European Journal of Biotechnology and Bioscience

Available online at www.biotechjournal.info

ISSN 2321-9122
EJBB 2013; 1(3): 62-64
Received 23-8-2013
Accepted: 25-9-2013

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Stability analysis of grain yield and its components of rice (*Oryza sativa* L.) genotypes

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ABSTRACT

Genotype x environment interaction was studied for grain yield and their component characters in twenty eight genotypes in three environments. The environment + (genotype x environment) was significant for all the characters indicating distinct nature of environments and genotype x environment interactions in phenotypic expression. The genotype x environment (linear) interaction component showed significance for all the characters studied. This indicated significant differences among the genotypes for linear response to environments (bi) behavior of the genotypes could be predicted over environments more precisely and G X E interaction was outcome of the linear function of environmental components. Based on stability parameters and over all mean, were stable in HB3319-2WX-6-3-1-B,IR47547-3B-26-2B-1,IR64419-3B-13-1,IR65192-4B-8-1,IR71833-3R-3-2-1-B,IR71895-3R-26-2-1-B,IR71999-3R-2-1-B andIR72046-B-R-3-1-1-B performance for grain yield.

Keywords: rice, stability, environment, yield

Introduction

Rice is one of the main sources of food in the world where the increased demand for rice is expected to enhance production in many parts of Asia, Africa and Latin America (Subathra Devi *et al*, 2011) [6]. Rice is the main factor of the lives of billions of people around the world and one of the ancient domesticated grains (~10,000 years). For more than 2.5 billion people of the world rice is main food and it cover 9% of the earth's arable land. It supplies 21% of global human per capita energy and 15% of per capital protein. Asia countries contribute for over 90% of the world's production of rice (Kanbar1 *et al*. 2011, Khush and Virk, 2000) [3, 4]. A Phenotype is the interplay of genotype and environment. A specific genotype does not exhibit the same phenotype under the changing environments and different genotypes respond differently to a specific environment. In present investigation, the approach suggested by Eberhart and Russell (1966) [1] has been employed to understand the differential G x E interactions of varieties to assess the stability of the performance of different genotypes.

Materials and Methods

The experiment material comprised of twenty eight genotypes (Table 1) and the experiment was carried out in a randomized block with three replications in each location. In each genotype, one seedling per hill was transplanted in the main field after 23 days with the spacing of 15 cm between rows and 20 cm between plants. Suggested dosage of P and K along with 50 per cent on N (75:75:90 kg NPK ha-1)was applied at the time of planting and 25 per cent of N was top dressed twice Ist at 30 and 2nd at 60 days after transplanting. Six quantitative characters related to yield traits viz., days to first flowering (days), plant height(cm),total number of productive tillers per plant(nos), total number of grains per panicle (nos),100 grain weight(g) and grain yield per plant (g) were recorded on single plant basis for five randomly selected plants of each genotype per replication in each location. The mean values for all the traits across the locations were subjected to stability analysis (Eberhart and Russell, 1966) [1].

Table 1: Details of genotypes used for the study

S. No	Code	Genotypes
1.	G1	HP3319-2WX-6-3-1-B
2.	G2	IR47547-3B-26-2B-1
3.	G3	IR52709- 2B-5-2B-1-1
4.	G4	IR61919-3 B-24-3
5.	G5	IR61920-3 B-15-2-2
6.	G6	IR61920-3 B-22-2-1
7.	G7	IR63311-B-3R-B-24-3
8.	G8	IR64419-3B-13-1
9.	G9	IR65192-4B-8-1
10.	G10	IR65204-4B-12-1-1-B
11.	G11	IR65847-3B-6-2
12.	G12	IR69323-4R-2B-1-3-1-1-B
13.	G13	IR70023-4B-R-12-3-1-1-B
14.	G14	IR70023-4B-R-12-3-1-B
15.	G15	IR71657-5R-B-12B
16.	G16	IR71829-3R-73-1-2-B
17.	G17	IR71829-3R-82-1-1-B
18.	G18	IR71833-3R-3-2-1-B
19.	G19	IR71863-3R-1-3-1-B
20.	G20	IR71866-3R-1-2-1-B
21.	G21	IR71895-3R-17-1-2-B
22.	G22	IR71895-3R-26-2-1-B
23.	G23	IR71896-3R-8-3-1-B
24.	G24	IR71991-3R-2-1-B
25.	G25	IR71995-3R-1-1-B
26.	G26	IR71999-3R-2-1-B
27.	G27	IR72046-R-1-1-2-1-B
28.	G28	IR72046-R-3-1-1-B

