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Association Study and Direct - Indirect Effects of Characters for Yield 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

The results indicated that the seed yield per plant showed a significant positive correlation with most of the traits like days to 50% flowering, plant height, filled grains per panicle, number of grains per panicle, spikelet fertility, flag leaf width, numbers of tillers per plant, number of effective tillers per plant, panicle length and 100 seed weight, representing the importance of these traits for development of great yielding varieties in contrast the trait spikelet sterility has been reported negative and significant association with yield trait and unfilled grains per panicle and flag leaf length reported a negative non-significant correlation with yield. Path coefficient analysis results showed that the direct positive effect on yield was recorded by the traits, effective tillers per plant, 100 seed weight, Number of grains per panicle, and most of the traits.

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1. INTRODUCTION

"Rice (*Oryza sativa*) is the most important cereal crop in the developing world and is the staple food of over half the world's population. The genus *Oryza* originated in the Gondwanaland continents" [1]. India ranks first in rice area and second in rice production, after China. Asian countries produce 89 % of word's rice and 50% of the people of the world depends on rice as major food (FAO, 2016). Since the Vedic period, rice has influenced the religions, traditions, culture, and life style of a large number of people on Earth. The cultivation of rice is practiced under more diverse conditions than any other food crop, ranging from irrigated (lowland), rainfed, and upland, to deep waterlogged conditions. "The rice, however,compares favorably with other cereals in amino acid content. The biological value of its protein is high. The fat content of rice is low (2.0 to 2.5 percent) and much of the fat is lost during milling. Rice contains a low percentage of calcium. Rice grain contains as many B group vitamins as wheat. Milled rice loses valuable proteins, vitamins and minerals in the milling process during which the embryo and the aleuronic layer are removed. Much of the loss of nutrients can be avoided through the parboiling process" [2]. "Information on the association of characters, direct and indirect effects contributed by each character towards yield will be an added advantage in aiding the selection process. Correlation and path analysis establish the extent of association between yield and its components and also bring out the relative importance of their direct and indirect effects, thus giving an obvious understanding of their association with grain yield" [3]. "Ultimately, this kind of analysis could help the breeder to design his selection strategies to improve grain yield" [4]. The present study aimed to highlights direct - indirect effects of characters for yield in rice (*Oryza sativa* L.).

2. MATERIALS AND METHODS

The experimental material consists of 120 rice germplasm accessions along with five checks *viz*. Poornima, Mahamaya, Swarna, Indira Sugandhit Dhan-1 and Indira Aerobic Dhan-1. The criteria for the selection of checks were the habits of heat tolerance and their yielding ability under diverse climatic conditions. The germplasm accessions were screened for heat tolerance and ratooning under natural conditions. The 120 rice germplasm and five checks used in the present investigation were obtained from the germplasm unit of IGKV, Raipur. The simple correlations (r) between different characters at phenotypic (p) and genotypic (g) levels were worked out as suggested by Searle (1961). Path coefficient analysis was carried out according to Dewey and Lu [5].

3. RESULTS AND DISCUSSION

In general, genotypic correlations were higher than phenotypic ones in magnitude for all the characters. The characters which showed negative correlation at genotypic level also showed a negative correlation at the genotypic level also showed a negative correlation at the phenotypic level. The correlation coefficient results show that the traits *viz*. days to 50% flowering, plant height, filled grains per panicle, number of grains per panicle, spikelet fertility, flag leaf width, numbers of tillers per plant, number of effective tillers per plant, panicle length and 100 seed weight has a significant positive association with seed yield per plant representing the importance of these traits for development of great yielding varieties in rice. This type of significant positive association of traits with yield is also reported by some researchers in last decades [6-8]. The trait spikelet sterility has been reported negative and significant association with yield trait, whereas the traits unfilled grains per panicle and flag leaf length reported a negative non-significant correlation with a yield which is similar to the findings of Ullah et al. [9]. Based on the present findings, the plant breeder can be encouraged to development of high yielding cultivars by making the selection of a higher number of filled grain per panicle with a reasonable balance for moderate plant height, moderate days to 50% flowering, a higher number of grains per panicle and higher number of effective tillers per plant. Similar findings were reported by Akinwale et al. [10], Jeke et al. [11] and Manivelan et al. [12].

The results of path coefficient analysis depicted that the traits *viz*. spikelet fertility (11.02), spikelet sterility (11.00), number of grains per panicle (1.75), number of effective tillers per plant (0.45), 100 seed weight (0.38), days to 50% flowering (0.30), flag leaf length (0.05), plant height (0.47), flag leaf width (0.41) and panicle length (0.21)

Table 1. Correlation coefficient between yield and yield contributing traits

Traits	D50	PH	FG	UG	NG	SF	SS	FLL	FLW	NT	NE	PL	100S	SY
D50	1.000													
PH	0.520**	1.000												
FG	0.610**	0.430**	1.000											
UG	0.130*	0.389**	0.266**	1.000										
NG	0.547**	0.508**	0.918**	0.626**	1.000									
SF	0.099^{NS}	-0.175**	0.239**	-0.806**	-0.137*	1.000								
SS	-0.099^{NS}	0.175**	-0.239**	0.806**	0.137*	-1.000**	1.000							
FLL	-0.266**	0.011^{NS}	-0.201**	-0.004^{NS}	-0.165**	-0.112^{NS}	0.112^{NS}	1.000						
FLW	0.228**	0.437**	0.232**	0.215**	0.276^{NS}	-0.072^{NS}	0.072^{NS}	0.083^{NS}	1.000					
NT	-0.008^{NS}	-0.214**	0.007^{NS}	-0.134*	-0.049^{NS}	0.094^{NS}	-0.094^{NS}	-0.167**	-0.190**	1.000				
NE	-0.035^{NS}	-0.269**	-0.024^{NS}	-0.177**	-0.092^{NS}	0.130*	-0.130*	-0.165**	-0.196**	0.978**	1.000			
PL	0.118^{NS}	0.609**	0.359**	0.406**	0.457**	-0.168**	0.167**	-0.031^{NS}	0.349**	-0.264**	-0.295**	1.000		
100S	-0.153*	-0.249**	-0.208**	-0.442**	-0.350**	0.304**	-0.304**	0.204**	-0.090^{NS}	-0.070^{NS}	-0.038^{NS}	-0.254**	1.000	
SY	0.460**	0.280**	0.484**	-0.062^{NS}	0.367**	0.271**	-0.271**	-0.063^{NS}	0.178**	0.172**	0.174**	0.191**	0.239**	1.000

