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INTER-RELATIONSHIP AND PATH ANALYSIS FOR YIELD AND QUALITY CHARACTERS IN RICE (*Oryza sativa* L.)

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Abstract: An investigation was carried out to assess the character association and the magnitude of direct and indirect effects of yield component traits on grain yield of rice for 11 characters *viz.,* days to 50% flowering, days to maturity, productive tillers per plant, plant height (cm), panicle length (cm), grains per panicle, test weight (g), kernel length (mm), kernel breadth (mm), L/B ratio and grain yield per plant. Character association studies revealed that, traits like Productive tillers per plant, grains per panicle, test weight, panicle length, days to maturity, kernel breadth, plant height, days to 50% flowering and kernel length were found to possess significant positive association with grain yield per plant at phenotypic level. Further, path analysis studies revealed that kernel breadth, L/B ratio, productive tillers per plant, grains per panicle, test weight, days to maturity, days to 50% flowering and plant showed true relationship with grain yield per plant by establishing significant positive association and high positive direct effect.

Keywords: Character association, path analysis, yield, rice.

Introduction

Rice (*Oryza sativa* L., 2n = 2x= 24) is the principal staple cereal food and source of calories for more than half of the world's population. It offers a wealth of material for genetic studies because of its wide ecological distribution and enormous variation encountered for various qualitative and quantitative characters (Kotaiah, 1983). It is the staple food for 65% of the global population and forms the cheapest source of food energy and protein. In India, rice is grown in an area of 43.86 Mha with a production and productivity of 105.48 Mt and 2424 kg ha^{-1} respectively (WWW.indiastat.com,2014-15). In Andhra Pradesh, rice is cultivated in an area of 38.09 Lha with a production of 115.65 Lt and productivity of 2856 kg ha^{-1} (WWW.indiastat.com,2014-15). Yield is a complex character and dependent on many component traits. Hence it is necessary to have knowledge on the extent of association between yield and yield contributing characters. Considering the nature and magnitude of character associations and their direct and indirect effects could serve as important traits in

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any selection programme for selecting high yielding genotypes in rice. But to know the direct effects of each independent variable on yield and indirect effects through other characters of each variable, path coefficient analysis has to be performed. In the present study, path analysis was used to work out the direct and indirect effects of yield contributing characters on yield using 40 genotypes of rice.

Material and Methods

Forty genotypes were evaluated during *kharif,* 2015 at Agricultural College Farm, Bapatla in a Randomized Block Design with three replications. The seeds were raised on nursery bed and seedlings were transplanted in main field after 28 DAS. Each genotype was represented by 2 rows of 4m length. The spacing of 20 cm between rows and 15 cm between the plants was followed. Observations were recorded on ten randomly chosen plants for eleven quantitative characters *viz*., days to 50% flowering, days to maturity, productive tillers per plant, plant height, panicle length, grains per panicle, test weight, kernel length, kernel breadth, L/B ratio and grain yield per plant. The data were subjected to statistical analysis and estimates of correlation coefficients were worked out as per Snedecor and Cochran, (1967). Direct and indirect effects of yield components on yield were calculated as suggested by Dewey and Lu (1959).

Results and Discussion

The traits, Productive tillers per plant, grains per panicle, test weight, panicle length, days to maturity, kernel breadth, plant height, days to 50% flowering and kernel length were found to possess significant positive association with grain yield per plant (table 1). These results were in accordance with findings of Ashok (2015) for productive tillers per plant, grains per panicle, test weight and panicle length, Premkumar *et al.* (2015) for kernel length and kernel breadth, Tushara *et al*. (2013) for days to 50% flowering and Bornare *et al.* (2014) for days to maturity. The trait L/B ratio showed negative significant association with grain yield per plant at phenotypic levels. Similar results were found by Krishnaveni and Sobharani (2006) for L/B ratio.

