International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(3): 329-332
www.biochemjournal.com
Received: 11-01-2024
Accepted: 15-02-2024

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Association analysis for yield and its contributing traits in rice (*Oryza sativa* L.)

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DOI: https://doi.org/10.33545/26174693.2024.v8.i3d.737

Abstract
The entitled research work "Association analysis for yield and its contributing traits in rice (*Oryza sativa* L.)" was executed Research cum Instructional Farm, Department of Genetics and Plant Breeding, IGKV Raipur (C.G.) during *kharif* 2021. The research material under research comprised of 50 rice germplasm lines including two checks namely Mahamaya and Rajeshwari, which were tested in RBD with two replications The observation of research investigation were recorded for total 8 characters *viz.* Days to 50% flowering, Number of tillers per plant, Panicle length (cm), Plant height (cm), 1000 seed weight (g), Grain yield per plant (g), Biological yield per plant (g), Harvest index (%). Positive significant correlation was showed Grain yield per plant with Number of tillers per plant, 1000seed weight, biological yield per plant. These characters would be beneficial for increasing yield and choosing superior genotypes among rice cultivars. Positive direct effect on Grain yield per plant showed by the Harvest index, biological yield per plant, Panicle length, Days to 50% flowering, Number of tillers per plant, 1000seed weight revealed true relationship between them and direct selection for these traits would be beneficial for increasing yield.

Keywords: Correlation, direct and indirect effect

Introduction
Rice (*Oryza sativa* L., 2n=24) belongs to family Poaceae and subfamily Oryzoidae. It is believed to be originated in South East Asia. "Rice is Life", the famous motto of the International Rice Year 2004, emphasised the importance of rice as a food and commerce commodity. India has the largest rice-growing area in the world, ranks second in production, with about 127.93 million tonnes in 2021-2022, after China. (Anonymous, 2022) [1]. In rice breeding programmes, yield increase is the primary breeding goal and recognizing of the type and degree of genetic variation influencing the inheritance of quantitative features like yield and yield components is critical for successful genetic improvement. Plant breeders frequently choose yield components that tangentially increase yield. Correlation coefficient analysis measures the mutual relationship between different plant characteristics and identifies the component characters on which selection can be based for genetic yield improvement. Correlation studies would offer trustworthy information regarding the nature, scope, and direction of the selection when choosing the best plant type, particularly when the breeder needs to combine high yield potentials with desirable agronomic traits and grain quality characters. According to Dewey and Lu (1959) [5], path analysis is a special type of multivariate statistical analysis, which has a linear correlation with each other and can separate direct and indirect effect towards crop yield.

Materials and Methods
The experimental materials included 50 rice genotypes including 48 germplasm and two checks namely Mahamaya and IGKVR1 (Rajeshwari). The experimental materials were received from germplasm section, Department of Genetics and Plant Breeding, IGKV, Raipur (C.G.). Genotypes of rice were evaluated at the Research cum Instructional Farm, Department of Genetics and Plant Breeding, College of Agriculture, IGKV, Raipur. The plant material of rice direct sowing on June 22, 2021 with 20x15cm spacing. The experimental material was planted in two replications in RBD design. Fertilizer was applied at a rate of 80N: 60P: 40K kg /ha. Half of the nitrogen dose, as well as full dose of phosphate

and potassium before of direct sowing. The remaining nitrogen was administrated in 2 stages, the 1st, at the start of tillering and the 2nd at the time of panicle initiation.

Table 1: List of Yield and its contributing traits

S. No.	Yield and its contributing traits
1	Days to 50% flowering
2	Numbers of tillers per plant
3	Plant height (cm)
4	Panicle length(cm)
5	1000 seed weight (g)
6	Grain yield per plant (g)
7	Biological yield per plant (g)
8	Harvest index (%)

Table 2: List of germplasm accessions used as experiment material and during *kharif season* 2021.

