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Correlation Studies in Hybrid Rice (*Oryza sativa* L.)

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Four male and three female parents, their twelve hybrids along with three standard checks of rice (*Oryza sativa* L.) were evaluated during Kharif 2016 to study the nature and extent of correlation among yield and yield attributing characters viz., days to 50 per cent flowering, days to maturity, productive tillers plant⁻¹, plant height (cm), panicle length (cm), total spikelets panicle⁻¹, fertile spikelets panicle⁻¹, spikelet fertility (%), 1000 grain weight (g), grain yield plant⁻¹ (g), straw yield plant⁻¹ (g) and harvest index (%). The results revealed that grain yield plant⁻¹ to be positively and significantly associated with days to 50 per cent flowering (0.988), days to maturity (0.998), productive tillers plant⁻¹ (0.849), panicle length (0.978), total spikelets panicle⁻¹ (0.806), fertile spikelets panicle⁻¹ (0.979) and straw yield plant⁻¹ (0.719) indicating importance of these traits as selection criteria in yield improvement programmes.

Introduction

Rice (*Oryza sativa* L.) is staple food of more than 60% of Indian population. It accounts for about 43% of total food grain production and 46% of total cereal production in the country. Rice occupies pivotal place in Indian Agriculture. In order to meet the domestic demand of the increasing population the present day production of 107.40 million tons (Anonymous, 2015-16) of milled rice has to be increased to 125 million tons by the year 2030. Since the yield of high yielding varieties (HYVs) of rice is plateauing, it is

rather difficult to achieve this target with the present day inbred varieties. Therefore, to sustain the self sufficiency in rice, additional production of 1.17 million tons is needed every year. At present, India has about 2.5 million hectares under hybrid rice cultivation of the total of 44 million hectares under rice cultivation (Ayyappan *et al.*, 2012). The need for hybrid rice rapidly increasing population, plateauing yield trend of HYV's, declining resources (Viraktamath, 1997). To break the yield barriers in rice breeding strategies, attempts are being made. The grain yield is a complex character dependent on many

component characters and it responds poorly to the direct selection. For the improvement of grain yield, the knowledge on the association between grain yield and its component characters will be helpful. The present study was, therefore, undertaken to understand the association among grain yield and its component characters Viraktamath, 1997).

Materials and Methods

The present study consists of F_1 s along with parents and three standard checks of rice (*Oryza sativa* L.) procured from different sources. The present investigation was carried out at the Experimental farm of Regional Agriculture Research Station, Karjat (Raigad) during *kharif* 2016. The experimental trial was laid out in Randomized Block design with three replications. Three CMS lines *viz.*, IR58025A, RTN 12A and RTN17A were crossed with four testers Chedo Local, CR-2829-PLN-36, NPQ-49 and RP-5898-19-8-6-1-1-1 in a Line \times Tester mating design developed 12 hybrids along with standard checks (Table 1). Data on the basis of 5 randomly taken competitive plants excluding borders were recorded on grain yield plant^{-1} (g), straw yield plant^{-1} (g), harvest index (%), plant height (cm), number of productive tillers plant^{-1} , panicle length (cm), total number of spikelets panicle^{-1} , number of fertile spikelets panicle^{-1} , spikelet fertility (%), 1000 grain weight (g) while days to 50 per cent flowering and days to maturity were recorded on plot basis. The analysis was done as per Panse and Sukhatme (1985), Burton and De Vane (1953) and Johnson *et al.*, (1955).

Results and Discussion

The analysis of variance for parents and hybrids was computed for different characters studied in Table 2. A study of various subdivisions of total variance elucidated the

importance of variance due to parents and hybrids. The results revealed that the mean squares due to parents for all the characters were found significant except for productive tillers plant^{-1} and panicle length (cm). The mean square values due to males were found to be highly significant for all the traits under study except number of productive tillers plant^{-1} and panicle length (cm). The mean square value due to females were found to be highly significant for all the traits under study except days to 50 per cent flowering, number of productive tillers plant^{-1} and panicle length (cm). The mean square value due to males vs females were found to be highly significant for all the traits under study except number of productive tillers plant^{-1} , panicle length (cm) and grain yield plant^{-1} (g). The mean square values due to hybrids were found to be highly significant for all the traits under study except number of productive tillers plant^{-1} . Similar results reported by Deepa Shankar *et al.*, (2006) and Ravindra Babu *et al.*, (2012). This indicated existence of considerable amount of genetic variability among parents and hybrids for all the traits under study.

