

## Character Association and Path Analysis for Yield, its Contributing Traits and Grain Quality Parameters in Restorer Lines of Rice (*Oryza sativa* L.)

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**Abstract** In the present investigation cause of association and direct and indirect effects were estimated between yield, its contributing traits and grain quality parameters in 50 restorer lines of rice (*Oryza sativa* L.). Correlation study revealed that, grain yield per plant registered highly significant positive relationship with productive tillers per plant, followed by grains per panicle, test-weight, number of productive tiller per sq. m and panicle length indicating that these characters were important for yield improvement. Among the quality parameters kernel breadth, kernel

length, kernel length after cooking kernel elongation ratio and amylose content exhibited positive significant association with single plant yield indicating that these characters could also be considered to achieve better results for improving yield as well as grain quality. Path analysis revealed that, highest positive direct effect on grain yield per plant was exerted by total number of productive tillers per plant followed by grains per panicle, test-weight, number of productive tillers per sq. m and panicle length indicating that selection for these characters was likely to bring about an overall improvement in single plant yield directly.

**Keywords** Rice, Correlation, Path analysis, Quality parameters, Yield.

### Introduction

Rice (*Oryza sativa* L.) is the main staple food crop of Asia and is being consumed by more than half of the developing countries in the world. It is a nutritious cereal crop, provides 20% of the calories and 15% of protein consumed by world's population. It has been estimated that the world will have to produce 60% more rice by 2030 than what it produced in 1995. Although, yield improvement is considered to be prime objective of any breeding program, quality traits are yet another important consideration of rice breeding in India. Grain quality has become an important selection criterion after yield as quality rice not only fetches

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**Table 1.** Genotypic correlation coefficients among grain yield and its components in rice. \*, \*\*Significant at 5% and 1% levels, respectively.

Sl. No.	Characters	Days to 50%	Days to maturity	No. of productive	Productive tillers plant <sup>-1</sup>	Panicle length	Grains panicle <sup>-1</sup>	Test weight (g)	Harvest index (%)	Grain yield plant <sup>-1</sup> (g)
1.	Days to 50% flowering	1.0000	0.3446**	-0.0945	-0.1488	-0.0378	-0.2334**	-0.1826*	-0.3642**	0.0139
2.	Days maturity		1.0000	0.0260	-0.0522	-0.0968	-0.2729**	-0.3957**	-0.5406**	0.0585
3.	No. of productive tillers sq m <sup>-1</sup>			1.0000	0.8153**	0.0174	-0.3076**	0.1337	-0.0799	0.1726*
4.	Productive tillers plant <sup>-1</sup> (No.)				1.0000	0.0635	-0.1377	0.2036*	0.0866	0.3197**
5.	Panicle length (cm)					1.0000	0.1051	0.2288**	0.1160	0.1692*
6.	Grains panicle <sup>-1</sup> (No.)						1.0000	-0.0399	0.1669	0.2585**
7.	Test weight (g)							1.0000	0.2455**	0.1797*
8.	Harvest index (%)								1.0000	0.1298
9.	Grain yield plant <sup>-1</sup> (g)									1.0000

higher returns to the farmers in local market but also earns foreign exchange through exports.

Yield is the end product of multiplicative interaction between various yield components and this necessitates a through understanding of character association and direct and indirect effects contributed by each character on grain yield before launching any breeding program.

Correlation and path analysis establish the extent of association between yield and its components and also bring out relative importance of their direct and indirect effects, thus giving an obvious understanding of their association with grain yield. Ultimately, this kind of analysis could help the breeder to design the selection strategies for improving grain yield. Hence, in the light of above scenario, the present investigation was carried out with the objective of determining the interrelationship between yield, its contributing characters and grain quality parameters as well as identifying the characters to be considered for selecting better genotypes suitable for use as parents in the development of high yielding varieties with superior grain quality.

## Materials and Methods

The present investigation was carried out at the fields of Agricultural Research Station, Vadgaon (Maval), Pune during *kharif* 2012. The investigation was carried out to assess character association analysis and path coefficient for 9 yield and its components and eleven quality characters among 50 restorer lines of rice. The material consisted of 50 restorer lines of rice of which 30 restorer lines were obtained from Directorate of Rice Research (DRR), Hyderabad and 20 lines selected from the germplasm maintained at Agricultural Research Station (ARS), Vadgaon (Maval), Pune. The experiment was laid in randomized block design (RBD) with 50 genotypes in three replications.

