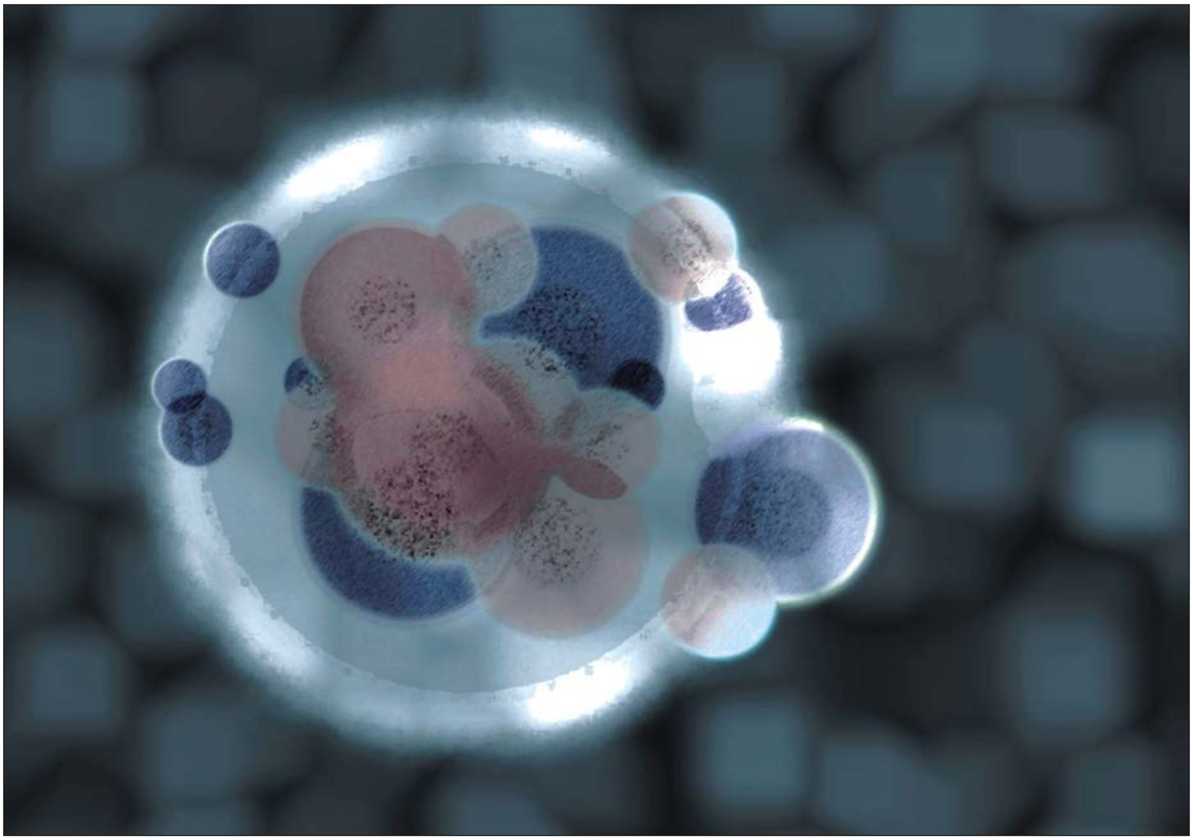

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Genotype-Environment Interaction in Irrigated Rice (*Oryza sativa* L.)

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Abstract: Genotype-environmental (GXE) interaction and adaptability of 12 irrigated rice genotypes for growth duration and yield were analyzed through regression and deviation from regression analysis. All the genotypes were found instable for growth duration. BR4839-17-5-2-2-HR5 and NJ70507 showed insignificant b_i and S^2d_i and their mean yield greater than grand mean. In stability parameters, these two genotypes considered to be the most stable and wider adaptable. BR5877-21-2-3, QINGLIALINO 1, ZHENGUI AI 1 and BRRI dhan28 showed significant S^2d_i indicating their instability but their higher mean yield over grand mean suggesting their suitability for poor environments.

