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Correlation and Path Coefficient Studies in F_2 Populations of Rice

Ghaffar KIANI* , Ghorbanali NEMATZADEH

*Sari Agricultural Sciences and Natural Resources University, Department of Agronomy and Plant Breeding, P.O. Box 578, Sari, Iran; ghkiani@gmail.com (*corresponding author)*

Abstract

This study performed to determine the association between grain yield and yield components in fifty-four selected rice genotypes at F_2 populations. Results showed that traits, the panicles per plant (r = 0.751) and filled grains per panicle (r = 0.458) correlated significantly with grain yield, while grain yield was negatively associated with non-filled grains per panicle (-0.297). Path coefficient analysis revealed that grain yield was associated with panicles per plant and filled grains per panicle with the direct effects of 0.691 and 0.568, respectively. The greatest indirect effect belonged to panicle length (0.301) through filled grains per panicle. Stepwise regression analysis showed that 72.1 percent of yield variation could be explained by three characters: the panicles per plant, filled grains per panicle and panicle length. Information obtained in this study revealed that traits, the panicles per plant and filled grains per panicle, could be used as selection criteria for grain yield improvement at segregating populations of rice.

Keywords: association, path analysis, rice, yield, yield components

Introduction

Rice is the staple food for about 2.5 billion of world's population which may escalate to 4.6 billion by the year 2050 (Maclean, 2002). Also it is a staple food for Iranian consumers after wheat. Yield is a complex entity and inheritance of yield depends on a number of characters which are often polygenic in nature and are highly affected by environmental factors (Nadarajan and Gunasekaran, 2005).

Selection of promising genotypes, in a breeding program, is based on various criteria, most importantly final crop yield and its quality (Kozak *et al.,* 2008). Relationships between yield and yield contributing traits also play an important role in plant breeding. To detect traits, having an influence on a final traits (e.g. yield), path analysis is commonly applied (Kozak and Kang, 2006; Popovic *et al.,* 2006; Shipley, 2002). The path coefficient analysis provides information on internal relation among the investigated characteristics, as well as their effect on certain traits. The path coefficient is a standardized partial regression coefficient that measures the direct influence of one trait upon another and permits the separation of a correlation coefficient into components of direct and indirect effects (Board *et al.,* 1997). The traits influencing yield may directly or indirectly affect each other and for the purpose of breeding programs, they should be subject to separate analysis.

The relationship between yield and its main economic components, in segregating populations of rice, has been studied by several researchers (Basavaraja *et al.,* 1997; Kumar *et al.,* 2009; Reddy and Ramachandraiah, 1990; Surek and Beser, 2005; Yogameenakshi and Vivekanandan, 2010). The information on relative direct and indirect contribution of each component character toward yield will help breeders to formulate the effective criteria in selecting desirable genotypes in early segregating populations. In view of this, the present study was planned to determine the correlation and path coefficients of yield and yield contributing characters by using F_2 generations of two crosses performed on rice.

Materials and methods

Crosses between 'DN-33-18' as female parent with either of 'IR60819' and 'IR58110' were made in 2009. Then F_1 seeds were self-pollinated to obtain F_2 populations in 2010. Thirty-day-old seedlings of F_2 populations ('DN-33-18'/'IR60819' and 'DN-33-18'/'IR60819') transplanted in cropping season of 2011 each population consisted of 500 individuals with 25×25 cm planting pattern (a single plant per hill). NPK fertilizers applied at the rate of 200, 100 and 50 Kg/ha, respectively.

Up to 54 superior genotypes were selected based on phenotypic performance in studied F_2 populations and important agronomic traits like, plant height (cm), panicles per plant, filled grains per panicle, non-filled grains per panicle, panicle length (cm), 1000-grain weight (g), grain length (mm), grain width (mm) and grain yield/plant (g) were recorded on those genotypes based on the standard evaluation system (SES) of rice (IRRI, 2002).

Statistical analyses, including estimation of descriptive statistics and coefficient of correlation performed using SPSS version 14 statistical package. Coefficient of correla-

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tion was partitioned into path coefficient using the technique outlined by Dewey and Lu (1959).

