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Stability analysis in scented rice (*Oryza sativa* L.)

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ABSTRACT

Sixteen genotypes of scented rice were evaluated for stability analysis of yield and qualitative traits at Zonal Research Station (Birsa Agricultural University), Chianki. Palamau in three consecutive years i.e. during kharif 2005, 2006 and 2007. Pooled analysis of variance showed highly significant differences among environments (year), genotypes and G x E interaction. Sufficient mean squares due to genotype x environment (G x E) interactions indicated that the genotypes interacted considerably with the environmental condition. Based on estimated stability parameters and over all mean performance of grain yield, genotypes Dhaniaphool and Birsamati were identified as superior, which were well adapted to all the environment, stable with above average yielding ability or highest grain yield (3416.3 kg/ha, 3365.1 kg/ha, respectively) with non-significant bi and S^2di values. While genotypes, Shamjeera and Ranikajar were above average stable and two genotypes, namely, Basmati-370 and Kasturi were below average stable ones and as such they are suitable for cultivation in poor, and rich environments, respectively.

Keywords: Scented rice, stability parameters, grain yield, grain quality characters

Introduction

Rice (Oryza sativa L.) is an important staple food of more than half of the world population. It is dominantly produced and consumed in the Asian continent. Asia countries contribute for over 90% of the world's production of rice {Kanbar et al. (2011) and Khush & Virk (2000)} [3,5]. Since the beginning of civilization, thousands of rice cultivars have been selected for increasing productivity {Singh et al. (2000)} [14]. Manipulation of genetic resources has contributed much towards meeting rising demands of food for ever escalating world population. Crop genotypes play a dominant role in crop production systems. They affect crop productivity by their higher yield potentials, resistance against insect pest and diseases under different climatic conditions. India is well known for its native wealth of rice genetic resources and among these the large numbers of aromatic varieties are cultivated in different agro-climatic regions of country. These varieties are photosensitive and insensitive having short, medium or long slender grain with aroma. Aroma is an important qualitative trait of scented rice which commands a higher price than non-scented rice. Jharkhand state is non-conventional area of its cultivation but several scented land races/genotypes are available in this region. These land races having small grain size with good cooking quality and taste but its commercial exploitation has not been done till date. A variety with high yield potential, desired grain quality and stable performance is of great value for improving the productivity of aromatic rice as well as in terms of economic benefits to the farmers. Some of these cultivars may or may not be able to perform well in different environments. As the performance of the genotypes may or may not be similar in the different environments and they do interact with the environment as such the knowledge of G × E interaction and stability analysis help in selecting the stable genotypes. To reduce the effect of genotype-environment interaction, selection of stable genotypes that interact least with the environment is advisable to attain consistent yield. Thus, evaluation of genotypes for stability of performance under varying environmental conditions for yield has become an essential part of any breeding programme. An understanding of the causes of genotype x environment interaction can help in identifying traits and environments for better cultivar evaluation. Therefore, the present investigation was carried out, identifying stable genotypes with high yield with good aroma using Eberhart and Russell model[1].

Materials and Methods

The experiment was carried out in three consecutive years i.e. during *kharif* 2005, 2006 and 2007 at Zonal Research Station (*Birsa Agricultural University*), Chianki, Palamau. The investigation was laid out in randomized block design with three replications and 18.0 m^2 (6.0 m x 3.0 m) with spacing of 20 and 15 cm between rows and between plants, respectively. Recommended fertilizer doses and cultural practices were adopted. The experimental materials comprised of 16 aromatic rice genotypes including four local land races/genotypes has been collected from different parts of the state, eleven promising scented varieties and one check. The observations were recorded for yield, yield attributing characters with qualitative characters of aromatic rice *viz.*, days to 50% flowering, days to maturity, plant height (cm), numbers of effective tillers/plant, panicle length (cm), number of filled grains/ panicle, 1000 grain weight (g), grain yield (q/ha), grain length (grain size) in mm and grain length width ratio (grain shape) in mm. under study. G × E and stability study were carried out by Eberhart and Russell (1966) model [1].