Table 2: Analysis of Variance for Stability for Different Characters

Source	Genotypes	Environment	G X E	Environment + (G X E)	E (Linear)	G X E (Linear)	Pooled Deviation	Pooled Error
Df	27	2	54	56	1	27	28	168
Days to first flowering	5.03*	15.43**	8.74**	8.98**	30.82**	8.79**	8.37**	2.61
Plant height	337.42**	172.50**	44.58**	49.15**	345.11**	77.61**	11.14**	2.87
Total number of productive tillers per plant	56.24**	3.02*	7.22**	7.07**	6.05**	8.49**	5.73**	1.69
Total number of grains per panicle	1107.27**	2.15*	138.32**	133.45**	4.20**	245.36**	30.15**	10.25
100 grain weight	0.46**	0.32**	0.32**	0.32**	0.64**	0.64**	0.34**	0.008
Grain yield per plant	79.51**	18.19**	18.90**	18.88**	36.38**	28.43**	9.04**	2.35

*Significant at 5 per cent level ** Significant at 1 per cent level

Table 3: Stability parameters for Yield and Yield traits

Genotypes	DFF			PH			TNPTPP			TNGPP			100GW			GY		
	Mean	bi	S^2 di	Mean	Bi	S^2 di	Mean	bi	S^2 di	Mean	Bi	S^2 di	Mean	Bi	S^2 di	Mean	Bi	S^2 di
G1	71.00	6.04	0.67	118.66	-2.72*	-2.83	28.33	11.89	12.39**	121.44	-7.99	92.66**	2.34	-0.37	-0.007	27.41	-0.26	-1.75
G2	70.44	2.33	-1.90	96.22	-0.02	-1.92	29.33	12.86	13.40**	86.44	25.09	-6.81**	2.21	-0.33	0.001	24.93	1.61	-1.39
G3	73.77	4.83	-1.63	96.05	-0.35	-2.60	35.77	0.34	3.23	134.88	-5.44	-6.63*	2.46	-0.53*	-0.009	30.55	-3.82	12.48**
G4	74.44	0.15	6.53*	101.77	2.78*	-2.86	26.33	3.41	-1.55	94.22	114.23*	-6.90**	2.64	0.44	-0.008	24.87	-9.53	4.78*
G5	72.77	-2.07	14.93**	95.55	0.14	0.06	25.00	9.72	0.06	55.66	4.29	-8.81**	2.51	-0.11	-0.004	17.38	0.44	-2.21
G6	71.11	-0.55	8.67**	95.00	0.33	-0.69	25.00	13.37	0.27	61.66	11.13*	-10.23**	2.31	-0.64	-0.004	16.36	-0.16	-1.49
G7	71.66	3.65	-2.42	93.11	1.90*	-2.86	29.22	2.40	19.79**	84.11	55.55*	-8.10**	2.57	-1.19	0.003	21.04	-4.04	-1.15
G8	73.44	1.25	28.82**	82.44	-1.89	-0.06	23.55	-1.54*	-1.69	59.00	2.82	-9.90**	2.24	0.15	0.003	16.12	1.90	-2.31
G9	71.77	1.15	16.43*	99.22	-0.36	-2.63	31.77	-6.23	-0.70	85.33	-2.09	-8.02**	3.20	-1.91	0.002	16.88	2.09	-2.35
G10	73.33	-2.62	7.33*	85.55	4.41	-0.47	22.66	-6.09	-1.50	67.11	15.13	-6.85**	2.72	4.13*	0.008	17.48	3.75	3.98*
G11	72.55	0.05	-2.32	86.55	3.92	0.80	29.00	-2.42	-0.29	94.44	16.16	9.42**	2.66	26.74	0.009	33.03	0.77	7.48*
G12	72.77	4.07	20.04**	88.33	2.01	43.83**	33.55	3.81	-1.66	97.88	32.20	11.66**	2.21	-0.11	0.004	22.03	-5.76	31.39**
G13	70.22	-0.89	2.35	104.88	-0.18	54.98**	24.66	-0.25	-0.15	102.77	25.90	-7.96**	2.70	-0.26	0.008	23.15	-0.67	-0.02
G14	71.77	6.28*	-2.44	106.33	4.56	4.98*	29.77	-7.46	-1.68	103.00	-52.04	56.20**	2.46	0.24	0.003	19.97	3.63	-0.97
G15	70.33	-5.84	15.83**	106.66	1.20	23.87**	23.22	3.08	-1.69	98.88	-30.22	-3.06	2.52	0.09	0.008	21.53	5.30	9.21**
G16	70.88	1.44	8.04**	99.88	2.79*	-2.76	33.44	1.59	23.61**	97.66	-22.57	-6.65**	2.32	1.69	0.007	25.13	1.42	-2.00
G17	72.55	-2.65	5.69*	100.33	2.42	11.13**	26.88	4.55	-1.43	113.33	-39.97	-4.26*	2.52	1.13	0.005	25.75	2.91	-1.55
G18	71.22	1.34	17.69**	98.44	0.49	11.03**	25.77	5.39	14.32**	94.11	17.96	-8.68**	2.34	-0.81	0.001	19.14	-5.08	2.06

