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Genotype X Seedling Age Interaction in Rice (*Oryza sativa* L.)

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Abstract: Genotype x environment interaction for plant height (cm), days to maturity and grain yield (t/ha) in HYV boro rice were studied by growing six genotypes over three different environments (seedling age of 45, 60 and 90 days old). Highly significant genotypes and G x E interaction were observed for all the traits. Highly significant environments were observed for days to maturity and grain yield. Both non-linear component (pooled deviation) and linear components (seedling age) were found highly significant for grain yield and days to maturity but non-significant for plant height and grains protein content (%). BRRI dhan29 and BRRI dhan28 were found to be stable for yield and its components over all seedling age. On the other hand, except BR3, all the varieties showed stability for grain protein content (%) over environments. BRRI dhan29 was observed to be the top yielding crop followed by BRRI dhan28. BR26 and BR24 were found to be suitable for favourable and poor environments, respectively. Sixty days old seedlings might be transplanted followed by 45 days old seedlings for higher grain yield for above varieties.

Key words: Stability, yield, yield component, protein content, seedling age

Introduction

Rice yields are subjected to considerable environmental fluctuations, especially under different seedling age. Yield is a complex character, which is dependent on a number of agronomic characters and highly influenced by many genetic as well as environmental factors (Joarder *et al*., 1978). Higher seedling age reduced the grain yield of rice by increasing sterility percentage of spikelets and decreasing tillering ability of rice. The potentials of genotypes and stability of their performance can be judged by multi environment testing. A precise knowledge of genotype x environment interaction is very important to evaluate the stability of grain yield and its components in different seedling age of rice. Generally low temperature during boro season, especially in the northern part of Bangladesh reduced the growth as well as survival capacity of the transplanted rice seedlings. Aged seedlings have more survival capacity due to higher recovery capacity of transplanting shock than the younger seedlings in low temperature during boro season (Rashid *et al*., 1990). Stable genotypes of rice overcome the reduction of growth and grain yield equally in different seedling age. The present investigation was undertaken to determine the relationship between high yield and its stability.

Materials and Methods

Six genotypes viz. BR3, BR24, BR26, BRRI dhan27, BRRI dhan28 and BRRI dhan29 were grown in three different microenvironments at the experimental research farm of Bangladesh Rice Research Institute (BRRI), Regional Station, Rangpur during boro season of 1998/1999. The experiment was laid out in completely randomized block design (RCBD) with three replications in each environment. The microenvironment includes three different seedling age of 45, 60 and 90 days old. The plot size for each treatment was 10-meter square and 25 x 15 cm^2 inter and intra row spacing with single seedling per hill. Fertilizer @ 120-60-60-30 kg/ha, N-P_2O_5-K_2O-S was applied. Application of fertilizer and intercultural operation were done as per recommendation for rice (Anonymous, 1999). Data on ten random hills on plant height (cm), days to maturity and grain yield (t/ha) was recorded. Percentage of grain protein content (Brown rice) was measured by microkjeldahl method in the laboratory of Grain Quality and Nutrition Division, BRRI, Gazipur-1701 after harvesting the crops. The phenotypic index (pi) is used for easy interpretation and decision (Ram *et al*., 1970). Stability parameters (bi and S^2di) were estimated following Eberhart and Russell's model (1966).

Results and Discussion

Combined analysis of variance due to seedling age, genotypes and genotype x seedling age interaction for grain yield and its components and grain protein content (%) are given in Table 1. Highly significant genotypic variances for yield and its components and grain protein content (%) were observed which indicated the existence of considerable variation among the genotypes. The mean sum of square due to environments was also highly significant for days to maturity and grain yield that revealed the difference among seedling age and their considerable influence in yield of rice. Plant height (cm) and grain protein content (%) were not influenced by seedling age due to non-significant mean sum of square. The highly significant mean sum of square for G x E interaction also revealed the variation of yield of rice genotypes for all the characters over environments. Sarker *et al*. (1994a) in peanut, Mondol and Alam (1992) in cotton, Alam *et al*. (1999) in soybean, Sarker *et al*. (1994b) in chickpea reported similar results. The non-significant G x E (linear) interaction for all the traits indicated the absence of difference among the regression of the genotypes on environmental indices. The mean sum of square for seedling age (linear) was observed significant for days to maturity and grain yield indicated the presence of the difference among the regression of the genotypes on the environmental indices. The significant pooled deviation (non-linear portion) for yield and growth duration indicated that the genotypes differed considerably in respect to their stability with change of seedling age. These results agreed with the results of Alam *et al*. (1999), Alam *et al*. (1994) and Sarker *et al*. (1994b).

