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Correlation and Path Coefficient Analysis for Yield and Yield Attributing Traits in Rice (*Oryza sativa* L.)

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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

This study aimed to investigate the correlations among yield and yield component traits and estimate the direct and indirect effects of these traits on grain yield in rice. The experiment was conducted during *kharif* 2022. Correlation coefficients and path coefficients were analyzed to determine the relationships between these traits and seed yield. The results showed significant positive correlations between seed yield and traits such as effective tillers per plant, total tillers per plant, number of filled grains, spikelet fertility, biological yield, harvest index, and 100 seed weight. The genotypic correlations were slightly higher than the corresponding phenotypic correlations. Path coefficient analysis revealed that biological yield had the maximum direct effect on seed yield, followed by harvest index, panicle length, and number of filled grains per panicle, plant height, and effective tillers per plant, 100 seed weight, and days to 50% flowering. These findings provide valuable information for selecting superior cross combinations in hybrid rice breeding programs to improve grain yield.

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1. INTRODUCTION

Rice (*Oryza sativa* L.) (2n=24) is a major cereal crop that belongs to the Poaceae family and the Oryzoidea subfamily. It is known as the "Global Grain" because it is a staple food in over 100 countries. Approximately 90% of the world's rice is grown and consumed in Asia, with rice providing food for 50% of the population [1]. Rice is one of the most essential staple crops worldwide, serving as a crucial source of nutrition and sustenance for billions of people. Ensuring optimal yield and improving yield-contributing traits in rice is of paramount importance to meet the increasing global demand for food. In this context, understanding the complex relationships between various yields attributes and their correlation with overall yield becomes crucial for effective crop management and breeding programs [2]. Yield is a complex character, which is highly influenced by the environment, hence direct selection for yield alone limit the selection efficiency and ultimately results in limited success in yield improvement. Thus, effective improvement in yield may be brought about through selection of yield component characters. Yield component characters show association among themselves and also with yield. Plant Breeder has to find significant correlations among yield and yield component traits, and effect of yield component traits on grain yield to predict the superior cross combinations and to select ideal plant type with increased yield [3]. The present study was undertaken to derive information on correlation among yield and yield component traits and to estimate the direct and indirect effects of yield component traits on grain yield. This helps in selection of superior cross combinations in hybrid rice.

2. MATERIALS AND METHODS

The current experiment will be conducted at Research cum Instructional farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, Department of Genetics and Plant Breeding, College of Agriculture, IGKV, Raipur (C.G.) during *Kharif* 2022, to determine the most suitable traits to improve the yield and measure them as a selection criteria through studying and analyzing the correlation and path coefficient. The experiment was conducted in a randomized complete block design with three replications. The experimental material consisted of five generations of P_1, P_2, F_1, F_2, and F_3 which generated from crosses between following parents Rajeshwari, Mahamaya, IGKV R 1244, IC0496940, IC0491194, IC0491254, and IC0558317. The characters studied were, days to 50 per cent flowering, plant height, panicle length, number of effective tillers per plant, total tillers per plant, number of filled grain per panicle, number of unfilled grain per panicle, spikelet fertility, biological yield per plant, harvest index, 100 seed weight, seed yield per plant as an selection index to improve grain yield on five randomly selected plants in each replications.

2.1 Data Analysis

Correlation coefficient and path coefficients were analyzed by using Windostat Statistical Software Version 9.3 Correlations coefficient were computed by using the formula as given below:

$$r = (Cov(xy)/\sigma x \times \sigma y) \times 100$$

Where, r=Correlation coefficient Cov (xy) =Covariance between the characters ‘x’ and ‘y’ σx and σy =variance of the character ‘x’ and ‘y’ respectively.

Whereas, path coefficients were obtained by solving the simultaneous equations, which express the basic relationship between correlations and path coefficients.

