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Correlation and Path analysis in Popular Rice (*Oryza sativa* L.) Varieties of India

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ABSTRACT

Correlation and path analysis studies for eleven yield attributing characters were conducted using eighty seven varieties of rice. The association studies revealed that the genotypic correlations in general were higher than the corresponding phenotypic correlations. Single plant yield exhibited highly significant positive association with plant height, panicle length, number of grains per panicle, number of filled grains per plant, number of chaffy grains per plant, total number of grains per plant, spikelet fertility and 100-grain weight and significant negative association with days to 50% flowering. Path coefficient analysis revealed that plant height, number of productive tillers per plant, number of grains per panicle, number of filled grains per plant and 100 grain weight were five important attributes in formulating selection criterion for effective improvement of grain yield in rice varieties.

Key words : Correlation, Path analysis, Rice and Yield

Rice (*Oryza sativa* L.) is one of the most important cereal crops of the world meeting the dietary requirements of the people living in the tropics and sub-tropics. Yield is a complex character which is genetically influenced by a large number of quantitative characters. Hence, direct selection for yield often misleads the plant breeder. Therefore, study of association of various component traits with yield and among themselves helps the breeder in fixing criteria for selection of elite parental lines having maximum grain yield coupled with desired combination of characters. Knowledge of the association between yield and its component characters themselves can prove the efficiency of selection and studies on path analysis were proven to be an effective tool for partitioning the correlation coefficient into direct and indirect effects of component characters. Information on direct and indirect effects contributed by each character towards yield will be an added advantage in aiding the selection process. Correlation in combination with path analysis would give a better insight into the cause and effect relationship between different pairs of characters.

Hence, the present investigation was carried out to determine the interrelationship between yield and its contributing characters as well as to identify the characters to be considered for selecting better genotypes for use as parents in the development of high yielding varieties.

MATERIAL AND METHODS

A field experiment was conducted using eighty seven popular varieties of rice collected from Plant Breeding Division, Crop Improvement Section, Directorate of Rice Research (DRR), Rajendranagar, Hyderabad in a randomized block design with three replications at DRR, Hyderabad, Andhra Pradesh, India. Thirty days old seedlings were transplanted 20 cm apart between rows and 15 cm within the row in three blocks. All necessary precautions were taken to maintain uniform plant population in each treatment. All the recommended package of practices was adopted besides providing necessary prophylactic plant protection measures to raise a good crop. Single plant observations on yield and its contributing characters were recorded on five randomly selected plants in each genotype from the middle row in each replication as per standard techniques for plant height, days to 50% flowering, number of productive tillers per plant, panicle length, number of grains per panicle, number of filled grains per plant, number of chaffy grains per plant, total number of grains per plant, single plant yield, spikelet fertility and 100-grain weight. Days to 50%

flowering were computed on plot basis. Seed weight was recorded by weighing 100-grains of each genotype. Statistical analyses for the above characters were done following Singh and Chaudhary (1995) for correlation coefficient and Dewey and Lu (1959) for path analysis.

RESULTS AND DISCUSSION

In the present investigation, the genotypic correlations in general were higher than the corresponding phenotypic correlations (Table 1) revealing the presence of a strong inherent association between the characters with negligible influence of environmental factors. Similar results were reported by Iftekharuddaula *et al.* (2002). Single plant yield exhibited highly significant positive association with plant height, panicle length, number of grains per panicle, number of filled grains per plant, number of chaffy grains per plant, total number of grains per plant, spikelet fertility and 100-grain weight and significant negative association with days to 50% flowering. The positive association between single plant yield and spikelet fertility was expected since the number of filled grains per plant had highly significant positive correlation with plant yield. Thus, in order to increase yield, it is important to reduce spikelet sterility and improve spikelet fertility. The results obtained in the present study indicated that grain yield increased whenever there was increase in characters that had positive and significant association with grain yield. These results are in agreement with the findings of Tayeng and Singh (2006), Padmaja *et al.* (2011) and Anbumalarmathi and Nadarajan (2008).

