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Correlation between traits and path analysis co-efficient for grain yield and other components in direct seeded aerobic rice (*Oryza sativa* L.)

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ABSTRACT : The experiment was conducted out at the Indian Institute of Rice Research, Rajendranagar, Hyderabad during dry season (*Rabi*) 2013-2014 and Wet season (*Kharif*) 2014 crop seasons. The objective was to establish the nature of relation between grain yield and yield components by partitioning the correlation co-efficients between grain yield and its components into direct and indirect effects by using simple correlation and path analysis. A correlation co-efficient and path analysis study was conducted with eleven parents and their 24 F_1 crosses for eleven component characters including grain yield. The correlation studies of these crosses showed that, grain yield per plant exhibited highly significant positive association with plant height, number of productive tillers per plant, panicle length, grains per panicle, and harvest index while days to 50 per cent flowering registered non-significant negative association with grain yield.

KEY **W**ORDS : Rice, Correlation, Path analysis, Direct effects, Yield components

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Rice (*Oryza sativa* L.) is the prime food crop in the world. In India about 65 per cent of the population has rice as major constituent in the diet. Mainly because of a still growing population demand for rice is expected to keep increasing in the coming decades. About 75 per cent of the global rice volume is produced in the irrigated low lands. Decreasing water availability for agriculture threatens the productivity of the irrigated rice ecosystem and a way must be sought to save water and increase the productivity of rice. Savings in irrigation water and increase in water utility for high production would be possible, if rice is grown under

aerobic soil condition. However, a key component for the success of aerobic systems is developing appropriate cultivars with high yield potential and drought tolerance under aerobic condition.

The studies on correlation values indicated the intensity and direction of character association in a crop. Hence, the knowledge on inter relationship of plant characters with seed yield and among themselves is of importance to the breeder for making importance in complex characters like grain yield, for which direct selection is not much effective. Hence, the association analysis was undertaken to determine the direction of selection and number of characters to be considered in improving the seed yield.

Character association provides information on the nature and extent of association between pairs of metric traits and helps in selection for the improvement of the character. Phenotypic and genotypic correlations were worked out on yield and yield contributing characters in 35 genotypes. In general, genotypic correlations were found to be higher than phenotypic correlations, which indicate that though there is strong inherent association between character studies, its expression is lessened due to influence of environment and considering the importance of phenotypic correlation.

RESEARCH PROCEDURE

The study was carried out at Indian Institute of Rice Research, Rajendranagar, Hyderabad. The experimental material consisted of three lines (APMS6A IR79156A and IR58025A) were crossed with eight testers (HHZ12-Y4-DT1-Y3, RPBIO4918-205, HHZ12-SAL2-Y3-Y2-1, HHZ17-Y16-Y3-Y1, IR11T254, HHZ12-SAL2-Y3-Y2, HHZ12-SAL8-Y1-SAL1 and ABR-158-81R) during *Rabi* 2013-2014. All the 24 along with parents of three lines and eight testers were sown in non-puddled and non-flooded aerobic soil, during *Kharif* 2014. The experiment was laid out in Randomized Block Design (RBD) with two replications and 35 treatments (24 hybrids + 11 parents). Normal agronomical practices and plant protection measures with external inputs such as supplementary irrigation and fertilizers were given at appropriate time.

RESEARCH ANALYSIS AND REASONING

The phenotypic and genotypic correlation co-efficients were estimated among the eight characters under aerobic conditions (Table 1).

Table 1 : Estimates of phenotypic (P) and genotypic (G) correlation co-efficient analysis of yield and yield contributing characters in rice

Characters		Days to 50% flowering	Plant height (cm)	No. of productive tillers/plant	Panicle length (cm)	No. of grains per panicle	Biomass (g)	Harvest index (%)	Grain yield/plant (g)
Days to 50% flowering	P	1.0000	-0.3890 **	-0.1179	-0.3904 **	-0.2020	0.1758	-0.2024	-0.0812
	G	1.0000	-0.5002**	-0.1588	-0.4334**	-0.2456*	0.2143	-0.2321*	-0.0911
Plant height (cm)	P		1.0000	0.1965	0.4596 **	0.2079	-0.0100	0.2205	0.3268*
	G		1.0000	0.2187	0.4950**	0.2712*	0.0625	0.2223	0.3681**
Number of productive tillers/plant	P			1.0000	0.3649 **	0.3501 **	0.0602	0.1840	0.3633**
	G			1.0000	0.4325**	0.4106**	0.0954	0.2569*	0.4421**
Panicle length(cm)	P				1.0000	0.6898 **	0.2048	0.1555	0.4711**
	G				1.0000	0.8576**	0.3277**	0.1720	0.5796**
Number of grains/panicle	P					1.0000	0.2835 *	0.1510	0.5323**
	G					1.0000	0.3897**	0.1707	0.6327**
Biomass (g)	P						1.0000	-0.7266**	0.0853
	G						1.0000	-0.6784**	0.0874
Harvest index (%)	P							1.0000	0.6093**
	G							1.0000	0.6701**

