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Stability Analysis of Rice Varieties and their Hybrids for Yield and Yield Attributes

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ABSTRACT

In a field experiment, 21 F_1 hybrids along with their seven parents were evaluated for their stability with respect to grain yield, days to 50 percent flowering, productive tillers per plant, filled grains per panicle, and 100 grain weight in three successive seasons (both wet and dry seasons of 1999 and 2000). The genotype x environment interaction was significant indicating genotype interacted considerably with environments existed. Significant pooled deviations for yield and its components indicated that the variation in performance of genotypes is entirely unpredictable. The stable performance in yield observed in certain crosses was due to involvement of parents with higher stability in yield and component characters. The stable parents are Lunisree, Tellahamsa and Erramallelu and the stable cross combinations are Tellahamsa/Lunisree, Lunisree/Erramallelu and Shiva/ Tellahamsa.

Key words : Rice hybrids, Rice varieties, Stability.

Rice is the major stable food in tropical and sub-tropical countries. Therefore, the mandate of rice improvement programme has to be chiefly aimed for achieving stable rice yields across the varied agroclimatic situations. Food security in any country depends not only on increase in productivity from time to time, but also on maintenance of stability at the increased levels. Thus, in breeding programs study and consideration of the amount of adaptability of crops in relation to different environmental conditions have a special importance. Since, there is a dire need for improving suitable varieties more adaptable to different geographical areas, estimates of genotype X environment interaction is extremely imperative. The stability model helps identification of stable genotypes (Eberhart and Russel, 1966). Therefore, the present study was undertaken to study the stability for yield and its components and also the relationships between parents and their respective hybrids.

MATERIAL AND METHODS

Twenty one F_1 hybrids which were produced from a 7 x 7 diallel mating (without reciprocals) and their respective seven parents were cultivated in a randomised blocks design in three replications at Agricultural Research Station, Warangal during three successive seasons viz., Wet 1999 (E_1), dry 1999-2000 (E_2) and wet, 2000 (E_3) under transplanted condition. Each entry was grown in 2 rows of 3 m long with a spacing of 20 x 15 cm. Seedlings at the age of thirty days were transplanted following a fertilizer dose of 100 N, 60 P_2O_5 and 40 K_2O kg ha^{-1}. The observations were recorded on 10 plants in each replication for productive tillers per plant, panicle length (cm), filled grains per panicle, 100 grain weight (g) and grain yield per plant (g). The observation, days to 50 percent flowering was recorded when 50% of the panicles in the row exerted fully and flowered. The same management practices and procedure was adopted uniformly for all the three seasons under study and the final mean data were statistically analysed for stability parameters as suggested by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Analysis of variance revealed significant interaction among the genotypes and environments for the characters studied. Mean squares due to environment (linear) was found significant for all the characters except days to 50 per cent flowering, indicating differences between environments and their influence on genotypes for expression of these characters (Table-1). This is in accordance with previous reports on rice by Sawant *et al.* (2005) and Panwar *et al.* (2008). Highly significant mean squares for pooled deviations with non-significant mean squares for genotype x environment (linear) recorded in respect of yield and its components *viz.,* productive tillers per plant and 100 grain weight indicates that variation in performance of genotypes for these traits is entirely unpredictable. Similar results were reported earlier by Kulkarni and Eswari (1994) and Lohithaswa *et al.* (1999). On the other hand, significance of both linear and non-linear components was observed in case of filled grain per panicle, panicle length and days to 50 percent flowering indicating the importance of both the components in determining stability of yield.

Higher grain yield is the ultimate objective in any breeding programme. Hence, for identification of a potential variety or hybrid combination over different environments, three stability parameters viz., mean (μ), regression coefficient (bi) and deviation from regression (s^2di) were taken into consideration. Apart from this, an attempt was made to analyze the stability relationship between the yield and its components and also between the parents and their respective cross combinations.

The range of regression coefficient values was very high (0.042-7.26) for days to 50 percent flowering, which indicates that this trait was highly influenced by environment (Table 3). As a result, only one parent (Shiva) and one cross (Tellahamsa/ Lunisree) with bi values near to 'unity' were identified as stable ones. Highly significant values of deviation from regression for this trait in most of genotypes suggests that the flowering behavior in rice is highly unpredictable (Deshpande and Dalvi, 2006).

