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Correlation between morphological and physiological traits and path analysis of grain yield in rice genotypes under Khuzestan conditions

Marzieh Moosavi*, Gholamali Ranjbar*, Hamid Najafi Zarrini* and Abdolali Gilani*

**Plant Breeding and Biotechnology Department,*
Sari Agricultural Sciences and Natural Resources University, Mazandaran, IRAN
***Khuzestan Agricultural Research Center, Khuzestan, IRAN*

(Corresponding author: Marzieh Moosavi)
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ABSTRACT: This experiments was to determine causal relationships of morphological and physiological traits, and also analysis of relationships between grain yield as dependent trait and morphological and physiological traits as independent traits in order to breeding of rice genotypes that can be tolerant to warm conditions in Khuzestan. In this study was conducted on 30 breeding lines of rice in a CRBD design with two replications at the Agricultural Research Station Shaoor, Khuzestan province of Iran, in 2014. The results of correlation among measured traits showed that the correlation between grain yield per plant and number of panicles (r = 0.55) was the highest. Stepwise regression for grain yield as dependent variable (Y) and other traits as independent variables (X) showed that panicle number, harvest index, dry weight and panicle length were able to explain a large portion of the variance (R^2 = 0.65).Due to high levels of direct effects of harvest index and number of panicles (0.6 and 0.565, respectively) and also significant correlation between these traits with grain yield per plant, these traits can be used as indicators for indirect selection of grain yield.

Keywords: Rice, correlation, stepwise regression, path analysis

INTRODUCTION

Rice is one of the most important cereal crops and provides the staple food for about half of the world's population especially for people in developing countries (Wu *et al.*, 2013).Yield component traits increasing grain yield (directly or indirectly) if they are highly heritable and positively correlated with grain yield (Hasan *et al.*, 2013). Since genetic gain in yield potential of crops is more difficult to achieve in a breeding program, breeders have applied indirect selection for yield based on plant traits (Yuan, *et al.*, 2011).

In spite of some studies such as Gravois and McNew (1993) that reported that selection for panicle weight and number alone was unsuccessful in increasing rice grain yield, compared with selection for yield *per se*, many researchers reported that indirect selection for yield based on yield components was more efficient than direct selection for yield on several crop species (Takeda and Frey, 1976; Kumar and Bahl, 1992; Saadalla, 1994; Totok *et al.*, 1998).

Plant breeders usually select for yield component traits which indirectly increase yield. The relationship between rice yield and its contributing characters has been studied widely at phenotypic level (Akinwal *et al.*, 2011). The grain yield is a complex trait, quantitative in nature and a combined function of a number of constituent traits. Consequently, selection for yield *per se* may not be much satisfying unless other yield component traits are taken into consideration (Satheeshkumar and Saravanan, 2012).

Understanding of correlation between yield and yield components are basic and fore most effort to find out strategies for plant selection. Separation of total correlation into direct and indirect effect by path analysis benefits in creating the selection more effective (Hasan *et al.*, 2013).

The present investigation undertaken to determine causal relationships of morphological and physiological traits, and also analysis of relationships between grain yield and morphological and physiological traits in order to breeding of rice genotypes that can be tolerant to warm conditions in Khuzestan.

MATERIAL AND METHODS

In this study was conducted on 30 breeding lines of rice at the Agricultural Research Station Shavur, Khuzestan province of Iran (longitude 48°28″ and latitude 31°50″ with 33 m above sea level), in 2014.

Thirty breeding lines of rice (Table 1) were obtained from International Rice Research Institute (IRRI) and performed in a completely randomized block design with two replications. The common agronomical practices and plant protection measures were followed to obtain a normal plant. Total nutrient input was 250 kg/ha urea, 50 kg/ha ammonium phosphate, 100 kg/ha sulphate potassium and 40 kg/ha zinc sulphate. Cultural practices and weed control were done manually. At the three or four-leaf stage, seedlings were transplanted into the experimental site with 20 cm × 20 cm spacing. A seven-row plot with size of 1.4 m × 5 m was used.

Nine traits *viz.* plant height (cm), panicle length (cm), spikelet fertility, 1000 grain weight (g), grain yield per plant (g), Number of primary branches, panicle weight, panicle number and harvest index were recorded evaluated based on standard evaluation system rice (IRRI, 2002).

Statistical analysis including correlation coefficients, stepwise regression and path analysis was done using SPSS (version 22) software.

Table 1: List of rice genotypes used in this study.

Genotype number	Genotype code	Genotype name	Genotype number	Genotype code	Genotype name
1	21	IR 95675-4-3	16	303	IR 96067-23-3
2	30	IR 95676-44-3	17	327	IR 96069-5-3
3	40	IR 95677-13-1	18	335	IR 96069-17-2
4	53	IR 95677-43-2	19	366	IR 96069-39-3
5	54	IR 95677-43-3	20	346	IR 96070-6-1
6	68	IR 95677-76-2	21	345	IR 96070-71-3
7	70	IR 95677-79-1	22	394	IR 96072-8-1
8	80	IR 95677-97-2	23	414	IR 96073-15-3
9	82	IR 95679-2-1	24	416	IR 96073-21-2
10	93	IR 95679-43-3	25	425	IR 96073-37-2
11	191	IR 95687-33-2	26	426	IR 96073-37-3
12	237	IR 95694-42-3	27	427	IR 96073-41-1
13	251	IR 95694-61-2	28	436	IR 96074-17-1
14	284	IR 95696-40-2	29	465	IR 96074-53-3
15	295	IR 96067-14-1	30	334	IR 96069-17-1

RESULTS AND DISCUSSION

A. Correlation

The degree of correlation between the traits is a key factor especially in complex and economic trait such as yield (Akinwale *et al.,* 2011). The result of correlation analysis (Table 2) reveals that grain yield exhibits the highest significantly positive correlation with panicle number (r = 0.55**). Therefore, this trait is a suitable factor for indirect selection of grain yield. Also, harvest index exhibits the significantly positive correlation with grain yield (r = 0.37*).

