Indian J. Genet., 52 (2): 139–143 (1992)

STABILITY OF RICE YIELD UNDER DIFFERENT LOWLAND SITUATIONS

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(Received: December 18, 1990; accepted: October 14, 1991)

ABSTRACT

Phenotypic stability was studied in 47 rice genotypes under four different lowland situations for grain yield and its two important components, panicle weight and ear bearing tillers (EBT) per hill. Significant genotype (G) x environment (E) interactions were observed for all the traits. Among the linear and nonlinear components of G x E interaction, linear component was predominant for EBT/hill and nonlinear component for grain yield, while both are equally important for panicle weight. On the basis of stability parameters, the genotypes CR 728-7-2-2, CR 673-431 and Utkal Prava were identified as best cultures for both intermediate and semi-deep low land situations under direct seeded as well as transplanted conditions.

Key words: Grain yield, EBT, panicle weight, stability, lowlands.

Nearly half of the total rice area in India belongs to rainfed lowlands. Out of the total 18 m ha of rice grown in eastern India, nearly 10.5 m ha are under rainfed lowland conditions [1]. Although lowlands are categorized into shallow (0–30 cm), intermediate (0–50 cm) and semideep (0–100 cm) situations depending on the depth of water, the situations many times overlap due to eratic rainfall and flash floods by rivers and crops are damaged. In Eastern India rice is mainly grown by direct seeding and transplanting in different lowland situations. A rice variety suitable for both direct seeding and transplanting under intermediate as well as semideep situations will be of great importance in this region. Keeping in view the above objectives, a study was conducted with 47 lowland genotypes under four different situations to identify high yielding stable genotypes.

MATERIALS AND METHODS

Fortyseven lowland genotypes including 34 improved cultures evolved at the Central Rice Research Institute (CRRI), Cuttack and 13 standard national and local checks were tested under four different lowland situations in kharif, 1989 with two replications. The details of four lowland situations are as follows:

(i) Direct seeded under intermediate water depth: Seeds germinated on 26 June. Water depth was recorded in July end 30 cm and in mid-August 40 cm (maximum). However, till flowering 30–40 cm water was observed.

(ii) Transplanted under intermediate water depth: Thirty three days old seedlings were transplanted on 19 July. Nine days after transplanting, water level was increased to 30 cm and maximum water depth of 45 cm was recorded on 14 August. However, after 2 October it came down below 30 cm.

(iii) Direct seeded under semideep situation: The crop germinated on 16 June. The water level was recorded on 27 July (30 cm), 3 August (50 cm), 18 September (85 cm) and 20 November (45 cm) which gradually reduced afterwards.

(iv) Transplanted under semideep situation: Thirty two days old seedlings were transplanted on 24 July. The water level of 40 cm was observed in mid-August and from end of August to 1st week of November 50–65 cm water was recorded.

Trial on direct seeded under intermediate water depth was conducted at Central Rainfed Lowland Rice Research Station, Kharagpur, West Bengal, while the other three experiments were conducted at CRRI, Cuttack. The crop was grown in lines with the spacing of 20 cm between lines and 15 cm between hills. Under direct seeded crop 3-4 seedlings/hill were maintained by thinning 10 days after germination. Under transplanted conditions 3-4 seedlings/hill were planted to keep uniformity in all the experiments. In all the experiments fertilizer was applied at the rate of 30 kg N and 30 kg P_2O_5 as only basal dose. At harvest observations were recorded for grain yield per square metre, panicle weight and ear bearing tillers (EBT) per hill on ten random competitive hills. Stability parameters were calculated according to Eberhart and Russell Model [2].

RESULTS AND DISCUSSION

Significant mean squares (Table 1) of genotypes (G) and environments (E) for characters under study indicated the differences within genotypes and environments. Mean squares due to G x E interaction showed significant values for all the traits indicating differential behaviour of genotypes under four lowland environments. Among the linear and nonlinear components of G x E interaction, linear component was predominant for EBT/hill, while nonlinear component for grain yield. However, both linear and nonlinear components were equally important for panicle weight.

Table 1. Pooled analysis of variance for grain yield and its components over 4 environments in rice

Source	d.f.	Mean squares		
		grain yield/m^2	panicle weight	EBT/hill
Genotypes (G)	46	13578.52**	0.47^{**++}	1.83^{**++}
Environments (E)	3	159752.00^{**++}	43.43^{**++}	114.67^{**++}
G x E interaction	138	11353.01**	0.24**	1.68^{**++}
Environment (linear)	1	479254.20^{**++}	130.28^{**++}	344.01^{**++}
G x E (linear)	46	7045.19**	0.25**	3.53^{**++}
Pooled deviation	94	13219.79**	0.24**	0.74**
Pooled Error	184	2578.75	0.14	0.53

**Significant against pooled error at 1% level.
$^{++}$Significant against pooled deviation at 1% level.

The positive and negative values of the environmental index (Table 2) indicated the favourable and unfavourable situations, respectively for each character.

According to Eberhart and Russel [2] a stable genotype is one which shows (i) a high mean yield, (ii) a regression coefficient (bi) around unity, and (iii) a mean square deviation from regression (S^2di) near zero. However, Jatasra and Paroda [3] emphasized the use of deviation from regression alone as a measure of stability, whereas linear regression could be treated as varietal response. Accordingly, in the present study the mean ($\bar{X}$) and deviation from regression (S^2di) of each genotype were considered for stability and linear regression (bi) was used for testing the varietal response.