Table 1. Pooled analysis of variance for yield and yield components in parents and 21 F_1s in rice.

Source	d.f.	Mean squares					
		Days to 50% flowering	Productive tillers plant^{-1}	Panicle length	Filled grains panicle^{-1}	100-grain weight	Grain yield plant^{-1}
Genotypes	27	92.59**	8.40**	3.92	2774.98*	0.55**	73.72**
Environment + Genotype x Environment		49.74	11.13**	6.57**	1210.66	0.01**	29.10*
Environment (Linear)	1	195.02	478.90**	289.70**	26302.29**	0.75**	687.73**
Genotype x Environment (Linear)	27	89.70**	2.55	2.12**	1182.89**	0.04	15.16
Pooled deviation	28	6.02**	2.70**	0.762**	341.32**	0.06**	19.01**
Pooled error	162	0.28	0.32	0.15	45.68	0.01	1.56

Table 2. Environmental index for yield and yield component characters in rice.

Character	Wet 1999 (E_1)	Dry 1999-2000 (E_2)	Wet 2000 (E_3)
Days to 50 percent flowering	-1.083	2.155	-1.071
Productive tillers per plant	0.456	2.670	-3.125
Plant height	8.983	-18.554	9.571
Panicle length	1.360	-2.626	1.266
Filled grains per panicle	12.906	-25.021	12.115
100 grain weight	0.133	-0.054	-0.079
Grain yield per plant	3.247	0.467	-3.715

Table 3. Stability parameters of yield and yield components of parents and F_1s in rice.

Parent /Cross	Days to 50 percent flowering			Productive tiller per plant			Panicle length		
	μ	bi	S^2di	μ	bi	S^2di	μ	bi	S^2di
IR 20	100.22	2.99**	0.61	8.64	1.07	0.90	25.43	0.69	0.82*
Shiva	100.55	1.13	13.97**	8.17	0.74	2.45**	24.35	0.19**	0.39
Tellahamsa	82.66	4.95**	-0.14	9.10	0.99	2.75**	24.96	0.92	4.01**
Lunisree	95.77	-3.30**	3.13**	8.73	1.15	0.36	22.44	0.55	0.07
WGL-NDL-2	96.44	-3.30**	3.14**	7.40	0.34**	0.26	23.70	1.22**	-0.09
Erramallelu	87.44	3.35**	2.48**	10.31	0.52	2.74**	24.21	0.24**	-0.00
RDR-763	89.11	6.13**	9.38**	13.23	0.90	8.13**	20.63	1.11	0.55*
IR-20/shiva	97.11	3.81**	-0.13	11.06	1.07	10.89**	25.85	1.01	-0.01
IR-20/ Tellahamsa	87.30	7.26**	4.43**	9.92	1.56	1.29*	25.22	0.27**	-0.10
IR-20/ Lunisree	87.11	-2.83**	4.28**	9.35	0.58	3.31**	24.26	1.31	1.56**
IR-20/ WGL-NDL-2	91.88	0.05**	1.06*	7.98	0.85	3.20**	23.95	1.29*	0.05
IR-20/ Erramallelu	94.55	4.07**	6.57**	12.32	0.59**	-0.23	25.98	0.66**	-0.10
IR-20/ RDR-763	87.77	1.96*	1.62*	9.17	0.70**	-0.12	23.52	1.13	4.26**
Shiva/ Tellahamsa	84.22	4.85**	5.03**	12.60	0.91	0.13	24.96	0.45**	0.25
Shiva/ Lunisree	92.88	-2.58*	13.74**	11.60	1.44	0.51	24.62	1.25**	-0.15
Shiva/ WGL-NDL-2	95.55	-3.66**	6.24**	8.34	0.82	-0.06	24.16	1.02	0.87
Shiva/ Erramallelu	87.77	3.04**	-0.25	10.68	1.46	1.27*	24.86	0.56**	-0.04
Shiva/ RDR-763	90.66	0.16	29.05**	11.19	2.05	5.33**	23.44	0.83	1.00**
Tellahamsa/Lunisree	82.66	0.92	1.70*	11.44	0.90	4.21**	26.20	1.77**	0.18
Tellahamsa/ WGL-NDL-2	83.44	1.95	1.72*	8.58	0.79	1.56	24.77	1.86**	0.08
Tellahamsa/Erramallelu	82.55	7.63**	-0.32	9.50	0.86**	-0.18	24.84	0.51	0.91**
Tellahamsa/ RDR-763	81.11	3.35	19.48**	10.37	1.18	4.17**	24.20	1.14*	0.09
Lunisree/ WGL-NDL-2	92.00	-3.71**	3.35**	8.90	1.11	0.21	23.75	1.04	-0.09
Lunisree/ Erramallelu	90.11	-2.68**	1.74**	9.66	0.97	0.23	24.46	1.40	1.02**
Lunisree/ RDR-763	95.11	-3.14**	6.54**	12.35	1.61	8.17**	22.91	1.00	0.65*
WGL-NDL-2/ Erramallelu	90.55	-1.49**	2.44**	7.92	0.50**	-0.30	24.38	1.58*	-0.14
WGL-NDL-2/RDR-763	96.00	-3.71**	3.12**	10.16	1.40	4.66*	23.30	1.40	0.92**
Erramallelu/RDR-763	86.33	0.77	15.68**	13.10	0.79	0.63	23.58	1.50**	0.22
Mean	90.32	1.00		10.06	1.00		24.25	1.00	
SE±	1.73	0.93		1.16	0.39		0.61	0.27	