The observed positive correlation of grain yield with various traits was supported by earlier researchers such as Sharma and Dubey (1997) for panicle length; Basavaraja *et al.* (1997) for plant height; Chakraborty *et al.* (2001) for 100 seed weight; Ismail and Alvarez (1986), Rao and Srivastava (1999) and Rajeshwari and Nandrajan (2004) for number of filled grains per panicle.

Azarpour (2013) reported that grain yield in rice had significant and positive correlation at 1% with panicle weight (r = 0.96) and biological yield (r = 0.71).

Table 2: Correlation of traits in 30 rice genotypes.

	Panicle length	Number of primary branches	Panicle weight	Panicle number	Grain yield/plant	Plant height (cm)	1000 grain weight	Fertility percentage	Harvest index
Panicle length	1								
Number of primary branches	0.3ns	1							
Panicle weight	0.3ns	0.21 ns	1						
Panicle number	-0.12 ns	0.09 ns	-0.08 ns	1					
Grain yield/plant	0.13 ns	-0.06 ns	-0.16 ns	0.55**	1				
Plant height (cm)	0.42*	0.24 ns	0.57**	-0.26 ns	-0.21 ns	1			
1000 grain weight	0.18 ns	0.16 ns	-0.07 ns	-0.47**	-0.27 ns	0.25 ns	1		
Fertility percentage	-0.22 ns	0.04 ns	-0.2 ns	-0.17 ns	0.09 ns	-0.24 ns	0.11 ns	1	
Harvest index	-0.21 ns	-0.12 ns	-0.32 ns	-0.06 ns	0.37*	-0.361*	-0.26 ns	0.446*	1
Dry weight of plant	0.15 ns	0 ns	0.1 ns	0.14 ns	0.37*	0.09 ns	-0.08 ns	-0.35 ns	-0.389*

* = significant at P<0.05; ** = significant at P<0.01; ns = non-significant.

B. Stepwise regression

Stepwise regression for grain yield as dependent variable (Y) and other traits as independent variables (X) showed that panicle number, harvest index, dry weight and panicle length were able to explain a large portion of the variance ($R^2 = 0.65$).

As shown in Table 3 and 4, a stepwise regression model was used to facilitate the understanding of grain yield. There was significant linear relationship between grain yield (y) with panicle number (X_1), harvest index (X_2), dry weight of plant (X_3) and panicle length (X_4). The regression model as follow:

$$Y = 0.749\ X_1 + 0.768\ X_2 + 0.037\ X_3 + 2.12\ X_4$$

Bagheri *et al.* (2011) reported that there was significant linear relationship between yield (y) and panicle length (X6) and the number of panicle per plant (X_1) and the number of filled grain per panicle (X10) in rice (*Oryza sativa* L.) genotypes.

C. Path analysis

The result of Path coefficient analysis (Table 5) showed that harvest index had the maximum direct effect (0.600) on yield followed by Panicle number (0.565), dry weight of plant (0.354) and panicle length (0.267).

Table 3: Stepwise regression models.

Model number	R	R^2	Adjusted R^2	Estimated SE	F
1	0.546	0.298	0.273	9.18749	11.87**
2	0.679	0.462	0.422	8.19356	11.57**
3	0.764	0.583	0.535	7.34512	12.13**
4	0.806	0.650	0.594	6.86805	11.59**

1: (constant), panicle number

2: (constant), panicle number, harvest index

3: (constant), panicle number, harvest index , dry weight of plant

4: (constant), panicle number, harvest index, dry weight of plant, panicle length

Dependent variable: grain yield

Table 4: Stepwise regression related to model number 4.

	B	Standard Error	Beta	t	Pro.
constant	-49.810	24.987		-1.993	0.057
Panicle number	0.749	0.160	0.565	4.675	0.000
harvest index	0.768	0.167	0.600	4.598	0.000
dry weight of plant	0.037	0.014	0.354	2.722	0.012
panicle length	2.120	0.974	0.267	2.177	0.039

Table 5: Path analysis showing direct and indirect effects of four traits on yield in 30 rice genotypes.

Traits	direct effects	indirect effects				Correlation with grain yield
		Panicle number	harvest index	dry weight of plant	panicle length	
Panicle number	0.565		-0.03279	0.077009	-0.06894	0.55**
harvest index	0.600	-0.03482		-0.2334	-0.12751	0.37*
dry weight of plant	0.354	0.04825	-0.13771		0.054317	0.37*
panicle length	0.267	-0.03258	-0.05674	0.040968		0.13ns

* = significant at P<0.05; ** = significant at P<0.01; ns = non-significant.

Bagheri *et al.* (2011) indicated that panicle length had the highest positive direct effect (0.510) on grain yield. They also reported grain yield linearly correlated with panicle length, the number of panicle per plant, and the number of filled grains per panicle.

Results of Azarpour (2013) study showed that coefficient analysis showed that, number of grain and number of panicle had the highest and positive effect on grain yield.

When many traits are affecting an assumed character, splitting the total correlation into direct and indirect effects of cause would give more meaningful understanding to the cause of association between the dependent trait like yield and independent trait like yield component traits (Nandan *et al.*, 2010).

Due to high levels of direct effects of harvest index and number of panicles (0.6 and 0.565, respectively) and also significant correlation between these traits with grain yield per plant. This may indicate that the direct selection for harvest index and panicle number would likely be effective in increasing grain yield.

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