3. RESULTS AND DISCUSSION

3.1 Correlations Coefficients

Correlation coefficients are the index of the association between two variables, which is due to linkage, pleiotropies or due to any environmental components. Coefficients of correlation among seed yield and its components for five populations illustrated in Table 1. result of the analysis revealed that the seed yield correlated positively, at both phenotypic and genotypic levels with effective tillers per plant (r_g=0.427), total tillers per plant (r_p=0.335, r_g=0.474), number of filled grain (r_p=0.506, r_g=0.559), spikelet fertility (r_p=0.344, r_g=0.600), biological yield (r_p=0.811, r_g=0.847), harvest index (r_p=0.382, r_g=0.333), 100 seed weight (r_p=0.270, rg=0.290). The results indicated that those above mentions traits had the strong association with seed yield. These indicated that simultaneous selection of all these traits was important for yield improvement. It revealed that

Table 1 Phenotypic (P) and genotypic (G) correlation coefficients for yield and its components in Rice

.Traits		DF 50%	PH	PL	ETP	TTP	NFG	NUFG	SF%	BYP	HI	100SW	SYP
DF 50%	**P**	1.000	-0.431**	-0.290*	-0.044	-0.053	0.148	-0.0001	0.026	-0.277*	0.546**	-0.393*	0.032
	G	1.000	-0.498**	-0.522**	-0.208	-0.098	0.130	-0.005	0.013	-0.299*	0.711**	-0.415*	0.048
PH	**P**		1.000	0.317*	-0.006	-0.108	-0.513**	0.107	-0.308*	0.074	-0.358*	0.435**	-0.151
	G		1.000	0.545**	0.026	-0.103	-0.587**	0.082	-0.617**	0.099	-0.495**	0.476**	-0.171
PL	**P**			1.000	0.141	0.118	-0.021	0.157	-0.101	0.119	-0.045	0.218	0.119
	G			1.000	0.373*	0.116	0.091	0.306*	0.040	0.342*	-0.186	0.395*	0.250
ETP	**P**				1.000	0.755**	0.250	-0.145	0.313*	0.225	-0.066	0.201	0.168
	G				1.000	0.178	0.371*	-0.173	0.343*	0.408*	0.049	0.395*	0.427**
TTP	**P**					1.000	0.317*	-0.310*	0.408*	0.333*	0.018	0.148	0.335*
	G					1.000	0.479**	-0.350*	0.665**	0.443**	0.047	0.193	0.474**
NFG	**P**						1.000	-0.210	0.548**	0.319*	0.290*	-0.084	0.506**
	G						1.000	-0.401*	0.857**	0.328*	0.424*	-0.084	0.559**
NUFG	**P**							1.000	-0.473**	-0.034	-0.173	0.143	-0.191
	G							1.000	-0.803**	-0.030	-0.202	0.218	-0.217
SF%	**P**								1.000	0.294*	-0.002	-0.061	0.344*
	G								1.000	0.451**	0.216	-0.091	0.600**
BYP	**P**									1.000	-0.205	0.522**	0.811**
	G									1.000	-0.210	0.528**	0.847**
HI	**P**										1.000	-0.292*	0.382*
	G										1.000	-0.328*	0.333*
100SW	**P**											1.000	0.270*
	G											1.000	0.290*

*DF50%-Days to 50% flowering , PH. –Plant height, ETP-. Effective tillers per plant ,TTP-Total tillers per plant, PL- Panicle length (cm), NFG- Number of filled grains per panicle ,NUFG- Number of unfilled grains per panicle SF%- Spikelet fertility (%) ,BYP-Biological yield per plant (g) . HI-. Harvest index (%) ,100SW-. 100 seed weight (g),SYP- Seed yield per plant (g) **Significant at P=1% & *Significant at P=5%*