According to Eberhart and Russell (1966), a stable genotypes is characterized by a slope not differ from unity (bi = 1) and the deviation from regression close to zero (S^2di = 0). The stability parameters- mean ($\bar{x}$), phenotypic index (Pi), environmental index (Ei), regression co-efficient (bi) and deviation from regression (S^2di) for yield and its components and grain protein content (%) of different genotypes are presented in Table 2. Though linear portions of G x E interaction was non-significant for all the traits and non-linear portion was non-significant for plant height but in case of individual test few genotypes exhibited significant regression (bi) value and deviation from regression (S^2di) thus stability appears to be the property of individual buffering rather than population buffering for these characters (Allard and Bradshaw, 1964). Dwarf and short growth duration is desirable

Table 1: Combined analysis of variances for grain yield and its components and grain protein content (%) in rice

Source of variation	df	Mean sum of square			
		Plant height (cm)	Days to maturity	Grain yield (t/ha)	Grain protein content (%)
Variety	5	1380.89**	129.92**	3.61**	5.3740**
Seedling age	2	0.35	332.63**	3.12**	0.0100
Variety x Seedling age	10	7.25**	8.30**	0.14**	0.0110**
Seedling age (linear)	1	0.69	665.25**	6.24**	0.0062
Variety x Seedling age (linear)	5	11.16	3.53	0.16	0.0051
Pooled deviation	6	2.78	10.89**	0.10**	0.0019
Pooled error	30	1.926	2.41	0.02	0.0063

* and ** significant at 5% and 1% level of significance, respectively

Table 2: Mean ($\bar{x}$), phenotypic index (Pi), environmental index (Ei) and stability parameters (bi and S^2di) for yield and its components and grain protein content (%) in six rice varieties

Variety	Plant height (cm)				Days to maturity			
	Mean ($\bar{x}$)	Pi	bi	S^2di	Mean ($\bar{x}$)	Pi	bi	S^2di
BR3	89.22	-22.34	3.02	-1.58	185	9.16	1.05**	-0.58
BR24	121.33	9.88	7.44	-1.51	170	-5.94	0.99	20.32**
BR26	101.33	-10.22	5.83	6.15*	170	-5.83	0.81	4.39
BRRI dhan27	150.00	38.46	-18.51	2.81	180	3.95	0.78	3.44
BRRI dhan28	104.66	-6.89	1.89	0.33	170	-5.50	1.23	-1.15
BRRI dhan29	102.67	-8.89	6.33	-1.05	180	4.16	1.14	24.48**
Grand mean	111.54				176			
Ei		45 days old	60 days old	90 days old		45 days old	60 days old	90 days old
		-0.11	-0.17	0.28		-7.50	0.11	7.39

* and ** significant at 5% and 1% level of significance, respectively

Table 2: Continued

Variety	Grain yield (t/ha)				Grain protein content (%)			
	Mean ($\bar{x}$)	Pi	bi	S^2di	Mean ($\bar{x}$)	Pi	bi	S^2di
BR3	5.14	-0.92	1.22	0.22**	7.99	-0.15	4.43*	-0.0061
BR24	4.42	-1.64	0.97**	-0.02	9.25	1.11	2.50	-0.0035
BR26	6.24	0.17	0.85*	-0.00	8.37	0.24	1.01	0.0048
BRRI dhan27	6.83	0.76	0.43	0.14*	7.29	-0.85	-0.02	0.0010
BRRI dhan28	6.36	0.29	0.93	0.06	8.63	0.50	0.03	-0.0063
BRRI dhan29	7.40	1.34	1.60	0.07	7.29	-0.85	-1.95	-0.0049
Grand mean	6.07				8.13			
Ei		45 days old	60 days old	90 days old		45 days old	60 days old	90 days old
		0.36	0.47	-0.83		0.0256	-0.0078	-0.0178