In the present study, days to 50 per cent flowering exhibited a positive and significant association with days to maturity (0.999) (Debchoudhary and Das, 1998), number of productive tillers plant^{-1} (0.756) (Sawant *et al.*, 1995) and panicle length (0.933), total spikelets panicle^{-1} (0.888), fertile spikelets panicle^{-1} (0.936) and grain yield plant^{-1} (0.988) (Yolanda and Vijendra Das, 1995) indicating a scope for simultaneous improvement of the traits. Similar results were reported by Deepa Sankar *et al.*, (2006) and Singh *et al.*, (2006). However, negative and significant association was noticed with spikelet fertility (-0.899), 1000 grain weight (-0.990) and harvest index (-0.812). If one component gets advantage over the other, a negative correlation may arise (Adams and Grafius, 1971).

Days to maturity had registered a positive and significant association with days to 50 per cent flowering (0.999), productive tillers plant⁻¹ (0.756) (Sawant *et al.*, 1995), panicle length (0.933) (Singh *et al.*, 1984) and total spikelets panicle⁻¹ (0.888), fertile spikelets panicle⁻¹ (0.936), grain yield per plant (0.998) (Debchoudhary and Das, 1998).

However, negative significant associations were observed with plant height (0.500) and straw yield plant⁻¹ (0.603). Negative and significant associations were recorded for spikelet fertility (-0.899), 1000 grain weight (0.990) and harvest index (0.812). Similar results reported by Deepa Shankar *et al.*, (2006) and Ravindra Babu *et al.*, (2012).

Plant height had registered positive and significant associations with productive tillers plant⁻¹ (0.945), panicle length (0.778) and fertile spikelets panicle⁻¹ (0.772) (Mirza *et al.*, 1992; Chaubey and Singh, 1994; Nayak *et al.*, 2001; Kole *et al.*, 2008; Khan *et al.*, 2009; Sadeghi, 2011; Ravindra Babu *et al.*, 2012) and straw yield plant plant⁻¹ (0.992). However, non-significant associations were noticed for the trait with days to maturity (0.500) and grain yield plant plant⁻¹ (0.629). Similar results reported by Deepa Shankar *et al.*, (2006) and Ravindra Babu *et al.*, (2012).

Productive tillers plant⁻¹ showed positive and significant association with traits viz., panicle length (0.941), fertile spikelet's panicle⁻¹ (0.938), straw yield plant (0.978), days to maturity (0.756) and grain yield plant⁻¹ (0.849). Similar results reported by Deepa Shankar *et al.*, (2006) and Ravindra Babu *et al.*, (2012).

Significant positive association was noticed for panicle length with fertile spikelets panicle⁻¹ (0.999), straw yield plant⁻¹ (0.849), days to maturity (0.933) and grain yield plant⁻¹ (0.978) at genotypic level, while negative

and significant association was recorded with 1000 grain weight (-0.872). However, it had recorded non significant association with total spikelets panicle⁻¹ (0.664). Similar results reported by Mirza *et al.*, (1992), Chaubey and Singh (1994), Nayak *et al.*, (2001), Kole *et al.*, (2008), Khan *et al.*, (2009), Sadeghi (2011) and Ravindra Babu *et al.*, (2012).

Total spikelets panicle⁻¹ had exhibited negative and significant association with spikelet fertility (-0.999), 1000 grain weight (-0.945) and harvest index (-0.989) while it had recorded positive significant association with days to maturity (0.888) and grain yield plant⁻¹ (0.806).

Similar non-significant association of the trait with fertile spikelets panicle⁻¹ (0.671) and straw yield plant⁻¹ (0.0169) was reported earlier by Surek and Beser (2003) and Bagheri *et al.*, (2011).

