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Correlation and path coefficient analysis for yield and its contributing traits in Rice (*Oryza sativa* L.)

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ABSTRACT

The present study was conducted to evaluate the relationship between grain yield and its contributing characters through correlation and path coefficient analysis in rice (*Oryza sativa* L.). Thirty genotypes were evaluated in a Randomized Block Design with three replications. Eleven quantitative traits were studied. Correlation analysis revealed that grain yield exhibited positive association with several yield contributing traits. Path coefficient analysis partitioned the correlation into direct and indirect effects, indicating that biological yield, harvest index, and fertile seeds per panicle had strong direct effects on grain yield. These traits can be used as selection criteria in breeding programs for yield improvement.

KEYWORDS

Correlation, Path Analysis, Yield, Direct Effect, Indirect Effect

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Rice (*Oryza sativa* L.) is one of the most important staple food crops worldwide. Yield is a complex trait influenced by multiple characters. Therefore, understanding the association between yield and its components is essential for effective selection. India is bestowed with a great diversity of rice germplasm in its vast territorial land area with varieties which are popular in different traditional rice growing areas. Since, the onset of the Green Revolution in 1960s, its single point policy of increasing yield of paddy became the slogan for the agriculture departments/universities in the country. As a result, indigenous varieties have been slowly dying out.

Over the years, thousands of varieties of land races that were part of our food and agricultural heritage began to be lost. Every variety of rice has traditionally had the agricultural and food significance. They have unique nutritive, cooking and eating qualities. It is considered that red rice has higher antioxidant activity than the white rice due to the presence of polyphenols in it. Loss of nutrients in white rice results from milling and polishing of the rice.In terms of resistance to pests and diseases and eating quality, it is found that the indigenous landraces are relatively superior. Due to their wider adaptability, the indigenous varieties are still liked by many farmers in various stress situations, non-relying on too much of chemical fertilizers and good cooking and eating quality. In addition to the implementation of different conservation initiatives and techniques, the mass awareness programme should also discuss the healthy guidance of established biological reserves for potential agricultural improvement. Before implementing any breeding programme, a thorough knowledge of the existence and magnitude of genetic diversity, genetic advance, heritability, genetic divergence and association between different characters with yield is needed. Even in the combination of the characters, information on the direct and indirect effects of each character to yield would be an added advantage for further crop improvement.

Correlation is the measure of the mutual relationship between two variables and it measures the degree of closeness and the linear relationship between them. In order to understand how the enhancement of one character can bring simultaneous improvement in other characters, correlation estimation is important. It is a prerequisite to have the information on the correlation coefficient between grain yield and yield attributing traits for yield enhancement. Path analysis divides the components of correlation coefficients into direct and indirect effects of various traits on yield information. In association of characters, direct and indirect effects provided by each trait towards yield will be a supplementary advantage in assisting the selection process. Correlation and path analysis offers the degree of association between yield and yield components and also convey the relative importance of their direct and indirect effects thus giving an understanding of their association with grain yield.

Finally, this kind of analysis could be beneficial to the breeder in designing the selection strategies to improve grain yield (Babu *et al.*, 2012).

Materials and Methods

The present experiment was conducted with a view to estimates the extent of correlation coefficients and path coefficients in rice (*Oryza sativa* L.). The present experiment consisted of thirty genotypes of rice were obtained from Acharya Narendra Dev University of Agriculture & Technology, Kumarganj, Ayodhya. Observations were recorded on the following 11 traits *viz*., days to 50% flowering, days to maturity, plant height (cm), number of tillers per plant, panicle length (cm), number of spikelets per panicle, fertile grains per panicle, 1000-grain weight (g), biological yield per plant (g), harvest index (%) and grain yield per plant (g). Correlation coefficients were calculated from variance and covariance components. Path coefficient analysis was done taking seed yield/ plant as dependent and rest 12 characters as independent traits. The analysis was done according to (Dewey and Lu, 1959). In this investigation, genotypic correlation coefficient was partitioned into direct and indirect effects.