* and ** significant at 5% and 1% level of significance, respectively

for rice. From the environmental index it was clear that 60 and 45 days old seedling were favourable environments for dwarf plant height. Except BR26 all the genotypes were found to be stable for plant height due to their regression co-efficient near unity (bi = 1) and deviation from regression near to zero (S^2di = 0) in different seedling age. Among them, BR3, BRRI dhan28 and BRRI dhan29 possessed lower mean ($\bar{x}$) and phenotypic index (Pi) was stable with dwarf plant stature while BRRI dhan27, BR24 possessed higher mean and phenotypic index was stable with tall plant stature. BR26 showed regression co-efficient near unity (bi = 1) but significant deviation from regression (S^2di > 0) indicated that non-linear portion were responsible for G x E interaction.

For growth duration, except BR3 all the varieties showed non-significant bi values that indicated they were not responsive to the change of environments. BR24, BRRI dhan29 showed highly significant deviation from regression (S^2di). The fate of these varieties could not be predicted over environments because of significant S^2di and as it invalidated linear prediction. BR3 showed higher mean and phenotypic index with significant regression co-efficient (bi > 1) and deviation from regression near to zero (S^2di = 0) considered to be highly responsive to duration over different seedling age. Lower mean, negative phenotypic index with bi near unity (bi = 1) and S^2di near to zero (S^2di = 0) was observed in BR26 and BRRI dhan 28 and might be considered short duration stable genotypes over different seedling age. On the other hand higher mean and phenotypic index with bi near unity (bi = 1) and S^2di near to zero (S^2di = 0) was observed in BRRI dhan 27 and might be considered long duration stable genotypes over different seedling age. Forty-five and 60 days old seedling age were suitable for shortening the growth duration.

High yield is associated with dwarf plant type and little bit more duration. In case of grain yield, the most favourable environments as indicated by the environmental index were 60 and 45 days old seedlings. BRRI dhan29 produced highest mean yield (t/ha) over seedling age and genotypes. In boro season, rice planted with 60 days old seedling gave higher grain yield followed by 45 days old seedling. Mannan and Siddique (1991) also observed that 60 days old seedling gave higher grain yield than 45 and 75 days old seedling. BR24 and BR26 were considered to be responsive to the environmental change due to significant bi value (bi > 1). BR3 and BRRI dhan27 showed significant deviation from regression (S^2di > 0). Non linear portion was responsible for G x E interaction for these genotypes. Lower mean, negative phenotypic index (Pi) with significant regression co-efficient (bi > 1) and deviation from regression near zero (S^2di = 0) was observed in the variety BR24. This variety was suitable for poor environments. BR26 possessed high mean and phenotypic index with significant regression co-efficient (bi > 1) and deviation from regression near zero and considered to be suitable for favourable environments. BRRI dhan29 and BRRI dhan28 showed high mean and phenotypic index with regression co-efficient near unity (bi = 1) and deviation from regression near to zero. These two genotypes were stable over all environments. Silveira and Vencovsky (1983) also reported stable rice cultivar with high yield.

Except BR3, all the genotypes were found to be stable for percentage of grain protein content due to their regression coefficient near unity (bi = 1) and deviation from regression near to zero (S^2di = 0) in different seedling age. Among them, BRRI dhan27 and BRRI dhan29 possessed lower mean ($\bar{x}$) and phenotypic index (Pi) and was considered to be stable with low protein content (%) while BR24, BR26 and BRRI dhan28, possessed higher mean and phenotypic index and was considered to be stable with high protein content (%).

BRRI dhan29 and BRRI dhan28 were found to be stable for yield and its components over all seedling age. BRRI dhan29 was observed to be the top yielding crop due to its high mean (7.40) and phenotypic index (1.34) for yield associated with desirable mean and phenotypic index for height and duration followed by BRRI dhan28. BR26 and BR24 were found suitable for favourable and poor environments, respectively. Sixty days old seedlings were better than 45 and 90 days old seedling for grain yield and its components.

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