

Correlation and Path Coefficient Analysis in Rainfed Upland Rice (*Oryza sativa* L.)

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Abstract Correlation and path coefficient analysis was studied for grain yield and its components in 44 diverse genotypes of upland rice. The correlation coefficient study revealed that in general, the genotypic correlations were higher than their corresponding phenotypic correlation for all the characters. It was observed that plant height, panicle length, number of total tillers per plant, number of effective tillers per plant, number of grains per panicle, harvest index and 1000-grain weight showed significant positive association with grain yield per plant at genotypic as well as phenotypic levels, while significant positive correlation contributed by straw yield per plant at phenotypic level only. Straw yield per plant and harvest index showed negative correlation among themselves. Straw yield per plant was found having significantly positive correlation with plant height,

panicle length and number of total tillers per plant. The harvest index showed significantly positive correlation with grain yield per plant and grain breadth. The results pointed out that more emphasis should be given on plant height, panicle length, number of grains per panicle, number of effective tillers per plant, straw yield and harvest index to improve grain yield. The path analysis showed that the characters viz., straw yield per plant, grain length, harvest index, days to maturity, protein content, number of total tillers per plant and number of grains per panicle were having high positive direct effect with grain yield, while grain L/B ratio, panicle length, grain breadth, 1000-grain weight, days to 50% flowering were having negative direct effect. Based on correlation and path analysis, it is suggested that more emphasis should be given on panicle length, number of grains per panicle, straw yield and harvest index for improvement in grain yield in upland rice.

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Introduction

Rice is one of the most important food crops in the world, second only to wheat in terms of annual production for human consumption. Rice belongs to family Poaceae and genus *Oryza*. There are 24 species of *Oryza* among which, only two species viz ; *Oryza sativa* L. and *Oryza glaberimma* steaud are under cultivation. The primary center of origin of *Oryza sativa* L. is large belt extending from north

east hills in India to the mountain ranges of the mainland south-east Asia and south west China. India has the largest area among the rice growing countries and enjoys second rank in rice production. The majority of rice comes from China, India, Japan, Indonesia, Thailand, Myanmar, Bangladesh, and Pakistan. The Rice crop in India accounts for about 22% of the total cropped area under cereals, and about 31% of the total area under food grains [1].

Average low yield of paddy in Gujarat as well as in India is due to the poor average productivity of drilled paddy. As the yield of transplanted paddy is reach at its plateau, further improvement can be done only either by heterosis breeding or by improvement of productivity of drilled paddy. At present results of heterosis breeding in rice are not so much enthusiastic. An extent research has been carried out on upland rice in China, Brazil and IRRI (Phillipines). In India, very poor work on upland rice has been carried out, confined to countable scientists [2—6]. Since, limited work has been reported on upland rice on this aspect in India and in Gujarat too, no much research efforts have been made. So, studies on this aspect were planned for the welfare of rice growing farmers of the water scarce areas.

Yield, being a complex character, is composed of several components some of which affect the yield directly, while, others affect indirectly. Hence knowledge of association between yield and its component is necessary. Correlation studies would provide estimates of degree of association between grain yield and its various components and also among the components. While, path co-efficient analysis further elucidates the intrinsic nature of association of component traits by determining direct or indirect contribution of these traits to yield. Hence, the present investigation was undertaken to study correlation and path coefficient analysis in 44 selected and diverse genotypes of upland rice.

