ISSN 2250-3153

Correlation and path coefficient studies of some yield related traits in rice (*Oryza sativa* L.)

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***Abstract*-**Rice being the second most important staple food in Pakistan plays an important role in economic stability of Pakistan. An insight of genetic diversity and correlation among the various traits related to yield is helpful in this regard. Twenty genotypes of rice (*Oryza sativa* L.) were evaluated for genetic variability and correlation. The experiment was conducted in the research area of department of Plant Breeding and Genetics, University of Agriculture Faisalabad, following randomized complete block design with three replications. The data was recorded on yield and different yield components. The results pertaining to analysis of variance showed highly significant differences among all genotypes for all the yield trails. Flag leaf area, number of productive tillers per plant, number of spikelets per panicle, number of grains per panicle and 1000 grain weight had a highly positive significant genotypic correlation with grain yield per plant. Same results were obtained for the phenotypic correlation. The study of path analysis for yield related traits revealed that number of productive tillers per plant, number of spikelets per panicle, number of grains per panicle and days to maturity had positive direct effect on grain yield per plant. In view of the results obtained from this experiment, it may be concluded that the characters like number of productive tillers per plant, number of spikelets per panicle could be used as a direct selection criteria for higher grain yield. Genotypes like Sr1-57, Basmati-385, Srs-505, Ksk-133, Sr1-13 and DM-2-25-9-2002 may be used to bring about improvement in rice grain yield by including these in rice breeding programs for development of commercial varieties.

***Index Terms*-** *Oryza sativa* L., correlation, path coefficient, quantitative traits.

I. INTRODUCTION

Rice (*Oryza sativa* L.) 2n=24 is the primary staple food for one third of the world population after maize and wheat. It is considered a model cereal crop in the world due to its relatively small genome size, vast germplasm collection, enormous repertoire of molecular genetic resources, and efficient transformation system (Paterson *et al*., 2005). In Pakistan it is second staple food after wheat and contributes more than two million tonnes to our food requirements. 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 *et al*., 2002). Being an exportable commodity, it has an immense economic value which greatly strengthens our national economy. Pakistan's local Basmati rice is very famous for its aroma in the international market and also for the high quality of the kernel. It provides 20% of the world's dietary energy supply, while wheat supplies 19% and maize 5 %. Rice is the predominant staple food for 17 countries in Asia and the Pacific, nine countries in Africa (Laxuman *et al*., 2011).

In Pakistan rice is cultivated over an area of 2.88 million hectares with a production of 6.88 million tons annually with an average yield of 2.39 tons per hectare (Anonymous, 2009-2010). It accounts for 6.4% value added in agriculture and 1.4% in GDP (Anonymous, 09-10). Pakistan is the fifth biggest rice exporting country in the world and exports more than one million tons of rice annually, which is 10% of the world's rice trade. The need and importance of rice is increasing day by day due to the increase in the population explosion on earth. Therefore, it is the basic need of these days to boost up rice yield and quality through the development of biologically superior, stable and high yielding rice varieties to meet the increasing food demand.

II. MATERIAL AND METHODS

The experiment was conducted at the research area of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad during the kharif season 2010-11. Twenty genotypes from local sources were studied for this purpose. The nursery was sown on 19-05-2010 and transplanted to the pots on 26-06-2010. There were three replications for each genotype. The data was recorded at different stages of crop development for ten characters which were: Plant height (cm), Flag leaf area (cm^2), Panicle length (cm), Number of effective tillers per plant, Number of spikelets per panicle, Number of grains per panicle, Days to heading, Days to maturity, 1000-grain weight (g), Grain Yield per Plant (g). The methodology given by Steel *et al.* (1997) was used for statistical analysis to compute variance and covariance from the data collected for the traits to ascertain the differences among various genotypes for variability and co-variability. The individual comparisons of genotypes means were compared by using Duncan's Multiple Range (DMR) test and the total variance was partitioned into genotypic and phenotypic components. Calculation for mean and coefficient of variability were made according to standard statistical techniques given by Steel *et al.* (1997). Genotypic and phenotypic correlation coefficients among the characters under study were estimated according to the statistical techniques outlined by Kwon and Torrie (1964). Path coefficient analysis was performed according to the method given by Dewey and Lu (1959) in yield related traits keeping grain yield as resultant variable and yield related traits such as days to maturity, days to

heading, plant height, panicle length, number of tillers per plant, flag leaf area, number of grains per panicle, number of spikelets per panicle and 1000 grain weight as causal variable.