S.N.	CGR	Accession No.	Name Of Accession
1	CGR:5386	M : 63 II	MUNI BHOG
2	CGR:5390	M : 804	MUNI BHOG
3	CGR:5391	M : 812	MUNI BHOG
4	CGR:5392	P : 132	PARSADI BHOG
5	CGR:5393	P : 138	PARSADI BHOG
6	CGR:5396	R : 112 I	RAJ BHOG
7	CGR:5398	R : 69 II	RAM BHOG
8	CGR:5399	R : 173 II	RAM BHOG
9	CGR:5407	B : 678 II	BISHUN BHOG
10	CGR:5408	B : 1306	BISHUN BHOG
11	CGR:5411	B : 2247	BISUN BHOG
12	CGR:5413	V : 15 II	VISHNOO BHOG
13	CGR:5415	V : 15 III	VISHNOO BHOG
14	CGR:5419	V : 34	VISHNU BHOG
15	CGR:5439	B : 1443 II	BAHRA SINKI
16	CGR:5443	B : 329 I	BAIGANI
17	CGR:5447	B : 226 II	BAIKUNA
18	CGR:5448	B : 304 I	BAIKONI
19	CGR:5449	B : 304 II	BAIKONI
20	CGR:5451	B : 476	BAIKONI
21	CGR:5452	B : 532	BAIKONI
22	CGR:5455	B : 580	BHUJANIN
23	CGR:5456	B : 1062	BAIKONI
24	CGR:5457	B : 1095 I	BAIKONI
25	CGR:5459	B : 1095 III	BAIKONI
26	CGR:5460	B : 1101 I	BAIKONI
27	CGR:5463	B : 1186 VI	BAIKONI
28	CGR:5464	B : 1193 I	BAIKONI
29	CGR:5466	B : 1227	BAIKONI
30	CGR:5472	B : 1590	BAIKONI
31	CGR:5474	B : 1914 I	BAIKONI
32	CGR:5475	B : 1955	BAIKONI
33	CGR:5477	B : 2003	BAIKONI
34	CGR:5478	B : 2906	BAIKONI
35	CGR:5481	B : 2916	BAIKONI
36	CGR:5482	B : 1547	BADE BAIKONI
37	CGR:5484	B : 1986	BAIHA BAIKONI
38	CGR:5485	B : 1988	BAIHA BAIKONI
39	CGR:5487	B : 1998	BAIHA BAIKONI
40	CGR:5491	B : 1192	BAIKUNI
41	CGR:5492	B : 1943	BAIKUNI
42	CGR:5493	B : 2708	BAIKUNI
43	CGR:5501	B : 1553 II	BAJRANG BALI
44	CGR:5505	B : 2004	BAKAI
45	CGR:5506	B : 2263	BAKAI
46	CGR:5508	B : 1239	BAKAL
47	CGR:5518	B : 435 I	BAL KESHAR
48	CGR:5519	B : 1883	BAL KESHAR
49	-	-	MAHAMAYA
50	-	-	RAJESHWARI

Statistical Analysis

The experimental data were produced by taking the mean value over 2 replications of randomly selected plants and subjected to the following statistical analysis-

1. Correlation coefficient analysis

Correlation coefficient measures the mutual relationship between various characters.

Formula for calculation of correlation coefficient is given below by Miller *et al.* (1958) [8].

$$Rxy = \frac{CO\ xy}{\sqrt{Var}x.vary}$$

Where,

rxy = Coefficient of correlation between x and y traits.

COxy = Covariance between x and y traits

Varx = Variance of x trait

Vary = Variance of y trait

Correlation coefficient were used tested for significance using t statistics at (n-2) degrees of freedom as given below-

$$T_c = |r| \sqrt{n-2} / \sqrt{1-r^2}$$

2. Path coefficient analysis

Path coefficient analysis refers to the standardized partial regression coefficient, which splits the correlation coefficient into the measures of direct and indirect effects and measured the direct and indirect contribution of each independent variable on the dependent variable.

The concept was originated by Wright in 1921 [15], but this technique was first used for plant selection by Dewey and Lu in 1959 [5].

Results and Discussion

Correlation coefficient analysis

1. Days to 50 % flowering

Days to 50 % flowering is positive significantly correlated with plant height and negative significantly correlated with harvest index at both genotypic and phenotypic level. Similar findings were reported by Lingaiah *et al.* (2022) [7] and Sudeepthi *et al.* (2020) [14].

2. Number of tillers per plant

Number of tillers per plant is positive significantly correlated with biological yield per plant and negative significantly correlated with plant height at both genotypic and phenotypic level.

3. Plant height (cm)

Plant height is negative significantly correlated with harvest index at both genotypic and phenotypic level and positive significantly correlated with panicle length at only phenotypic level. Similar results have been reported by Muthuramu and Rangavan (2020) [9] for plant height with harvest index.

4. Panicle length (cm)

Panicle length is positive significantly correlated with 1000 seed weight only genotypic level. Similar results have been reported by Begum *et al.* (2021) [3].

5. 1000 seed weight (g)

1000 seed weight is positive significantly correlated with at biological yield per plant at both genotypic level and phenotypic level.

7. Biological yield per plant (g)

Biological yield per plant is positive significantly correlated with panicle length at both genotypic and phenotypic level.

8. Harvest index (%)

Harvest index is negative significantly correlated with panicle length and positive correlated with number of tillers per plant at only genotypic level.

Grain yield per plant is positive significant correlated with number of tillers per plant, 1000 seed weight, biological yield per plant, harvest index and negative significant correlated with plant height at both genotypic and phenotypic level. At only genotypic level grain yield is positive significant correlated with panicle length whereas negative significant with days to 50 % flowering. Similar results were reported by Prasad *et al.* (2017) [11].

The traits days to 50 % flowering and plant height showed significant negative correlation with grain yield per plant and indicated that if plant is taller and maturity is late then yield of plant would be reduced and hence selection of genotypes for high yielding would be from short or dwarf heighted and maturity wouldn't be so late. This was in accordance with Barhate *et al*. (2021) [2] and Prasad *et al.* (2017) [11].