Plant height exhibited a positive and significant association with panicle length, 100-grain weight and days to 50% flowering, while a positive and non-significant association with number of filled grains per plant, total number of grains per plant and number of grains per panicle. Days to 50% flowering showed positive and significant correlations with plant height but a negative significant association with number of productive tillers per plant and 100-grain weight. Number of productive tillers per plant had positive and significant association with days to 50% flowering, spikelet fertility and a negative and significant correlation with number of grains per panicle while a positive and non significant association with 100-grain weight, number of grains per plant and number of filled grains per plant. Panicle length recorded a positive and significant association with plant height, 100-grain weight and number of grains per panicle. These results are in unison with the findings of Kuldeep *et al.* (2004), Suman *et al*. (2006) and Padmaja *et al.* (2011). From the results it was evident that increase in panicle length would always contribute to more number of grains per panicle and thereby increase in grain yield. Panicle length had a positive and non-significant association with spikelet fertility, total number of grains per plant, number of filled grains per plant and number of chaffy grains per plant, which is in agreement with the findings of Padmaja *et al.* (2011).

Number of grains per panicle had a positive and significant correlation with total number of grains per plant, number of filled grains per plant, number of chaffy grains per plant and panicle length. Number of productive tillers per plant and 100-grain weight showed negative significant correlation with this trait which confirms the findings of Kavitha and Reddy (2001), Yogameenakshi *et al*. (2004) and Padmaja *et al.* (2011). Remaining characters showed non-significant association with this trait. Number of filled grains per plant was positively and significantly correlated with total number of grains per plant, number of grains per panicle, number of chaffy grains per plant and spikelet fertility, while negative significant association of this character was observed with 100-grain weight. Number of chaffy grains per plant had a positive and significant correlation with total number of grains per plant, number of filled grains per plant, number of grains per panicle. A positive but non-significant association of this character was noticed with days to 50% flowering and panicle length. Number of chaffy grains per plant was negatively correlated with spikelet fertility while number of filled grains per plant was positively associated with spikelet fertility indicating that increase in filled grains due to high spikelet fertility results in higher yield, due to decrease in number of chaffy grains per plant.

Total number of grains per plant had a positive and significant correlation with number of filled grains per plant, number of grains per panicle, number of chaffy grains per plant and spikelet fertility. Negative significant association was

Table 1. Estimates of phenotypic and genotypic correlation coefficients

	Plant height (cm)	Days to 50% flowering	Number of productive tillers per plant	Panicle length (cm)	Number of grains per panicle	Number of filled grains per plant	Number of chaffy grains per plant	Total number of grains per plant	Spikelet fertility (%)	100-grain weight (g)	Single plant yield (g)
Plant height (cm)	1.000	0.1554*	-0.0130	0.4121**	0.0037	0.0298	-0.0269	0.0264	-0.0263	0.1818**	0.1419*
		(0.1586)	(0.4683)	(0.4683)	(0.0023)	(0.0296)	(-0.0188)	(0.0273)	(-0.0393)	(0.1852)	(0.1440)
Days to 50% flowering		1.000	-0.1980*	-0.0248	-0.0137	0.0230	0.0817	-0.0031	-0.0747	-0.1364**	-0.1344**
			(-0.2617)	(-0.0255)	(0.0136)	(-0.0247)	(0.0872)	(-0.0049)	(-0.0917)	(-0.1373)	(-0.1385)
Number of productive tillers per plant			1.000	-0.0392	-0.4690**	0.0793	-0.1001	0.0622	0.1400*	0.0599	0.0096
				(-0.1056)	(-0.5247)	(0.0835)	(-0.136)	(0.0606)	(0.2293)	(0.0711)	(0.0211)
Panicle length (cm)				1.000	0.1469*	0.0997	0.0393	0.1028	0.0154	0.1961**	0.2295**
					(0.1752)	(0.1448)	(0.0618)	(0.1157)	(0.0435)	(0.2319)	(0.2755)
Number of grains per panicle					1.000	0.6147**	0.3240**	0.6196**	0.1099	-0.1786**	0.6595**
						(0.6336)	(0.3458)	(0.6373)	(0.1394)	(-0.1802)	(0.6777)
Number of filled grains per plant						1.000	0.4013**	0.9898**	0.3464**	-0.2250**	0.6536**
							(0.4434)	(0.9931)	(0.3821)	(-0.2262)	(0.6540)
Number of chaffy grains per plant							1.000	0.5048**	-0.5175**	-0.0360	0.3171**
								(0.5425)	(-0.5798)	(-0.0406)	(0.3328)
Total number of grains per plant								1.000	0.2177**	-0.2188**	0.6533**
									(0.2768)	(-0.2200)	(0.6499)
Spikelet fertility (%)									1.000	-0.1178	0.1392*
										(-0.1474)	(0.1892)
100-grain weight (g)										1.000	0.4014**
											(0.4062)

Figures in parenthesis are genotypic correlation coefficients *Significant at P = 0.05 level ** Significant at P = 0.01 level

Table 2. Direct and indirect effects between yield and its component traits in rice.

