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Correlation and Path Coefficient Studies of Three Line Rice Hybrids

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Thirty-one three-line rice hybrids and three commercial checks were used in the current study for correlation and path coefficient analysis. In *Kharif* 2021, the experiment was carried out at the TCA Hybrid Rice field in Dholi, Pusa, Bihar, India. The experimental design adopted was a Randomized Complete Block Design (RBD) with three replications that included 18 quantitative attributes. Plant height, number of tillers per plant, number of panicles per plant, leaf length, leaf area, kernel length, kernel width, root fresh weight, root dry weight, spikelet fertility, and test weight showed a positive significant correlation with grain yield per plant. Hence, selection for any one of these characteristics would ultimately bring improvement in grain yield. The traits number of tillers per plant, plant height, root fresh weight, leaf length, no. of panicles per plant, leaf width, kernel length, and root volume revealed a significant direct impact on grain yield per plant. Thus, breeding for these characteristics could end up resulting in a higher grain yield.

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Keywords: Correlation; hybrids; path coefficient; yield.

1. INTRODUCTION

Rice (*Oryza sativa* L.), which is an annual plant is grown in every part of the world as it is the most important cereal crops. It can reach a height of 36 to 150 cm. There are about twenty different species, *Oryza sativa* and *Oryza glaberrima* being the most common [1]. In terms of producing wheat, rice, and other grains, India ranks second in the world [2]. Warm-season rice is a crop that is extensively grown in humid tropical and subtropical climates across the globe [3,4]. About 47 million hectares of rice are under cultivation in India, where it is produced on 135.5 million tonnes of land and has a productivity of 3059 kg/ha [5].

The breeder's primary goal in any crop is to increase the grain yield as it is the most important and difficult variables of any research. Most breeding initiatives have grain yield enhancement as their primary goal [6]. Improving yield components was hypothesised to more successfully increase grain production because they were more heritable than grain yield. Through correlation and path analysis, phenotypic and genetic relationships between grain yield and its component parts have been determined.

Yield being a complex character depends on several other characters and available relation between economic desired trait and other traits can be assessed by using correlation. Further path analysis reveals interconnection among different traits and their indirect and direct impact on the yield components coefficient [7,8]. Using correlation and path analysis, phenotypic and genetic relationships involving grain yield and the individual components were identified.

2. MATERIALS AND METHODS

2.1 Experimental Site and Materials

The site of the research carried out is at hybrid rice plot of Dholi, Pusa, Bihar which is situated on the bank of Burhi Gandak river having humid sub-tropical climate at a latitude of 25^0 59 N and 85^0 75 E longitude. To evaluate the agro-morphological characteristics and production efficiency of three lines of rice hybrids, the hybrid genotypes were cultivated in RCBD with three different replications in Kharif 2021, accompanied by three checks. The list of genotypes is presented in Table 1. The observation for 18 quantitative attributes were recorded for estimation of various parameters. Five competing plants were randomly chosen from each plot and tagged in order to gather data. But the data of exceptional traits like days to maturity and 50% flowering were taken on an individual plot basis.

2.2 Statistical Analysis

Correlation coefficients measure the association between two or more series of variables. The formula used to calculate the correlation coefficients between characters based on phenotypic, genotypic, and environmental factors, along with the corresponding components of variance and co-variance is given below:

Phenotypic coefficient of correlation (rp) = r (xi, xj) p = Cov . (xi.xj) / $\sqrt{V(xi)p.v(xj)p}$

Dewey and Lu [9] 's formula was utilized for calculating path coefficient. Lenka and Mishra [10] 's classification is used for the classification of path coefficient values.

3. RESULTS AND DISCUSSION

3.1 Correlation Coefficient Analysis

An essential strategy in a breeding program is association analysis. It establishes component traits on which selection might be based on genetic improvement in grain yield and provides a concept of how the relationships between the various characters relate to one another. The strength of the selecting process is also impacted by the degree of association. The correlation coefficient analysis measures how closely two variables are related. Knowing the strength and direction of the correlation between the characters under study is essential for attaining a reasonable genetic increase in yield. Table 2 represents the phenotypic correlation between grain yield and other traits.