Key words: Irrigated rice, *Oryza sativa*, genotype-environment interaction, stability

Introduction

Rice is considered as the stuff of life in Bangladesh. It covers about 10.3 million ha of cropped area with an annual production of 18.9 million m. ton, but the average yield is 1.8 t ha^{-1} clean rice (BBS, 1998) which is much below than the potential yield of the popular cultivated varieties. The main reason of the less average yield is the poor performance a variety over a range of environment. To cop up with the ever increasing population, new varieties should be developed with high yield potentiality and wider adaptability.

Genotype-environment interaction is of prime concern for the breeders. Stability performance of a genotype is a genetically controlled character (Patra and Mohanty, 1987). Wider adaptability and stability is the main consideration in generating efficient breeding programme. To determine the superiority of a given genotype across a wide range of environment, it is essential to examine G × E interaction. This experiment was undertaken to evaluate some advanced breeding lines and varieties over a wide range of environment for selecting the superior and stable genotypes.

Materials and Methods

Twelve advanced breeding line/varieties were grown at six locations of Bangladesh namely Gazipur, Comilla, Barisal, Bhanga, Rajshahi and Habiganj during the dry season of 1998 and 1999. Each location in a given year was considered as an individual environment. Thus, there were 12 environments. The experiment was laid out in Randomized Complete Block Design (RCBD). Each plot consisted of 12 rows 5.4 m long. 45 days old seedlings were transplanted in all environments spaced at 25 × 15 cm row to row and plant to plant respectively using 2 seedlings/hill. N, P, K, Gypsum and $ZnSO_4$ were applied at100-80-60-100-10 kg ha^{-1}. One third of urea and the entire TSP and MP were applied during the final land preparation. Remaining urea was applied in two splits, one at 21 days after transplanting (DAP) and the other before panicle initiation.

Data on growth duration, yield per plot (kg) were recorded and yield was converted into t ha^{-1} at 14% moisture level from each environment. Stability parameters i.e. regression coefficient (b_i) and deviation from regression (S^2d_i) were calculated after Eberhart and Russell (1966). Phenotypic index (Pi) was estimated following Ram *et al.* (1970).

Results and Discussion

Results of combined analysis of variance for growth duration and yield of 12 rice genotypes over 12 environments are presented in Table 1. The variation among the genotypes and the environments were found highly significant for both the characters indicated that the prediction of genotypes in the environment appeared feasible. Significant mean square for G × E interaction showed the variation of the genotypes over the environments suggested that the data might be extended for the estimation of stability parameters.

Significant nonlinear (pooled deviation) portions for the characters suggested that the prediction of the performance of the genotypes based on regression analysis differed considerably in respect of their stability performance.

Das *et al.* (1991) and Ray *et al.* (1998) also found significant linear and nonlinear component of G × E interaction in growth duration and yield of rice.

Maturity: Stability parameters (b_i and S^2d_i) for growth duration of the individual genotype are presented in Table 2. The genotypes showed nonlinear sensitivity (significant S^2d_i). Among them, BR5877-21-2-3, ZHENGUI AI 1,BR4839-17-5-2-2-HR5 IR60913-42-3-3-2-2, BRRI dhan28 and BRRI dhan29 showed linear sensitivity (i.e. significant b_i) suggesting that the growth duration of these genotypes cannot be predicted. Although IR45912-9-1-2-2 and IR60832-187-2-2-2 showed insignificant b_i but their negative P_i made them difficult for prediction over environments. Most of the genotypes matured earlier in Barisal and later in Rajshahi and Comilla.