Table 3. cont............

Parent /Cross	Days to 50 percent flowering			Productive tiller per plant			Panicle length		
	μ	bi	S^2di	μ	bi	S^2di	μ	bi	S^2di
IR 20	158.03	-0.20*	200.41*	1.84	0.93	0.02**	15.58	1.41	15.88**
Shiva	147.30	0.02*	186.29*	2.39	1.76	0.01**	16.48	1.23	6.52*
Tellahamsa	121.24	-0.39**	-32.34	2.45	1.07	-0.03	16.71	0.41	31.98**
Lunisree	159.84	1.45	85.19	3.00	1.08	0.02*	23.93	1.85	6.75*
WGL-NDL-2	264.08	2.87	1204.73**	1.39	0.51*	0.03	15.25	0.40	26.27**
Erramallelu	144.06	-0.25*	10.90	1.97	1.06	0.02**	17.58	-0.02	15.57**
RDR-763	139.05	0.23	354.65**	1.59	1.09	0.01**	15.27	1.70	3.96
IR-20/shiva	175.20	0.15	382.40**	2.16	0.52	0.01**	21.03	1.33	11.94**
IR-20/ Tellahamsa	136.66	-0.38**	125.96	2.23	0.35**	-0.01	20.96	1.36	40.56**
IR-20/ Lunisree	187.83	1.77*	-34.52	2.44	1.55*	0.01	22.90	0.23	19.05**
IR-20/ WGL-NDL-2	191.82	1.56**	-25.73	1.80	0.68	0.01	19.16	2.23	21.55**
IR-20/ Erramallelu	173.08	-0.33*	59.42	2.05	0.35**	-0.01	25.02	1.29	-0.41
IR-20/ RDR-763	158.83	0.13**	47.74	1.84	0.73**	-0.01	18.72	0.02	2.08
Shiva/ Tellahamsa	133.48	0.07**	-39.48	2.70	1.02	0.01	27.12	0.22**	-1.14
Shiva/ Lunisree	189.95	2.51**	-25.33	2.88	1.80	-0.01	34.72	2.88	78.85**
Shiva/ WGL-NDL-2	200.10	2.21**	593.95**	1.99	0.62	0.02*	21.01	1.69	20.47**
Shiva/ Erramallelu	140.73	0.15	-45.28	2.43	1.12	0.01*	20.55	0.89	42.15**
Shiva/ RDR-763	148.42	0.93*	26.67	2.07	1.29	0.01*	17.47	1.68	6.98*
Tellahamsa/Lunisree	162.84	0.80**	-42.01	3.02	1.70**	0.01	30.14	0.92	-1.24
Tellahamsa/ WGL-NDL-2	191.26	1.66*	640.20**	1.95	0.84	-0.02	19.43	0.42*	-0.63
Tellahamsa/Erramallelu	148.32	-0.15**	0.93	2.34	0.79**	-0.01	19.44	0.84	22.69**
Tellahamsa/ RDR-763	154.60	0.91	373.17**	2.03	1.42	0.02**	19.76	0.68	4.68*
Lunisree/ WGL-NDL-2	218.06	2.56**	11.475	2.29	0.68	0.04*	26.73	2.04	56.96**
Lunisree/ Erramallelu	157.76	1.34	-43.16	2.74	1.66	0.06**	25.28	1.13	24.67*
Lunisree/ RDR-763	190.05	1.42	222.17**	2.34	0.77	0.05**	29.33	-0.25	12.23**
WGL-NDL-2/ Erramallelu	188.76	3.52	2965.42**	1.70	0.71	0.04*	17.27	0.28	8.82**
WGL-NDL-2/RDR-763	200.06	2.14	420.06**	1.58	0.66	0.02*	17.08	1.25	0.09
Erramallelu/RDR-763	170.58	1.21	688.17**	1.82	1.12	-0.01	19.12	-0.12	9.26**
Mean	169.71	1.00		2.18	1.00		21.18	1.00	
SE±	13.063	0.60		0.05	0.49		3.083	0.87	