III. RESULTS AND DISCUSSION

Selection holds prime importance in development of any crop and knowledge about selection criteria for a specific crop is an asset. Plant breeder must always have a target in his mind before proceeding towards the crop improvement through selection among different lines of a single cross in advance generations. All the genotypes under study showed significant differences for all the traits (Table 1). Genotypic and phenotypic variances, genotypic coefficient of variance (GCV) and phenotypic coefficient of variance (PCV), heritability, grand means and standard errors of 10 yield and related traits were studied. The genotypic coefficient of variance ranged from 4.78% to 26.28% grain yield per plant showed the highest value of GCV followed by number of spikelets per panicle 23.93%, flag leaf area 20.24 % and plant height 20.17 as given in Table 2. High heritability estimates were found for plant height (99.8%), number of spikelets per panicle (99.7%), flag leaf area (99.3%), number of grains per panicle (99.3%), days to maturity (99.3%), days to heading (99.1%), number of productive tillers per plant (98.4%) and grain yield per plant (98.4%) as shown in the (Table 2) which indicated the presence of additive genes. The heritability percentage is above 90 among all the traits under study, hence these high heritability estimates can be useful in making selection of superior genotypes on the bases of phenotypic performance.

The genotypic and phenotypic correlation coefficients were studied and the results revealed that flag leaf area (0.138^{*}), number of productive tillers per plant (0.407^{*}), number of spikelets per panicle (0.167^{*}), number of grains per panicles (0.278^{*}) and 1000-grain weight (0.424^{*}) had significant and positive correlation with grain yield per plant. The research study of (Ekka *et al*., 2011) also revealed the same results. Whereas plant height (-0.311), panicle length (-0.137), days to heading (-0.468) and days to maturity (-0.403) had negative and non-significant correlation with grain yield per plant at genotypic level, as given in the (Table 3). (Ravindra *et al*., 2012) reported similar results. At phenotypic level similar results were observed. Plant height and flag leaf area showed positive and non-significant correlation at both genotypic (0.015) and phenotypic (0.016) levels, Ahmed *et al*., (2010) also obtained the same results. The plant height showed negative and non-significant correlation with productive tillers per plant at both genotypic (-0.121) and phenotypic (-0.118) levels, similarity in the results were also observed by Qamar *et al*., (2005). This concludes that with the increase in plant height the number of productive tillers per plant may decrease. There was positive and significant correlation between flag leaf area and number of productive tillers per plant at genotypic level (0.192) and positive and non-significant correlation at phenotypic level (0.189). Positive and significant correlation was present between panicle length and number of grains per panicle at both genotypic (0.481^{*}) and phenotypic (0.471^{**}) levels. Akinwale *et al*. (2011) observed similar results.

According to the results presented in the Table 4, it is indicated that highest positive direct effect on grain yield per plant was contributed by days to maturity which was (0.672), followed by number of spikelets per panicle (0.575). Number of grains per panicle showed positive direct effect on grain yield per plant (0.293). The genotypic correlation between number of grains per panicle and grain yield per plant was positive (0.278). This positive association between the characters shows that direct selection of plants can be done on phenotypic basis upon this trait. Song and Cho (2008) also found the similar results. Number of grains per panicle showed positive direct effect on grain yield per plant (0.293), The genotypic correlation between number of grains per panicle and grain yield per plant was positive (0.278). The research findings of Nandan *et al.* (2010) also revealed the same results. Direct effect of plant height on grain yield per plant was found negative (-0.345). The genotypic correlation coefficient between two traits was also negative (-0.311). The negative direct effect indicates that the direct selection through this trait would not prove to be useful for the improvement of grain yield. The research study of Hairmasis *et al.* (2010) and Akhtar *et al*., (2011) was in correspondence with the results obtained.

