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Correlation and path analysis for yield and attributing traits in rice (*Oryza sativa* L.)

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Abstract
An experiment was conducted in the field of department of molecular biology and biotechnology comprising of 46 lines of crosses Swarna x IBD-1, yield data were recorded on each lines and data were subjected to statistical analysis to estimate correlation and path analysis, which result revealed that significant differences present among genotypes for various yield attributing traits. Here we found that number of tillers, total number of spikelet's, panicle length, thousand grain weight, biological yield per plant and harvest index were significantly associated with grain yield and also showed positive direct effect toward yield, hence these traits can be used for yield enhancement.

Keywords: Rice, yield attributing traits, path coefficient, genetic variability

Introduction
Rice is a self- pollinated crop and belongs to the genus Oryza, tribe Oryzeae in the grass family Poaceae (Graminaeae). Rice is the world's second most important cereal crop following only corn. Asia having the largest area of rice. Rice is the most important cereal crop that has been referred as "Global food as it is cultivated worldwide as its use as prime staple food in about 100 countries of the world. To meet the demand of increasing human population, agriculture sector will need to produce almost 50% more food and biofuels till 2050. The FAO (2017) [6] estimated that the world population would reach 9.73 billion in 2050 (Anon., 2017) [2] Hence it is important to produce rice in more quantity to full fill the growing demand of continuously increasing population. Rice is the most prominent crop of India as it is the staple food for most of the people of country. This crop is the back bone of livelihood for millions of the rural households and plays vital role in the country's food security, so the term "Rice is life" is right in Indian context (Mahajan *et al*., 2017) [9]. Rice is rich source of various important minerals which is helpful in digestion. The edible rice contains carbohydrates, 2 protein, fat, potassium, beside its rice is a rich source of iron, zinc and calcium. Average daily intake of rice provides 20-80 per cent of dietary energy and 12-17 per cent of dietary protein for Asians. Compelled by the realization that there was no alternative to full fill the population (Chopra, 2001) [4].
By keeping in view demand of rice it become important to increasing the production of rice there is also need to further increase rice productivity because land area under rice cultivation is continuously reducing. Breeding strategies for developing the hybrids with high yield potential and better grain quality requires the expected level of heterosis and combining ability. In breeding for high yield crop plants, the breeders often face with the problem of selecting parents and crosses. Some breeding strategies are there like variability parameters, path analysis and correlation analysis for selecting best lines for better production and for selecting desirable parents and crosses for the exploitation of heterosis (Faiz *et al*., 2006) [5].
Many diverse genotypes or farmers varieties are still cultivating by the farmers of the state due to their extra ordinary quality but yield potentials of these traditional rice varieties are very low. Therefore, it is essential to evaluate diverse genotypes or farmers varieties to develop some promising lines. In this paper our focus is adopting some breeding strategies to determine which trait is more helpful toward high yielding for this purpose we used path analysis and variability parameters. This work can help our scientists in developing varieties with high yielding ability by improving contributing traits.

Material and Method

Experimental Location: The experiment was performed in the field of the Department of Plant Molecular Biology and Biotechnology, IGKV, Raipur,

Experimental Material: This experiment was conducted by choosing 46 individual lines of F_5 generation of previous selected genotypes namely Swarna and IBD-1. These two genotypes (Swarna and IBD-1) were selected on the basis of previous performance, as Swarna having high yielding ability and locally popular variety and IBD-1 is well known for its tolerance capacity for abiotic stress. Previous tests were to confirm their ability in the field of Department of Plant Molecular Biology and Biotechnology, IGKV, Raipur. On the basis of previous performance these individual lines of F_5 generations were selected for experiment.

Experiment Method: Path coefficient analysis and correlation strategies were used to finding the most important yield attributing traits.

Result and Discussion

The estimates of correlation coefficient measure the mutual relationship between various traits and depicts whether simultaneous improvement of the associated traits may be possible or not. Yield is an expression of the sum of contribution made by its individual components so it makes possible to enhance the efficiency of selection for yield by making proper choice of yield components for maximum genetic gain of yield.