Materials and Methods

The study was conducted at Agricultural Research Station, Anand Agricultural University, Derol *kharif* of 2012. The material for the present study comprised of 44 diverse genotypes of upland rice. The experi-

ment was laid out in a randomized complete block design with three replications. Plot length was kept 3 meter with double rows of each entry and row to row as well as plant to plant spacing were maintained 30 cm and 15 cm, respectively. The recommended agronomic practices and plant protection measures were followed timely for the successful raising of the crop. Five randomly selected competitive plants from each replications were tagged for the purpose of recording the observations on 16 characters viz., days to 50% flowering, days to maturity, plant height (cm), panicle length (cm), number of total tillers per plant, number of effective tillers per plant, number of grains per panicle, grain yield per plant (g), straw yield per plant (g), harvest index (%), 1000-grain weight (g), grain length (mm), grain breadth (mm), grain L/B ratio, amylose content (%), protein content (%). The observations on days to 50% flowering and days to maturity were recorded on plot basis. The genotypic and phenotypic correlation were calculated following the method of Singh and Chaudhary [7], whereas, the path coefficient analysis as per method given by Dewey and Lu [8].

Results and Discussion

Correlation

The results on correlation coefficients revealed that both genotypic and phenotypic correlations followed the same trend but the genotypic correlations were generally higher than the phenotypic correlations indicating that the phenotypic expression of correlations is reduced under the influence of environment (Table 1). The result revealed that days to 50% flowering and days to maturity not exhibited direct correlation with grain yield but it is useful for improvement indirectly by plant height, total tillers per plant and 1000-grain weight. It was observed that grain yield per plant had positive and significant correlation with plant height ($r_g = 0.477$ and $r_p = 0.399$), panicle length ($r_g = 0.659$ and $r_p = 0.464$), number of total tillers per plant ($r_g = 0.320$ and $r_p = 0.259$), number of effective tillers per plant ($r_g = 0.520$ and $r_p = 0.409$), number of grains per panicle ($r_g = 0.436$ and $r_p = 0.370$), harvest index ($r_g = 0.604$ and $r_p = 0.600$) and 1000-grain weight ($r_g = 0.328$ and $r_p = 0.241$) at both genotypic and phenotypic levels while positively and sig-

Table 1. Genotypic and phenotypic correlation between yield and other traits of upland rice under study. *, **Significant at 5% and 1% levels respectively. DFF : Days to 50% flowering, DTM : Days to maturity, PLH : Plant height (cm), PL : Panicle length (cm), NTTP : Number of total tillers per plant, NETP : Number of effective tillers per plant, NGP : Number of grains per panicle, GYP : Grain yield per plant (g), SYP : Straw yield per plant (g), HI : Harvest index (%), TWT : Test weight (g), GL : Grain length (mm), GB : Grain breadth (mm), L : B ratio : Length : Breadth ratio, AC : Amylose content (%), PC : Protein content (%).

Charac- ters		DFF	DTM	PLH	PL	NTTP	NETP	NGP	GYP
DFF	Rg		1.011	0.463**	0.275	0.486**	0.205	-0.105	0.012
	Rp		0.966**	0.359**	0.162	0.348**	0.156	-0.092	0.041
DTM	Rg			0.439**	0.264	0.464**	0.184	-0.103	0.021
	Rp			0.357**	0.166	0.347**	0.166	-0.090	0.041
PLH	Rg				0.670**	0.458**	0.507**	0.298*	0.477**
	Rp				0.530**	0.312**	0.354**	0.262*	0.399**
PL	Rg					0.512**	0.504**	0.567**	0.659**
	Rp					0.325**	0.286**	0.419**	0.464**
NTTP	Rg						0.903**	0.300*	0.320*
	Rp						0.790**	0.225*	0.259*
NETP	Rg							0.332*	0.520**
	Rp							0.251*	0.409**
NGP	Rg								0.436**
	Rp								0.370**
GYP	Rg								
	Rp								
SYP	Rg								
	Rp								
HI	Rg								
	Rp								
TWT	Rg								
	Rp								
GL	Rg								
	Rp								
GB	Rg								
	Rp								
L:B R	Rg								
	Rp								
AC	Rg								
	Rp								
PC	Rg								
	Rp								

Table 1. Continued.

