The Journal of Animal & Plant Sciences, 21(4): 2011, Page: 660-664
ISSN: 1018-7081

ESTIMATION OF HERITABILITY, CORRELATION AND PATH COEFFICIENT ANALYSIS IN FINE GRAIN RICE (*Oryza sativa* L.)

N. Akhtar, M. F. Nazir, A. Rabnawaz*, T. Mahmood**, M. E. Safdar, M. Asif and A. Rehman

University College of Agriculture, University of Sargodha, Sargodha, Pakistan
*Rice Research Institute Kala Shah Kaku, Punjab, Pakistan
**PMAS Arid Agriculture University, Rawalpindi, Pakistan
Corresponding author: naeem.uca@gmail.com

ABSTRACT

Yield contributing traits in ten rice genotypes were studied for variances, heritability, correlation (genotypic and phenotypic) and path coefficient analysis. The heritability was found to be highest for number of grains panicle^{-1}, days to maturity, plant height and paddy yield while lowest for number of tillers plant^{-1}. Paddy yield had strong genetic correlation with number of grains panicle^{-1}, days to maturity and 1000-grain weight. Genotype PK4831-6-1 produced highest paddy yield (5.1 t ha^{-1}), number of grains panicle^{-1} (144) as well as higher 1000-grain weight (25.56 g) whereas PK7909-27-1 and PK7378-4-1-1-1 achieved higher plant heights (162.5 cm and 148.6 cm, respectively) and spent longer growth duration (112 days) to reach maturity. Super Basmati produced highest number of tillers plant^{-1} (20) but lowest paddy yield (3.1 t ha^{-1}). Regression analysis revealed that paddy yield had significant positive correlation with number of grains panicle^{-1} (b = 0.0164) and 1000-grain weight (b = 0.1356). It can be concluded that number of grains panicle^{-1}, 1000-grain weight and days to maturity are important plant traits which should be considered when any breeding program for higher paddy yield in rice is to be planned.

Key words: Correlation, fine rice, heritability, yield components

INTRODUCTION

Grain yield, being a quantitative trait is a complex character of any crop. Various morphological and physiological plant characters contribute to yield. These yield contributing components are interrelated with each other showing a complex chain of relationship and also highly influenced by the environmental conditions (Prasad *et al*., 2001). Breeding strategy in rice mainly depends upon the degree of associated characters as well as its magnitude and nature of variation (Zahid *et al*., 2006; Prasad *et al*., 2001). For selection in rice, information on correlation coefficient always has been helpful as a basis for selection in a breeding programme. Path coefficient analysis partitions into direct and indirect matrix presenting correlation in a more meaningful way (Mohsin *et al*., 2009). The present research study was conducted to find out the genetic variability among different plant traits, direct and indirect contribution of these parameters towards paddy yield and to identify better combinations as selection criteria for developing high yielding fine rice genotypes.

MATERIALS AND METHODS

The research study was conducted at Rice Research Institute Kala Shah Kaku, Lahore, Pakistan for two years i.e. during summer seasons of 2009 to 2010. The nursery of eight uniform fine grain rice genotypes viz., PK4831-6-1, PK8644-1-1, PK8535-4-2, 99417, PK7378-4-1-1-1, PK7705-4-1-1-1, PK7705-4-1-1-1-1, PK7909-27-1 along with two standard varieties (Super basmati and Basmati 2000) were sown during the month of June each year. The nursery was raised by conventional method which included 24 h seed soaking followed by 48 h incubation for seed sproutening then broadcasting of sprouted seed in the puddled soil. The seed rate was kept 10 kg ha^{-1}. Thirty days old nursery was transplanted in the field with a plant spacing of 22.5 cm x 22.5 cm during both the years. The experiment was laid out In Randomized Complete Block Design (RCBD) with three replications.

At maturity, data on 10 random plants from each replication were recorded for number of grains panicle^{-1}, number of tillers plant^{-1}, plant height, 1000-grain weight, days to maturity and paddy yield. The data were subjected to analysis of variance and covariance through the procedure outlined by Steel *et al*., (1997) in randomized complete block design (RCBD). Genetic and phenotypic correlation coefficients were calculated as outlined by Known and Torrie (1964) and means of both years (2009 & 2010) of each character were compared by Duncan's Multiple Range (DMR) test. The present study with eight promising lines including two check varieties of *Oryza sativa* L. was carried out to find the interrelationship between different yield contributing factors for developing new varieties with better combinations of these traits.