Table 2. Direct and Indirect effect relationship among yield attributing traits

Traits	DF 50%	PH	PL	ETP	TTP	NFG	NUFG	SF%	BYP	HI	100SW	SYP
DF 50%	**-0.028**	0.012	0.008	0.001	0.001	-0.004	0.000	-0.0007	0.007	-0.015	0.011	0.032
PH	-0.005	**0.011**	0.003	-0.0001	-0.001	-0.005	0.001	-0.003	0.0009	-0.004	0.005	-0.151
PL	-0.014	0.016	**0.051**	0.007	0.006	-0.001	0.008	-0.005	0.006	-0.002	0.011	0.119
ETP	0.001	0.0002	-0.003	-**0.026**	-0.020	-0.006	0.003	-0.008	-0.006	0.001	-0.005	0.168
TTP	0.0001	0.0002	-0.0002	-0.001	**-0.002**	-0.0006	0.0006	-0.0008	-0.0007	0.000	-0.0003	0.335*
NFG	0.003	-0.011	-0.0005	0.005	0.006	**0.0219**	-0.004	0.012	0.007	0.006	-0.001	0.506**
NUFG	0.000	-0.003	-0.005	0.005	0.010	0.007	**-0.034**	0.016	0.001	0.005	-0.004	-0.191
SF%	0.001	-0.018	-0.006	0.019	0.024	0.033	-0.028	**0.060**	0.017	-0.0001	-0.003	0.344*
BYP	-0.255	0.068	0.110	0.208	0.307	0.294	-0.032	0.271	**0.923**	-0.189	0.482	0.811**
HI	0.306	-0.201	-0.025	-0.037	0.010	0.163	-0.097	-0.001	-0.115	**0.562**	-0.164	0.382*
100SW	0.023	-0.025	-0.013	-0.012	-0.008	0.005	-0.008	0.003	-0.031	0.017	**-0.059**	0.270*

DF50%-Days to 50% flowering , PH. –Plant height, ETP-. Effective tillers per plant ,TTP-Total tillers per plant, PL- Panicle length (cm), NFG- Number of filled grains per panicle ,NUFG- Number of unfilled grains per panicle SF%- Spikelet fertility (%) ,BYP-Biological yield per plant (g) . HI-. Harvest index (%) ,100SW-. 100 seed weight (g),SYP- Seed yield per plant (g)