μ = Mean; bi = Regression coefficient; S^2di = Deviation from regression; * Significant at 5% level; ** Significant at 1% level

Productive tillers play a greater role in obtaining higher grain yield. The parents *viz.,* RDR-763, Tellahamsa and Lunisree and the crosses *viz.,* Shiva/ Tellahamsa, Tellahamsa/ Lunisree, IR – 20/ Shiva, Erramallelu/ RDR-763 and Lunisree/ Erramallelu with bi values near to 'unity' and higher mean values, and less deviations from regression exhibited stable performance for this trait. Among these four crosses, shiva/Tellahamsa (mean: 12.60; regression coefficient: 0.91; deviation from regression: 131) was found to be highly promising. The hybrid *viz.*, Erramallelu/ RDR – 763 exhibited better performance in poor environment. The parents and hybrids with higher mean values for filled grains per panicle also had higher bi values (more than unity) which indicated that they are better suited for favorable environments (E_1 and E_3). The parents and hybrids which exhibited stability in yield also exhibited stability for 100-grain weight. The parents *viz.,* Lunisree, Tellahamsa, IR-20 and hybrids *viz.,* Shiva/Tellahamsa, Shiva/ Erramallelu and Erramallelu/ RDR-763 were also stable for productive tillers per plant.

With respect to grain yield per plant, the G x E (linier) was non significant where as, the component, pooled deviation was highly significant which indicated that yield performance of genotypes is entirely unpredictable in nature. Similar findings were reported earlier by Lohithaswa *et al*. (1999) and Kulkarni and Eswari (1994). Among all the parents, Shiva (mean: 16.48; regression coefficient: 1.23; deviation from regression: 6.52) was observed to be stable one. The parents, lunisree and RDR 763 (regression coefficient more than unity) are suited to favourable environment (E_1) whereas, Tellahamsa (regression coefficient less than unity) performed well in poor environment (E_3).

The genotype, Lunisree which produced maximum grain yield (mean: 23.93) across three environments also exhibited stability for productive tillers per plant (regression coefficient: 1.15), 100 grain weight (regression coefficient: 1.08) and filled grains per panicle (regression coefficient: 1.45) with non significant values of deviation from regression. The other parent, Tellahamsa with good potential also exhibited consistent performance in respect yield components like 100 grain weight (regression coefficient: 1.07) and productive tillers per plant (regression coefficient: 0.99). The stable performance in yield observed in certain crosses was due to involvement of parents with higher stability in yield and component characters. The stable parents are Lunisree, Tellahamsa and Erramallelu and the stable cross combinations are Tellahamsa/Lunisree, Lunisree/Erramallelu and Shiva/ Tellahamsa.

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