RESULTS AND DISCUSSION

Yield and yield related traits: Mean squares for analysis of variance (ANOVA) of paddy yield and yield contributing traits are given in Table 1. All the six plant parameters studied were significantly affected by the rice genotypes, indicating that all rice genotypes including standard varieties differed with each other in respect to their plant traits.

Means of paddy yield and yield related traits of rice genotypes studied are presented in figures 1, 2 and 3. Data presented in figure 1 revealed that PK7909-27-1 gained maximum plant height (162.5 cm) which was statistically at par with that recorded in 99417, PK7705-4-1-1-1-1, PK7705-4-1-1-1 and PK7378-4-1-1-1. However, the minimum plant height (125.7 cm) was observed in Super Basmati rice genotype. More or less similar trend can be seen with days to maturity (Figure 1) which shows that significantly highest growth duration was spent by rice genotypes PK7909-27-1 and PK7378-4-1-1-1, both of which took 112 days to reach maturity. On the other hand, PK4831-6-1 genotype was found to be of shortest growth duration as it matured only in 100 days, the other rice genotypes were proved to be of intermediate growth duration. Among all the rice genotypes studied, statistically highest number of grains panicle^{-1}(144) was produced by genotype PK4831-6-1 whereas lowest number of grains (53) by genotype PK7909-27-1 (Figure 2). As depicted in figure 2, maximum 1000-grain weight (25.81 g) was attained by rice genotype PK7705-4-1-1-1-1 which was statistically similar with that recorded in 99417, PK4831-6-1, PK8644-1-1, PK7909-27-1 and Basmati 2000. While minimum value of 1000-grain weight (21.01 g) was recorded in PK7378-4-1-1-1 rice genotype. Data regarding number of tillers plant^{-1} and paddy yield can be observed from figure 3 which revealed that maximum number of tillers plant^{-1} (20 tillers) was produced by rice cultivar Super Basmati which was not significantly different from that observed in genotypes PK7378-4-1-1-1 and PK7909-27-1. While, 99417 and PK7705-4-1-1-1-1 remained at lowest position by producing only 10 tillers plant^{-1}. The final resultant of all the yield components and ultimate objective of rice grower is the paddy yield. Paddy yield (Figure 3) unveiled that PK4831-6-1 attained statistically highest paddy yield (5.1 t ha^{-1}) whereas Super Basmati produced the lowest paddy yield which was 3.1 t ha^{-1}. The probable gain in paddy yield of PK4831-6-1 can be best explained through regression analysis of paddy yield with its positively correlated yield components i.e. number of grains panicle^{-1} and 1000-grain weight (Figures 4, a & b). Perusal of figures 4 (a & b) reveals that paddy yield has significant positive correlation with number of grains panicle^{-1} (b = 0.0164) and 1000-grain weight (b = 0.1356) suggesting that these two traits contributed to the increased paddy yield of this rice genotype. Parsad *et al* (2001) and Zahid *et al*. (2006) also found similar results.

Variance, coefficient of variation and heritability: Data of variances, coefficient of variation and broad sense heritability for characters under consideration are presented in table 2. Genotypic coefficients of variation ranged from 3.907 to 28.475 whereas phenotypic coefficient of variation ranged from 3.914 to 29.159 among various parameters studied. Highest genotypic as well as phenotypic coefficients of variation were obtained in case of number of grains panicle^{-1} followed by number of tillers plant^{-1}, paddy yield and plant height. Among these characters number of grains panicle^{-1}, number of tillers plant^{-1} and paddy yield have more than 15% variation at phenotypic level. These results are in agreement with the findings of Prasad *et al*. (2001) and Zahid *et al*. (2006) who also reported maximum variation for these plant traits. Heritability estimate is an important parameter which helps the breeder to select a plant trait that is high heritable as compared to that a trait which is less heritable. High heritability values related to days to maturity, number of grains panicle^{-1}, number of tiller plant^{-1} and plant height were obtained which indicated reasonable variation for these traits. This suggests that selection can be practiced by using these traits to improve paddy yield in rice. The results get support from the findings of Ehdaie and Waines (1989), Ayciecek and Yildirim (2006) and Mohsin *et al* (2009) who reported such type of heritability in wheat.