	Plant height (cm)	Days to 50% flowering	Number of productive tillers per plant	Panicle length (cm)	Number of grains per panicle	Number of filled grains per plant	Number of chaffy grains per plant	Total number of grains per plant	Spikelet fertility (%)	100-grain weight (g)	Correlation with single plant yield (g)
Plant height (cm)	**0.0338**	0.0053	-0.0004	0.0139	0.0001	0.0010	-0.0009	0.0009	-0.0009	0.0061	0.1419
	(0.0115)	(0.0018)	(-0.0002)	(0.0054)	(0.0000)	(0.0003)	(-0.0002)	(0.0003)	(-0.0005)	(0.0061)	(0.1440)
Days to 50%	-0.0018	**-0.0115**	0.0023	0.0003	-0.0002	0.0003	-0.0009	0.0003	0.0009	0.0016	-0.1344
flowering	(0.0107)	**(-0.0674)**	(0.0176)	(-0.0020)	(-0.0009)	(-0.0017)	(-0.0059)	(-0.0003)	(-0.0062)	(0.0093)	(-0.1385)
Number of productive	-0.0033	-0.0499	**0.2522**	-0.0099	-0.1170	0.0200	-0.0253	0.0157	0.0353	0.0151	0.0096
tillers per plant	(-0.0065)	(-0.0978)	**(0.3735)**	(0.0032)	(-0.1960)	(0.0312)	(-0.0508)	(0.0226)	(0.0857)	(0.0226)	(0.0211)
Panicle length (cm)	-0.0089	0.0005	0.0008	**-0.0215**	0.0032	-0.0021	-0.0008	-0.0022	-0.0003	-0.0042	0.2295
	(0.0089)	(-0.0005)	(0.0020)	**(-0.0190)**	(0.0033)	(0.0022)	(0.0012)	(0.0022)	(-0.0008)	(0.0044)	(0.2755)
Number of grains per	-0.0024	0.0091	-0.3062	0.0970	**0.6600**	0.4057	0.2139	0.4090	0.0726	-0.1179	0.6595
panicle	(0.0018)	(0.0109)	(-0.4235)	(-0.0018)	**(0.8071)**	(0.5114)	(0.2791)	(0.5143)	(0.1125)	(-0.1455)	(0.777)
Number of filled	0.0546	-0.0126	0.0434	0.0163	0.3366	**0.5476**	0.2197	0.5420	0.1897	-0.1218	0.6536
grains per plant	(0.4562)	(-0.1349)	(0.4562)	(0.1620)	(3.4637)	**(5.4663)**	(2.4237)	(5.4285)	(2.0887)	(-1.2363)	(0.6540)
Number of chaffy	0.0005	-0.0016	0.0020	-0.0008	-0.0065	-0.0081	**-0.0202**	-0.0102	0.0104	0.007	0.3171
grains per plant	(-0.0090)	(0.0420)	(0.0656)	(-0.0328)	(0.1667)	(0.2138)	**(-0.4821)**	(0.2615)	(0.2795)	(-0.0196)	(0.3328)
Total number of	0.0043	0.0005	-0.0100	-0.0166	-0.0998	-0.1594	-0.0813	**-0.1611**	-0.0351	0.0352	0.6533
grains per plant	(0.1470)	(0.0263)	(-0.3264)	(-0.0030)	(-3.4352)	(-5.3534)	(-2.9242)	**(-5.3907)**	(-1.4922)	(1.1968)	(0.6499)
Spikelet fertility	0.0017	0.0049	-0.0091	-0.0010	-0.0072	-0.226	0.0337	-0.0142	**-0.0652**	0.0077	0.1392
(%)	(0.0094)	(0.0219)	(-0.0548)	(0.0000)	(0.0333)	(-0.0913)	(0.1385)	(-0.0661)	**(-0.2389)**	(0.0352)	(0.1892)
100-grain weight (g)	0.1052	-0.0790	0.0347	0.1135	-0.1034	-0.1288	-0.0208	-0.1267	-0.0682	**0.5789**	0.4014
	(0.1022)	(-0.0758)	(0.0392)	(0.1280)	(-0.0994)	(-0.1248)	(-0.0224)	(-0.1225)	(-0.0813)	**(0.5517)**	(0.4062)