Residual effect= 0.128

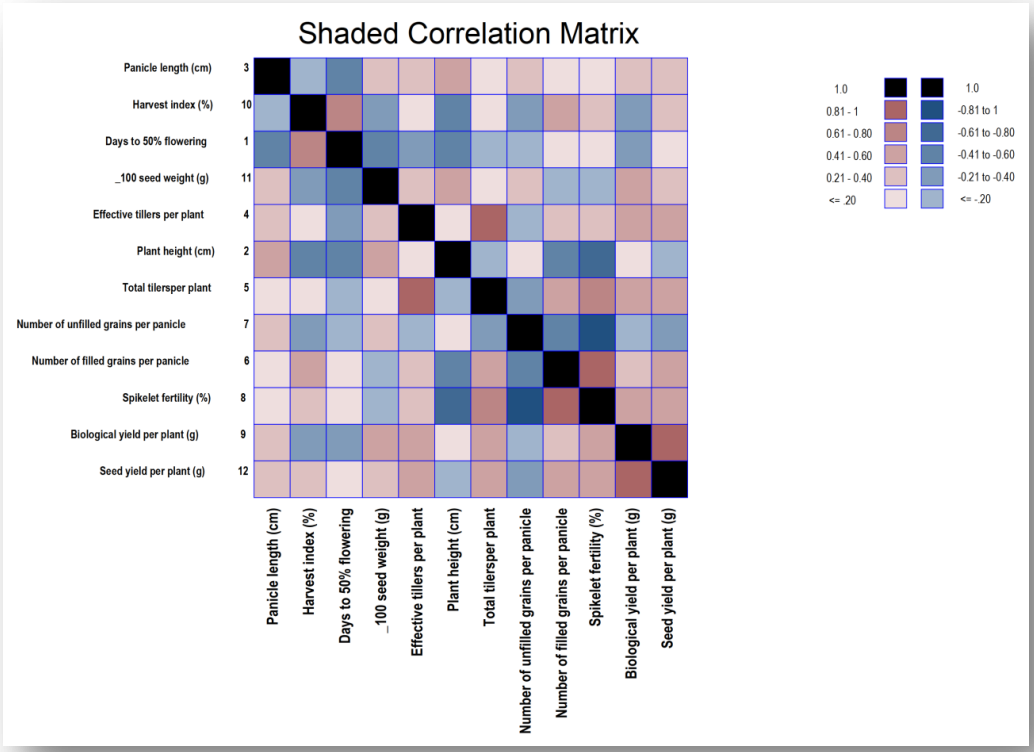

Fig. 1. Shaded correlation matrix based on correlation coefficient analysis

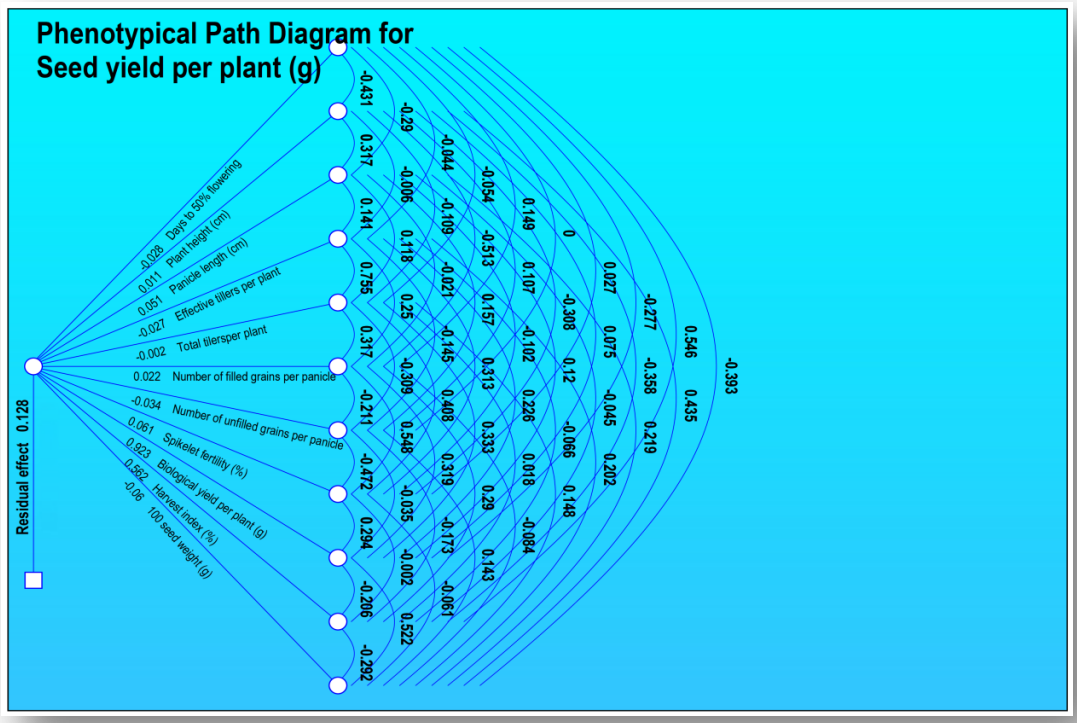

Fig. 2. Phenotypical Path diagram showing direct and indirect effect relationship among yield attributing traits

grain yield could be increased whenever there was an increase in characters that showed positive and significant association with seed yield. Hence, these characters could be considered as criteria for higher yield as these were mutually and directly associated with seed yield. Almost similar findings have been reported by [4-10].

The trait days to 50 percent flowering exhibited significant positive correlation with harvest index (r_p = 0.546, rg = 0.711) while it was significant negatively correlated with plant height (r_p=-0.431, r_g=-0.498), panicle length (r_p= -0.290, r_g=-0.522).it indicates that dyas to 50% flowering had positive correlation on yield via harvest index. Similar findings have been reported by [11,12].

