17	1.35	0.57	22.95	1.55	7.28
32	Blackgora	21.54	0.47	5.37	46.25	1.16	68.46**	59.37	0.95	28.62	107.32	1.46	32.07**	21.31	1.34	3.62**	27.24	1.46	2.14
33	Kalakeri	22.66	0.98	3.71	52.45	1.24	36.22	60.58	0.57	155.98**	95.63	1.84	33.01**	19.73	1.21	0.88*	25.97	1.13	16,54**
34	N-22	23.46	0.57	7.75	60.78	0.89	103.38**	59.17	1.12	101.26**	95.49	1.25	94.31**	19.13	1.64	1.19**	19.48	1.15	12.43*
35	Dular	23.25	0.64	2.95	49.58	0.95	215.84**	65.57	1.23	47.06*	108.05	1.83	48.38**	22.17	1.82	-0.23	20.70	1.36	16.24*
36	Bhatta Sel-2	23.42	0.81	-2.91	54.47	0.25	-16.05	57.63	1.07	217.05**	92.49	2.20	16.77*	19.81	2.20	0.28	25.81	1.24	7.18
37	OR 1519-2	21.53	0.98	3.18	50.12	0.85	-12.23	63.00	0.79	70.10*	83.58	1.05	2.15	21.36	1.10	0.02	18.44	1.13	-3.21
38	PNR 556-5-20-3	25.10	1.23	23.24**	61.58	1.32	-0.23	58.15	0.46	-19.20	101.63	0.63	7.58	21.34	0.61	0.72*	12.37	0.76	1.10
39	RR 340-1	20.65	0.83	7.21	44.82	0.56	30.57	78.60	0.51	79.55*	86.02	0.92	18.74**	21.78	0.62	1.58**	23.18	1.92	8.76
40	CR 876-4	23.98	1.23	44.91**	56.22	1.36	-17.19	54.53	0.52	92.72*	98.81	0.26	26.91**	20.92	0.06	1.53**	12.53	0.64	-3.14
41	ORS 102-4	33.78	0.78	15.25**	77.53	1.12	-18.25	100.53	0.59	53.09*	91.55	1.07	20.27**	18.93	0.50	0.44	18.51	0.95	-1.61
42	OR 1509-7	23.85	0.90	18.88	59.83	1.39	188.47**	72.53	1.10	163.91**	81.27	1.10	6.60	20.81	1.18	0.19	24.13	1.39	12.12*
	Mean	25.26	0.99	12.92	61.65	1.00	57.92	66.41	1.00	60.68	82.72	1.00	42.67	20.51	1.00	0.46	19.00	1.00	7.58
	SE	0.511	0.07	3.55	1.17	0.042	12.40	1.36	0.06	10.67	1.84	0.063	28.48	2.22	0.06	0.11	0.54	0.044	3.64
	CV	13.10	22.70	168.40	12.45	27.00	138.74	13.33	40.17	115.79	14.48	41.0	432.26	6.84	42.89	165.91	18.44	28.91	311.19

* Significant at P = 0.05 ** Significant at P = 0.01

$\bar{x}$ mean performance,
bi = regression coefficient,
S^2di= deviation of regression

Table 3. Classification of early duration genotypes into different groups on the basis of stability parameters

Groups	Characteristics	Stability performance	Mean $(\bar{X})$	Genotypes	No. of genotypes
I	b>, $S^2di \approx 0$	Below average stability	High	Vanaprava, Udayagiri	2
			Low	Rudra, Subhadra	2
II	B<, $S^2di \approx 0$	Above average stability	High	-	-
			Low	Blackgora, N-22, Dular, Bhatta sel-2	4
III	b≈1, $S^2di \approx 0$	Average stability	High	Parija, Khandagiri, Ghanteswari, Annapurna, OR 1045-1-6, OR 929-3-2, OR 930-1-2, OR 1062-10-3, ORS 1062-10-5, OR 929-3-11-3, ORS 102-4	12
			Low	Heera, Dhala Heera, Suphala, Pathara (13), Lalitagiri, Annada, Kala Keri, OR 1519-2, RR 340-1	9
IV	B = any value,	Unstable	High	Sankar, Zhu 11-26, Kalinga III, Bandana, Nilagiri, OR 1509-6, OR 1531-3	7
			Low	Sneha, Neela, Aditya, PNR 556-15-20-3, CR 876-4 OR 1509-7	6

S^2di = deviation from regression, bi = regression coefficient

average stability making them to fit to wide range of environments. The stability of their better yield performance over environments was found to be associated with stable performance with respect to the yield attributing character like effective tiller m^{-2} and grains $panicle^{-1}$.

REFERENCES

Arumugam, M., Rajana, M.P. and Vidyachandra, B.(2007). Stability of rice genotypes for yield and yield components over extended dates of showing under Cauvery Command area in Karnataka, Oryza, 44:104-107.

Eberhart, S.A. and Russell, W.A. (1966). Stability performance for comarping varieties Crop Sci : 36-40.

Mahapatra, K.C. and Das, S. (1999). Stability of yield in relation to component traits in rice. Oriya 36 : 301-305.

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

Roy, A. and Panwar, D.V.S. (1994). Phenotypic yield stability analysis of some Indian and exotic genotypic of rice (*Oryza sativa* L.) Oryza 31 : 184-187.

Singh, G., Singh, M., Ehutia, D.T. and Awasthi, R.P. (1995). Genotype and environment interaction in rice (*Oryza sativa* L.). Indian J. Agric. Sci., 65 : 832-833.