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Research article

CORRELATION BETWEEN TRAITS AND PATH ANALYSIS COEFFICIENT FOR GRAIN YIELD AND OTHER COMPONENTS IN RICE (*ORYZA SATIVA* L.) GENOTYPES

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ABSTRACT: Current research was conducted out at the Wet land farm of S.V. Agricultural College, Tirupati during kharif, 2011 and rabi, 2011-12 crop seasons. The objective was to establish the nature of relation between grain yield and yield components by partitioning the correlation coefficients between grain yield and its components into direct and indirect effects by using simple correlation and path analysis. A correlation coefficient and path analysis study was conducted with six parents and their 15 F1 crosses for eleven component characters including grain yield. The obtained results indicated that number of grains per panicle, total number of productive tillers per plant, harvest index, kernel L/B ratio, milling percentage and panicle length showed highly significant positive association with grain yield per plant. In the path coefficient analysis, number of grains per panicle and total number of productive tillers per plant should be considered as the main yield components because these traits showed the highest positive direct effects towards increasing grain yield with the values of +0.773 and +0.572, respectively. Depending on the findings of present study, number of grains per panicle and total number of productive tillers per plant may be used an effective selection criterion to improve genetic yield potential of rice genotypes.

Key words: Rice, Correlation, path analysis, direct effects, yield components.

INTRODUCTION

Rice is the staple food for two thirds of the Indian population. It contributes 43 per cent of caloric requirement and 20-25% of agricultural income). The area grown under rice (45.5 million hectares) in India is the largest among all the rice growing countries and it ranks second in production of 99.1 million tonnes as compared to China with an area and production of 29 million hectares and 178 million tonnes, respectively, the productivity in India is 2178 kg ha^{-1} as against 6000 kg ha^{-1} in China (MOA & FCI, 2011). To meet the demands of increasing population and to maintain self sufficiency, the present production levels of 99.1 million tonnes, need to be enhanced up to 125 million tonnes by 2020 in India. To achieve this target, it is necessary to enhance the production and productivity of the existing rice cultivars through pyramiding of high yield alleles into a agronomically desirable genotypes. Therefore, keeping in mind the future demand of rice as a food for human, there is a continuous need to evolve new hybrids, which should exceed the existing hybrids in yield. For this to happen, yield improvement through genetic approaches would become essential. Yield is a complex character, which is highly influenced by the environment, hence direct selection for yield alone limit the selection efficiency and ultimately results in limited success in yield improvement. Thus, effective improvement in yield may be brought about through selection of yield component characters. Yield component characters show association among themselves and also with yield. Plant Breeder has to find significant correlations among yield and yield component traits, and effect of yield component traits on grain yield to predict the superior cross combinations and to select ideal plant type with increased yield. The present study was undertaken to derive information on correlation among yield and yield component traits and to estimate the direct and indirect effects of yield component traits on grain yield. This helps in selection of superior cross combinations in hybrid rice.

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MATERIALS AND METHODS

The initial experimental material consisted of six pure lines *viz.*, MTU 1010, NLR 33654, CRMR 1523, MTU 4870, BPT 5204 and MTU 9993 which were maintained at S.V.Agricultural College, Tirupati. By using these six diverse parental lines, fifteen F1 hybrids were generated in a diallel fashion during *kharif*, 2011. Clipping method was followed for hybridization. The evaluation trail was carried out in a Randomized Block Design (RBD) with three replications during *rabi*, 2011-12 at wetland farm, S.V Agricultural College, Tirupati. The row to row and plant to plant spacing was 22.5 X 10 cm. Border rows were raised all along the field to avoid environmental influences. The crop was maintained healthy by following all other agronomic and plant protection practices applicable for commercial rice crop. A composite sample of five plants from the middle row was used to record observations on these plants for plant height, total number of productive tillers per plant, panicle length, number of grains per panicle, test weight, harvest index, grain yield per plant, milling percentage and kernel L/B ratio, while the traits *viz*., days to 50 per cent flowering and days to maturity were recorded on per plot basis. The replication wise mean values of genotypes were subjected to statistical analysis using INDOSTAT software.
The data collected for all the characters studied were subjected to analysis of variance technique on the basis of model proposed by Panse and Sukhatme (1961). The phenotypic and genotypic correlation coefficients were calculated using the method given by Johnson *et al*. (1955) and path coefficient analysis were worked as suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance (Table 1) 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 was further subjected to correlation and path coefficient analysis to estimates the association existing between yield and yield contributing components and direct and indirect effects of yield related traits, respectively. The genotypic correlation coefficients were of higher in magnitude than their corresponding phenotypic correlation coefficients for almost all the characters which might be due to the masking or modifying effect of the environment in genetic association between characters. The perusal of phenotypic and genotypic correlation (Table 2) analysis revealed that, grain yield per plant had highly significant positive phenotypic and very strong positive genotypic correlation with number of grains per panicle (r_p = 0.789**; r_g= 0.816), total number of productive tillers per plant (r_p = 0.661**; r_g= 0.688), harvest index (r_p = 0.564**; r_g= 0.598), kernel L/B ratio (r_p = 0.461**; r_g= 0.468), milling percentage (r_p = 0.365**; r_g =0.412) and panicle length (r_p = 0.229*; r_g= 0.240) levels indicating the importance of these traits for yield improvement in rice. Thus the indirect selection for higher yield based on these characters would be reliable. These results were in conformity with reports of Ullah *et al.* (2011) where in positive association of panicle length and grains per panicle, Selvaraj *et al.* (2011) for total number of productive tillers per plant with grain yield, respectively. On contrary, Plant height displayed highly significant negative correlation with grain yield per plant (r_p = -0.473**; r_g = -0.485). Negative correlation coefficient of plant height with grain yield indicated that in general, tall genotypes were low yielders due to accumulation of photosynthates in vegetative parts as compared to reproductive parts (*i.e.* seed formation and grain filling) and were lodging susceptible (Zahid et al., 2006).