Positive significant association was noticed for fertile spikelets panicle⁻¹ with days to 50 per cent flowering (0.936), plant height (0.772), productive tillers plant⁻¹ (0.938), panicle length (0.999), days to maturity (0.936), straw yield plant⁻¹ (0.845) and grain yield plant⁻¹ (0.979), while it registered negative and significant association with 1000 grain weight (-0.876). Similar results reported by Mirza *et al.*, (1992), Chaubey and Singh (1994), Nayak *et al.*, (2001), Kole *et al.*, (2008), Khan *et al.*, (2009), Sadeghi (2011) and Ravindra Babu *et al.*, (2012).

Spikelet fertility showed positive significant correlation with 1000 grain weight (0.952) and harvest index (0.986) while negative significant association was noticed with days to 50 per cent flowering (-0.899), total spikelets panicle⁻¹ (-0.999), days to maturity (-0.899) and grain yield plant⁻¹ (-0.819). Similar results reported by Deepa Shankar *et al.*, (2006) and Ravindra Babu *et al.*, (2012).

Table.1 List of females, male lines, their hybrids along with standard checks

Sr. No.	CMS Lines	Restorer Lines	Hybrids	Standard Checks
1	IR58025A	Chedo Local	IR58025A x Chedo Local	Karjat-7
2	RTN12A	CR-2829-PLN-36	IR58025A x CR-2829-PLN-36	Sahyadri-2
3	RTN17A	NPQ-49	IR58025A x NPQ-49	Sahyadri-3
4		RP-5898-19-8-6-1-1-1	IR58025A x RP-5898-19-8-6-1-1-1	
5			RTN12A x Chedo Local	
6			RTN12A x CR-2829-PLN-36	
7			RTN12A x NPQ-49	
8			RTN12A x RP-5898-19-8-6-1-1-1	
9			RTN17A x Chedo Local	
10			RTN17A x CR-2829-PLN-36	
11			RTN17A x NPQ-49	
12			RTN17A x RP-5898-19-8-6-1-1-1	

Table.2 Analysis of variance in Line x Tester analysis for twelve characters in rice (*Oryza sativa* L.)

Source of variation	DF	Characters											
		Days to 50 per cent Flowering	Plant Height (cm)	Productive Tillers Plant ⁻¹	Panicle Length (cm)	Total Spikelets Panicle ⁻¹	Fertile Spikelets Panicle ⁻¹	Spikelet Fertility (%)	1000 Grain Weight (g)	Grain Yield Plant ⁻¹ (g)	Straw Yield Plant ⁻¹ (g)	Harvest Index (%)	Days to Maturity
Replication	2	0.018	7.78	1.31	0.36	92.57	49.42	5.14	0.025	0.14	0.36	0.40	0.018
Parents	6	5.38**	370.27**	0.79	0.39	445.97**	370.02**	31.23**	9.15**	6.22**	88.1**	6.60**	5.38**
Male	3	9.33**	326.52**	0.83	0.67	722.92**	298.51**	39.64**	2.27	3.44	122.2**	57.56**	9.33**
Female	2	1.00	36.00**	0.05	0.12	22.46**	9.00	5.75**	4.78**	13.09**	6.88	3.21**	1.01
Male vs Female	1	2.28**	1170**	2.15	0.09	462.13**	1306.61**	56.96**	38.5**	0.82	148.1**	77.19**	2.27
Hybrids	11	54.45**	107.38**	1.15	8.55**	85.67**	234.96**	19.08**	4.74**	63.25**	55.15**	4.48**	54.46**
Parents vs. Hybrids	1	102.92**	7.86**	154.54*	112.6**	2725.1**	9036.16**	359.4**	87.15**	838.3**	221.1**	206.56**	102.91**
Error	36	3.24	18.58	0.71	1.07	87.03	50.65	2.64	0.54	5.17	4.14	6.47	3.25

*Significant at 5% level of significance

**Significant at 1% level of significance

Table.3 Correlation matrix showing close association between twelve quantitative characters of rice (*Oryza sativa* L.).