Correlation coefficients were calculated at genotypic, phenotypic and environmental level in order to study the masking influence of the environment on the genotypic expression of the character under study. Through the environmental correlation coefficient would not be of much use to the breeder but they will give an idea about the extent to which character are influenced by environmental factors irrespective of their genetic control. The estimates of phenotypic correlation coefficients along with genotypic ones, also gives the clear picture of the extent of inherent association and also indicates to what extent the phenotypic correlation coefficients are influenced by the environment.

In this paper we have worked out simple correlation coefficient for yield and yield attributing traits, It can be seen in table no.1 that days to 50% flower exhibited strong significant and positive association with days to plant height indicated selection of one trait simultaneously improve the other, whereas significant and negative correlation was observed with number of tillers, panicle length, number of filled spikelet, total spikelet, grain yield and harvest index indicated early ness is favour in these traits. Plant height shows strong significant and positive association only with the days to 50 percent flowering indicating selection of plant height can improve the other trait, days to 50 percent flowering.

Number of tillers shows strong significant and positive association with panicle length, thousand grain weight, number of filled spikelet, number of unfilled spikelets, total spikelets, grain yield, biological yield and harvest index, indicating that selection of the one trait simultaneous improvement will be done to associate traits in the same direction and negative correlation was observed with days to 50% flowering and shoot length. Panicle length shows strong significant and positive association with number of tillers, total spikelets, grain yield and harvest index indicating selection for panicle length can improve number of tillers, total spikelets, grain yield and harvest index, whereas negative correlation was observed only with days to 50% flowering means this trait not works in direction of improvement of panicle length. Significant and positive association of thousand grain weight was observed with the traits namely, number of tillers, number of filled spikelets, number of unfilled spikelets, total spikelet, grain yield, biological yield and harvest index, means thousand grain weight is positively helpful in improvement of these traits. Number of filled spikelets showed positive association with number of tillers, thousand grain weight, number of unfilled spikelets, total spikelet, grain yield, biological yield harvest index, similarly number of un-filled spikelet showed strong positive correlation with number of tillers, thousand grain weight, number of filled spikelets and total spikelets, total spikelet was revealed significant positive correlation with number of tillers, panicle length, thousand grain weight, number of filled spikelets, number of un filled spikelets, grain yield, biological yield, harvest index. Grain yield was strongly significant positive correlated with number of tillers, panicle length, thousand grain weight, number of filled spikelets, total spikelets, biological yield and harvest index.

Biological yield showed strongly significant positive correlation with number of tillers, thousand grain weight, number of filled spikelet, total spikelet and grain yield, likewise, Harvest index showed positive significant correlation with number of tillers, panicle length, thousand grain weight, number of filed spikelet, total spikelet and grain yield which indicates that strong linkage between the traits, hence, by selection of the one trait simultaneous improvement will be done to associate trait in the same direction. Aghaei *et al*. (2017) [1], Kumar *et al*. (2018) [8], Bagudam *et al*. (2018) [3] also reported significant relation between biological and grain yield.

Hence after observing overall scenario it becomes clear that traits like panicle length, total number of spikelets, number of filled spikelets, thousand grain weight, biological yield and harvest index was showed significant association with the grain yield. So, effort can be made for improving these traits, as these traits are directly correlated with grain yield, means higher grain yield can be achieved by simultaneous improvement of these traits.

Table 1: Correlation coefficient among various yield and yield related traits

	DTF	PH	NT	PL	TGS	NFS	NFUS	TS	GY	BY	HI
DTF	1	0.38**	-0.47**	-0.35*	-0.24	-0.46**	-0.23	-0.55**	-0.41**	-0.05	-0.39**
PH		1	-0.09	-0.06	-0.05	-0.24	0.13	-0.12	-0.05	0.05	-0.24
NT			1	0.38**	0.56**	0.57**	0.47**	0.67**	0.76**	0.32*	0.41**
PL				1	0.27	0.26	0.21	0.34*	0.33*	-0.02	0.35*
TGS					1	0.62**	0.35*	0.65**	0.70**	0.32*	0.38**
NFS						1	0.38**	0.86**	0.75	0.41**	0.36*
NFUS							1	0.70**	0.31*	0.07	0.14
TS								1	0.71**	0.30*	0.40**
GY									1	0.64**	0.38**
BY										1	-0.35*
HI											1
*Significant at 5 % level of significance						** Significant at 1 % level of significance					