Results and Discussion

Correlation Coefficient

In present investigation the genotypic and phenotypic correlation coefficients between pairs of characters are presented in table 1 and table 2. Generally the genotypic correlation coefficients were higher than the phenotypic correlation in most of the characters indicating the association is largely due to genetic reasons. The genotypic correlation revealed that the grain yield per plant showed positive and significant genotypic correlation with plant height, while grain yield per plant showed negative and significant genotypic correlation with harvest index (%). The harvest index (%) showed positive and significant genotypic correlation with days to maturity, plant height, 1000 grain weight and biological yield per plant. The biological yield per plant also showed positive and significant genotypic correlation with plant height. 1000 grain weight showed positive and significant genotypic correlation with spike length.

Table 1. Genotypic correlation coefficient analysis for yield and its attributing of 11 quantitative characters in rice

Characters	Day to 50 % Flower-ing	Days to 50% Maturity	Plant Height (cm)	Tiller Number /Plant	Panicle Length (cm)	Spiklets in/ Panicle	Fertile Seed/ Panicle	1000-Grain Weight (cm)	Biological Yield/ Plant (g)	Harvest Index (%)	Grain Yield/ Plant (g)
Day to 50% Flowering	1	0.9849**	-0.8505**	0.3587	-0.9158**	-0.4936**	-0.7546**	0.1691	-0.7992**	-0.5954**	-0.2718
Days to 50% Maturity		1	-0.7803**	0.3982*	-0.8684**	-0.4974**	-0.7887**	0.102	-0.7663**	-0.6406**	-0.3459
Plant Height (cm)			1	-0.5545**	0.8141**	0.6686**	0.6304**	-0.0412	0.5863**	0.4323*	0.1607
Tiller Number/ Plant				1	-0.4647**	-0.7077**	-0.5361**	-0.617**	-0.4331*	-0.5437**	-0.4356*
Panicle Length (cm)					1	0.6596**	0.8323**	-0.1013	0.866**	0.6976**	0.3521
Spikelet's in/ Panicle						1	0.6996**	0.4883**	0.5837**	0.7438**	0.6393**
Fertile Seed/ Panicle							1	0.1041	0.8927**	0.9457**	0.7102**
1000-Grain Weight (cm)								1	-0.0562	0.3653*	0.5512**
Biological Yield/ Plant (g)									1	0.7846**	0.3722*
Harvest Index (%)										1	0.8627**
Grain Yield/ Plant (g)											1

Note: **=Significant at 0.01% level of significance, *=Significant at 0.05% level of significance

The genotypic correlation revealed that the tiller number per plant showed positive and significant genotypic correlation with day to 50% flowering and spike length. The plant height showed positive and significant genotypic correlation with spike length. The days to maturity showed positive and significant genotypic correlation with day to 50% flowering. The phenotypic correlation revealed that the grain yield per plant showed negative and significant phenotypic correlation with day to maturity and harvest index (%). The harvest index (%) showed positive and significant phenotypic correlation with day to maturity, 1000 grain weight and biological yield per plant, while harvest index (%) showed negative and significant phenotypic correlation with plant height.

The biological yield per plant showed positive and significant phenotypic correlation with days to maturity and 1000 grain weight while biological yield per plant showed negative and significant phenotypic correlation with days to 50% heading and plant height. 1000 grain weight showed negative and significant phenotypic correlation with number of grains per spike. The number of grains per spike showed negative and significant phenotypic correlation with days to 50% heading. The tiller number per plant showed positive and significant phenotypic correlation with days to 50% heading. The plant height showed positive and significant phenotypic correlation with spike length, while plant height showed negative and significant phenotypic correlation with days to maturity.