In addition to exhibiting a negative and significant relationship with the number of days to 50% flowering, plant height imposed a strong and positive correlation with the number of tillers per plant, the number of panicles per plant, leaf length, leaf area, kernel width, root fresh weight, root dry weight, and grain yield per plant [11].

The important trait i.e., number of tillers per plant exhibited a noteworthy positive relationship with the number of panicles on the plant, test weight, kernel length, root fresh weight, as well as the length, area, and freshness of the leaves. It also showed a positive correlation with the grain yield per plant [12].

The phenotypic correlation between the number of panicles per plant and the following variables was significant and positive: panicle length, leaf length, test weight, spikelet fertility, root fresh weight, and root dry weight; on the other hand, there was a negative significant relationship with culm diameter [11,13].

There was a substantial and positive correlation between panicle length and culm diameter. The phenotypic correlation between Culm diameter and test weight, days to maturity, and leaf length was found to be significant and negative [14].

With regard to leaf area, test weight, root dry weight, and grain yield per plant, leaf length exhibited a strong and positive correlation. Additionally, there was a significant and negative association between spikelet fertility and leaf length [12,14,15].

List 1. Expectation of mean of sum of products

Source	Df	Mean of sum of products	Expectation of mean of sum of products
Replication	**(r-1)**	**Mr1**	**-**
Genotypes	(g-1)	Mg1	$Cov_{exy} + Cov_{gxy}$
Error	(r-1) (g-1)	Me1	Cov_{exy}

List 2. classification of path coefficient values

<0.09	**Considered negligible**
0.10-0.19	Low
0.20-0.29	Moderate
0.30-0.99	high
More than 1.00	Very high

Table 1. List of genotypes

S No.	A line	R line	S No.	A line	R line
1	IR 68897A	RRR-1	17	Raj-3A	RRR-1
2		RRR-2	18		RRR-2
3		RRR-3	19		RRR-3
4		RRR-4	20		RRR-4
5		RRR-5	21		RRR-5
6		DR714-1-2	22		DR714-1-2
7		KMR-3R	23		MSN-36R
8		MSN-36R	24	IR-58025A	MSN-36R
9	Raj-1A	RRR-1	25	CMR-32A	RRR-1
10		RRR-2	26		RRR-2
11		RRR-3	27		RRR-3
12		RRR-4	28		RRR-4
13		RRR-5	29		RRR-5
14		DR714-1-2	30		KMR-3R
15		KMR-3R	31		MSN-36R
16		MSN-36R	**Checks**		
			32	Rajendra Sweta	
			33	Arize Gold6444	
			34	Rajendra Bhagwati	

Table 2. Phenotypic correlation between pairs of quantitative characters in rice

TRAITS	PH	DFL	NTP	NPP	PL	CD	LL	LW	LA	KL	KW	RV	RFW	RDW	DTM	SF	TW
PH																	
DFL	-0.251*																
NTP	0.271**	0.042															
NPP	0.202*	-0.076	0.616**														
PL	0.113	0.206*	0.228*	0.204*													
CD	0.119	-0.242*	-0.076	-0.267**	0.206*												
LL	0.243*	-0.002	0.288**	0.265**	0.063	-0.259**											
LW	-0.187	0.164	-0.038	-0.083	-0.153	-0.166	0.157										
LA	0.378**	-0.093	0.315**	0.034	0.056	-0.156	0.583**	0.028									
KL	0.099	-0.043	0.329**	0.081	0.03	-0.18	0.087	-0.166	0.326**								
KW	0.255**	-0.314**	0.083	0.111	0.019	0.067	-0.057	0.029	-0.058	0.087							
RV	0.027	0.105	-0.027	0.044	0.012	-0.106	0.139	0.084	0.048	-0.12	0.024						
RFW	0.287**	-0.058	0.400**	0.261**	0.102	-0.057	0.187	-0.011	0.096	0.238*	0.382**	-0.033					
RDW	0.328**	-0.041	0.415**	0.195*	0.05	-0.07	0.308**	0.206*	0.115	0.179	0.266**	-0.004	0.757**				
DTM	-0.111	0.822**	0.094	0.02	0.193	-0.255**	0.049	0.107	-0.011	-0.004	-0.225*	0.161	0.047	0.043			
SF	0.112	-0.292**	0.148	0.209*	0.072	0.149	-0.219*	-0.267**	0.001	0.112	0.390**	-0.073	0.249*	-0.061	-0.235*		
TW	-0.027	0.134	0.443**	0.442**	-0.07	-0.287**	0.197*	0.240*	0.087	0.081	0.03	0.102	0.15	0.169	0.182	0.171	
YLD	0.535**	-0.087	0.722**	0.589**	0.153	-0.121	0.438**	0.031	0.337**	0.299**	0.267**	0.081	0.591**	0.525**	0.045	0.196*	0.356**