Result and Discussion

The analysis of variance for stability revealed significant differences among genotypes and the environments (Table-1). The significant genotype x environment interaction were also observed for the characters like days to 50% flowering, days to maturity, plant height, 1000-grain weight, grain yield, kernel length, length/breadth ratio and elongation ration. The partitioning of genotype x environment interaction into linear and nonlinear components showed highly significant mean squares due to environment and environment (Linear), which reflected seasonal variation all the characters except for kernel length, indicated the predominant effect of these attributes. High magnitude of mean square environment (Linear) in comparison to respective mean square genotype x environment (Linear) was observed for all the characters. Mean squares due to genotype x environments (Linear) were highly significant for all the characters except for grain weight per panicle, test weight and kernel length. These observations are similar to the earlier findings of Mahapatra *et al.* (1996), Pawar *et al.* (2008) and Reddy *et al.* (1998) [6, 10, 13]. Significant pooled deviation (nonlinear) indicating considerable genetic diversity in the material was observed for plant height, grain yield, test weight, days to maturity, kernel length and elongation ratio as also reported by Koli and Chandra (2012), Nayak *et al.* (2003) and Pawar *et al.* (2008) [4, 9, 10]. (4, 9, 10) in their observations. Such non-linear response might be of practical value to construct and test the utility of multiple regression models to know more critically the complex mechanism of adaptation.

In the present study, the adaptation of 16 different aromatic rice genotypes in respect to characters studied was judged by three parameters viz., mean (x), regression coefficient (bi) and deviation from regression (S^2di) using the model proposed by Eberhart and Russell (1966). The stability analysis was done for only those characters which were found significant for genotype x environment interaction in G × E interaction analysis and has been presented in Table 2a and 2b. On the basis of above three parameters of stability, Dhania phool (3416.3 kg/ha) and Birsamati (3435.9 kg/ha had maximum grain yield and above the population mean with bi near unity and the deviation from regression was non-significant. It is, thus, average stable genotype for grain yield. Basmati-370 (3435.9 kg/ha) and Kasturi (3154.2 kg/ha) were below average stable genotypes with high mean, bi > unity and non-significant S^2di which can perform well in rich environments only. Shamjeera (2870.8 kg/ha) and Ranikajar (2762.1 kg/ha) expressed maximum grain yield (2488.30 kg/ha) having high mean, bi<unity and nonsignificant deviation of regression and thus considered as above average stable genotype which can equally perform in rich as well as poor environments. These findings are in general agreement with the previous findings of Hatyanto *et al.* (2008), Koli and Chandra (2012), Nayak (2008), Ramezani and Torab (2011) and Masood and Akram (2008) [2, 4, 8, 11, 12].

In this investigation Kapurthala Basmati was earliest in day to 50% flowering and maturity. Considering all the three stability parameters five genotypes namely Sugandha, Pusa Basmati, Birsamati, Pakistani Basmati and Katarni Bhog had lower mean value i.e. desirable and stable for days to 50% flowering and maturity. In respect of plant height Dhaniaphool, Shamjeera, Pakistani Bamati and Katarnibhog were found to be stable. The genotype Katarnibhog received higher mean plant height wher as Assam Culture gave medium plant height. The genotype Ranikajar and Kadamphool having bi < 1 and s^2di =0 expected to give better plant height in poor rice growing condition. For filled grain per panicle, two genotypes found as stable and they are Birsamati and Dhaniaphool in which only one genotype Dhaniaphool had higher average mean filled grain and considered as desirable and stable genotypes. The local genotype Kadamphool had bi< and s^2di =0 may give better performance in poor or unfavorable environments. The genotypes Dhaniaphool and Kadam phool having bi = 1 (unity) and S^2di =0 were adjudged as the best desirable and stable genotype for 1000-seed weight. In qualitative character elongation ratio, the genotype Birsamati having bi = 1 and S^2di =0 was considered as stable while Dhaniaphool genotype had bi <1 and s^2di =0 may perform well in poor rice growing condition. These results are in agreement with earlier workers Mishra and Dash (1997) and Nayak (2008) [7, 8].