The data on five competitive plants from each genotype in each replication were recorded for days to 50% flowering, days to maturity, total number of productive tillers per plant, productive tillers per sq.m, grains per panicle, panicle length, test weight, harvest index and grain yield per plant. The treatment means for all the characters were subjected to the statistical analysis. Among the quality parameters kernel length, kernel breadth, kernel L/B ratio, kernel

**Table 2.** Genotypic correlation coefficients among grain yield and quality traits in rice. \*, \*\* Significant at 5% and 1% levels, respectively.

Sl. No.	Characters	Kernel length (mm)	Kernel breadth (mm)	Kernel L/B ratio	Kernel length after cooking (mm)	Kernel elongation ratio	Alkali spreading value	Water uptake (ml/10g)	Volume expansion ratio	Amylose content (%)	Grain yield plant (g)
1.	Kernel length (mm)	1.000	-0.274*	0.677**	0.446**	-0.409**	0.081	0.367*	0.148	-0.152	0.078
2.	Kernel breadth (mm)		1.000	-0.805**	-0.033	0.160	-0.467**	-0.426**	-0.098	0.379*	0.356*
3.	Kernel L/B ratio			1.000	0.270*	-0.281*	0.437**	0.481**	0.170	-0.384*	-0.184
4.	Kernel length after cooking (mm)				1.000	0.593**	-0.138	0.238*	-0.090	0.241*	0.132
5.	Kernel elongation ratio					1.000	-0.233	-0.080	-0.208	0.276*	0.061
6.	Alkali spreading value						1.000	0.535**	0.290*	-0.355*	-0.172
7.	Water uptake (ml/10g)							1.000	0.157	-0.220	-0.229
8.	Volume expansion ratio								1.000	0.072	-0.018
9.	Amylose content (%)									1.000	0.171

length after cooking, kernel elongation ratio, alkali spreading value, water uptake, volume expansion ratio and amylose content were also estimated as per the standard procedures. The data collected on all the characters were subjected to standard methods of analysis of variance, correlation coefficients and path coefficient analysis.

## Results and Discussion

The analysis of variance revealed the existence of significant differences among the genotypes for all the traits, indicating the existence of sufficient variation in the material studied. Hence, the data were further subjected to correlation (Table 1 and 2) and path coefficient analyses (Table 3) to estimate the association existing between yield, its contributing characters and grain quality parameters and the direct and indirect effects of these traits on yield respectively.

The genotypic correlation revealed that grain yield per plant showed highly significant positive re-

lationship with productive tillers per plant (0.3197) followed by grains per panicle (0.2585), test weight (0.1797), number of productive tiller per sq. m (0.1726) and panicle length (0.1692). It is suggested that top priority should be given to these traits while making selection for yield improvement. Similar kinds of association were revealed earlier [1, 2]. Days to 50% flowering (0.0139), days to maturity (0.0585) and harvest index (0.1298) also exhibited non-significant positive correlation with the grain yield plant<sup>-1</sup>. Similar results reported Latha et al. [3].

Kernel breadth showed significant positive association with grain yield per plant (0.356). This suggests that increase in character will inturn result in increase in the grain yield. Amylose content (0.171), kernel elongation after cooking (0.132) and kernel length (0.078) displayed non-significant positive association with grain yield per plant. These were in consonance with the results earlier [4, 5]. However, non-significant low negative genotypic association with grain yield per plant was observed by water uptake (-0.229), kernel L/B ratio (-0.184), alkali value (-