Cha- rac- ters		DFF	SYP	HI	TWT	GL	GB	L:B R	AC	PC
DFF	Rg		0.306*	-0.202	0.331*	0.218	-0.045	0.158	0.374*	0.210
	Rp		0.244*	-0.140	0.240*	0.183	-0.064	0.152	0.319**	0.174
DTM	Rg		0.290	-0.179	0.319*	0.235	-0.059	0.176	0.369*	0.197
	Rp		0.215*	-0.124	0.229*	0.196	-0.079	0.169	0.312**	0.160
PLH	Rg		0.615**	-0.143	0.251	0.517**	-0.218	0.409*	0.212	0.391**
	Rp		0.542**	-0.135	0.193	0.439**	-0.184	0.346**	0.190	0.347**
PL	Rg		0.622**	0.044	0.331*	0.322*	-0.157	0.285	-0.159	0.491**
	Rp		0.507**	-0.016	0.249*	0.254*	-0.149	0.259*	-0.118	0.295**
NTTP	Rg		0.403**	-0.095	0.003	-0.187	-0.115	-0.072	0.333*	0.385*
	Rp		0.303**	-0.048	0.013	-0.140	-0.058	-0.061	0.266*	0.289**

Table 1. Continued.

Cha- rac- ters		DFF	SYP	HI	TWT	GL	GB	L:B R	AC	PC
NETP	Rg		0.280	0.127	-0.121	-0.171	0.044	-0.115	0.270	0.297
	Rp		0.225*	0.101	-0.119	-0.163	-0.048	-0.091	0.224*	0.234*
NGP	Rg		0.270	0.096	-0.121	0.129	-0.221	0.203	-0.086	0.091
	Rp		0.237*	0.085	-0.111	0.127	-0.182	0.186	-0.082	0.080
GYP	Rg		0.192	0.604**	0.328*	0.288	0.043	0.157	-0.063	0.226
	Rp		0.229*	0.600**	0.241*	0.255*	0.023	0.145	-0.052	0.213
SYP	Rg			-0.649**	0.249	0.360*	-0.439**	0.473**	0.290	0.032
	Rp			-0.612**	0.209	0.325*	-0.349**	0.405**	0.261*	0.020
HI	Rg				0.115	-0.071	0.419**	-0.273	-0.313*	0.171
	Rp				0.068	-0.063	0.325**	-0.221*	-0.280*	0.180
TWT	Rg					0.447**	0.450**	0.037	0.059	0.145
	Rp					0.414**	0.392**	0.009	0.056	0.085
GL	Rg						-0.407**	0.852**	-0.045	0.265
	Rp						-0.309**	0.789**	-0.041	0.226*
GB	Rg							-0.815**	-0.068	-0.093
	Rp							-0.816**	0.059	-0.076
L:B R	Rg								-0.015	0.207
	Rp								-0.011	0.173
AC	Rg									-0.112
	Rp									-0.102
PC	Rg									
	Rp									

nificantly correlated with straw yield ($r_p = 0.229$) and grain length ($r_p = 0.255$) at phenotypic level only (Table 1). Straw yield per plant and harvest index showed negative correlation among themselves. The harvest index showed significant positive correlation with grain yield per plant, while it was negatively correlated with plant height and number of total tillers per plant. Straw yield showed positive significant association with plant height, whereas, grain length was found positively associated with 1000-grain weight and grain L/B ratio. Other characters, grain length, protein content, straw yield per plant, grain L/B ratio and grain breadth contributed positive association towards yield in respective order of magnitude. The amylose content was found negatively associated with grain yield. The strong positive correlations of plant height, panicle length, number of total tillers per plant, number of effective tillers per plant, number of grains per panicle, harvest index and 1000-grain weight with grain yield per plant indicated that these characters might be utilized as selection criteria for improving grain yield in upland rice. The observed positive correlation of grain yield with various traits was conformed by earlier workers viz., [3, 9, 10] for

plant height, panicle length and 1000-grain weight ; Chandra et al. [9] for number of total tillers per plant and number of effective tillers per plant, and for number of grains per panicle; Sravan et al. [3] for harvest index.