For aromatic rice both yield and quality are of major concern. On overall basis, in the present investigation, four aromatic rice genotypes, namely, Dhania phool (local genotype f Jharkhand), Birsamati (developed by BAU, Ranchi), Basmati-370, Kasturi, Shamjeera and Ranikajar (last two are local landraces of Jharkhand) were identified as high yielding stable genotypes for grain yield. These genotypes are also showing stability and superiority for other component characters of grain yield.

Table 1: Pooled analysis of variance over environments for different quantitative and quality characters in aromatic rice

Source of variation	d.f.	Days to 50% flowering	Days to maturity	Plant height (cm)	Effective tillers/ plant	No. of filled grain/ panicle	1000-grain weight (g)	Grain yield (q/ha)	Kernel length (mm)	Length/ breadth ratio	Elongation ratio
Environments	2	1501.0**	946.8**	856.8**	96.5**	4898.2**	0.08**	55695.3**	0.01	0.65**	0.07**
Genotypes	15	242.2**	230.6**	2475**	102.3**	9548.6**	0.39**	52301.5**	6.2**	3.45**	0.05**
Genotype x Env.	30	16.3**	20.7**	28.6**	1.8	112.5	0.02**	10123.3**	0.01**	0.02**	0.00**
Pooled Error	90	1.85	2.14	8.2	1.7	100.5	0.001	1275.6	0.002	0.00	0.00
Total	47	112.3	99.8	546.2	26.9	2546.2	0.11	21297.2	1.65	0.89	0.02

Environments (Lin.)	1	4942.4**	2856.6**	2675.8**	275.9**	13056.5**	0.26**	165487.2**	0.02	2.01**	0.22**
Genotype x Env. (Lin.)	15	47.5**	50.6**	45.4**	3.6**	212.3**	0.01	15.056.4**	0.01	0.04**	0.01**
Pooled deviation	16	1.58	6.7**	19.6**	0.8	61.3	0.02**	7291.8	0.01*	0.00**	0.00**

*,**: Significant at 5% and 1% respectively

Table 2a: Estimates of stability parameters for different quantitative and quality traits in aromatic rice

S. No.	Genotype	Days to 50% flowering			Days to maturity			Plant height			Effective tillers/plant		
		Mean	bi	S^2di	Mean	bi	S^2di	Mean	Bi	S^2di	Mean	bi	S^2di
1	Kapurthala Basmati	104	0.76	13.42*	134	1.61	6.42	105.89	1.61	-2.18*	11.33	0.49	0.01
2	Katarnibhog	112	1.39	1.27	148	0.81	5.94	132.40	0.81	1.58	10.33	0.53	0.40*
3	Jammu Basmati	111	1.70	-1.12*	146	0.59	-1.91	110.40	1.45	0.67	9.33	0.48	0.02
4	Pusa Basmati	108	2.08	-1.96	140	2.13	15.26*	128.60	0.68	-.68*	8.73	0.70*	20.42
5	Pakistani Basmati	109	2.13	-1.75	143	1.46	9.68*	106.80	0.88	1.71	10.0	0.15	19.18
6	Basmati 370	114	1.24	-1.23	150	1.68	4.26	117.00	1.48	0.69	9.93	1.38	0.02*
7	BR-9	116	0.82	-2.16**	153	0.75	26.72**	119.80	0.64	2.17	8.00	0.68	0.07*
8	Assam Culture	117	0.63	-2.12	155	0.87	32.61**	120.00	0.06	-4.82	8.33	0.09**	202.00
9	Kasturi	110	0.78	-1.86*	146	0.95	16.68**	107.40	0.74	-8.85	10.46	0.13*	18.65
10	Birsamati	109	0.92	-1.89	144	0.89	-0.99**	104.20	0.28	-1.21	9.00	0.72	0.14
11	Sonachur	113	1.49	-2.50	149	2.45	3.68	118.00	1.43	22.68*	7.73	0.18	18.68*
12	Ranikajar	114	0.58	-0.72	151	0.68	1.59	114.80	0.56	0.08	6.73	0.03	20.56
13	Shamjeera	117	0.72	-1.21	156	0.86	-1.69	116.80	0.86	-8.12	10.40	0.41	-0.22
14	Dhaniaphool	116	1.06	-1.55	154	1.07	-.038	112.75	0.88	-3.12	9.06	0.77	-0.01
15	Kadamphool	115	0.70	-1.65	152	0.97	5.61	113.65	0.58	-7.19	8.40	0.05*	21.95
16	Sugandha	108	0.85	-2.08	141	1.09	-1.98	106.59	1.67	-8.15	8.46	1.09	0.03**
	Mean	112.1			147.6			114.69			9.14		