Correlation: The genetic and phenotypic correlation coefficients among paddy yield and yield contributing traits (Table 3) showed that most of the traits have higher genetic correlation coefficients than corresponding phenotypic correlation coefficients because the relationship was affected by environment at phenotypic level, indicated the low phenotypic correlation coefficients (Chaubey and Singh, 1994; Ojo *et al*., 2006).

Paddy yield revealed significant positive genetic association with number of grains panicle^{-1}, days to maturity and 1000-grain weight and while negative relationship with plant height both at phenotypic and genetic levels. The findings suggest that paddy yield can be improved in these rice genotypes by using these traits as selection criteria in succeeding generations. The results get conformity with the findings of Prasad *et al* (2001) and Zahid *et al*. (2006) who showed positive correlations with these traits. Plant height was found negatively correlated with number of grains panicle^{-1}, no of tillers plant^{-1} and paddy yield. Negative correlation coefficient of plant height with paddy yield indicates that tallness in rice reduces the paddy yield due to high accumulation of photosynthates in vegetative parts as compared to reproductive parts (i.e. seed formation and grain filling) and lodging susceptibility (Tahir *et al*., 1988 and Zahid *et al*., 2006).

Path analysis: Path coefficient analysis (Table 4) revealed that 1000-grain weight (0.6556) has highest positive direct effect, followed by days to maturity (0.0914) which indicated that these two traits were more contributors towards paddy yield in these rice genotypes. However, the results are in contrary with Yolanda and Das (1995) and Zahid *et al*. (2006) who reported that number of grains panicle^{-1} has highest positive direct effect followed by 1000-grain weight. Negative direct effect was found in number of grains panicle^{-1}, number of tillers plant^{-1} and plant height. Negative effect of plant height on paddy yield showed that paddy yield in fine grain rice can be increased with reduction in plant height. Thus semi dwarf genotypes will be preferred to boost up paddy yields in rice.

Number of tillers plant^{-1} has high indirect effect (0.519) through plant height and negatively with 1000-grain weight. Number of grains panicle^{-1} showed negative direct effect but positive indirect effect through number of tillers plant^{-1}, plant height and 1000-grain weight. These results indicated that getting higher number of grains panicle^{-1}, other causal factors must be considered.

Table 1: Means squares for analysis of variance of paddy yield and yield related traits in fine rice genotypes

Source of variation	DF	Number of grains panicle^{-1}	Number of tillers plant^{-1}	Plant Height (cm)	1000-grain weight (g)	Days to maturity	Paddy yield (t ha^{-1})
Replication	2	48.531	1.4333	12.312	1.428	0.109	0.172
Genotype	9	2224.68**	36.848**	503.576**	9.095**	53.274**	1.087**
Error	18	35.460	4.581	40.684	1.3888	0.0625	0.1460

** Significant at P≤ 0.01

Table 2: Genetic parameters for paddy yield and yield related traits in fine rice genotypes

Plant Traits	Variances		CV (%)		Heritability
	Genotypic	Phenotypic	Genotypic	Phenotypic	(B.S.)
Number of grains panicle^{-1}	729.740	765.200	28.475	29.159	0.954
Number of tillers plant^{-1}	10.755	15.337	21.342	25.485	0.701
Plant height (cm)	154.297	194.981	8.452	9.501	0.791
1000-grain weight (g)	2.568	3.958	6.812	8.456	0.649
Days to maturity	17.737	17.799	3.907	3.914	0.996
Paddy yield (t ha^{-1})	0.314	0.459	15.452	18.708	0.684

Table 3: Upper diagonal genetic correlation and lower diagonal phenotypic correlation in fine rice genotypes

Plant Traits	Number of grains panicle^{-1}	Number of tillers plant^{-1}	Plant height (cm)	1000-grain weight	Days to maturity	Paddy yield (t ha$^{-1)}$
Number of grains panicle^{1}		-0.6379*	-0.3029	0.6677**	-0.815**	0.8121**
Number of tillers plant^{-1}	-0.5305		-0.5946	0.9383**	0.7716**	0.2844
Plant height (cm)	-0.2734s	-0.3664		0.3461**	0.1116**	-0.4965
1000-grain weight (g)	0.5169	-0.5809	0.2277		0.8635**	0.527**
Days to maturity	-0.7941**	0.6346*	0.1009**	-0.6941*		-0.7934**
Paddy yield (t ha^{-1})	0.6234	-0.2277	-0.2284	0.2094	-0.6436*	