Results and discussion

The success of plant breeding programs relies heavily on the existence of genetic variability in crops for a particular trait. Estimates for range, mean, standard deviation and coefficient of variation (CV) for selected genotypes in F_2 populations are shown in Tab. 1. Maximum standard deviation belonged to filled grains per panicle (34.08) followed by grain yield (22.47) and non-filled grains per panicle (15.74). Amongst agronomic traits, non-filled grains per panicle, panicles per plant, grain yield and filled grains per panicle with the CVs of 61.85, 30.87, 28.85 and 23.69 percent had more phenotypic variations, respectively. While grain length and grain width had less variation. Plant breeder uses selection for improving the architecture of a crop by management of available genetic variability (Gravois and McNew, 1993; Mehetre *et al.,* 1994). This study reveals the possibility of effective selection for improvement of yield and its important components in subsequent segregating populations.

The degree of correlation among characteristics is an important factor, especially regarding economic and complex characteristics such as yield direct selection, which shows low effectiveness. Hence, association analysis was undertaken to determine the direction of selection and number of characteristics to be considered in improving grain yield. Correlation coefficients of studied traits (Tab. 2) showed that there was a highly significant correlation between grain yield with panicles per plant and filled grains per panicle ($p<0.01$). A strong correlation of grain yield with these traits indicated that, simultaneous improvement of these traits is possible. Previous studies have mentioned similar findings (Abarshahr *et al.,* 2011; Lanceras *et al.,* 2004; Muhammed *et al.,* 2007; Samonte *et al.,* 1998). Panicle length had a strong and significant positive association with filled grains per panicle (r= 0.530)

Tab. 1. Descriptive statistics for agronomic traits in fifty-four rice genotypes

Traits	Range	Mean	Standard deviation	Coefficient of variation (%)
PH	110-153	122.00	7.85	6.43
PP	10-36	19.24	5.94	30.87
PL	28.2-36.7	32.04	2.01	6.28
TGW	17-37	25.16	3.25	12.92
GL	8.94-11.22	10.28	0.59	5.74
GW	1.96-2.62	2.30	0.14	6.09
FGP	70-234	143.85	34.08	23.69
NFG	4.54-68.48	25.45	15.74	61.85
GY	45.4-167.3	77.88	22.47	28.85

PH= plant height, PP= panicles per plant, PL= panicle length, TGW= 1000-grains weight, GL= grain length, GW= grain width, FGP= filled grains per panicle, NFG= non-filled grains per panicle, GY= Grain yield/plant

Tab. 2. Correlation coefficients between traits in fifty-four rice genotypes

Traits	PH	PP	PL	TGW	GL	GW	FGP	NFG	GY
PH	1	0.022	0.024	-0.039	-0.117	0.158	-0.214	0.276*	-0.056
PP	0.022	1	0.083	0.154	0.034	0.073	0.133	-0.174	0.751**
PL	0.024	0.083	1	-0.085	-0.045	-0.356**	0.530**	0.194	0.115
TGW	-0.039	0.154	-0.085	1	0.238	0.434**	-0.090	-0.115	0.203
GL	-0.117	0.034	-0.045	0.238	1	-0.256	-0.193	-0.026	-0.023
GW	0.158	0.073	-0.356**	0.434**	-0.256	1	-0.157	-0.228	0.117
FGP	-0.214	0.133	0.530**	-0.090	-0.193	-0.157	1	-0.395**	0.458**
NFG	0.276*	-0.174	0.194	-0.115	-0.026	-0.228	-0.395**	1	-0.297*
GY	-0.056	0.751**	0.115	0.203	-0.023	0.117	0.458**	-0.297*	1

* Correlation is significant at the 0.05 level, ** Correlation is significant at the 0.01 level PH= plant height, PP= panicles per plant, PL= panicle length, TGW= 1000-grains weight, GL= grain length, GW= grain width, FGP= filled grains per panicle, NFG= non-filled grains per panicle, GY= Grain yield/plant

Tab. 3. Direct (diagonal) and indirect effects of studied traits on grain yield in fifty-four rice genotypes

Traits	PH	PP	PL	TGW	GL	GW	FGP	NFG	Correlation with grain yield
PH	0.025	0.015	-0.006	-0.004	-0.009	0.006	-0.122	0.031	-0.057
PP	0	0.691	-0.020	0.015	0.002	0.002	0.075	-0.020	0.750
PL	0	0.057	-0.233	-0.009	-0.004	-0.014	0.301	0.022	0.115
TGW	-0.001	0.106	0.019	0.102	0.017	0.016	-0.052	-0.014	0.202
GL	-0.003	0.023	0.010	0.024	0.074	-0.010	-0.110	-0.003	-0.024
GW	0.004	0.05	0.082	0.044	-0.020	0.038	-0.090	-0.026	0.116
FGP	-0.006	0.092	-0.124	-0.010	-0.015	-0.007	0.568	-0.045	0.458
NFG	0.007	-0.121	-0.046	-0.012	-0.002	-0.009	-0.225	0.113	-0.297