Yield: The average yield of the genotypes under different environments and the mean yield over all the environments along with regression coefficient and deviation from regression are presented in Table 3. Highest mean grain yield was obtained from Bhanga (7.77 in 1998 and 7.80 t ha^{-1} in 1999) followed by Habiganj (6.76 in 1998 and 6.61 t ha^{-1} in 1999). High positive environmental index of Bhanga followed by Habiganj indicated highly favorable environments. BRRI dhan29 at Bhanga yielded the highest (9.0 t ha^{-1}) among all

Table 1: Mean sum of squares from combined analysis of variance for growth duration and yield of 12 irrigated rice genotypes

Source	df	Mean sum of square	
		Growth duration	Yield
Genotype	11	372.968**	2.053**
Environment	11	194.88**	9.029**
Genotype × Environment	121	15.643**	0.225**
Environment (linear)	1	2142.02**	88.438**
Genotype × Environment (linear)	11	54.499**	0.253**
Pooled deviation	120	10.764**	0.2001**
Pooled error	288	0.948	0.068

**significant at 1% level

Table 2: Location wise mean growth duration and estimated stability parameters for 12 irrigated rice genotypes

Genotype	Location: Gazipur		Comilla		Barisal		Bhanga		Rajshahi		Habiganj		Mean	Pheno typic index (P_i)	Regre ssion (b_i)	Deviation from regression (S^2d_i)
	1988	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999				
BR5877-21-2-3	139.7	142.3	141.3	138.7	142.3	137.0	141.0	143.0	144.7	143.7	141.3	141.7	141.4	-9.27	0.332**	2.1064**
IR45912-9-1-2-2	146.3	151.0	140.0	146.0	147.0	141.0	140.3	151.7	142.7	152.0	142.0	143.3	145.3	-5.43	0.962	4.1303**
IR60832-187-2-2-2	144.7	150.7	146.0	146.0	146.7	140.0	143.0	154.3	166.7	153.0	143.7	145.3	148.3	-2.33	1.072	34.093**
QINGLIALI NO1	156.3	159.0	147.7	151.0	152.0	146.0	149.7	155.0	150.3	160.7	151.0	149.7	152.4	1.70	1.041	1.774*
ZHENGUI AI1	151.3	155.0	140.7	141.7	146.0	138.0	150.0	154.3	150.0	160.3	147.0	141.7	148.0	-2.66	1.495*	8.8403**
BR4839-17-5-2-2-HRS	159.7	163.0	148.0	153.0	152.0	146.7	148.0	156.0	153.7	171.3	151.0	148.7	154.3	3.59	1.719**	4.6278**
BR(BE) 6158-RWBC2-7-11	154.0	157.0	149.7	146.3	148.7	142.0	150.0	156.0	157.0	164.0	151.0	147.3	151.9	1.26	1.355	5.2456**
BR(BE)6158-RWBC2-8	150.3	158.0	149.7	157.3	152.0	145.0	146.0	153.3	156.0	160.7	152.0	148.0	152.4	1.70	1.046	6.0131**
IR60913-42-3-3-2-2	167.0	168.0	156.0	161.0	158.3	153.0	151.0	162.0	162.0	177.3	161.7	153.3	160.9	10.23	1.721**	7.0542**
NJ70507	150.7	157.0	150.0	152.0	158.0	147.0	153.0	158.7	154.7	162.3	152.3	150.0	153.8	3.12	0.933	5.0997**
BRRI dhan 28	146.0	146.3	142.7	145.0	143.0	140.0	139.0	142.3	136.3	151.3	140.0	140.3	143.4	-7.22	0.370**	17.043**
BRRI dhan 29	163.0	158.0	152.3	159.0	158.7	154.0	151.0	159.7	155.7	146.0	157.3	156.3	155.9	5.26	-0.045	21.762**
Environmental mean	152.4	155.4	147.0	149.8	150.4	144.9	146.8	153.9	152.5	158.6	149.2	147.1	150.7	-----	-----	-----
Environmental index	1.754	4.779	-3.654	-0.913	-0.271	-5.771	-3.829	3.196	1.821	7.888	-1.471	-3.529	---	-----	-----	-----

* and **significant at 5% and 1% level

Table 3: Location wise mean yield and estimated stability parameters for 12 irrigated rice genotypes