The result of path analysis showed that, the direct effect of days to 50% flowering is positive and the correlation coefficient is significantly positive at phenotypic level. Similar results were reported by Panwar *et al.* (2006). While it had positive indirect effects via grains per panicle, L/B ratio, days to maturity, kernel breadth, test weight, productive tillers per plant and plant height, which seem to be the cause for positive correlation. Hence, these characters through which days to 50% flowering is showing positive indirect effect are to be considered

simultaneously during the selection process for the improvement of the dependent variable grain yield per plant. The character days to maturity recorded positive direct effects as well as significant positive correlation coefficients with grain yield per plant. Similar results were recorded by Aditya and Bhartiya (2013). Further, this trait also recorded positive indirect effects via grains per panicle, L/B ratio, kernel breadth, days to 50% flowering, test weight, productive tillers per panicle and plant height. Hence, for improvement of grain yield per plant simultaneous selection of these characters along with days to maturity should be carried out.

Productive tillers per plant recorded positive direct effect coupled with highly significant positive correlation on grain yield per plant at phenotypic level. These results are in accordance with Eradasappa *et al.* (2007) and Panwar and Ali (2007). The indirect effects through kernel breadth, test weight, kernel length, grains per panicle, days to maturity, plant height and days to 50% flowering were also positive. Therefore along with days to maturity, the causal factors which had positive indirect effects on grain yield per plant may be considered simultaneously during the process of selection. Plant height showed positive direct effect coupled with significant positive association on grain yield per plant. These findings were in agreement with the results of Janardanam *et al.* (2001), Nagajyothi (2001), Shasidhar *et al.* (2005) and Bekele *et al.* (2013). This trait also exhibited positive indirect effects via kernel breadth, productive tillers per plant, test weight, grains per panicle, days to maturity and days to 50% flowering. In such situations, these indirect casual factors are to be considered along with plant height during selection for improvement of grain yield per plant.

Panicle length showed negative direct effect coupled with significant positive association on gain yield per plant. These findings were in agreement with the results of Eradasappa *et al*. (2007), Rani and Reddy (2010) and Sudharani *et al*. (2013). It also exhibited the positive casual factors via kernel breadth, productive tillers per plant, grains per panicle, test weight, days to 50% flowering, plant height and days to maturity. For improvement of grain yield per plant, this type of correlation does not explains the true relationship and direct selection through this trait will not be rewarding. In such situations the casual factors showing positive indirect effect on grain yield per plant were responsible for positive correlation. Therefore these traits are to be considered simultaneously during selection process for improvement of the dependent variable. The trait, grains per panicle recorded positive direct effect coupled with significant positive association. Similar results were recorded by Janardhanam *et al.* (2001), Nagajyothi (2001), Kumar and Bapu (2005) and Panwar (2006). It also possessed

positive indirect effect via productive tillers per plant, kernel breadth, test weight, days to maturity, days to 50% flowering, plant height and L/B ratio. This indicate that direct effect of grains per panicle accounted for the major portion in the total correlation between them, hence, direct selection through grains per panicle will be effective.

The trait, test weight showed positive direct effect coupled with highly significant positive association with grain yield per plant. These findings were in agreement with the results of Kumar and Bapu (2005) and Gangasetty *et al.* (2013). Further, this trait also recorded positive casual factors through kernel breadth, productive tillers per plant, grains per panicle, days to maturity, days to 50% flowering and plant height. This indicate direct effect of test weight on grain yield per plant accounted for major portion in the total correlation between them, therefore direct selection through test weight will be effective.

The trait, kernel length showed negative direct effect coupled with significant positive correlation coefficient with grain yield per plant. Similar result for direct effect was recorded by Kumari *et al*. (2011), Aditya and Bhartiya (2013) and Tejaswini (2016). This trait also recorded positive indirect effects via kernel breadth, L/B ratio, grains per panicle, days to maturity, days to 50% flowering, plant height and test weight. Here the contribution of high positive indirect effects nullified the negative direct effect. In such situations, the high positive casual factors are to be considered during selection process for improvement of grain yield per plant.

Kernel breadth exhibited positive direct effect coupled with significant positive correlation coefficient with grain yield per plant. Similar result for direct effect was earlier reported by Kumari *et al*. (2011), Aditya and Bhartiya (2013) and Tejaswini (2016). It also possessed positive indirect effects through productive tillers per plant, grains per panicle, test weight, plant height, days to maturity and days to 50% flowering. As kernel breadth recorded high positive direct effect coupled with significant positive association on grain yield per plant and accounted for the major portion in the total correlation between them, direct selection through kernel breadth will be effective for improvement of grain yield pr plant. Thus, path analysis studies revealed that out of 11 characters studied, the characters *viz.,* Productive tillers per plant, grains per panicle, test weight, panicle length, days to maturity, kernel breadth, plant height, days to 50% flowering and kernel length were showed true relationship with grain yield per plant by establishing significant positive association and high positive direct effect (table 2).