** Significant at P≤ 0.01

Table 4: Direct and indirect effects matrix of paddy yield and yield related traits in fine rice genotypes

Plant Traits	Number of grains panicle^{-1}	Number of tillers plant^{-1}	Plant height (cm)	1000-grain weight (g)	Days to maturity	Paddy yield (t ha-^{1})
Number of grains panicle^{-1}	**(-0.0309)**	0.1987	0.2812	0.4377	-0.0745	0.8121
Number of tillers plant^{-1}	0.0197	**(-0.3114)**	0.5519	-0.6151	0.0705	-0.2844
Plant height (cm)	0.0094	0.1852	**(-0.9282)**	0.2269	0.0102	-0.4965
1000-grain weight (g)	-0.0207	0.2922	-0.3212	**(0.6556)**	-0.0789	0.527
Days to maturity	0.0252	0.2403	-0.1036	-0.5661	**(0.0914)**	-0.7934

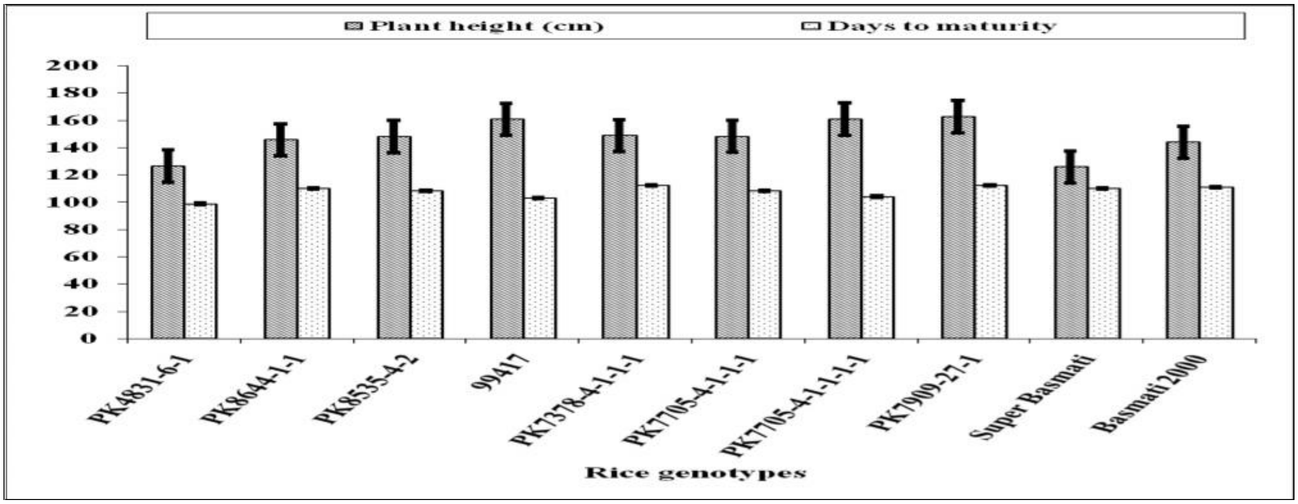

Figure 1: Comparison of plant height and growth duration of ten rice genotypes. Error bars represent least significant difference (LSD) value between genotypes with respect to corresponding parameter

