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Character association and path coefficient analysis for rice (*Oryza sativa* L.) yield and component characteristics

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Abstract
Study evaluating fifty-five genotypes was conducted at the Instructional Cum Research Farm, Department of Genetics and Plant breeding, IGKV, Raipur, Chhattisgarh, with the goal of determining the degree of relationship between yield and its constituent characteristics, as well as their direct and indirect impacts on grain yield in narrow grain rice. According to the findings of the correlation studies, there is a positive correlation between Days to 50 percent flowering and plant height, leaf length, harvest index, leaf width, flag leaf length, plant height, total number of tillers per plant, and panicle length. The highest positive and direct benefits are produced by grain yield per plant, which is followed by harvest index, total tillers, leaf length, days to 50 percent flower, and grain length. Days to fifty percent flower have negative indirect effects through total number of effective tillers, leaf length, leaf width, and grain L/B ratio. Panicle length showed positive correlation with grain yield per plant due to indirect effects of days to 50 percent flowering, leaf width, total number of tillers, harvest index, 100 seed weight, grain length, grain width, harvest index, and grain L/B ration.

Keywords: Correlation, path coefficient, grain yield, characters and genotypes

Introduction
Rice is the world's second most significant cereal crop and the staple diet of more than two-thirds of India's population. Rice (*Oryza sativa* L.) belongs to the poaceae family. Grown in 115 countries around the world. Approximately 90 percent of world's rice area is covered by Asian continent. It occupies second position in cereal cultivation around the world and important position in India's economy as an export item. Worldwide, the rice is grown on an area of 165.25million hectares, with the production of 503.27 million metric tons (Anonymous, 2021) [12]. In India, total production of rice is 124 million metric tons with productivity of 2.8 thousand kg ha^{-1} (Anonymous, 2019) [11]. Chhattisgarh, also known as the "Rice Bowl of India," has an area under rice of 3.61 million ha, a production of 7 million MT, and a state productivity ranging from 1.2 to 1.6 q ha^{-1} (Anonymous, 2021) [12]. With an annual rainfall of 1200-1600 mm, the state is fully dependent on the monsoon. Rice is mostly grown in the irrigated regions ecosystem of Chhattisgarh, which spans around 74, 97, and 95 percent of the Chhattisgarh plain, Bastar plateau, and Northern hill zones, respectively. The rich biodiversity of rice in Chhattisgarh is evidence to this fact that rice is still grown as the main crop in Chhattisgarh. Governments struggle to maintain the food security of their citizens as a result of the expanding population. In order to satisfy increasing demand, a specific amount of capital goes every year to research aimed at raising the yield and quality of rice. According to the most recent study on rice yield enhancement, the yield increase is now on a downward trend and is expected to plateau shortly. In order to use it in planned future hybridization, plant breeders must investigate and assess a large amount of germplasm to understand the relationship between yield and its component traits. Association analysis is a technique used to evaluate the association of both morphological characters and genetic variability, further referred to as association mapping or association disequilibrium. Grain yield is a complex character and is correlated with number of yield components which are correlated to each other. Information of character association and how each trait has significantly affected yield, will be an added advantage in the selection process. The path coefficient analysis paints a clear picture of each component character's direct and indirect influence on yield. It is critical to understand the link between component characteristics and yield.

Plant breeders benefit from this in the selection process.

Materials and Methods

The current study included fifty-five elite breeding lines from the Station Yield Trial - Grain rice experimental materials, as well as five existing check varieties. *viz*., Dagad Desi, RRF-127, RRF-140, DRR-42, and MTU-1010. These fifty rice germplasm accessions were taken from germplasm section, Genetics and Plant Breeding Department, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (CG). During Kharif 2021, the experiment was carried out with three replications utilizing a Randomized Block Design. The field experiment was managed using a transplanted irrigation system. The plant was shown direct on June 22, 2021.Plantlets were planted in the field using a randomized block design with three replications inKharif-2021.The check varieties were randomized in blocks. Fertilizer was applied @ of 80 N: 50 P: 30 K kg ha^{-1}. The complete potassium, phosphorus, and half dose nitrogen were used as the basal dose before transplanting. The other half of the nitrogen was divided into two doses; the first was applied at the start of the tillering stage and the second in the following week. Crop production was carried out using conventional agronomic methods. When crop was harvested, a specific set of procedures was suggested. Documentation of observations of correlation and path analysis was done for the following characters i.e., days to 50 percent flowering, plant height, flag leaf length, effective tillers plant^{-1}, total number of tillers plant^{-1}, leaf length, leaf width, panicle length, grain yield plant^{1}, biological yield plant^{-1}, harvest Index, grain length, grain width, LB ratio, 100 seed weight.