** Significant at (p=0.05) level; ** Significant at (p=0.01) level, PH- Plant Height; DFL- Days to 50% Flowering; NTP- No. of Tillers per Plant; NPP- No. of Panicles per Plant; PL- Panicle Length; CD= Clum Diameter; LL- Leaf Length; LW- Leaf width; KL- Kernel Length; KW- Kernel Width; RV- Root Volume; RFW- Root Fresh Weight; RDW- Root Dry Weight; DTM- Days to Maturity; SF- Spikelet Fertility; TW- Test Weight; YLD- Yield*

Table 3. Phenotypic path coefficient analysis of 18 characters on yield in rice

TRAITS	PH	DFL	NTP	NPP	PL	CD	LL	LW	LA	KL	KW	RV	RFW	RDW	DTM	SF	TW	YLD
PH	0.334	0.014	0.108	0.032	-0.004	0.001	0.052	-0.028	-0.039	0.011	0.002	0.002	0.092	-0.042	-0.007	0.006	0.0001	0.535^{**}
DFL	-0.084	-0.054	0.017	-0.012	-0.006	-0.002	0.0003	0.024	0.010	-0.005	-0.003	0.007	-0.018	0.005	0.053	-0.016	-0.001	-0.087
NTP	0.091	-0.002	0.400	0.097	-0.007	-0.001	0.061	-0.006	-0.033	0.036	0.001	-0.002	0.127	-0.052	0.006	0.008	-0.003	0.722^{**}
NPP	0.068	0.004	0.246	0.158	-0.006	-0.003	0.056	-0.012	-0.003	0.009	0.001	0.003	0.083	-0.025	0.001	0.012	-0.003	0.589^{**}
PL	0.038	-0.011	0.091	0.032	-0.031	0.002	0.013	-0.023	-0.006	0.003	0.0001	0.001	0.033	-0.006	0.012	0.004	0.0004	0.153
CD	0.040	0.013	-0.030	-0.042	-0.006	0.010	-0.055	-0.025	0.016	-0.020	0.001	-0.007	-0.018	0.009	-0.016	0.008	0.002	-0.121
LL	0.081	0.0001	0.115	0.042	-0.002	-0.003	0.212	0.023	-0.060	0.010	-0.001	0.009	0.060	-0.039	0.003	-0.012	-0.001	0.438^{**}
LW	-0.063	-0.009	-0.015	-0.013	0.005	-0.002	0.033	0.149	-0.003	-0.018	0.0002	0.005	-0.003	-0.026	0.007	-0.015	-0.001	0.031
LA	0.126	0.005	0.126	0.005	-0.002	-0.002	0.124	0.004	-0.104	0.036	-0.001	0.003	0.031	-0.015	-0.001	0.00003	0.0004	0.337^{**}
KL	0.033	0.002	0.131	0.013	-0.001	-0.002	0.018	-0.025	-0.034	0.110	0.001	-0.008	0.076	-0.023	0.0002	0.006	0.0004	0.299^{**}
KW	0.085	0.017	0.033	0.018	-0.001	0.001	-0.012	0.004	0.006	0.010	0.009	0.002	0.122	-0.034	-0.015	0.022	0.0001	0.267^{**}
RV	0.009	-0.006	-0.011	0.007	0.0003	-0.001	0.030	0.012	-0.005	-0.013	0.0002	0.064	-0.010	0.001	0.010	-0.004	-0.001	0.081
RFW	0.096	0.003	0.160	0.041	-0.003	-0.001	0.040	-0.002	-0.010	0.026	0.003	-0.002	0.319	-0.096	0.003	0.014	-0.001	0.591^{**}
RDW	0.110	0.002	0.166	0.031	-0.002	-0.001	0.065	0.031	-0.012	0.020	0.002	0.000	0.241	-0.127	0.003	-0.003	-0.001	0.525^{**}
DTM	-0.037	-0.045	0.038	0.003	-0.006	-0.003	0.010	0.016	0.001	0.000	-0.002	0.010	0.015	-0.005	0.064	-0.013	-0.001	0.045
SF	0.037	0.016	0.059	0.033	-0.002	0.001	-0.046	-0.040	0.00006	0.012	0.004	-0.005	0.079	0.008	-0.015	0.055	-0.001	0.196^{*}
TW	-0.009	-0.007	0.177	0.070	0.002	-0.003	0.042	0.036	-0.009	0.009	0.000	0.006	0.048	-0.021	0.012	0.010	-0.006	0.356^{**}