Genotype	Location: Gazipur		Comilla		Barisal		Bhanga		Rajshahi		Habiganj		Mean	Pheno typic index (P_i)	Regre ssion (b_i)	Deviation from regression (S^2d_i)
	1988	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999				
BR5877-21-2-3	6.2	5.7	7.2	6.7	5.8	6.1	8.1	7.5	5.7	5.3	7.0	6.4	6.48	0.25	0.8435	0.1227*
IR45912-9-1-2-2	5.8	5.7	6.4	6.4	5.4	6.0	7.6	7.6	5.4	4.9	6.6	5.9	6.14	-0.09	0.853	0.092
IR60832-187-2-2-2	5.5	5.1	6.6	5.8	5.4	5.1	6.7	7.5	4.3	5.0	6.7	6.1	5.82	-0.41	0.9661	0.0943
QINGLIALI NO1	5.2	5.7	6.7	6.5	6.9	6.0	8.9	8.2	5.9	6.4	7.6	7.2	6.84	0.61	1.0994	0.1314*
ZHENGUI AI1	6.1	6.0	6.6	6.5	7.1	6.6	8.4	7.7	5.3	6.2	6.1	6.1	5.64	0.31	0.7754	0.2008**
BR4839-17-5-2-2-HRS	5.3	5.7	7.0	6.8	6.1	6.1	8.2	8.8	5.1	5.9	7.0	6.9	6.55	0.32	1.2499	-0.0096
BR(BE) 6158-RWBC2-7-11	5.0	5.3	6.1	5.4	5.2	6.1	7.5	7.0	4.9	5.6	6.6	7.6	6.03	-0.20	0.9513	0.1864**
BR(BE)6158-RWBC2-8	5.0	5.3	5.8	4.7	5.4	5.3	7.4	7.1	4.1	5.8	5.8	6.3	5.66	-0.57	0.9899	0.0886
IR60913-42-3-3-2-2	5.1	5.4	4.0	6.1	5.2	5.0	6.6	8.1	4.1	5.0	6.6	6.3	5.62	-0.61	1.1117	0.4041**
NJ70507	5.8	5.6	6.3	6.2	5.8	5.3	7.9	8.7	4.9	5.9	6.9	7.1	6.38	0.15	1.2311	0.0148
BRRI dhan 28	5.7	5.3	6.4	6.2	4.9	5.8	7.0	7.0	4.8	5.9	6.6	6.4	6.00	-0.23	0.747	0.0565
BRRI dhan 29	5.7	6.3	5.8	6.1	6.9	5.7	9.0	8.5	5.5	6.8	7.6	7.1	6.74	0.51	1.1818	0.2038*
Environmental mean	5.53	5.59	6.24	6.09	5.85	5.83	7.77	7.80	5.00	5.72	6.76	6.61	6.23	-----	-----	-----
Environmental index	-0.701	-0.635	0.007	-0.151	-0.393	-0.401	1.540	1.573	-1.235	-0.51	0.524	0.382	-----	-----	-----	-----

the genotypes and the environments, but this genotype did not perform well equally in all the specific environment indicating differential yielding ability of the genotypes in environmental fluctuation. No genotype showed linear sensitivity (significant b_i), although the genotypes combindly responded well to the change of environments (Table 1). Six genotypes showed nonlinear sensitivity (significant S^2d_i). This indicates that only nonlinear component was alone responsible for G×E interaction. Sinha and Biswas (1984) also found similar results. Both insignificant linear and nonlinear component showed by other 6 genotypes indicating the non existence of GxE interaction for those. BR4839-17-5-2-2-HR5 and NJ70507 showed insignificant b_i and S^2d_i and mean yield greater than the grand mean. These two genotypes may be considered to be most stable with the change of environments.IR45912-9-1-2-2,IR60832-187-2-2-2, BR(BE)6158-RWBC2-8 and BRRI dhan28 had b_i near unity and S^2d_i near zero, thus they were stable but the mean yield were less than the grand mean (negative P_i) and for this reason they were not desirable. Borthakur *et al*. (1979), Ray *et al.* (1991, 1998) also found such type of genotypes with stable yield. Genotype BR5877-21-2-3, QINGLIALI NO1, ZHENGUI AI 1 and BRRI dhan29 showed significant S^2d_i indicating their instability but the mean yield of those genotypes were higher than the grand mean suggesting their suitability for poor environments like Bhanga and Habiganj.

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