Here, D50 = days to 50% flowering, PH = plant height, FG = filled grains per panicle, UG = unfilled grains per panicle, NG = number of grains per panicle, SF = spikelet fertility, SS = spikelet sterility, FLL = flag leaf length, FLW = flag leaf width, NT = numbers of tillers per plant, NE = number of effective tillers per plant, PL = panicle length, 100S = 100 seed weight and SY = seed yield per plant

Table 2. Path coefficient of yield contributing traits on seed yield of rice germplasm accessions

Traits	D50	PH	FG	UG	NG	SF	SS	FLL	FLW	NT	NE	PL	100S	Correlation With SY
D50	**0.30759**	0.02453	-0.68164	-0.10070	0.95941	1.09701	-1.09346	-0.01445	0.00946	0.00134	-0.01579	0.02564	-0.05878	**0.460**
PH	0.16004	**0.04714**	-0.48107	-0.30022	0.89102	-1.92874	1.92287	0.00059	0.01809	0.03568	-0.12135	0.13170	-0.09595	**0.280**
FG	0.18754	0.02029	**-1.11800**	-0.20510	1.61088	2.64040	-2.63596	-0.01093	0.00961	-0.00123	-0.01063	0.07772	-0.08014	**0.484**
UG	0.04012	0.01833	-0.29701	**-0.77203**	1.09778	-8.89089	8.87327	-0.00024	0.00891	0.02243	-0.07992	0.08777	-0.17012	**-0.062**
NG	0.16822	0.02394	-1.02658	-0.48310	**1.75433**	-1.51610	1.51245	-0.00894	0.01144	0.00821	-0.04144	0.09894	-0.13472	**0.367**
SF	0.03060	-0.00825	-0.26770	0.62246	-0.24120	**11.02726**	-11.00658	-0.00607	-0.00297	-0.01568	0.05882	-0.03625	0.11696	**0.271**
SS	-0.03056	0.00824	0.26775	-0.62239	0.24107	-11.02724	**11.00661**	0.00606	0.00297	0.01568	-0.05885	0.03624	-0.11698	**-0.271**
FLL	-0.08186	0.00051	0.22504	0.00343	-0.28891	-1.23349	1.22904	**0.05431**	0.00344	0.02781	-0.07433	-0.00668	0.07844	**-0.063**
FLW	0.07019	0.02058	-0.25930	-0.16593	0.48411	-0.79060	0.78860	0.00451	**0.04145**	0.03168	-0.08834	0.07561	-0.03454	**0.178**
NT	-0.00248	-0.01007	-0.00827	0.10368	-0.08629	1.03505	-1.03359	-0.00904	-0.00786	**-0.16701**	0.44177	-0.05716	-0.02709	**0.172**
NE	-0.01075	-0.01266	0.02631	0.13657	-0.16089	1.43555	-1.43355	-0.00893	-0.00811	-0.16330	**0.45181**	-0.06376	-0.01450	**0.174**
PL	0.03645	0.02869	-0.40151	-0.31312	0.80206	-1.84729	1.84333	-0.00168	0.01448	0.04412	-0.13311	**0.21641**	-0.09781	**0.191**
100S	-0.04699	-0.01176	0.23286	0.34136	-0.61430	3.35214	-3.34658	0.01107	-0.00372	0.01176	-0.01702	-0.05502	**0.38475**	**0.239**
Residual effect: 0.50359														

Note: Bold diagonal figures indicate the direct effect

Here,D50 = days to 50% flowering, PH = plant height, FG = filled grains per panicle, UG = unfilled grains per panicle, NG = number of grains per panicle, SF = spikelet fertility, SS = spikelet sterility, FLL = flag leaf length, FLW = flag leaf width, NT = numbers of tillers per plant, NE = number of effective tillers per plant, PL = panicle length, 100S = 100 seed weight and SY = seed yield per plant

are the main contributors to yield because these traits have a direct positive effect on yield. In the past studies also found that spikelet fertility had a positive direct effect on yield followed by the number of grains per panicle [13]. The traits such as number of effective tillers per plant, days to 50% flowering, and plant height have a positive direct effect on yield [14]. Based on the basis of path coefficient analysis the residual effect was 0.50 representing the contribution of component traits on yield. Hence, we can say that the contribution of component traits (fourteen traits studied) is 50% on yield and the 50% contribution came from the traits which are not studied in path coefficient analysis. Similar findings were reported by Williams et al. [15] and Reetisana et al. [16].

4. CONCLUSION

It is concluded that genotypic correlations were higher than phenotypic ones in magnitude for all the characters. The characters which showed negative correlation at genotypic level also showed a negative correlation at the genotypic level also showed a negative correlation at the phenotypic level.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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