Environment & Ecology 27 (2) : 489—492, 2009
 ISSN 0970-0420

Stability of Grain Yield and its Important Component Characters in Rice (*Oryza sativa* L.)

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Abstract

Stability of ten promising rice genotypes was evaluated for grain yield and its components in four environments viz. E_1 (1 May sowing, 20 × 10 cm spacing), E_2 (1 May sowing, 20 × 20 cm spacing), E_3 (1 June sowing, 20 × 10 cm spacing), E_4 (1 June sowing, 20 × 20 cm spacing). The linear components of G × E interaction were significant only for three characters, viz. plant height at maturity, days to 50% flowering and grain yield per plot ; whereas the non-linear component was significant for all the characters. Among the genotypes, CAUR-2 and KD-2-7-6-2 produced better grain yield. However, on the basis of estimated parameters of stability, the genotypes RCM-9 and KD-2-7-6 could be considered better for grain yield for general cultivation under this situation in Manipur valley.

Key words : Yield stability, *Oryza sativa* L., Spacing, Sowing dates, Grain yield.

The present rice production scenario of Manipur revealed that one of the most plausible ways for increasing rice production immediately with less annual fluctuations in production is the introduction of stable high yielding inbred rice varieties under rainfed lowland condition of Manipur valley. Because, the rice crop of this system of cultivation contributed more than 50% of the total rice production of the state. Rice varietal adaptability to different planting time of rainfed rice under Manipur valley condition during *kharif* season is of paramount importance for stable high yield as the sowing/transplanting time of rice is dependent upon erratic rainfall. Moreover rainfed lowland rice farmers of Manipur by and large do not give much attention to the appropriate planting density thereby resulting into low yield. To increase rice productivity and production of the rainfed lowland *kharif* rice in Manipur, development or identification of high yielding rice varieties which produce stable yield under different sowing time and planting density is considered essential. Any specific genotype does not always exhibit similar phenotypic characteristics under all environments ; instead their behavior would like by to be varied with environment. An attempt was therefore made to identify the stable genotypes of rice under different spacings and different sowing dates for further use in the breeding program.

Methods

The materials of the study comprised of ten genotypes of rice viz. CAUR-1, CAUR-2, KD-1-1-38-7-2, KD-2-6-3, KD-2-7-6, KD-2-7-6-2, KD-4-13-1-2, KD-6-7-1, RCM-5 and RCM-9. The experiment was carried out in randomized block design with three replications. The genotypes were grown under four environments created through the combination of two sowing dates and two spacing of transplantation of the crop. The four environments namely, E_1 (1 May sowing, 20 × 10 cm spacing), E_2 (1 May sowing, 20 × 20 cm spacing), E_3 (1 June sowing, 20 × 10 cm spacing) and E_4 (1 June sowing, 20 × 20 cm spacing). The gross size of each plot size is 9 m^2. Seedlings were raised by sowing seeds on raised nursery beds and were uprooted when they attained 4–5 leaf stage i.e. about 25 days after sowing. A fertilizer dose of 60 kg N, 40 kg P_2O_5 and 30 kg K_2O per hectare was applied in the transplanted crop. Other recommended package of practices were followed to raise good crop. A sample size of three two × two hills units (1) from each plot was taken, discarding the border row and leaving behind an undisturbed central area of about 5 m^2 for recording the data on important characters, viz. plant height at maturity, days to 50% flowering, days to 80% maturity, panicle per plant hill, spikelets per panicle, grains per panicle, 1,000-grain weight, grain

Table 1. Analysis of variance (mean squares) for phenotypic stability for different characters in rice. *, **Significant at 5 and 1% levels respectively. NS = Not significant.