Results and Discussion

Because yield is a complicated variable that is linked with many other characteristics and significantly influenced by the environment, selecting just on yield can frequently result in suboptimal progress in isolating improved genotypes (Madhubabu *et al*. 2017) [15]. Therefore, in order to improve yield, plant breeders must use indirect selections through component traits. Studies on character association give an understanding of the nature and purpose of selection, assisting plant breeders in developing an effective selection strategy to achieve an affordable and dependable balance between diverse qualities.

In this study, an effort has been made to quantify the degree of character association in order to choose genotypes where a balanced combination of traits correlates to higher yield. Table 1 shows the extent and kind of character associations at the genotypic and phenotypic levels. Correlation analysis is a crucial method for breeding programs because it shows how different features are related to one another and identifies the traits that should be given greater significance when selecting for genetic grain production enhancement. Plant height (0.426**), leaf length (0.275*), and flag leaf length (0.381**) were found to positively and significantly correlate with days to 50 percent flowering.

Total number of tillers per plant showed significant positive correlation with number of effective tillers plant^{-1} (0.853**), biological yield plant^{-1} (0.778*), grain yield plant^{-1} (0.740**). The present analysis revealed that the traits number of effective tillers plant^{-1} (0.691**), panicle length (0.300*), total number of tillers biological yield (0.740**), Grain L/B ratio (0.489**) and biological yield plant^{-1} (0.847**) had a positive relationship with grain yield plant^{-1}. However, traits days to 50 percent flowering (-0.644**) and plant height (-0.658**) showed negative association with grain yield per plant, suggesting direct selection for these traits will produce undesirable results. To improve yield, selection criteria should be based on number of effective tillers plant^{-1}, panicle length, total number of tillers biological yield, Grain L/B ratio and biological yield plant^{-1}.

The path coefficient values of all the traits are presented in the Table 2. Grain yield per plant has high positive and direct effects with harvest index (0.50586), biological yield plant^{-1} (0.9635), leaf length (0.1137), days to fifty percent flower (0.05453), and grain length. Days to 50 percent flower has negative direct effects through total number of effective tillers, Flag leaf length, panicle length, and grain L/B ration. Naik *et al*. (2021) found that biological yield per plant showed positive correlation with grain yield per plant due to its indirect positive flag leaf length, plant height, total number of tillers, 100 seed weight, grain length, grain width, harvest index, and grain L/B ration. Harvest index showed positive correlation with the with grain yield due to its indirect positive effects. 100 seed weight showed negative significant correlation with the with grain yield due to its indirect negative effect of leaf length, plant height, total number of tillers, panicle length, total number of effective tillers, biological yield, harvest index, and grain LB ratio.

Table 1: Correlation coefficient analysis of yield traits in fifty-five genotypes of rice

	DTF	LL	LW	FLL	PH	PL	TNOT	NOET	BY	GY	HI	100 SW	GL	GB	L/B
DTF	1														
LL	0.275*	1													
LW	0.086	0.184	1												
FLL	0.381**	0.754**	0.101	1											
PH	0.426**	0.102	0.035	0.125	1										
PL	-0.418**	0.066	-0.246	0.128	-0.101	1									
TNOT	-0.437**	-0.044	-0.032	0.106	-0.666**	0.228	1								
NOET	-0.372**	0.012	-0.003	0.102	-0.699**	0.213	0.853**	1							
BY	-0.594**	-0.233	-0.199	-0.173	-0.505**	0.344**	0.778**	0.720**	1						
GY	-0.644**	-0.039	-0.239	-0.11	-0.658**	0.300*	0.740**	0.691**	0.847**	1					
HI	-0.065	0.374**	-0.125	0.224	-0.136	-0.025	-0.174	-0.108	-0.344**	0.175	1				
100 SW	0.169	-0.12	0.055	-0.104	0.636**	0.026	-0.462**	-0.566**	-0.426**	-0.507**	-0.072	1			
GL	-0.400**	-0.169	-0.249	-0.222	-0.015	0.149	0.127	0.047	0.242	0.295*	0.105	0.222	1		
GB	0.171	-0.226	0.148	-0.055	0.474**	-0.155	-0.416**	-0.450**	-0.451**	-0.593**	-0.164	0.505**	-0.037	1	
L/B	-0.348**	0.127	-0.267*	-0.052	-0.403**	0.209	0.410**	0.393**	0.489**	0.637**	0.195	-0.314*	0.537**	-0.849**	1