Path coefficient analysis

In the present investigation path coefficient analysis has been conducted taking grain yield per plant as dependent variable. The persual of the results revealed that straw yield per plant had highest direct effect on grain yield per plant followed by grain length, harvest index, days to maturity, protein content, number of total tillers per plant and number of grains per panicle (Table 2). This may indicate that direct selection of these characters would likely be effective in increasing grain yield. Plant height and panicle length has high indirect effect via straw yield per plant and grain length while high indirect effect of grain breadth via grain L/B ratio. Harvest index was also highly contributed indirectly via grain L/B ratio and days to 50% flowering. These indirect effects had not only supported the low magnitude direct ef-

Table 2. Path coefficient analysis showing direct and indirect effects of various traits on grain yield per plant in upland rice. Diagonal values are direct effects. Residual effect = 0.0088, *, **Significant at 5% and 1% levels respectively. DFF : Days to 50% flowering, DTM : Days to maturity, PLH : Plant height (cm), PL : Panicle length (cm), NTTP : Number of total tillers per plant, NETP : Number of effective tillers per plant, NGP : Number of grains per panicle, SYP : Straw yield per plant (g), HI : Harvest index (%), TWT : Test weight (g), GL : Grain length (mm), GB : Grain breadth (mm), L:B ratio : Grain Length : Breadth ratio, AC : Amylose content (%), PC : Protein content (%), GYP : Grain yield per plant (g).

Sl. No.	Geno-types	DFF	DTM	PLH	PL	NTTP	NETP	NGP	SYP
1.	DFF	-1.209	1.616	-0.366	-0.533	0.303	-0.121	-0.030	1.318
2.	DTM	-1.222	1.599	-0.347	-0.513	0.289	-0.109	-0.030	1.249
3.	PLH	-0.559	0.702	-0.790	-1.301	0.285	-0.299	0.087	2.646
4.	PL	-0.332	0.422	-0.529	-1.942	0.319	-0.298	0.165	2.678
5.	NTTP	-0.587	0.742	-0.362	-0.995	0.623	-0.533	0.087	1.735
6.	NETP	-0.247	0.294	-0.401	-0.979	0.562	-0.591	0.097	1.207
7.	NGP	0.127	-0.164	-0.236	-1.102	0.187	-0.196	0.291	1.163
8.	SYP	-0.370	0.464	-0.486	-1.209	0.251	-0.166	0.079	4.302
9.	HI	0.244	-0.287	0.113	-0.086	-0.059	-0.075	0.028	-2.790
10.	TWT	-0.401	0.509	-0.198	-0.642	0.002	0.072	-0.035	1.072
11.	GL	-0.264	0.375	-0.408	-0.625	-0.117	0.101	0.037	1.550
12.	GB	0.054	-0.095	0.172	0.305	-0.071	0.026	-0.064	-1.889
13.	L:B R	-0.191	0.282	-0.323	-0.554	-0.045	0.068	0.059	2.033
14.	AC	-0.452	0.590	-0.168	0.309	0.208	-0.160	-0.025	1.248
15.	PC	-0.253	0.315	-0.309	-0.954	0.240	-0.176	0.026	0.140

Table 2. Continued.