Table 1: Mean Squares for the morphological traits and their significance.

Traits	PH	FLA	PL	NPT	NSPP	NGPP	DH	DM	TGW	GYPP
Treatment SS	33544	2218.505	391.723	380.751	73082.89	37255	3153.1	3060.1	393.353	2625.01
Replication SS	1.801	0.467	0.282	0.843	13.757	30.366	4.075	4.233	1.827	1.01
Error SS	125.998	29.275	21.811	12.449	456.525	531.99	54.758	42.433	30.381	90.723
Total SS	33672.026	2248.246	413.817	394.043	73553.17	37817	3211.9	3106.7	425.561	2716.74
Treatment MS(df = 19)	1765.486	116.763	20.617	20.04	3846.468	1960.8	165.95	161.06	20.703	138.158
Replication MS (df = 2)	0.9	0.233	0.141	0.422	6.878	15.183	2.037	2.117	0.914	0.505
Treatment F. Ratio	532.4584^{**}	151.563^{**}	35.9191^{**}	61.1709^{**}	320.17^{**}	140.05^{**}	115.16^{**}	144.23^{**}	25.8945^{**}	57.869^{**}
Replication F. Ratio	0.2715^{ns}	0.3030^{ns}	0.2455^{ns}	1.2870^{*}	0.5725^{ns}	1.0845^{*}	1.4139^{*}	1.896^{*}	1.1426^{*}	0.2116^{ns}

Note: *PH= Plant height, FLA= Flag leaf area, PL= Panicle length, NPT= Number of productive tillers per plant, NSPP= Number of spikelets per panicle, NGPP= Number of grains per panicle, DH= Days to heading, DM= Days to maturity, TGW= Thousand grain weight, GYPP= Grain yield per plant.*

Table 2: Grand means, phenotypic and genotypic variances, broad sense heritability and coefficients of variability for various yield related traits.

Traits	PH	FLA	PL	NPT	NSPP	NGPP	DH	DM	TGW	GYPP
Mean ± SE	120.52 ±0.007	30.712 ±0.029	27.826 ±0.068	15.141 ±0.069	149.364 ±0.005	122.979 ±0.007	123.325 ±0.024	152.767 ±0.024	24.754 ±0.069	25.593 ±0.026
Genotypic variance	587.4	38.66	6.68	6.57	1278.15	648.92	54.83	53.31	6.63	45.25
Phenotypic variance	588.495	38.92	6.87	6.68	1282.15	653.91	55.32	53.68	6.9	46.05
Heritability %	99.8	99.3	97.2	98.4	99.7	99.3	99.1	99.3	96.1	98.3
GCV %	20.171	20.24	9.28	16.93	23.93	20.714	6.005	4.78	10.405	26.28
PCV %	20.19	20.313	9.42	17.07	23.97	20.788	6.031	4.76	10.61	26.51

Note: *PH= Plant height, FLA= Flag leaf area, PL= Panicle length, NPT= Number of productive tillers per plant, NSPP= Number of spikelets per panicle, NGPP= Number of grains per panicle, DH= Days to heading, DM= Days to maturity, TGW= Thousand grain weight, GYPP= Grain yield per plant.*