Characters	Days 50 per cent Flowering	Plant Height (cm)	Productive Tillers plant ⁻¹	Panicle Length (cm)	Total Spikelets Panicle ⁻¹	Fertile Spikelets Panicle ⁻¹	Spikelet Fertility (%)	1000 Grain Weight (g)	Straw Yield Plant ⁻¹ (g)	Harvest Index (%)	Days to Maturity	Grain Yield Plant ⁻¹ (g)
Days 50 % Flowering	1.000											
Plant Height (cm)	0.500	1.000										
Productive Tillers plant⁻¹	0.756*	0.945**	1.000									
Panicle Length (cm)	0.933**	0.778*	0.941**	1.000								
Total Spikelets Panicle⁻¹	0.888**	0.047	0.371	0.664	1.000							
Fertile Spikelets Panicle⁻¹	0.936**	0.772*	0.938**	0.999**	0.671	1.000						
Spikelet Fertility (%)	-0.899**	-0.069	-0.392	-0.681	-0.999**	-0.687	1.000					
1000 Grain Weight (g)	-0.990**	-0.371	-0.655	-0.872*	-0.945**	-0.876*	0.952**	1.000				
Straw Yield Plant⁻¹ (g)	0.603	0.992**	0.978**	0.849*	0.169	0.845*	-0.191	-0.482	1.000			
Harvest Index (%)	-0.812*	0.099	-0.232	-0.548	-0.989**	-0.555	0.986**	0.887*	-0.024	1.000		
Days to Maturity	0.999**	0.500	0.756*	0.933**	0.888*	0.936**	- 0.899**	- 0.990**	0.603	-0.812*	1.000	
Grain Yield Plant⁻¹ (g)	0.988**	0.629	0.849*	0.978**	0.806*	0.979**	-0.819*	- 0.955**	0.719*	-0.712*	0.998**	1.000

Positive significant association was noticed for 1000 grain weight with spikelet fertility (0.952) and harvest index (0.887) while negative significant association was noticed with days to 50 per cent flowering (-0.990), panicle length (-0.872), total spikelets panicle⁻¹ (-0.945), fertile spikelets panicle⁻¹ (-0.876), days to maturity (-0.990) and grain yield plant⁻¹ (-0.955). Similar results reported by Mirza *et al.*, (1992), Chaubey and Singh (1994), Nayak *et al.*, (2001), Kole *et al.*, (2008), Khan *et al.*, (2009), Sadeghi (2011) and Ravindra Babu *et al.*, (2012).

Straw yield plant⁻¹ showed positive significant with plant height (0.992), productive tillers plant⁻¹ (0.978), panicle length (0.849), fertile spikelets panicle⁻¹ (0.845) (Nayak *et al.*, 2001 and Nayak and Reddy, 2005) and grain yield per plant⁻¹ (0.719). Similar results reported by Deepa Shankar *et al.*, (2006) and Ravindra Babu *et al.*, (2012).

Positive significant association was noticed for harvest index with spikelet fertility (0.986) and 1000 grain weight (0.887) while negative and significant association was recorded with days to 50 per cent flowering (-0.812), total spikelets panicle⁻¹ (-0.989), days to maturity (-0.812) and grain yield plant⁻¹ (-0.712), similar to the findings of Sadeghi (2011).

A perusal of the results on character associations for grain yield, yield components and quality characters revealed phenotypic and genotypic correlation to be of similar direction and significance. The genotypic correlation values were also in general higher than the phenotypic correlation values indicating the masking effects of environment on these traits (Table 3). Similar results were reported by Rajput *et al.*, (1996). Grain yield plant⁻¹ was observed to be positively and significantly associated with days to 50 per cent flowering, days to maturity, productive tillers plant⁻¹, panicle length, total spikelets

panicle⁻¹, fertile spikelets panicle⁻¹ and straw yield plant⁻¹ indicating the importance of these traits as selection criterion in yield enhancement programmes. The results are in line with the findings of Nayak *et al.*, (2001) and Nayak and Reddy (2005).

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