Table 2: Path coefficient analysis - Direct and Indirect effects of yield attributing traits

	DTF	LL	LW	FLL	PH	PL	TNOT	TNOET	BY	HI	SI	GL	GW	L/B	Correlation with yield
DTF	0.0545	0.0312	0.0013	-0.0604	-0.0360	0.0012	-0.0717	0.0455	-0.5720	-0.0331	-0.0010	-0.0137	-0.0112	0.0213	-0.644**
LL	0.0150	0.1137	0.0028	-0.1194	-0.0087	-0.0002	-0.0073	-0.0015	-0.2242	0.1891	0.0007	-0.0058	0.0147	-0.0078	-0.039NS
LW	0.0047	0.0209	0.0154	-0.0159	-0.0029	0.0007	-0.0052	0.0003	-0.1916	-0.0633	-0.0003	-0.0085	-0.0097	0.0163	-0.239NS
FLL	0.0208	0.0858	0.0016	-0.1584	-0.0106	-0.0004	0.0173	-0.0125	-0.1667	0.1131	0.0006	-0.0076	0.0036	0.0032	-0.110NS
PH	0.0232	0.0117	0.0005	-0.0198	-0.0846	0.0003	-0.1093	0.0854	-0.4863	-0.0688	-0.0037	-0.0005	-0.0309	0.0246	-0.658**
PL	-0.0228	0.0075	-0.0038	-0.0203	0.0085	-0.0028	0.0374	-0.0260	0.3319	-0.0124	-0.0002	0.0051	0.0101	-0.0127	0.300*
TNOT	-0.0238	-0.0050	-0.0005	-0.0167	0.0563	-0.0006	0.1640	-0.1043	0.7498	-0.0881	0.0027	0.0043	0.0271	-0.0250	0.740**
TNOET	-0.0203	0.0014	0.0000	-0.0162	0.0591	-0.0006	0.1399	-0.1222	0.6942	-0.0547	0.0033	0.0016	0.0293	-0.0240	0.691**
BY	-0.0324	-0.0265	-0.0031	0.0274	0.0427	-0.0010	0.1276	-0.0880	0.9636	-0.1739	0.0025	0.0083	0.0294	-0.0298	0.847**
HI	-0.0036	0.0425	-0.0019	-0.0354	0.0115	0.0001	-0.0286	0.0132	-0.3312	0.5059	0.0004	0.0036	0.0107	-0.0119	0.175NS
SI	0.0092	-0.0137	0.0009	0.0165	-0.0538	-0.0001	-0.0757	0.0692	-0.4108	-0.0366	-0.0058	0.0076	-0.0329	0.0191	-0.507**
GL	-0.0218	-0.0193	-0.0038	0.0352	0.0013	-0.0004	0.0208	-0.0058	0.2333	0.0534	-0.0013	0.0341	0.0024	-0.0327	0.295*
GW	0.0093	-0.0257	0.0023	0.0087	-0.0401	0.0004	-0.0682	0.0549	-0.4346	-0.0827	-0.0029	-0.0013	-0.0652	0.0518	-0.593**
L/B	-0.0190	0.0145	-0.0041	0.0082	0.0341	-0.0006	0.0672	-0.0480	0.4708	0.0988	0.0018	0.0183	0.0554	-0.0610	0.637**

Residual are 0.01645

DTF = Days to flowering; LL = Leaf Length; LW= Leaf Width; FLL = Flag leaf Length (cm) PH = plant height (cm); PL = Panicle Length (cm); TNT = Total number of tillers plant^{-1}; NOET = Number of effective tillers plant^{-1}; BY= Biological yield (gm); GY = Grain yield plant^{-1} (gm); SW = 100 seed weight (gm) GL = Grain Length (mm); GB = Grain breadth (mm); L/B ratio = Grain L/B ratio.

Conclusion

Plant breeders should use indirect selections through component traits to improve yield, as yield is a complex variable influenced by environment. Character association studies help develop effective strategies for balancing diverse qualities. This study quantifies character association to select genotypes with higher yield. Correlation analysis helps identify traits for genetic grain production enhancement. Results show plant height, leaf length, and flag leaf length positively correlate with days to 50% flowering and also found a positive correlation between the number of tillers per plant and the number of effective tillers, biological yield, and grain yield. However, traits like days to 50% flowering and plant height showed negative associations, suggesting that selection criteria should focus on these factors. Path coefficient values shows days to 50% flower has negative effects through total number of effective tillers, flag leaf length, panicle length, and grain L/B ration. Biological yield has a positive correlation with grain yield, while harvest index has a negative correlation.

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