Source of variation	df	Plant height at maturity (cm)	Days to 50% flowering	Days to 80% maturity	Panicles per plant hill	Spikelets per panicle	Grains per panicle	1000-grain weight (g)	Grain yield per plot (kg)	Harvest index (%)
Genotype (G)	9	126.84**	112**	197**	5.14*	519.71**	342.42**	14.14**	0.88**	0.003*
Environment (E) + (G × E)	30	33.45	22	8	1.67	258.96	336.88	0.5	1.57	0.001
E (linear)	1	600.20**	69**	29**	41.38**	2470.20**	7477.59**	NS	4.13**	0.016**
G × E Linear	9	34.13**	54**	NS	NS	NS	NS	NS	0.43**	NS
Pooled deviation	20	4.18**	5**	6**	0.26**	148.64**	77.43**	0.48**	0.10**	0.001**
CAUR-1	2	6.72**	2**	3**	0.08**	383.03**	244.79**	1.31**	0.13**	NS
CAUR-1	2	2.18**	1**	2**	0.33**	89.25**	36.46**	8.86**	NS	NS
KD-1-1-38-7-2	2	4.35**	12**	22**	0.18**	149.58**	109.45**	NS	0.06**	NS
KD-1-1-38-7-2	2	4.48**	1**	10**	0.48**	98.74**	NS	3.27**	0.10**	NS
KD-1-1-38-7-2	2	0.98**	3**	1**	NS	30.29**	55.20**	6.45**	0.18**	NS
KD-1-1-38-7-2	2	19.56**	NS	1**	0.26**	147.99**	9.97*	NS	0.06**	NS
KD-1-1-38-7-2	2	2.45**	1**	2**	0.65**	6.98**	45.76**	NS	0.02*	NS
KD-1-1-38-7-2	2	1.70**	17**	4**	0.18**	405.66**	205.26**	1.02**	0.40**	NS
RCM-5	2	5.29**	8**	11**	0.36**	68.99**	57.18**	NS	0.09**	NS
RCM-5	2	NS	1**	0.4**	0.09**	78.29**	NS	NS	NS	NS
Pooled error	72	0.18	0.07	1	0.01	0.16	2.73	0.11	0.005	0.00

yield/plot and harvest index. The data were analyzed for stability parameters using the model proposed by Eberhart and Russel (2). According to this model an ideally stable genotype is one with high mean ($\overline{Xi}$) performance, unit regression coefficient i.e. linearity in regression (bi = 1) and deviation from regression as small as possible ($S^2di = 0$).

Results and Discussion

Pooled analysis of variance (Table 1) revealed significant differences of all the characters among the genotypes (G) (Table 1). Even significant mean sums of squares due to environment (linear) indicated that different environments had significant linear influence to the expression of all the characters except 1,000-grain weight. The results were in agreement with those of Roy and Panwar (3) and Mahapatra and Das (4). The significance of genotype × environment (linear) for plant height at maturity, days to 50% flowering and grain yield per plot revealed that there were significant linear relationship in the expression of these characters with different environments and therefore prediction of stability for these characters would be possible. The G × E (linear) and pooled deviation mean sum of squares were found to be significant for plant height at maturity, days to 50% flowering and grain yield per plot indicating the presence of both predictable and non-predictable components. The importance of both linear and non-linear sensitivity for the expression of these traits was thus evident. These results were in conformity with earlier reports (4, 5). The non-significant effects of genotypes × environment (linear) interaction against pooled deviation were observed for days to 80% maturity, panicles per plant hill, spikelets per panicle, grains per panicle, 1000-grain weight and harvest index. However, the estimates of stability parameters ($\overline{Xi}$, bi and S^2di) were found to be suitable for identifying individual genotypes (6) (Table 2).

The mean ($\overline{Xi}$), regression coefficient (bi) and deviation from regression (S^2di) for different characters were presented in Table 2. The magnitude of regression coefficient and deviation from regression varied from genotype to genotype. Varied G × E interaction of different genotypes for plant height at maturity, days to 50% flowering, panicles per plant hill, grains per panicle, 1,000-grain weight and grain yield per plot and harvest index under different environments were observed in the present study. Similar results were reported by Das et al. (7) and Singh et al. (8).

Among the environments, the E_1 environment (May sowing and 20 cm × 10 cm spacing) was the

Table 2. Genotypic means with stability parameters for some important component characters.