*and ** indicate significance of values at P=0.05 and 0.01, respectively; P- Phenotypic level; G- Genotypic level

Correlation between grain yield and its components:

Grain yield per plant :

Phenotypic correlations revealed that grain yield per plant had significant positive association with plant height (0.3268), number of productive tillers per plant (0.3633), number of grains per panicle (0.5796), panicle length (0.4711) and harvest index (0.6093). Non-significant positive association with biomass (0.0853) and this trait showed negative and non-significant with days to flowering (Table 1).

Grain yield per plant showed positive significant association with plant height, number of productive tillers per plant, number of filled grains per panicle. This indicated that all these characters were important for yield improvement. Similar kind of association was revealed by Krishna *et al*. (2008) and Fiyaz *et al*. (2011) for plant height, Fiyaz *et al*. (2011) and Babu *et al*. (2012) for number of productive tillers per plant, Padmaja *et al*. (2011) and Haider *et al*. (2012) for number of filled grains per panicle. Hence, these characters could be considered as criteria for selection for higher yield as these were mutually and directly associated with grain yield.

Inter correlation among yield components :

Days to 50 per cent flowering :

The days to 50 per cent flowering recorded a non-significant negative phenotypic correlation with grain yield per plant (-0.0812) and positive and non-significant correlation with biomass (0.1758). The characters, plant height (-0.3890), panicle length (-0.3904) showed negative significant association. Number of productive tillers per plant (-0.1179), number of grains per panicle (-0.2020) and harvest index (-0.2024) showed negative and non-significant association. The similar results were reported by Genetic Seyoum *et al*. (2012) for grain yield, Venkanna *et al*. (2014) for plant height and panicle length, Nikhil *et al*. (2014) for harvest index and biomass, Panwar and Ali (2007) for number of grains per panicle, Sharma and Sharma (2007) for number of reproductive tillers per plant (Table 1).

Plant height :

The plant height registered a significant positive phenotypic correlation with grain yield per plant (0.3268) and panicle length (0.4596) where as it is positive and non-significant correlation with number of productive tillers per plant (0.1965), number of grains per panicle (0.2079) and harvest index. It had negative and non-significant correlation with biomass (-0.0100) (Table 1). The similar results were reported by Gopikannan and Ganesh (2013) for grain yield and panicle length, Eradasappa *et al*. (2007) for number of reproductive tillers and grains per panicle.

Number of productive tillers per plant :

Number of productive tillers per plant exhibited significant positive phenotypic correlation with grain yield per plant (0.3633), number of grains per panicle (0.3501) and panicle length (0.3649). It exhibited positive and non- significant correlation with biomass (0.0602) and harvest index (0.1840) (Table 1). The similar result was reported by Eradasappa *et al*. (2007) for grain yield per plant and number of grains per panicle, Padmaja *et al*. (2011) for panicle length, Nikhil *et al*. (2014) for biomass and harvest index.

Panicle length :

Panicle length registered significant positive phenotypic correlation with number of grains per panicle (0.6898) and grain yield per plant (0.4711) and non-significant positive with biomass (0.2048) and harvest index (0.1555) (Table 1). The similar result was reported by Chandra *et al*. (2009) for grain yield and number of grains per panicle.

Number of grains per panicle :

Number of filled grains per panicle exhibited a significant positive phenotypic correlation with grain yield per plant (0.5323) and biomass (0.2835) and positive non-significant with harvest index (Table 1). The similar results were reported by Padmaja *et al*. (2011) for grain yield per plant, Venkanna *et al*. (2014) for biomass.