G19	73.33	0.15	0.02	104.77	5.07	10.23**	21.22	-12.00	-0.55	104.77	-17.70	13.81**	2.27	-0.31	-0.002	21.08	2.77	-1.44
G20	70.44	2.36	-1.14	100.88	1.91	-2.73	23.66	-1.70	-1.66	115.55	-10.50	31.89**	2.25	0.38	-0.009	28.42	8.80	-0.08
G21	69.66	-0.60	-0.13	111.66	6.03*	-2.78	32.00	-8.49	4.25	110.22	-39.75	-0.21	2.36	-0.53*	0.005	27.80	6.55	-1.72
G22	73.33	-0.89*	-2.61	102.00	3.48	44.00**	26.22	-0.09	-0.73	108.88	-24.52	-7.92**	2.36	0.04	0.01	23.65	0.78	3.41
G23	73.33	-1.15	-2.53	112.11	-2.37	20.34	25.88	0.16	-1.63	120.11	-26.39	3.79	2.25	0.17**	0.009	26.45	-0.41	2.96
G24	73.88	-1.05	12.23**	104.77	-0.47*	-2.86	22.33	-5.61	0.15	114.33	-98.55	60.53**	2.31	0.75	0.01	30.14	10.77	29.90**
G25	71.22	3.15	2.49	86.33	-0.31	12.15**	23.88	0.16	-1.63	110.88	7.33	-8.50**	2.15	-0.44	-0.008	33.77	9.22	6.75**
G26	72.33	0.47	1.80	102.66	-2.58	6.14*	17.88	0.86	6.21*	95.33	9.25	10.41**	2.86	-4.56*	-0.006	17.43	0.29	-2.26
G27	71.11	3.17	1.88	133.11	-2.68	3.11	22.88	1.83	6.99**	97.77	75.09*	-6.59*	2.72	3.87	-0.007	22.04	-5.42*	-2.15
G28	72.11	4.36	6.92**	99.44	-1.52	12.83**	20.33	4.44	26.95**	86.55	-6.62	-6.99**	2.22	0.63	-0.008	17.36	0.13	-2.08

Results and Discussion

The analysis of variance for grain yield revealed significant differences among the genotypes and environments indicating the presence of wider variability among the genotypes and environment (Table 2). Highly significant mean squares due to genotype × environment (G×E) interaction revealed that the genotypes interacted considerably with environmental conditions. This is in accordance with previous reports on rice by Panwar *et al*. (2008) [5], Uma devi *et al*. (2011) [7].

The variance due to Environment + (G x Env.) was partitioned into linear (i.e. variance due to G x E) and nonlinear components (i.e. variance due to pooled deviation). Both linear and non-linear components of Environment + (G x Env.) interaction were found to be significant for grain yield as indicated by high significant mean squares due to G×E (linear) interaction and pooled deviation revealed their importance in the expression of traits. These high significant differences are very important for determining G x E interaction. Relatively higher value of the linear component as compared to nonlinear component suggested the possibility of prediction of performance for grain yield over the environments. Therefore, linear (*bi*) and nonlinear (*S2di*) component of G x E interactions were considered while predicting the phenotypic stability of a genotype (Finlay and Wilkinson, 1963; Eberhart and Russell, 1966) [1]. They emphasized the use of deviation from regression as a measure of stability, whereas the linear regression could be treated as a measure of varietal response to environments. Accordingly, the mean and the deviation from regression of each genotype were considered for stability and linear regression was used for testing the varietal response. The stability parameters such as mean, regression coefficient (bi) and mean square deviation from regression (S^2di) are presented in Table :3.

Eberhart and Russell (1966) [1] defined a stable genotype as the one which showed high mean yield, regression co-efficient (bi) around unity and deviation from regression near to zero. Accordingly, the mean and deviation from regression of each genotype were considered for stability and linear regression was used for testing the varietal response.

1. Genotypes with high mean, bi = 1 with non-significant δ2 di are suitable for general adaptation, *i.e.*, suitable over all environmental conditions and they are considered as stable genotypes.
2. Genotypes with high mean, bi > 1 with non-significant δ2di are considered as below average in stability. Such genotypes tend to respond favorably to better environments but give poor yield in unfavorable environments. Hence, they are suitable for favorable environments
3. Genotypes with low mean, bi < 1 with non-significant δ2di do not respond favorably to improved environmental conditions and hence, it could be regarded as specifically adapted to poor environments.
4. Genotypes with any bi value with significant δ2di are unstable.

Out of twenty eight genotypes evaluated the genotypes all the genotypes were found to be non- significant deviation from regression and regression coefficient as around the unity and high mean value which indicated the stable performance of these genotypes for days to first flowering, plant height, total number of productive tillers per plant, total number of grains per panicle and hundred grain weight.

Yield is the main criterion for any type of research, accordingly when grain yield was considered the genotypes HB3319-2WX-6-3-1-B,IR47547-3B-26-2B-1,IR64419-3B-13-1,IR65192-4B-8-1,IR71833-3R-3-2-1-B,IR71895-3R-26-2-1-B,IR71999-3R-2-1-B andIR72046-B-R-3-1-1-B recorded non-significant deviation from regression and regression coefficient as around the unity indicating that the performances of these genotypes will be stable.

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