The genetic reasons for this type of negative association may be attributed to linkage or pleiotropy. Similar kind of negative association between plant height and grain yield was reported earlier by Akthar et al. (2011) and corroborates the findings of the present study. Grain yield had positive and non-significant association with days to maturity (r_p = 0.159; r_g = 0.165), days to 50 per cent flowering (r_p = 0.083; r_g = 0.094) and test weight (r_p =0.168; r_g =0.164). Similar kind of positive association of phonological characters with grain yield was reported earlier for observations on days to 50% flowering (Kole et al., 2008), 1000-grain weight (Ullah et al., 2011) and days to maturity (Khan et al., 2009). Besides the correlation studies, *inter se* association studies also provide an opportunity to select only those characters which are favourably associated among them as well as with yield. In the present investigation, studies on *inter se* associations among yield components revealed that the trait total number of productive tillers per plant exhibited highly significant positive association with most of the traits *viz.*, panicle length, number of grains per panicle, harvest index, milling percentage and kernel L/B ratio besides highly significant positive correlation with yield per plant. Satish Chandra et al. (2009) reported positive association of total number of productive tillers per plant and number of grains per panicle while, Mohanakrishna et al. (2009) revealed significant positive association of total number of productive tillers per plant with harvest index. Hence, the trait total number of productive tillers per plant could be exploited for the improvement of yield using the present material.

Grain yield, which is the major economic character in rice depends on several component traits, which are mutually related. Mere change in any one of the component would ultimately disturb the complex. Hence, these related traits have to be analyzed for its action namely direct effect of component character on grain yield and the indirect effects through other component traits on grain yield. Therefore, the total correlations were partitioned in to direct and indirect effects (Table 3 and Fig. 1).

The path coefficient analysis furnishing the cause and effect of different yield components would provide better index for selection rather than mere correlation coefficients. Number of grains per panicle exhibited maximum positive direct effect on grain yield (P = 0.773; G = 1.027) followed by total number of productive tillers per plant (P = 0.572; G = 1.000), plant height (P =0.249; G =0.515) and kernel L/B ratio (P =0.034; G =0.054). Hence selection based on these traits would be effective in increasing the grain yield potential of rice. These findings were in agreement with reports of Shanthalatha et al. (2004) who revealed the positive direct effect of total number of productive tillers per plant on grain yield. Similarly, the direct effect of component traits on grain yield were reported earlier by Ravindra Babu et al. (2012) with number of productive tillers plant, number of grains per panicle and plant height, Satish Chandra et al. (2009) with productive tillers per plant, Zahid et al. (2006) and Chitra et al. (2005) with harvest index and Akthar et al. (2011) with plant height. Thus, direct selection based on these traits will be rewarding for yield improvement in rice.