Considering the nature and magnitude of character associations and their direct and indirect effects, it can be inferred that Productive tillers per plant followed by grains per panicle, test weight, panicle length, days to maturity, kernel breadth, plant height, days to 50% flowering and kernel length could serve as important traits in any selection programme for selecting high yielding genotypes in rice. In the present study, the residual effect is 0.6406 indicating that the characters included in present investigation had contributed around 36 % of variability pertaining to the dependent variable *i.e.,* yield (fig.1).

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Table 1. Phenotypic correlations among grain yield and yield contributing characters in rice (*Oryza sativa* L.)

Character	Days to maturity	Productive tillers per plant	Plant height	Panicle length	Grains per panicle	Test weight (g)	Kernel length (mm)	Kernel breadth (mm)	L/ B ratio (mm)	Grain yield per plant (g)
Days to 50% flowering	0.4418**	0.0452	0.0785	0.1650	0.2861**	0.1263	0.1929*	0.0246	0.0938	0.2719**
Days to maturity		0.0550	0.2614**	0.1141	0.3264**	0.1775	0.2745**	0.0566	0.1150	0.3175**
Productive tillers per			0.1599	0.5445**	0.4105**	0.4225**	-0.0293	0.1297	-0.1516	0.5740**
Plant height				0.3961**	0.1290	0.2583**	0.3799**	0.4119**	-0.1889*	0.2852**
Panicle length					0.4557**	0.5357**	0.0803	0.1786	-0.1329	0.4826**
Grains per panicle						0.4389**	0.2366**	0.1257	0.0046	0.5644**
Test weight							0.1097	0.1392	-0.0742	0.5233**
Kernel length								0.4498**	0.1471	0.1481*
Kernel breadth									-0.8072**	0.3025**
L/ B ratio										-0.2167*

G: Genotypic correlation
P: Phenotypic correlation

* Significant at 5% level
** Significant at 1% level

Table 2. Phenotypic Direct and indirect effects of different traits on Grain yield per plant in rice (*Oryza sativa* L.)

Character	Days to 50% flowering	Days to maturity	Productive tillers per plant	Plant height	Panicle length	Grains per panicle	Test weight	Kernel length	Kernel breadth	L/ B ratio
Days to 50% flowering	**0.1116**	0.0493	0.0050	0.0088	0.0184	0.0319	0.0141	0.0215	0.0027	0.0105
Days to maturity	0.0574	**0.1300**	0.0071	0.0340	0.0148	0.0424	0.0231	0.0357	0.0074	0.0149
Productive tillers per plant	0.0150	0.0182	**0.3307**	0.0529	0.1800	0.1357	0.1397	-0.0097	0.0429	-0.0501
Plant height	0.0034	0.0114	0.0070	**0.0436**	0.0173	0.0056	0.0113	0.0166	0.0180	-0.0082
Panicle length	-0.0031	-0.0022	-0.0104	-0.0075	**-0.0190**	-0.0087	-0.0102	-0.0015	-0.0034	0.0025
Grains per panicle	0.0780	0.0890	0.1119	0.0352	0.1243	**0.2727**	0.1197	0.0645	0.0343	0.0012
Test weight	0.0253	0.0355	0.0845	0.0517	0.1072	0.0878	**0.2001**	0.0220	0.0279	-0.0148
Kernel length	-0.1142	-0.1625	0.0174	-0.2248	-0.0475	-0.1401	-0.0649	**-0.5919**	-0.2662	-0.0871
Kernel breadth	0.0261	0.0601	0.1377	0.4372	0.1896	0.1334	0.1478	0.4775	**1.0616**	-0.8569
L/ B ratio	0.0724	0.0887	-0.1169	-0.1457	-0.1025	0.0035	-0.0572	0.1134	-0.6226	**0.7713**
Grain yield per plant	0.2719**	0.3175**	0.5740**	0.2852**	0.4826**	0.5644**	0.5233**	0.1481*	0.3025**	-0.2167*