Sl. No.	Geno-types	HI	TWT	GL	GB	L:B R	AC	PC	'r _e ' with GYP
1.	DFF	-0.590	-0.442	0.917	0.079	-0.867	0.208	0.145	0.012
2.	DTM	-0.524	-0.425	0.987	0.105	-0.970	-0.205	0.136	0.021
3.	PLH	-0.416	-0.335	2.171	0.385	-2.250	-0.118	0.271	0.477**
4.	PL	0.129	-0.441	1.352	0.277	-1.569	0.088	0.340	0.659**
5.	NTTP	-0.278	-0.004	-0.788	0.203	0.396	-0.185	0.267	0.320*
6.	NETP	0.370	0.162	-0.720	0.077	0.634	-0.150	0.206	0.520**
7.	NGP	0.281	0.161	0.541	0.390	-1.117	0.048	0.063	0.436**
8.	SYP	-1.893	-0.332	1.514	0.775	-2.600	-0.161	0.022	0.192
9.	HI	2.918	-0.154	-0.300	-0.740	1.500	0.174	0.118	0.604**
10.	TWT	0.336	-1.334	1.877	-0.794	-0.203	-0.033	0.100	0.328*
11.	GL	-0.209	-0.596	4.203	0.719	-4.689	0.025	0.183	0.288
12.	GB	1.222	-0.600	-1.710	-1.766	4.486	0.038	-0.065	0.043
13.	L:B R	-0.796	-0.049	3.582	1.440	-5.502	0.008	0.143	0.157
14.	AC	-0.912	-0.078	-0.188	0.120	0.081	-0.556	-0.078	-0.063
15.	PC	0.498	-0.193	1.112	0.165	-1.139	0.062	0.692	0.226

fect but also resulted in high significant positive correlation with grain yield. Grain L/B ratio, panicle length, grain breadth, 1000-grain weight and days to 50% flowering exhibited higher negative direct effects on grain yield. The observed positive direct effect of various traits on grain yield was also supported by earlier workers viz., Chandra et al. [9] for number of total tillers per plant, and for number of grains per panicle. Malini et al. [10] for straw yield. Sravan et al.

[3] for harvest index ; [11] for grain length. However in contradictory to the present findings, Ekka Ruth et al. [11] and Sravan et al. [3] revealed that days to 50% flowering had positive direct effect on grain yield.

The overall study suggested that characters like panicle length, number of grains per panicle, straw yield and harvest index exhibited strong and positive correlation as well as positive direct effect on grain

yield which revealed their due importance as the indicator characters and their manipulation through selection. Thus, these characters can be utilized as selection indices in upland rice to bring about the improvement in grain yield.

References

1. Singhal V (2003) In Indian agriculture 2003. Singhal Publ, New Delhi, pp 120—136.
2. Seyoum Mulugeta, Sentayehu Alamerew, Kassahun Bante (2012) Genetic variability, heritability, correlation coefficient and path analysis for yield and yield related traits in upland rice. *J Pl Sci* 7 : 13—22.
3. Sravan T, Rangare NR, Suresh BG, Kumar SR (2012) Genetic variability and character association in rainfed upland rice. *J Rice Res* 5 : 24—29.
4. Fukrei P, Kumar A, Tyagi W, Rai M, Pattanayak A (2011) Genetic variability in yield and its components in upland rice grown in acid soils of North East India. *J Rice Res* 4 : 4—7.
5. Sunayana R, Yadav RNS, Sharma RN (2010) Variability in grain quality characters of upland rice of Assam, India. *Rice Sci* 17 : 330—333.
6. Vange T (2008) Biometrical studies on genetic diversity of some upland rice accessions. *Nature and Sci* 6 : 36—41.
7. Singh RK, Chaudhary BD (1985) Biometrical methods in quantitative genetic analysis. Kalyani Publ. 3rd edn, pp 318.
8. Dewey DR, Lu KH (1956) A correlation and path coefficient analysis of components of wheat grass seed production. *Agron J* 51 : 515—518.
9. Chandra Kishor, Prasad Yogendra, Haider ZA, Kumar Ravi, Kumar Kamleshwar (2008) Quantitative analysis of upland rice. *Oryza* 45 : 268—272.
10. Malini N, Sundaram T, Hari Ramakrishnan S (2007) Studies on cause and effect relationship between yield and its contributing traits in rice (*Oryza sativa* L.). *Crop Res* 34 : 149—151.
11. Ekka Ruth Elizabeth, Sarawgi AK, Kanwar Raja R (2011) Correlation and path analysis in traditional rice accessions of Chhattisgarh. *J Rice Res* 4 : 11—17.