Table 2. Values of environmental indices for grain yield and its components in rice

Environment	Environmental index		
	grain yield	panicle weight	EBT/hill
Direct seeding under intermediate water depth	–8.09	1.38	–0.83
Transplanting under intermediate water depth	–72.94	–0.31	0.12
Direct seeding under semideep situation	68.17	–1.24	–1.42
Transplanting under semideep situation	12.86	–0.83	2.13

Grain yield. Of the 47 genotypes tested, only 21 showed stability for grain yield as indicated by their nonsignificant S^2di values and among them only 11 (Table 3) showed grain yield above population mean (329.1 g). Among the stable genotypes highest grain yield was recorded in CR 728-7-2-2 (432.2 g) followed by CR 673-431 (404.4 g) and Utkal Prava (380.8 g). Though the highest grain yield was observed in CR 626-14-1 (472.7 g), followed by Tilakkachari (432.2 g) but they were unstable over environments. All the 47

Table 3. Stability parameters for grain yield and its two components in 11 best genotypes in rice

Genotypes	Grain yield/m^2			Panicle weight			EBT/hill		
	mean ($\bar{x}$) (g)	bi	S^2di	mean ($\bar{x}$) (g)	bi	S^2di	mean ($\bar{x}$)	bi	S^2di
CR 728-7-2-2	432.2	2.19	2850.3	2.9	1.24	0.01	5.6	0.75	–0.23
CR 673-431	404.8	1.36	84.4	3.3	1.32	0.25	5.3	0.74	0.13
Utkal Prava	380.8	1.04	– 675.3	2.6	0.56	0.10	5.9	0.60	–0.20
CR 724-253	368.6	0.15	–1299.5	2.2	0.60	0.05	5.9	0.22	–0.12
CR 682-276	365.6	1.06	–1654.9	2.0	0.77	–0.09	7.3	1.20	–0.04
Tulasi	354.5	1.34	1208.1	2.7	1.11	–0.04	6.0	0.81	1.63*
CR 625-18-2	346.7	1.58	–916.7	2.6	1.28	–0.01	5.6	1.05	–0.36
CR 729-9-14-2	340.7	2.20*	–1465.8	2.7	1.04	–0.10	5.4	0.54	–0.14
Hatipanjari	340.4	2.52*	–1239.2	3.1	0.96	–0.09	5.1	0.88	0.77
CR 624-1-1	340.2	0.93	3183.2	3.2	1.31	–0.04	4.7	0.65	–0.27
CR 728-1-10-1	336.6	0.69	4736.5	2.5	0.90	–0.12	5.6	0.32*	–0.39

*bi significantly different from unity.

* S^2di significantly different from zero.

genotypes except four showed average response to environmental changes as indicated by their nonsignificant regression coefficients from unity. Two low yielding, but stable genotypes CR 673-268 and MJ 27 showed significantly low regression coefficients (–0.98 and 0.38, respectively) from unity indicating their responsiveness under favourable situations. On the other hand, two high yielding stable genotypes CR 729-9-14-2 and Hatipanjari were more responsive under favourable conditions as indicated by their significantly high regression coefficients (2.20 and 2.52, respectively) from unity.

Panicle weight. Thirty seven genotypes were stable for this trait, of which 24 depicted above the mean (2.7 g). However, only 16 genotypes were stable and had high panicle weight. Highest panicle weight was recorded in CR 673-431 (3.3 g) followed by Tilakkachari (3.3 g) and Sabita (3.2 g), which were also stable over different lowland situations. All the 47 genotypes excepting two showed average response over the four environments. Genotypes CR 605-3-34-3 and MJ 27, which were stable for this trait showed significantly high regression coefficients (1.28 and 1.54, respectively) from unity indicating their responsiveness under favourable situations.

Number of EBT/hill. Fortyone genotypes showed stability for this trait, but only 20 exhibited values above the mean (5.5). Highest EBT was recorded in CR 682-276 (7.3), followed by CR 626-14-1 (6.9) and CR 625-18-3 (6.9), which were also stable for this trait.

Thirtyeight genotypes showed average response to the environmental changes. Three stable genotypes CR 625-18-3, CR 728-58-2-2 and Tulasi were more responsive under favourable situations. On the other hand, six stable genotypes CR 673-361, CR 725-261, CR 728-1-7-1, CR 728-1-10-1, CR 729-2-2-6 and Sabita showed significantly low regression coefficients from unity, indicating their responsiveness under unfavourable situations.

The study revealed that out of 21 genotypes stable for grain yield, 16 showed stability for the other two characters. Two genotypes each showed stability for panicle weight and EBT/hill along with grain yield. One culture was stable for grain yield only. However, eleven stable and high yielding genotypes (Table 3) showed stability for panicle weight and EBT/hill except in one genotype (Tulasi for number of EBT). So, it might be suggested that the stability for grain yield in these high yielding genotypes was mostly imparted by the stability of panicle weight and EBT/hill. Considering grain yield and stability of these three traits the genotypes CR 728-7-2-2, CR 673-431 and Utkal Prava were identified very promising.

Nine of the eleven genotypes depicted average response to the environmental changes for grain yield. Genotypes CR 729-9-14-2 and Hatipanjari were more responsive under favourable situations. All the 11 genotypes except one (CR 728-1-10-1 for EBT/hill) showed average response over different lowland situations to panicle weight and EBT/hill.

In lowland varietal improvement programme, situation specific breeding has a great importance and a high yielding stable genotype for variable water depth and management has a great practical utility to minimize the crop risk due to eratic rainfall and uncertainty of flash floods specially in eastern India. Accordingly, on the basis of the above results the genotypes CR 728-7-2-2, CR 673-431 and Utkal Prava may be utilised for both intermediate and semideep situations under direct seeded and transplanted conditions for rainfed lowland areas.

ACKNOWLEDGEMENT

The authors are grateful to the Director, Central Rice Research Institute, Cuttack for providing necessary facilities for this study.

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