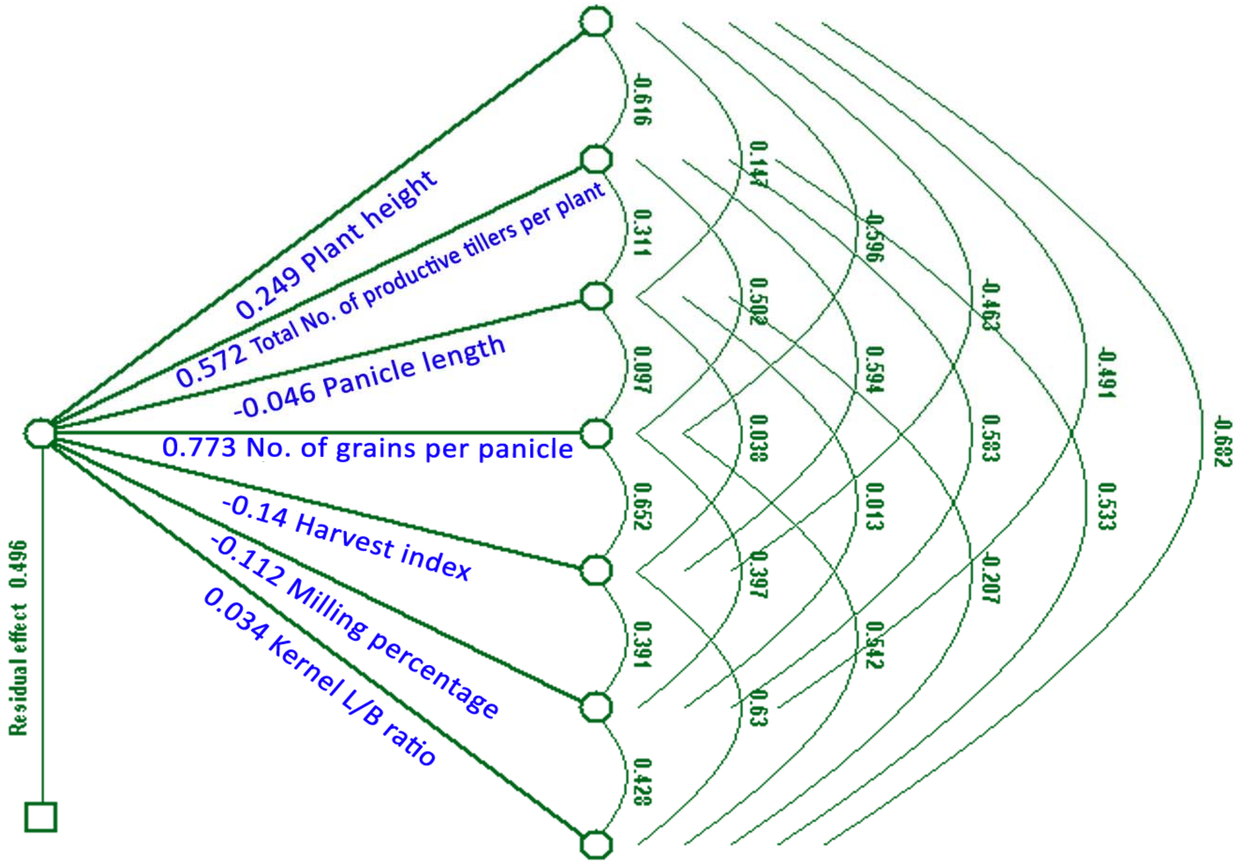

Figure. 1. Phenotypic Path Diagram for Grain Yield and Yield Components in Rice

Conversely, the direct effects of panicle length, harvest index and milling percentage were negative both at phenotypic and genotypic levels on grain yield. Further in the present investigation, it was evident that 50 per cent of the yield contributing characters was utilized in this analysis as the residual effect was 0.496 (49.6 %) as revealed in the results (Fig. 1).

From the foregoing results, it is to conclude that number of grains per panicle and total number of productive tillers per plant displayed significant positive correlation and exerted the highest positive direct effect on grain yield. The high positive direct effect of these traits on grain yield resulted in strong genetic correlation. Hence, number of grains per panicle and total number of productive tillers per plant were the most important traits which should be given due emphasis in formulating indirect selection criterion for isolation of high yielding rice genotypes.

Table 1. Analysis of Variance For Grain Yield and Yield Components in Rice

S. No.	Character	Mean squares due to		
		Replications (df=2)	Genotypes (df=20)	Error (df=40)
1.	Days to 50 % flowering	5.53	139.38**	5.45
2.	Days to maturity	1.33	56.67**	4.31
3.	Plant height (cm)	1.68	409.00**	3.86
4.	Total number of productive tillers per plant	0.91	19.69**	0.48
5.	Panicle length (cm)	10.87	18.81**	0.67
6.	Number of grains per panicle	18.33	1005.64**	4.61
7.	Grain yield per plant (g)	14.69	174.02**	1.16
8.	Test weight (g)	0.03	17.72**	0.42
9.	Harvest index (%)	0.16	160.99**	1.07
10.	Milling percentage	1.80	17.37**	0.32
11.	Kernel L/B ratio	0.00	0.25**	0.00