* Significant at 1% level

** Significant at 5% level

Diagonal values indicate direct effects Residual effect = 0.6406

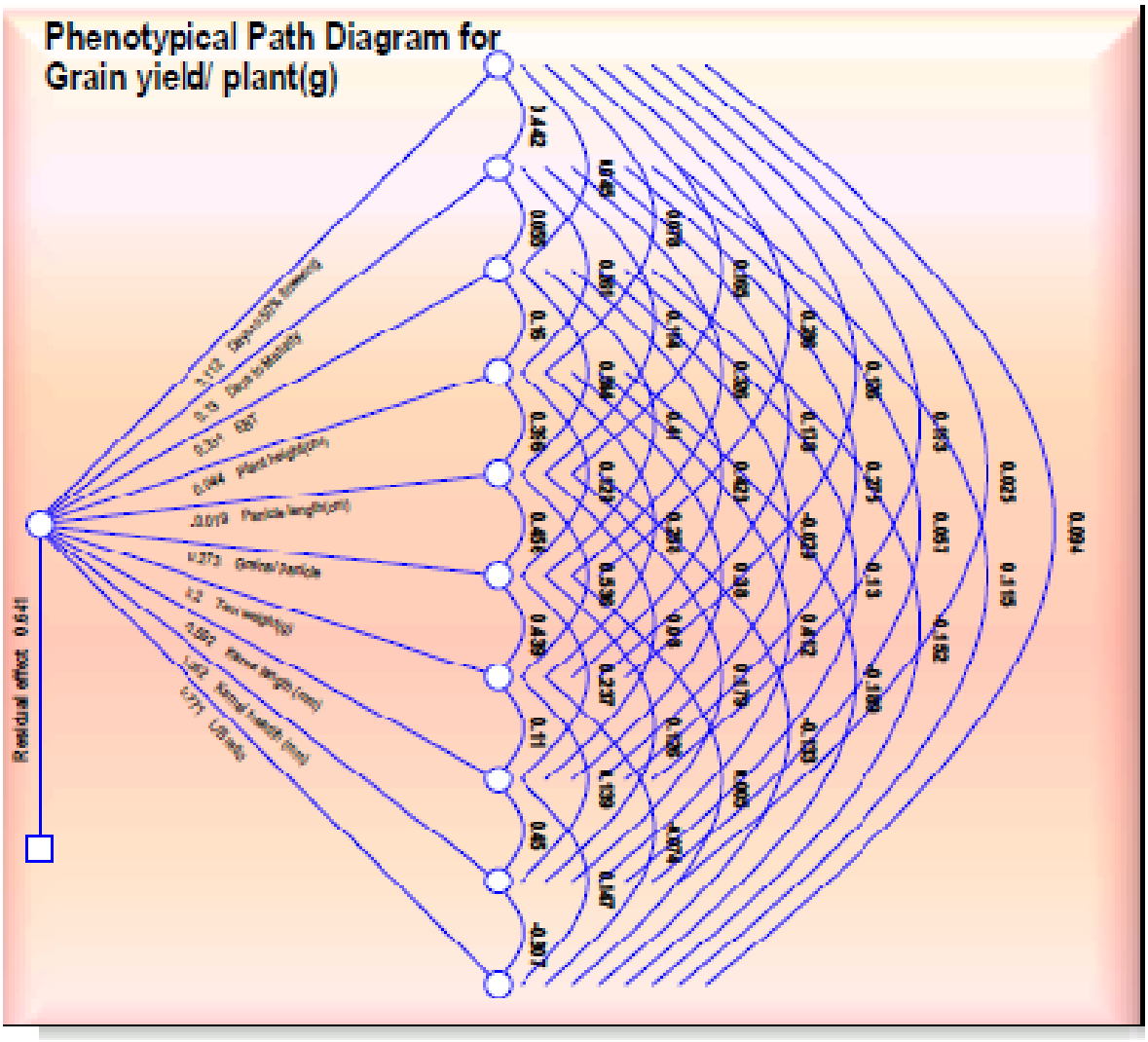

Fig. 1. Phenotypic path diagram showing direct and indirect effects of yield components on grain yield per plant in rice (*Oryza sativa* L.)