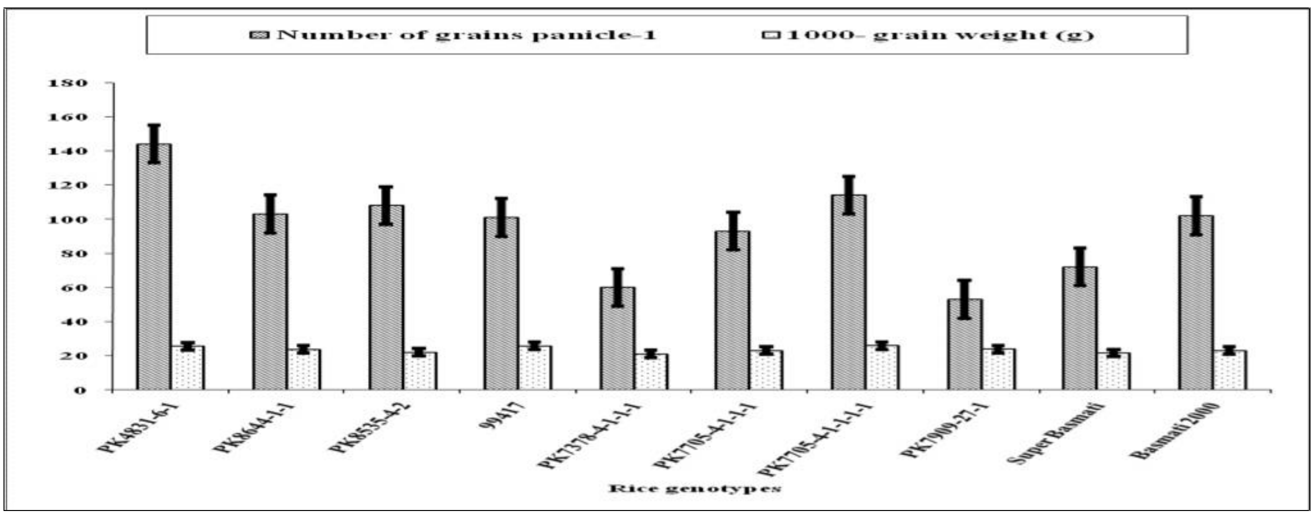

Figure 2: Comparison of grain count and grain weight of ten rice genotypes. Error bars represent least significant difference (LSD) value between genotypes with respect to corresponding parameter

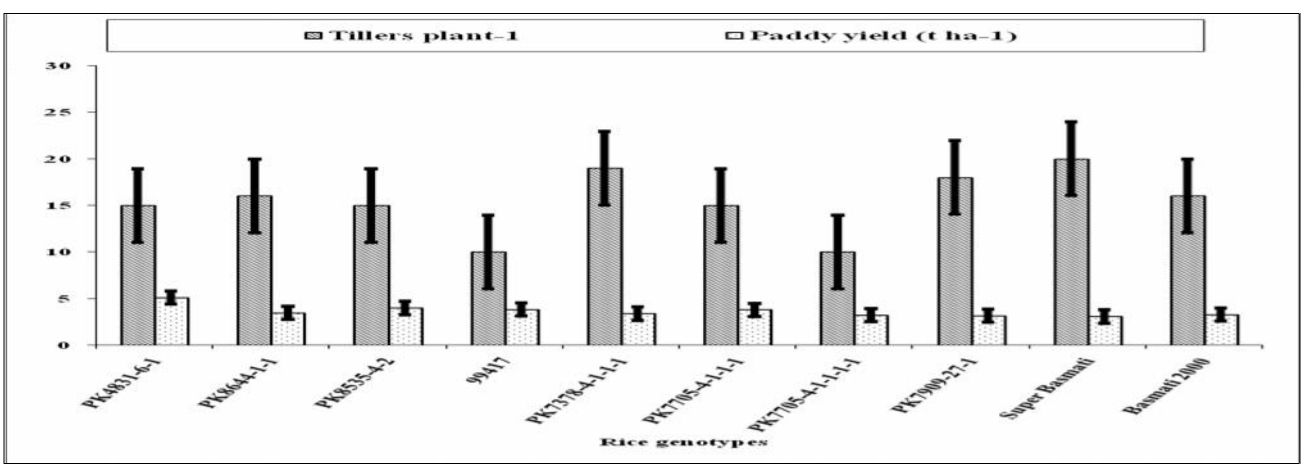

Figure 3: Comparison of grain count and paddy weight of ten rice genotypes. Error bars represent least significant difference (LSD) value between genotypes with respect to corresponding parameter.