Residual effect, R= 0.504; PH= plant height, PP= panicles per plant, PL= panicle length, TGW= 1000-grains weight, GL= grain length, GW= grain width, FGP= filled grains per panicle, FG= non-filled grains per panicle

Tab. 4. Stepwise regression for selection of traits explaining variation of rice grain yield

Model	Traits	R^2 Relative	R^2 Cumulative	Mean square	Constant	Regression coefficient of traits
1	PP	56.4	56.4	15108.66**	23.19	2.67**
2	FG	13.1	69.5	9298.38**	-7.83	0.306**
3	PL	2.6	72.1	6429.77**	50.34	-2.12*
ŷ = 50.34 + 2.67 (PP) + 0.306 (FG)-2.12 (PL)						

* Significant at the 0.05 level, ** significant at the 0.01 level

PP= panicles per plant, FG= filled grains per panicle, PL= panicle length

while it was negatively correlated with grain width (r=-0.356). The correlation of 1000-grain weight exhibited positive and significant correlation with grain width (r= 0.434) (Tab. 2). It suggests that, priority should be given to these traits while making selection for yield improvement study.

Path coefficient analysis of yield components revealed that panicles per plant had the highest direct positive effect (0.691) on grain yield (Tab. 3). High direct positive effect of this character was nullified by the negative indirect effect of panicle length and non-filled grains per panicle (-0.02), however its indirect effect via filled grains per panicle was high (0.075), bringing the total correlation to r = 0.750 with grain yield (Tab. 3). Results on importance of direct effect of panicles per plant were reported by several researchers (Bagheri *et al.,* 2011; Kumar, 1992; Madhavilatha *et al.,* 2005; Yadav and Bhushan, 2001; Yogameenakshi and Vivekanandan, 2010).

The number of filled grains per panicle showed to be the second most important trait; it showed high direct positive effect (0.568) on grain yield. Its indirect effect via panicles per plant was high (0.092), whereas its effect via panicle length and non-filled grains per panicle was negative (-0.124 and-0.045). In many researches the filled grains per panicle has been reported as effective trait with the highest direct effect on grain yield improvement (Bagheri *et al.,* 2011; Ram, 1992; Sundaram and Palanisamy, 1994; Samonte *et al.,* 1998).

The direct effect of panicle length on grain yield was negative (-0.233) but it showed high indirect positive effect on it through the filled grains per panicle (0.301) and panicles per plant (0.057), while the negative force of this character was grain width (-0.014).

The traits (plant height, panicles per plant, 1000-grain weight, grain length, grain width, filled grains per panicle and non-filled grains per panicle) had a direct effect on yield if other traits were kept constant. But the magnitude of direct effect of the panicles per plant was high followed by filled grains per panicle, confirming the results of Basavaraja *et al.* (1997) and Kole *et al.* (2008). Then, appropriate selection indices should be formulated using these traits for yield improvement. The residual effect was 0.504, which indicated that the contribution of component traits on grain yield was 74.60 percent by eight traits studied in path analysis.

In this study a stepwise regression model was used to facilitate the interpretation of grain yield (Tab. 4). There was a significant linear relationship between grain yield (ŷ) with panicles per plant (PP), filled grains per panicle (FG) and panicle length (PL). The following model was obtained:

$$\hat{y} = 50.34 + 2.67\ (PP) + 0.306\ (FG) - 2.12\ (PL)$$

The panicles per plant had the highest R^2 percent and explained 56.4% from total variations relative to grain yield (Tab. 4). Also this trait had the highest direct positive effect (0.691) and the highest correlation coefficient (r = 0.750) with grain yield. Filled grains per panicle together with panicle length explained 15.7 percent of grain yield variation. These results showed that regression analysis agreed with path analysis in this study (Ezeaku and Mohammed, 2006).

Conclusions

In summary, the results of this investigation indicated that the panicles per plant and filled grains per panicle could be considered as critical criteria for yield improvement in segregating generations of rice.

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