Bold values are direct effects and all other values are indirect effects. Figures in parenthesis indicate genotypic estimates

noticed with 100-grain weight. This trait had a positive but non-significant correlation with panicle length, plant height and number of productive tillers per plant. Spikelet fertility had a positive and significant association with number of filled grains per plant, total number of grains per plant and number of productive tillers per plant. These findings were similar with those of Borkakati *et al*. (2005) and Paramesha *et al*. (2005). This trait had negative significant association with number of chaffy grains per plant. 100-grain weight recorded positive and significant correlation with panicle length and plant height. Negative and significant association of this character was found with number of filled grains per plant, total number of grains per plant, number of grains per panicle and days to 50% flowering.

Correlation coefficient does not project the complete picture especially when the casual factors are interrelated. Therefore, the correlation coefficients between single plant yield and each of its component characters are partitioned into the corresponding direct and indirect effects through path coefficient analysis and are furnished in Table 2. In rice, path analysis has been effectively used in identifying useful traits as selection criteria to improve grain yield. Number of grains per panicle exhibited maximum positive direct effect as against its highest positive significant correlation value with single plant yield. This was due to high positive indirect effects of number of grains per panicle *via* total number of grains per plant, number of filled grains per plant, number of chaffy grains per plant, spikelet fertility and days to 50% flowering. Plant height expressed a positive direct effect on single plant yield. It recorded positive indirect effects on single plant yield *via* panicle length, 100-grain weight, days to 50% flowering, number of filled grains per plant, total number of grains per plant and number of grains per panicle, while rest of the characters showed negative indirect effects. Days to 50% flowering exhibited a negative direct effect on single plant yield. It had shown positive indirect effects on single plant yield *via* number of productive tillers per plant and 100-grain weight. Number of productive tillers per plant expressed a positive direct effect on single plant yield. It had a positive indirect effect *via* spikelet fertility, number of filled grains per plant, total number of grains per plant and 100-grain weight on single plant yield. Panicle length expressed a negative direct effect on single plant yield. It had shown positive indirect effects on single plant yield *via* number of grains per panicle and number of productive tillers per plant. Number of grains per panicle exhibited a positive direct effect on single plant yield. Total number of grains per plant, number of filled grains per plant, number of chaffy grains per plant, spikelet fertility and days to 50% flowering showed positive indirect effect on single plant yield. Negative indirect effects were manifested through number of productive tillers per plant and 100-grain weight. Number of filled grains per plant expressed a positive direct effect on single plant yield. It had a positive indirect effect *via* total number of grains per plant, number of grains per panicle, number of chaffy grains per plant, spikelet fertility, plant height, number of productive tillers per plant and panicle length indicating that plants with large panicles tend to have high number of fertile grains. Negative indirect effect of this triat on single plant yield was noticed *via* days to 50% flowering and 100-grain weight. Number of chaffy grains per plant expressed a negative direct effect on single plant yield. It had a positive indirect effect on single plant yield *via* spikelet fertility and number of productive tillers per plant. Total number of grains per plant expressed a negative direct effect on single plant yield. It had a positive indirect effect *via* 100-grain weight, plant height and days to 50% flowering, while negative indirect effects were exhibited by number of productive tillers per plant, panicle length, number of grains per panicle, number of filled grains per panicle, number of chaffy grains per plant and spikelet fertility. Spikelet fertility expressed negative direct effect on single plant yield and positive indirect effects were manifested through number of chaffy grains per plant, 100-grain weight, days to 50% flowering and plant height. 100-grain weight expressed positive direct effect on single plant yield. It had shown positive indirect effects *via* panicle length, plant height and number of productive tillers per plant and rest of characters showed negative indirect effect on single plant yield.

Partitioning of correlation values showed that some of the characters such as days to 50% flowering, panicle length, number of chaffy grains per plant, total number of grains per plant and spikelet fertility could not produce significant correlation with yield which might be either due to

high negative direct effect or due to low direct effect or high negative indirect effect of plant height, number of productive tillers per plant, number of filled grains per plant and 100-grain weight. Similar situation was reported earlier in case of panicle length by Yogameenakshi *et al*. (2004).

Critical analysis of results obtained from character association and path analysis revealed that plant height, number of productive tillers per plant, number of grains per panicle, number of filled grains per plant and 100-grain weight exhibited positive direct effect on grain yield. All these characters showed both positive associations and positive direct effects. Hence, selection for these traits could bring improvement in yield and yield attributes.

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