*,**: Significant at 5% and 1% respectively

Table 2b: Estimates of stability parameters for different quantitative and quality traits in aromatic rice

S. No.	Genotype	No. of filled grain/panicle			1000-Seed weight			Grain Yield/Plot			Elongation ratio		
		Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
1	Kapurthala Basmati	120.73	1.57	2.09**	16.91	1.41	2.23*	2555.9	2.89	-1.87*	1.50	1.30	0.01
2	Katarnibhog	148.00	-0.05*	8.75**	19.41	-2.13	2.31	2609.5	0.68	-72.5	0.99	0.34	2.15
3	Jammu Basmati	107.26	-0.47*	17.96**	14.35	4.46	0.83*	2120.4	1.89	-0.56**	1.49	3.98	0.01*
4	Pusa Basmati	101.93	0.19	23.35**	19.82	1.96	0.47	2196.3	2.06	101.9*	1.51	1.12	-0.05
5	Pakistani Basmati	62.26	2.16	8.48*	22.05	1.66	0.36	2186.8	1.63	164.56	1.53	0.13	0.01*
6	Basmati 370	131.93	1.36	8.42*	14.64	1.83	0.68	3435.9	1.83	0.03	1.52	3.58	0.04
7	BR-9	174.2	0.59	6.59*	10.41	0.66	-0.02	2945.7	-0.68	2.74	1.19	1.42	0.05*
8	Assam Culture	95.2	0.70	48.68**	16.71	0.56	0.01	1964.7	3.14	338.61*	1.16	-0.06	0.00*
9	Kasturi	77.26	0.95	3.82*	19.61	2.15	2.34	3154.2	1.48	296.68	1.23	0.07	0.01*
10	Birsamati	110.93	1.06	4.12	19.52	1.54	-2.13	3365.1	0.99	0.10	1.19	0.98	0.06
11	Sonachur	128.86	1.26	7.55*	13.45	0.79	-0.01	2570.0	-2.78	188.95	1.11	-0.06	0.00
12	Ranikajar	122.46	0.19	4.34	11.90	0.26	-0.02	2762.1	0.29	422.54	1.09	0.12	0.00
13	Shamjeera	107.66	1.60	2.73*	12.35	0.36	0.20	2870.8	0.65	1.87	1.11	0.42	0.12
14	Dhaniaphool	134.2	0.89	-1.68	9.67	0.96	0.36	3416.3	1.01	0.02	1.17	0.59	0.24
15	Kadamphool	97.20	0.62	5.28	14.62	0.78	-0.03	2325.2	0.45	5.56	1.03	0.12	-0.68
16	Sugandha	86.93	1.69	13.69**	22.53	2.56	0.13*	30.55.7	1.86	758.68**	1.42	3.92	-0.65*
	Mean	112.94			16.12			2689.9			1.27		

*,**: Significant at 5% and 1% respectively

Summary

Genotype × environment interaction was observed to be significant for most of the characters under study. Highly significant mean squares due to environment reflected seasonal variation for most of the characters. Highly significant G × E interaction for most of the characters indicated its significant portion due to linear component. Significant pooled deviation (non-linear) reflected considerable genetic diversity for the concerned traits. Among 16 genotypes for yield, Shamjeera and Ranikajar weres above average stable, Dhaniaphool and Birsamati were average stable and two genotypes, namely, Basmati-370 and Kasturi were below average stable ones and as such they are suitable for cultivation in poor, average (rich and poor both) and rich environments, respectively. These genotypes are also showing stability and superiority for other component characters of grain yield.

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