DTF- Days to flowering, PH-plant height, NT- Number of tillers, PL- Panicle length, SI- Seed Index, NFS- Number of filled spikelets, NUFS- Number of unfilled spikelets, TS- Total spikelet, BY- Biological yield, SY- seed yield and HI-Harvest Index

Table 2: Estimation of path coefficient for yield and its component characters

Characters	DTF	PH	NT	PL	TGW	NFS	NUFS	TS	BY	HI
DTF	-0.03	0.03	-0.10	-0.02	-0.03	-0.04	0.01	-0.05	-0.03	-0.14
PH	-0.01	0.08	-0.02	0.00	-0.01	-0.02	0.00	-0.01	0.03	-0.09
NT	0.02	-0.01	0.22	0.02	0.07	0.05	-0.02	0.06	0.20	0.14
PL	0.01	-0.01	0.08	0.06	0.04	0.02	-0.01	0.03	-0.01	0.11
SI	0.01	0.00	0.12	0.02	0.13	0.06	-0.01	0.06	0.20	0.12
NFS	0.02	-0.02	0.12	0.02	0.08	0.09	-0.01	0.08	0.25	0.12
NUFS	0.01	0.01	0.10	0.01	0.05	0.04	-0.03	0.07	0.05	0.02
TS	0.02	-0.01	0.15	0.02	0.09	0.08	-0.02	0.09	0.19	0.11
BY	0.00	0.00	0.07	0.00	0.04	0.04	0.00	0.03	0.61	-0.15
HI	0.01	-0.02	0.08	0.02	0.04	0.03	0.00	0.03	-0.25	0.39

Residual-0.069

Path coefficient analysis is the commonly used biometrical technique, widely used in plant breeding, in which correlation coefficients depict the nature of association among the characters, it is the path analysis that divided the correlation coefficients into direct and indirect effects thus specifying the relative contribution of each character.

Direct effect (Table-2) was found positive and high for total number of tillers, seed index, biological yield and harvest index hence these traits were observed as the most important direct influencing yield contributing character. Thus, the selection pressure on these traits may lead to overall increase in the yield. The selection based on total number of tillers, seed index, biological yield and harvest index would be effective for improving yield. This implies that these components are important yield determinants in rice. The low direct positive effect showed by plant height, panicle length, number of filled spikelets, total spikelet indicated improvement of these important characters through selection of its mutually associated characters. Similarly, as direct effect, the indirect effects will also find its contribution via different traits towards seed yield per plant. On the contrary to our findings, direct effect of constituent characters on grain yield were informed former by Ravindra *et al.* (2012) [11] and Naseem *et al.* (2014) [10], Wattoo *et al.* (2010) [12] and Naseem *et al.* (2014) [10], Kumar *et al.* (2018) [8] and Bagudam *et al.* (2018) [3], and Jyothirupa *et al.* (2018) [7].

The residual effects in the analysis are less which indicates that in present investigation most of the important characters were included in the expression of seed yield.

Correlation and path coefficient study revealed that the traits plant height number of tillers, panicle length, seed index, number of filled spikelets, total spikelets, biological yield and harvest index showed positive and significant correlation with seed yield per plant as well as it has direct effect on seed yield. Thus, these traits might be considered for constructing high yielding plant type.

Conclusion

To full fill the demand of increasing production, there is need to further increase rice productivity because land area under rice cultivation is continuously reducing. Breeding strategies for developing the hybrids with high yield potential are helpful in production of such varieties, hence here we used correlation path coefficient to find out the traits contributing toward yield, traits like number of tillers, biological yield per plant, grain yield per plant and harvest index were observed positively related with yield, hence these traits can be used for improvement of yield.

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