The traits plant height showed significant positive correlation with panicle length (r_p=0.317, r_g=0.545) and 100 seed weight (r_p= 0.435, r_g = 0.476) on the other hand it was showed negatively significant with no of filled grain (r_p= -0.513, r_g = -0.587), spikelet fertility (r_p = -0.308, r_g = -0.617) and harvest index (r_p= -0.358, r_g= -0.495). Panicle length exhibited positively significant with traits like 100 seed weight (r_g= 0.395) followed by effective panicle per plant, biological yield (r_g= 0.342) and number of unfilled grain (r_g= 0.306). Effective tillers per plant showed positive correlation with traits like total tillers per plant (r_p=0.755), spikelet fertility (r_p= 0.313, r_g= 0.343), biological yield (r_g= 0.408), 100 seed weight (r_g=0.395). Similar findings have been reported by [13-15].

Total tillers plant exhibited significant negative correlation with traits like no of unfilled grain (r_p=-0.310, r_g= -0.350) and it showed significant positive correlation with traits like spikelet fertility (r_p= 0.408, r_g= 0.665) followed by no of filled grain (r_p= 0.317, r_g= 479), biological yield (r_p= 0.333, r_g= 443).Number of filled grain showed significant positive correlation with the traits like spikelet fertility (r_p= 0.548, r_g= 0.857), biological yield (r_p= 0.319, r_g= 0.328) and harvest index (r_p= 0.290, r_g = 0.424). While it was showed significant negative correlation with trait like number of unfilled grain (r_g= -0.401).Number of unfilled grain exhibited significant negative correlation with spikelet fertility (r_p= -0.473, r_g= -0.803).Spikelet fertility showed significant positive correlation with biological yield (r_p= 0.294, r_g= 0.451). Biological yield exhibited significant positive correlation with 100 seed weight (r_p= 0.522, r_g= 528). Harvest index showed significant negative correlation with 100 seed weight (r_p= -0.292, r_g= - 0.328). Similar findings have been reported by [16-19]. In this present investigation, the genotypic and phenotypic correlations coefficient were similar in directions, while in magnitude genotypic correlations were slightly higher than corresponding phenotypic correlations indicating absence of environmental effects that enhanced genetic inherent associations which is in agreement with the findings of [2], [20].

3.2 Path Coefficient Analysis

Among all traits, biological yield showed a positive direct effect on seed yield followed by spikelet fertility, harvest index, panicle length, Number of filled grain per panicle and Plant height (Table 2.). Indicating that selection for these characters are likely to bring about an overall improvement in grain yield directly. Similar results were also reported by [3,9,21] for biological yield [12, 2]. For harvest index. [19] for plant height [4]. For panicle length [22] for number of filled grains per panicle. Traits like effective tillers per plant, 100 seed weight, days to 50%flowering; total tillers per plant and number of unfilled grains per panicle were showed negative direct effect on seed yield.

The indirect effect of biological yield via days to 50%flowering, plant height, panicle length, nu of filled grain, no of unfilled grain were observed positive on seed yield. . The indirect effect of plant height via effective tillers per plant, total tillers per plant, number of filled grain, number of unfilled grain, 100 seed weight were found positive on seed yield. The indirect effect of panicle length showed on yield via days to 50%flowering, panicle length, biological yield were found positive. These results are in the agreement with the finding of [23,7,24].

4. CONCLUSION

This study investigated the correlations among yield and yield component traits in rice and assessed their direct and indirect effects on grain yield. The results revealed several significant associations between yield-related traits and seed yield. Traits such as effective tillers per plant, total tillers per plant, number of filled grains, spikelet fertility, biological yield, harvest index, and 100 seed weight showed positive correlations with seed yield. Additionally, path coefficient analysis identified biological yield as the trait with the highest direct effect on seed yield. These findings emphasize the importance

of considering multiple yield-contributing traits in rice breeding programs to enhance grain yield. By selecting superior cross combinations based on these traits, breeders can develop rice varieties with increased yield potential. Ultimately, this research contributes to the sustainable improvement of rice productivity and supports global food security efforts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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