Genotype	Stability parameters: Plant height at maturity			Days to 50% flowering			Days to 80% maturity		
	$\bar{X}i$	bi	S^2di	$\bar{X}i$	bi	S^2di	$\bar{X}i$	bi	S^2di
1. CAUR-1	98.97	-0.06	6.54	113	1.71	1.65	141.92	2.34 +	2.41
2. CAUR-2	94.64	2.57 ++	1.99	119	-3.78 ++	1.10	146.00	-3.29 ++	2.25
3. KD-1-1-38-7-2	88.55	1.39 ++	4.17	111	1.85	12.21**	139.67	1.62	21.52**
4. KD-2-6-3	91.50	0.49	4.30	113	1.00	0.96	142.75	1.49	9.59
5. KD-2-7-6	100.61	0.90	0.80	122	5.81 ++	2.69	157.42	1.72++	0.63
6. KD-2-7-6-2	98.72	1.47 ++	19.37**	114	0.12	-0.01	143.50	-0.87	1.06
7. KD-4-1-3-1-2	104.52	1.90 ++	2.27	108	4.25 ++	0.79	139.75	3.84++	1.69
8. KD-6-7-1	88.75	0.82	1.52	107	-1.41	16.98**	136.58	-0.20	3.88
9. RCM-5	90.77	0.16	5.11	114	1.84	7.88**	139.92	3.11+	10.96**
10. RCM-9	100.30	1.37 ++	0.21	122	-1.40	0.54	156.08	0.27	0.27
Mean	95.73			114.47			144.35		
CD (G)at 5%	2.64			2.58			2.83		

Table 2. Continued.

Genotype	Stability parameters: Spikelets per panicle			Harvest index		
	$\bar{X}i$	bi	S^2di	$\bar{X}i$	bi	S^2di
1. CAUR-1	110.88	0.77	382.87**	0.35	0.98	0
2. CAUR-2	128.40	1.26	89.09**	0.42	-0.74	0
3. KD-1-1-38-7-2	117.93	1.89 +	149.42**	0.37	0.08	0
4. KD-2-6-3	129.68	0.61	98.57**	0.40	0.11	0
5. KD-2-7-6	140.48	-0.90	30.75**	0.35	1.41	0
6. KD-2-7-6-2	126.32	2.49 ++	174.82**	0.42	1.46	0
7. KD-4-1-3-1-2	122.03	2.09 ++	6.81	0.39	2.98++	0
8. KD-6-7-1	111.36	1.36	405.49**	0.35	-0.45	0
9. RCM-5	105.68	0.24	68.83**	0.36	2.10 +	0
10. RCM-9	136.56	0.20	78.12**	0.39	1.33	0
Mean	122.89			0.38		
CD (G) at 5%	14.76			0.02		

best for yield and its two primary components viz. grains per panicle and 1,000-grain weight. However, E_4 environment (June sowing and 20 cm × 20 cm spacing) was the lowest for yield and its two primary components viz. grains per panicle and 1,000-grain weight. For other primary components panicle per plant hill, E_2 (May sowing and 20 cm × 20 cm spacing) was the best environment and E_3 (June sowing and 20 cm × 10 cm spacing) was the lowest.

Yield per unit area in rice is decided by total number of panicles per unit area, number of grains per panicle and average grain weight. The highest yield is obtained when the product of these three components is maximum (9). Among the genotypes, the genotype RCM-9 was found to be stable for three characters, viz. panicles per plant hill, grains per panicle and grain yield per plot, as it had unit regression and non-significant S^2di value with higher mean value than the general mean ; while the genotype KD-2-7-6 was found to be stable for another three characters viz. plant height at maturity, panicles per plant hill and grain yield per plot. Considering the estimates of stability parameters, the genotypes RCM-9 and KD-2-7-6 were considered to be the most stable under the present created environmental conditions in Manipur valley. Regarding the character grain yield per plot the genotypes CAUR-2 and KD-2-7-6-2 are considered as better performing genotypes under favorable and unfavorable environments. These genotypes could be recommended for early sowing (1 May sowing) and closer spacing (20 cm × 10 cm), and also recommended for late sowing and closer spacing and for late sowing and wider spacing as these genotypes performed well under unfavorable environments.

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