**Table 3.** Genotypic path coefficients among grain yield and its components in rice. Residual effect = 0.54.

Sl. No.	Characters	Days to 50% flowering (No.)	Days to maturity (No.)	No. of productive tillers sq. m <sup>-1</sup>	Productive tillers plant <sup>-1</sup> (No.)	Panicle length (cm)	Grains panicle <sup>-1</sup> (No.)	Test weight (g)	Harvest index (%)	Correlation with grain yield (g)
1.	Days to 50% flowering	0.0382	0.0384	0.0207	-0.0953	-0.0041	0.0661	-0.0058	-0.0443	0.0139
2.	Days maturity	0.0132	0.1296	-0.0112	-0.0334	-0.0106	0.0533	-0.0126	-0.0696	0.0585
3.	No. of productive tillers per sq. m	-0.0936	0.0033	0.2095	0.0947	0.0019	0.0542	0.0024	-0.0997	0.1726*
4.	Productive tillers per plant (No.)	-0.0057	-0.0094	-0.3510	0.6252	0.0069	0.0366	0.0065	0.0105	0.3197**
5.	Panicle length (cm)	-0.0014	-0.0173	-0.0075	0.0707	0.1193	-0.0298	0.0113	0.0241	0.1692*
6.	Grains per panicle (No.)	-0.0089	-0.0489	0.1307	-0.0882	0.0115	0.2433	-0.0013	0.0203	0.2585**
7.	Test weight (g)	-0.0070	-0.0409	-0.0576	0.1572	0.0250	0.0213	0.0518	0.0299	0.1797*
8.	Harvest index (%)	-0.0139	-0.0869	0.0439	0.0760	0.0160	-0.0466	0.0098	0.1316	0.1298

0.172) and volume expansion ratio (-0.018).

Path coefficient analysis helps in partitioning of correlation coefficients into direct and indirect effects of various characters on grain yield. It provides an effective means of finding out direct and indirect causes of association and presents a critical examination of the specific forces acting to produce a given correlation and measures the relative importance of each causal factor on yield. This, correlation in conjunction with path analysis could give a better insight into cause and effect relationship between different pairs of characters. This will help in the simultaneous improvement of characters along with grain yield in breeding program. Path coefficient analysis was investigated for grain yield and its components in the present study.

The highest positive direct effect on grain yield per plant was exerted by total number of productive tillers per plant (0.6252). Grains per panicle (0.2433), number of productive tillers per sq.m (0.2095) contributed moderately to grain yield, while harvest index (0.1316), days to maturity (0.1296) and panicle length (0.1193) contributed low to the grain yield per plant. However, test weight (0.0518) and days to 50% flowering (0.0382) showed negligible contribution to

grain yield. These findings were in agreement with reports earlier [6, 7].

If the correlation coefficient between caused factor and the effect is almost equal to its direct effect, then correlation explains the true relationship and direct selection of this trait will be effective. The correlation coefficient is positive and the direct effects are negative or negligible, the indirect effects seem to be the cause of correlation. In such situations the other factors influencing the trait have to be considered simultaneously. Correlation coefficients may be negative but the direct effect may be positive and high. Under these conditions a restricted simultaneous selection model is to be followed i.e., restrictions are to be imposed to nullify the undesirable indirect effects in order to make use of the direct effects.

Days to 50% flowering have negligible indirect effect on grain yield through days to maturity, productive tillers per sq.m and grain per panicle and showed non-significant positive correlation with grain yield. However, these traits influenced the yield through the positive indirect effects mainly via number of tillers per sq. m, straw yield per plant and grains per panicle. Days to maturity contributed negligible positive indirect effect through grains per panicle and

days to 50% flowering showed non-significant positive correlation with grain yield. Number of productive tillers per plant had low positive indirect effect through productive tillers per plant, grains per panicle, test weight and panicle length. In spite of its low indirect contribution, it displayed significant positive correlation with grain yield due to its high direct effects on yield. The trait panicle length displayed negligible positive indirect effect on grain yield through total number of productive tillers per plant, harvest index, days to maturity and test weight. It displayed positive and significant correlation with grain yield. Number of grains per panicle had low positive indirect effect on grain yield through productive tillers per sq.m whereas it had negligible positive indirect effect through panicle length and harvest index. It also showed highly significant positive correlation with grain yield. Similarly, the character test weight had low positive indirect effect on grain yield through productive tillers per plant and negligible positive indirect effect through panicle length, grains per panicle, test weight and harvest index. Further it had positive significant correlation with grain yield. Harvest index had negligible positive indirect effect on grain yield through total number of productive tillers per plant, panicle length and test weight. It also displayed positive non-significant correlation with grain yield.

### Conclusion

Critical analysis of results obtained from character association and path analysis indicated that the total number of productive tillers plant<sup>-1</sup> exerted the high-

est positive direct effect on single plant yield and it had positive significant association with yield, hence direct selection of this trait will be effective. No. of productive tillers sq.m<sup>-1</sup>, panicle length grains panicle<sup>-1</sup> and test weight displayed significant positive correlation as well as positive direct effect on grain yield. The positive direct effects of these traits on yield might have resulted in strong genetic correlations. Hence, due emphasis should be given to these traits in formulating selection criteria to bring yield improvement.

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