** Significant at P = 0.01 level

Table 2. Phenotypic (r_p) and Genotypic (r_g) Correlation Coefficients Among Grain Yield and Its Components in Rice

Character		Days to 50% flowering	Days to maturity	Plant height	Total number of productive tillers per plant	Panicle length	Number of grains per panicle	Test weight	Harvest index	Milling percentage	Kernel L/B ratio	Grain yield per plant
Days to 50% flowering	r_p	**1.000**	0.863**	-0.078	-0.001	0.076	0.184*	-0.537**	0.245**	0.113	-0.086	0.083
	r_g	**1.000**	0.903	-0.077	-0.007	0.054	0.199	-0.571	0.245	0.138	-0.086	0.094
Days to maturity	r_p		**1.000**	-0.169	0.168	0.148	0.234*	-0.446**	0.322**	0.182*	0.079	0.159
	r_g		**1.000**	-0.191	0.185	0.124	0.273	-0.531	0.332	0.253	0.095	0.165
Plant height	r_p			**1.000**	-0.616**	0.147	-0.596**	0.213*	-0.463**	-0.491**	-0.682**	-0.473**
	r_g			**1.000**	-0.635	0.170	-0.608	0.233	-0.481	-0.532	-0.689	-0.485
Total number of productive tillers per plant	r_p				**1.000**	0.311**	0.502**	0.095	0.595**	0.583**	0.533**	0.661**
	r_g				**1.000**	0.347	0.515	0.097	0.633	0.645	0.547	0.688
Panicle length	r_p					**1.000**	0.097	0.307*	0.038	0.013	-0.207*	0.229*
	r_g					**1.000**	0.106	0.353	0.002	0.017	-0.221	0.240
Number of grains per panicle	r_p						**1.000**	0.090	0.652**	0.397**	0.542**	0.789**
	r_g						**1.000**	0.106	0.692	0.443	0.545	0.816
Test weight	r_p							**1.000**	0.049	-0.012	0.137	0.168
	r_g							**1.000**	0.050	-0.002	0.149	0.164
Harvest index	r_p								**1.000**	0.391**	0.630**	0.564**
	r_g								**1.000**	0.411	0.659	0.598
Milling percentage	r_p									**1.000**	0.428**	0.365**
	r_g									**1.000**	0.411	0.412
Kernel L/B ratio	r_p										**1.000**	0.461**
	r_g										**1.000**	0.468

*,** Significant at p = 0.05 and p = 0.01 level, respectively

Table 3. Phenotypic (P) and Genotypic (G) Path Coefficients among Grain Yield and Its Components in Rice

Character		Plant height	Total number of productive tillers per plant	Panicle length	Number of grains per panicle	Harvest index	Milling percentage	Kernel L/B ratio	Grain yield per plant
Plant height	P	**0.249**	-0.153	0.037	-0.149	-0.115	-0.122	-0.170	-0.473**
	G	**0.515**	-0.327	0.087	-0.313	-0.247	-0.274	-0.355	-0.485
Total number of productive tillers per plant	P	-0.352	**0.572**	0.178	0.287	0.340	0.334	0.305	0.661**
	G	-0.635	**1.000**	0.347	0.515	0.632	0.644	0.547	0.688
Panicle length	P	-0.007	-0.014	**-0.046**	-0.005	-0.002	-0.001	0.001	0.229*
	G	-0.050	-0.103	**-0.295**	-0.031	-0.001	0.005	0.065	0.240
Number of grains per panicle	P	-0.461	0.388	0.075	**0.773**	0.504	0.307	0.419	0.789**
	G	-0.624	0.529	0.109	**1.027**	0.710	0.454	0.560	0.816
Harvest index	P	0.065	-0.083	-0.005	-0.091	**-0.140**	-0.055	-0.088	0.564**
	G	0.203	-0.267	-0.000	-0.292	**-0.422**	-0.173	-0.278	0.598
Milling percentage	P	0.055	-0.066	-0.002	-0.045	-0.044	**-0.112**	-0.048	0.365**
	G	0.144	-0.174	0.005	-0.119	-0.111	**-0.270**	-0.125	0.412
Kernel L/B ratio	P	-0.023	0.018	-0.007	0.019	0.022	0.015	**0.034**	0.461**
	G	-0.037	0.030	-0.012	0.030	0.036	0.025	**0.054**	0.468

* Significant at p = 0.05 level Residual Effect (Phenotypic):0.495 Diagonals: Direct effect;
** Significant at p = 0.01 level Residual Effect (Genotypic) :0.364 Off diagonals: Indirect effects

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