Biomass :

Biomass exhibited a positive non-significant phenotypic correlation with grain yield per plant (0.3540) and negative and significant correlation with harvest index (Table 1). The similar result were reported by Dwivedi *et al*. (2012) for harvest index.

Harvest index :

Harvest index exhibited significant positive phenotypic correlation with grain yield per plant (0.6093) and similar results reported by Dwivedi *et al*. (2012).

Path co-efficient analysis :

Correlation gives only the relation between two variables whereas path co-efficient analysis allows separation of the direct effect and their indirect effects through other attributes by partitioning the correlations (Wright, 1921). Hence, this objective was undertaken in the present investigation.

Based on the data recorded on the genotypes in the present investigation, the genotypic and phenotypic correlations were estimated to determine direct and indirect effects of yield and yield contributing characters.

As discussed in character association based on the importance of phenotypic effects the present results of phenotypic path co-efficient of yield and yield contributing characters discussed here under which are presented in Table 2.

Days to 50 per cent flowering :

The days to 50 per cent flowering had direct phenotypic positive effect (0.0280) on grain yield. Positive low level of indirect effect was exerted on grain yield per plant by days to 50 per cent flowering through spikelet fertility and biomass. Days to 50 per cent flowering had indirect negative effect on grain yield through plant height, number of productive tillers/ plant, panicle length, number of grains/ panicle. Similar result of direct positive effect of days to 50 per cent flowering on grain yield per plant was reported by Genetic Seyoum *et al.* (2012), Kumar and Senapathi (2013), Nikhil *et al*. (2014) and Kumar and Saravanan (2012) for biomass.

Plant height :

Plant height had phenotypic positive direct effect on grain yield per plant (0.0280). In direct positive influence of plant height on grain yield was observed through number of productive tillers per plant (0.0055), number of filled grains per panicle (0.0058), panicle length (0.0128) and harvest index (0.0062). The similar results were reported by Selvaraj *et al*. (2011); Bhadru *et al*. (2012) and Venkanna *et al*. (2014).

Number of productive tillers per plant :

Productive tillers per plant which exhibited a phenotypic positive direct effect on grain yield per plant (0.0425). Positive low level of indirect effect was exerted on grain yield per plant by number of productive tillers

Table 2 : Estimates of phenotypic (P) and genotypic (G) path co-efficient analysis of yield and yield contributing characters in rice

Characters		Days to 50% flowering	Plant height (cm)	No. of productive tillers/plant	Panicle length (cm)	No. of grains per panicle	Spikelet fertility (%)	Biomass (g)	Harvest index (%)	Grain yield/plant (g)
Days to 50% flowering	P	0.0280	-0.0109	-0.0033	-0.0109	-0.0057	0.0072	0.0049	-0.0057	-0.0812
	G	0.0264	-0.0132	-0.0042	-0.0114	-0.0065	0.0083	0.0056	-0.0061	-0.0911
Plant height(cm)	P	-0.0109	0.0280	0.0055	0.0128	0.0058	-0.0090	-0.0003	0.0062	0.3268 **
	G	-0.0007	0.0013	0.0003	0.0007	0.0004	-0.0004	0.0001	0.0003	0.3681**
Number of productive	P	-0.0050	0.0083	0.0425	0.0155	0.0149	-0.0152	0.0026	0.0078	0.3633 **
tillers / plant	G	-0.0001	0.0001	0.0006	0.0003	0.0003	-0.0003	0.0001	0.0002	0.4421**
Panicle length (cm)	P	-0.0193	0.0227	0.0180	0.0493	0.0340	-0.0273	0.0101	0.0077	0.4711**
	G	-0.0354	0.0405	0.0354	0.0818	0.0701	-0.0497	0.0268	0.0141	0.5796 **
Number of	P	0.0036	-0.0037	-0.0063	-0.0124	-0.0180	0.0084	-0.0051	-0.0027	0.5323 **
grains/panicle	G	0.0029	-0.0032	-0.0049	-0.0101	-0.0118	0.0064	-0.0046	-0.0020	0.6327**
Spikelet fertility (%)	P	0.0122	-0.0153	-0.0171	-0.0263	-0.0222	0.0476	-0.0099	-0.0047	-0.3540**
	G	0.0157	-0.0142	-0.0200	-0.0302	-0.0270	0.0496	-0.0132	-0.0053	-0.3878**
Biomass(g)	P	0.1935	-0.0110	0.0663	0.2254	0.3119	-0.2282	1.1004	-0.7995	0.0853
	G	0.2090	0.0610	0.0930	0.3197	0.3801	-0.2592	0.9754	-0.6617	0.0874
Harvest index (%)	P	-0.2834	0.3088	0.2577	0.2177	0.2114	-0.1374	-1.0174	1.4002	0.6093**
	G	-0.3089	0.2958	0.3418	0.2289	0.2271	-0.1426	-0.9028	1.3308	0.6701**