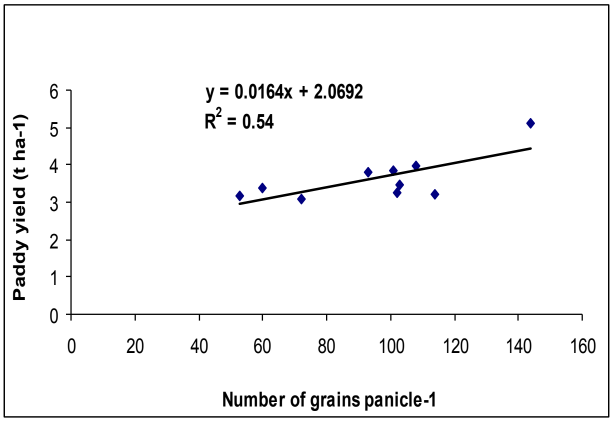

Figure 4 (a): Regression analysis of paddy yield with number of grains panicle^{-1}

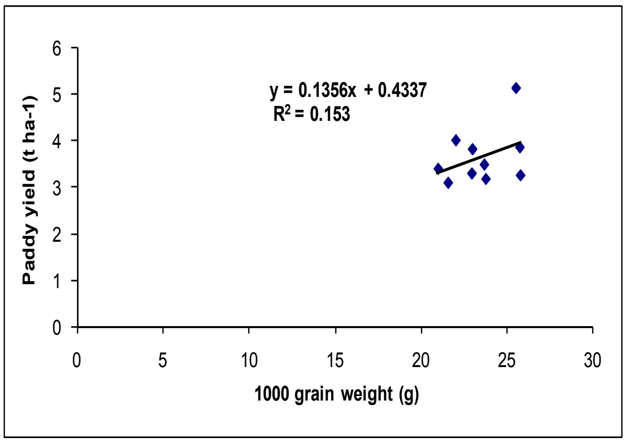

Figure 4 (b): Regression analysis of paddy yield with 1000 grain weight

Conclusion: On the basis of results as summarized above, it is concluded that number of grains panicle^{-1}, days to maturity, number of tillers plant^{-1} and 1000-grain weight have high broad sense heritability, strong genetic association and direct effect on paddy yield in studied rice genotypes. Furthermore, development of semi dwarf genotypes will be preferred to increase paddy yield in rice. Thus, these plant traits deserve greater attention in further breeding programs for developing high yielding fine grain rice.

REFERENCES

Aycicek M. and T. Yildirim (2006). Heritability of yield and some yield components in bread wheat (*Triticum aestivum* L.) genotypes. *Bangladesh J. Botany* 7-22.

Chaubey P. K. and R. P. Singh (1994). Genetic variability, correlation and path analysis of filled components in rice. *Madras Agri. J.,* 81: 438-470.

Ehdaie B. and J. G. Waines (1989). Genetic variation, heritability and path-analysis in landraces of bread wheat from South Western, Iran. *Euphytica* 41: 183-190.

Kwon S. H. and J. H. Torrie (1964). Heritability and interrelationship of traits of two soybean populations. *Crop Sci.,* 4: 196-198.

Mohsin T, N. Khan and F. N. Naqvi (2009). Heritability, phenotypic correlation and path coefficient studies for some agronomic characters in synthetic elite lines of wheat. *J. Food, Agri. and Envi.,* 7: 278-282.

Ojo D. K, O. A. Omikunle, M. O. Ajala and S. A. Ogunbayo (2006). Heritability, character correlation and path coefficient analysis among six-linked of maize. *World J. Agri. Sci.* 2: 352-358.

Prasad B, A. K. Patwary and P. S. Biswas (2001). Genetic variability and selection criteria in fine rice (*Oryza sativa* L.). *Pakistan J. Biol. Sci.* 4:1188-1190.

Steel R. G. D., J. H. Torrie and D. A. Dickey (1997). Principles and Procedures of Statistics: A Biometric Approach (3rd Ed.) McGraw-Hill Book Co., New York. USA.

Tahir, H., G. Jillani and M. Z. Iqbal (1988). Integrated use of organic and inorganic N fertilizers in rice-wheat cropping system. *Pakistan J. Soil Sci.* 3: 19-23.

Yolanda J. L. and L. D.V. Das (1995). Correlation and path analysis in rice (*Oryza sativa* L). *Madras Agri. J.,* 82: 576-578.

Zahid M. A., M. Akhtar, M. Sabir, Z. Manzoor and T. H. Awan (2006). Correlation and path analysis studies of yield and economic traits in Basmati rice (*Oryza sativa* L.). Asian J. Plant Sci., 5: 643-645.