Table 3: Genotypic and phenotypic correlation coefficient of various yield and its contributing traits

Characters		Days to 50% flowering	Number of tillers per plant	Plant height	Panicle length	1000 seed weight	Biological yield per plant	Harvest index
Number of tillers per plant	G	-0.149						
	P	0.131						
Plant height	G	0.652**	-0.384**					
	P	0.519**	-0.247*					
Panicle length	G	0.085	0.175	0.190				
	P	0.026	0.103	0.285**				
1000 seed weight	G	0.086	0.013	0.184	0.261**			
	P	0.056	-0.004	0.116	0.053			
Biological yield per plant	G	0.074	0.520**	0.094	0.493**	0.224*		
	P	0.084	0.400**	0.073	0.210*	0.210*		
Harvest index	G	-0.352**	0.231*	-0.473**	-0.207*	0.162	-0.121	
	P	-0.330**	0.192	-0.345**	-0.044	0.130	-0.122	
Grain yield per plant	G	-0.199*	0.593**	-0.315**	0.269**	0.285**	0.669**	0.648**
	P	-0.163	0.465**	-0.226*	0.151	0.254*	0.697**	0.607**

Path coefficient analysis

In present research work grain yield per plant was dependent variable and days to 50 % flowering, numbers of tillers per plant, plant height, panicle length, 1000 seed weight, biological yield per plant and harvest index were taken as independent variables for analyzing path coefficient. The direct and indirect effects of yield and yield attributing traits were estimated by path coefficient analysis are presented in table 2. A residual effect of 0.02135 indicates high contribution towards variability in single plant yield by the characters chosen for study. As residual effect determines how best the casual factors account for the variability of the dependent variable.

Path Coefficient analysis revealed that the highest positive direct effects on grain yield per plant were observed through harvest index (0.7114) followed by biological yield per plant (0.7102). Both of these characters showed high positive direct effects on grain yield and hence these traits should be taken into consideration in selecting for yield among the genotypes studied. The direct effects of days to 50 % flowering, numbers of tillers per plant, plant height, panicle length and 1000 seed weight were observed to be negligible, but the characters plant height, panicle length and 1000 seed weight showed significant positive correlation with grain yield per plant via indirect effects. This was in accordance with Noatia *et al.* (2021) [10].

Similar results were reported by Sreedhar *et al.* (2019) [13] and Prasad *et al.* (2017) [11] for days to 50 % flowering, plant height and 1000 seed weight, by Begum *et al.* (2021) [3] for days to 50 % flowering, plant height, panicle length, 1000 seed weight, by Pravalika *et al.* (2021) [12] for biological yield per plant and harvest index, by Kumar *et al.* (2020) [6] for number of tillers per plant, plant height and 1000 seed weight, by Sudeepthi *et al.* (2020) [14] and Bhor *et al.* (2020) [4] for days to 50 % flowering, number of tillers per plant, panicle length, 1000 seed weight, by Barhate *et al.* (2021) [2] for plant height, panicle length, 1000 seed weight and harvest index.

Table 4: Path analysis (Direct and indirect effect) of various yield and its contributing traits of 50 genotypes

	1	2	3	4	5	6	7	GCC of GYPP
1	0.0490	-0.0034	-0.0534	0.0061	0.0002	0.0528	-0.2502	-0.199*
2	-0.0072	0.0232	0.0314	0.0126	0.00003	0.3692	0.1640	0.593**
3	0.0319	-0.0089	-0.0819	0.0137	0.0004	0.0664	-0.3365	-0.315**
4	0.0041	0.0040	-0.0155	0.0724	0.0006	0.3502	-0.1470	0.269**
5	0.0042	0.0003	-0.0151	0.0189	0.0024	0.1591	0.1149	0.285**
6	0.0036	0.0120	-0.0077	0.0357	0.0005	0.7102	-0.0858	0.669**
7	-0.0172	0.0053	0.0387	-0.0149	0.0003	-0.0856	0.7114	0.648**

Residual effect 0.0213

1-Days to 50 % flowering, 2-Number of tillers per plant, 3-Plant height, 4-Panicle length,5-1000 seed weight, 6-Biological yield per plant,7-Harvest index, GCC of GNPP-Genotypic correlation coefficient of grain yield per plant.

Summary
Number of tillers per plant, 1000 seed weight, biological yield per plant and harvest index are positive significantly correlated with grain yield per plant at both phenotypic and genotypic level among yield and its contributing traits.
Path analysis revealed that positive direct effect on grain yield per plant showed by the harvest index, biological yield per plant, panicle length, days to 50 % flowering, number of tillers per plant and 1000 seed weight among yield and its contributing traits.

Conclusion

- If the correlation value is significant, the association between the two characters is high. Grain yield per plant is positive significantly correlated with number of tillers per plant, 1000 seed weight, biological yield per plant and harvest index. These characters would be rewarding for grain yield improvement and selection of superior genotypes from the rice cultivars.
- Positive direct effect on grain yield per plant showed by the harvest index, biological yield per plant, panicle length, days to 50% flowering, number of tillers per plant, 1000 seed weight revealed true relationship between them and direct selection for these characters would be rewarding for yield improvement.

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