Table 3: Genotypic, Phenotypic and Environmental correlation coefficient

Traits	COEF	PH	FLA	PL	NPT	NSPP	NGPP	DH	DM	TGW	GYPP
FLA	G	0.015									
	P	0.016									
	E	0.333									
PL	G	0.487*	0.071*								
	P	0.482**	0.07								
	E	0.227	0.018								
NPT	G	-0.121	0.192*	-0.304							
	P	-0.118	0.189	-0.293*							
	E	0.396	0.012	0.436							
NSPP	G	0.089*	0.475*	0.546*	-0.279						
	P	0.089	0.472**	0.538**	-0.275*						
	E	-0.089	-0.203	-0.037	0.149						
NGPP	G	0.065*	0.429*	0.480*	-0.016	0.795*					
	P	0.065	0.425**	0.471**	-0.016	0.792**					
	E	0.132	-0.084	-0.086	-0.005	0.224					
DH	G	0.187*	-0.282	0.208*	-0.111	0.035*	0.138*				
	P	0.187	-0.279*	0.209	-0.109	0.035	0.137				
	E	0.247	0.035	0.285	0.029	0.051	0.03				
DM	G	0.243*	-0.252	0.127*	-0.092	0.033*	0.121*	0.944*			
	P	0.242	-0.25	0.128	-0.089	0.033	0.119	0.938**			
	E	-0.028	0.014	0.169	0.091	-0.125	-0.134	0.243			
TGW	G	-0.573	-0.011	-0.407	0.184*	0.225*	0.100*	-0.3	-0.221		
	P	-0.563**	-0.012	-0.406*	0.171	0.218	0.1	-0.299*	-0.218		
	E	-0.153	-0.079	-0.369	-0.329	-0.108	0.16	-0.312	-0.088		
GYPP	G	-0.311	0.138*	-0.137	0.407*	0.169*	0.278*	-0.468	-0.403	0.424*	
	P	-0.309*	0.136	-0.138	0.396**	0.167	0.272**	-0.459**	-0.398**	0.408**	
	E	-0.099	-0.049	-0.203	-0.229	0.059	-0.187	0.184	0.079	-0.145	

Note: *PH= Plant height, FLA= Flag leaf area, PL= Panicle length, NPT= Number of productive tillers per plant, NSPP= Number of spikelets per panicle, NGPP= Number of grains per panicle, DH= Days to heading, DM= Days to maturity, TGW= Thousand grain weight, GYPP= Grain yield per plant. G= Genotypic coefficient, P= Phenotypic coefficient, E= Environmental coefficient, COEF= Coefficient.*

Table 4: Direct (Bold values) and indirect (Normal values) effects of some yield related traits on grain yield per plant

Traits	PH	FLA	PL	NPT	NSPP	NGPP	DH	DM	TGW	rg
PH	**-0.345**	-0.008	-0.085	-0.067	0.051	0.019	-0.235	0.163	0.196	-0.311
FLA	-0.005	**-0.54**	-0.012	0.109	0.273	0.126	0.354	-0.17	0.004	0.138
PL	-0.168	-0.039	**-0.174**	-0.175	0.314	0.141	-0.261	0.086	0.139	-0.137
NPT	0.042	-0.104	0.054	**0.566**	-0.16	-0.005	0.139	-0.062	-0.06	0.407
NSPP	-0.031	-0.257	-0.095	-0.158	**0.575**	0.233	-0.044	0.022	-0.08	0.169
NGPP	-0.022	-0.232	-0.084	-0.009	0.457	**0.293**	-0.173	0.081	-0.03	0.278
DH	-0.064	0.153	-0.036	-0.063	0.02	0.04	**-1.255**	0.635	0.103	-0.468
DM	-0.084	0.136	-0.022	-0.052	0.019	0.035	-1.185	**0.672**	0.076	-0.403
TGW	0.198	0.006	0.071	0.104	0.129	0.029	0.377	-0.149	**-0.345**	0.424

Note: *PH= Plant height, FLA= Flag leaf area, PL= Panicle length, NPT= Number of productive tillers per plant, NSPP= Number of spikelets per panicle, NGPP= Number of grains per panicle, DH= Days to heading, DM= Days to maturity, TGW= Thousand grain weight, GYPP= Grain yield per plant, rg= Correlation coefficient. Values in the diagonal are direct effects.*

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