Table 2. Phenotypic correlation coefficient analysis for yield and its attributing of 11 quantitative characters in rice

Characters	Days to 50% Flowering	Days to 50% Maturity	Plant Height (cm)	Tiller Number /Plant	Panicle Length (cm)	Spiklets in/ Panicle	Fertile Seed/ Panicle	1000-Grain Weight (cm)	Biological Yield/ Plant (g)	Harvest Index (%)	Grain Yield/ Plant (g)
Days to 50% Flowering	1										
Days to 50% Maturity	0.95**	1									
Plant Height (cm)	-0.5828**	-0.5395**	1								
Tiller Number / Plant	0.242*	0.2773**	-0.3193**	1							
Panicle Length (cm)	-0.6993**	-0.6572**	0.6433**	-0.3411**	1						
Spiklets in/ Panicle	-0.3776**	-0.3956**	0.4684**	-0.4027**	0.511**	1					
Fertile Seed/ Panicle	-0.531**	-0.5356**	0.3569**	-0.3498**	0.6378**	0.6831**	1				
1000-Grain Weight (cm)	0.0974	0.0286	0.0115	-0.3362**	0.0559	0.26*	0.1589	1			
Biological Yield/ Plant (g)	-0.6317**	-0.5737**	0.5368**	-0.1307	0.6882**	0.5848**	0.7665**	-0.0112	1		
Harvest Index (%)	-0.4055**	-0.42**	0.2729**	-0.2025	0.5413**	0.6411**	0.932**	0.3872**	0.7234**	1	
Grain Yield / Plant (g)	-0.1276	-0.1809	0.0373	-0.1844	0.3003**	0.4941**	0.7597**	0.5086**	0.352**	0.8889**	1

Note: **=Significant at 0.01% level of significance, *=Significant at 0.05% level of significance

Table 3. Genotypic path coefficient direct and indirect effects of 11 characters towards yield in Rice

Characters	Days to 50% Flowering	Days to 50% Maturity	Plant Height (cm)	Tiller Number /Plant	Panicle Length (cm)	Spiklets in/ Panicle	Fertile Seed/ Panicle	1000-Grain Weight (cm)	Biological Yield/ Plant (g)	Harvest Index (%)
Days to 50% Flowering	0.43758	-0.24862	0.00911	0.08039	-0.23489	0.02087	-0.54971	0.05786	-0.1226	-0.0455
Days to 50% Maturity	0.43097	-0.25243	0.00836	0.08924	-0.22273	0.02104	-0.5746	0.0349	-0.1175	-0.0579
Plant Height (cm)	-0.37214	0.19696	-0.01071	-0.12428	0.20881	-0.0283	0.45929	-0.01408	0.0899	0.02688
Tiller Number/ Plant	0.15696	-0.10051	0.00594	0.22412	-0.11921	0.02993	-0.39055	-0.21107	-0.0664	-0.0729
Panicle Length (cm)	-0.40071	0.2192	-0.00872	-0.10416	0.2565	-0.0279	0.60636	-0.03466	0.13279	0.0589
Spiklets in/ Panicle	-0.21597	0.12556	-0.00716	-0.1586	0.16918	-0.0423	0.50963	0.16703	0.08951	0.10693
Fertile Seed/ Panicle	-0.33018	0.1991	-0.00675	-0.12015	0.21349	-0.0296	0.72851	0.03562	0.13689	0.1188
1000-Grain Weight (cm)	0.07401	-0.02575	0.00044	-0.13828	-0.02599	-0.0207	0.07586	0.34208	-0.0086	0.0922
Biological Yield/ Plant (g)	-0.34971	0.19345	-0.00628	-0.09707	0.22212	-0.0247	0.65036	-0.01921	0.15334	0.06226
Harvest Index (%)	-0.11892	0.08732	-0.00172	-0.09763	0.09032	-0.027	0.51741	0.18856	0.05707	0.16727

Note: Dependent variable = Grain yield /plant (g) Residual effect = 0.003

The days to maturity showed positive and significant phenotypic correlation with days to 50% heading. These results were in agreement with (Jayasudha *et al.,* 2010, Kishore *et al.,* 2015 and Minnie *et al.,* 2013).