* and ** indicate significance of values at P=0.05 and 0.01, respectively; P- Phenotypic level; G- Genotypic level

per plant through plant height (0.0083), panicle length (0.0155), and number of filled grain per panicle (0.0149), biomass (0.0026) and harvest index (0.0078). Number of productive tillers per plant had indirect negative effect on grain yield through days to 50 per cent flowering and spikelet fertility. These results are in agreement with the earlier reports of Babu *et al.* (2012); Kumar and Senapathi (2013); Naseem *et al*. (2014) and Rao *et al.* (2014) .

Panicle length (cm) :

Panicle length had direct positive phenotypic effect (0.0493) on grain yield per plant and the correlation was positive. Positive low level of indirect effect was exerted on grain yield per plant by panicle length through plant height (0.0227), number of productive tillers per plant (0.0180), number of filled grains per panicle (0.0340), biomass (0.0101) and harvest index (0.0077). Panicle length had indirect negative effect on grain yield through days to 50 per cent flowering and spikelet fertility. Positive direct effect of panicle length on yield in the present study is in conformity with the results of Chakraborty *et al*. (2010); Selvaraj *et al*. (2011); Bhadru *et al*. (2012) and Venkanna *et al*. (2014).

Number of grains per panicle :

Number of grains per panicle had direct phenotypic negative effect (-0.0180) on grain yield per plant. Indirect positive influence of number of grains per panicle on grain yield was observed through spikelet fertility and indirect negative influence through plant height, number of productive tillers, panicle length, biomass, harvest index. Yadav *et al*. (2010); Selvaraj *et al*. (2011); Naseem *et al*. (2014) and Rao *et al.* (2014) reported positive direct effect of number of filled grains per panicle on grain yield per plant.

Spikelet fertility

Spikelet fertility showed direct positive phenotypic effect (0.0476) on grain yield per plant. Spikelet fertility exhibited positive indirect effect on grain yield through days to 50 per cent flowering. Indirect negative influence of spikelet fertility on grain yield was observed through plant height, number of productive tillers, panicle length, number of grains per panicle biomass, harvest index. Similar to present results Fiyaz *et al*. (2011); Padmaja *et al*. (2011); Basavaraja *et al*. (2011); Sharma *et al*. (2012) and Hasan *et al*. (2013) also reported positive direct effect of spikelet fertility on grain yield per plant.

Biomass :

Biomass showed direct positive phenotypic effect (1.1004) on grain yield per plant. Biomass exhibited positive indirect effect on grain yield through days to 50 per cent flowering, number of productive tillers per plant, panicle length, number of grains per panicle. indirect negative influence of spikelet fertility on grain yield was observed through plant height and harvest index. Similarly Dwivedi *et al*. (2012); Fiyaz *et al*. (2011); Nikhil *et al*. (2014); Venkanna *et al*. (2014); Panwar and Ali (2007) and Reddy *et al.* (2008) also reported positive direct effect of biomass on grain yield per plant.

Harvest index :

Harvest index had high direct phenotypic positive effect (1.4002) on grain yield per plant. Indirect positive influence of harvest index on grain yield was observed through plant height, number of reproductive tillers, panicle length, grains per panicle and indirect negative influence through days to 50 per cent flowering, spikelet fertility and biomass. Similar results were reported by Dwivedi *et al*. (2012); Nikhil *et al*. (2014) and Fiyaz *et al*. (2011).

Conclusion :

A critical analysis of both character association and path analysis is among the yield components were investigated, number of grains per panicle, harvest index and biomass are important, as the correlation co-efficients as well as the direct effects were high. Another important character to be considered simultaneously for high yield is the panicle length, however, length of panicle always never yields higher because of loosely packed spikelets and selection should be for compact and dense spikelets.

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