** Significant at (p=0.05) level; ** Significant at (p=0.01) level, PH- Plant Height; DFL- Days to 50% Flowering; NTP- No. of Tillers per Plant; NPP- No. of Panicles per Plant; PL- Panicle Length; CD= Clum Diameter; LL- Leaf Length; LW- Leaf width; KL- Kernel Length; KW- Kernel Width; RV- Root Volume; RFW- Root Fresh Weight; RDW- Root Dry Weight; DTM- Days to Maturity; SF- Spikelet Fertility; TW- Test Weight; YLD- Yield*

The test weight and root dry weight showed a strong and positive correlation with leaf width. Spikelet fertility was significantly inversely correlated with leaf width. Leaf area had a positively associated relation with grain yield and kernel width [16,17].

Grain yield per plant was significantly and positively correlated with kernel length. In addition to showing a significant negative correlation with days to maturity, kernel width also showed a significant positive correlation with spikelet fertility, root fresh weight, and root dry weight [12,18].

None of the traits exhibited a significant correlation with root volume. Grain yield per plant, spikelet fertility, and root fresh weight all exhibited a positive and significant correlation. Grain yield per plant was positively and significantly correlated with the root dry weight. There was a substantial and negative correlation between spikelet fertility and days to maturity [19,20].

Grain yield per plant was positively and significantly correlated with spikelet fertility. There was a strong and positive correlation between test weight and grain yield per plant. Plant height, the number of tillers per plant, the number of panicles per plant, leaf length, leaf area, kernel length, kernel width, root fresh weight, root dry weight, spikelet fertility, and test weight all significantly and favourably correlated with grain yield [13,15,21].

3.2 Path Coefficient Analysis

Analysing the relationships between quantitative traits is essential to deciding whether joint selection for two or more qualities is feasible instead of choosing secondary features based on genetic gain for the main characteristic under consideration. The path coefficient measures the direct impact of a predictor variable on its response variable. Path analysis has been used in agriculture by plant breeders to help identify desirable traits for use as criteria for breeding to increase crop yield.

It was found that each character had both direct and indirect effects on grain yield (Table 3). The character with the highest positive direct effect on grain yield was the number of tillers per plant (0.400), which was followed by root fresh weight (0.319), leaf length (0.212), the number of panicles per plant (0.158), leaf width (0.149), kernel length (0.110), root volume (0.064), days to maturity (0.064), spikelet fertility (0.055), culm diameter (0.010), kernel width (0.009). Priya *et al.*, [13] Pankaj *et al*., [15] Faysal *et al.,* [21] Meena *et al*., [22].

While characters like days to 50% flowering (-0.054), panicle length (-0.031), leaf area (-0.104), root dry weight (-0.127) and test weight (-0.006) had direct negative effects on grain yield per plant (Gopikannan *et al*., [23] Islam *et al*., [24] Jasmine *et al*., [25] Ekka *et al*., [26,27].

4. CONCLUSION

The study's conclusions indicate that there was a strong and positive relationship between the tested traits and the amount of grain yield per plant. Test weight, spikelet fertility, root fresh and dry weight, leaf length, leaf area, kernel length, and kernel width were among these characteristics. Thus, selecting any one of these characteristics would ultimately result in a higher grain yield. In the path coefficient analysis, the number of tillers per plant, plant height, root fresh weight, leaf length, number of panicles per plant, leaf width, kernel length, and root volume were the attributes that demonstrated a strong direct influence on grain yield per plant. Thus, selection based on these traits would have a higher chance of increasing grain yield.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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