Path Coefficient Analysis

Path coefficient analysis was done on the basis of genotypic and phenotypic correlation. The analysis was performed considering seed yield per plant as the effect or dependent character. Eleven characters were considered as causal factors or independent factors. The genotypic and phenotypic correlation coefficient of grain yield with other characters was partitioned into direct and indirect effects. The path coefficient analysis is presented in table 3 and table 4. The positive and highest genotypic direct effect on seed yield per plant are recorded for the character biological yield per plant followed by 1000 grain weight, number of grains per spike, spike length and days to 50% heading. Similarly the negative genotypic direct effect on seed yield per plant were observed for the characters harvest index (%), plant height, tiller number per plant and days to maturity (table 3). On the other hand the positive and high indirect effect on seed yield per plant were recorded for the character number of days to 50% heading, spike length, plant height via tiller number per plant (table 3). The positive and highest phenotypic direct effect on seed yield per plot are recorded for the character biological yield per plantfollowed by 1000 grain weight, number of grains per spike and days to 50% heading. Similarly the negative genotypic direct effect on seed yield per plot were observed for the characters days to maturity, spike length, plant height, tiller number per plant and harvest index % (table 4). On the other hand the positive and high indirect effect on seed yield per plant were recorded for the character days to 50% heading, spike length, plant height via tiller number per plant (table 4). The results are in agreement with those obtained by (Allam *et al.,* 2015, Bhati *et al.,* 2015, Bhatt *et al.,* 2016, Devi *et al.,* 2017, Edukondalu *et al.,* 2022 and Jarwar *et al.,* 2019).

Table 4. Phenotypic path coefficient direct and indirect effects of 11 characters towards yield in Rice

Characters	Days to 50% Flowering	Days to 50% Maturity	Plant Height (cm)	Tiller Number /Plant	Panicle Length (cm)	Spiklets in/ Panicle	Fertile Seed/ Panicle	1000-Grain Weight (cm)	Biological Yield/ Plant (g)	Harvest Index (%)
Days to 50% Flowering	-0.01327	0.00714	-0.00138	0.02445	0.01812	0.00481	-0.23136	0.01451	-0.1754	-0.0532
Days to 50% Maturity	-0.0126	0.00752	-0.00128	0.02803	0.01704	0.00504	-0.23336	0.00426	-0.1593	-0.0754
Plant Height (cm)	0.00773	-0.00406	0.00237	-0.03227	-0.01668	-0.006	0.1555	0.00171	0.14901	0.01554
Tiller Number/ Plant	-0.00321	0.00209	-0.00076	0.10105	0.00884	0.00513	-0.15241	-0.05011	-0.0363	-0.0768
Panicle length (cm)	0.00928	-0.00494	0.00152	-0.03448	-0.02592	-0.0065	0.27789	0.00833	0.19104	0.1251
Spiklets in/ Panicle	0.00501	-0.00298	0.00111	-0.04068	-0.01325	-0.0127	0.29763	0.0387	0.16234	0.20586
Fertile Seed/ Panicle	0.00704	-0.00403	0.00085	-0.03535	-0.01653	-0.0087	0.4357	0.02367	0.21278	0.31658
1000-Grain Weight (cm)	-0.00129	0.00022	0.00003	-0.034	-0.00145	-0.0033	0.06923	0.14897	-0.0031	0.21194
Biological Yield/ Plant (g)	0.00838	-0.00431	0.00127	-0.01321	-0.01784	-0.0075	0.33397	-0.00168	0.27759	0.14668
Harvest Index (%)	0.00169	-0.00136	0.00009	-0.01864	-0.00778	-0.0063	0.331	0.07576	0.09771	0.41672

Note: Dependent variable = Grain yield/ plant (g) Residual effect = 0.0048

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