Original Research Article

Correlation and path coefficient analysis in rice varieties (*Oryza sativa* L.) and rice landraces

Abstract

The present research was carried out to study the correlation and path coefficient analysis in twenty six rice (*Oryza sativa* L.) varieties, among 26 rice genotypes, 15 rice varieties and 11 landraces collections from hilly region of Mirzapur in eastern Uttar Pradesh. At phenotypic and genotypic level, GPP (0.603), Chl (0.326), EBT(0.356) showed highly positive significant correlation with YPP to emerge as most important associates of grain yield in rice. Path analysis identified the highest positive direct effect on grain yield per plant was exhibited by GPP(0.485), DFF(0.414), PH @45DAT(0.255), Chl(0.255), EBT(0.173), PH @30DAS(0.042), NOT(0.029), PL(0.024) are the most significant direct as well as indirect effect. Yield contributing components which under consideration at time of devising selection strategy aimed at developing varieties having higher yield. In reference to most of the previous reports on rice, comparatively small proportion of direct and indirect effects of different components attained high order value in the present research.

Keywords: Correlation, Path analysis, landraces, Rice

Comment [A1]: Twenty-six

Introduction

Rice (Oryza sativa L.) occupies a pivotal place in Indian agriculture, as it forms the staple food for two-thirds of the population and provides 43 per cent calories requirement and 20-25% agriculture income. More than 90 percent of the world's rice is grown and consumed in Asia, where 60 per cent of the earth's people and two third of world's poor live (Khush and Virk, 2000). Rice farming is about 10,000 year old and largest single use of land for producing food. About 11% of total Earth's arable land was covered by rice fields. The frequent occurrence of drought as well as other abiotic stresses has been identified as the major issue to the low productivity of rice in rainfed ecosystems, particularly in eastern region of India. Most of agronomical traits are quantitative traits showing normal distributions in phenotype of the traits. Information on association of characters, direct and indirect effects contributed by each character towards yield will be an added advantage in helping the selection process. (Singh, *et. al*., 2018) Correlation and path analysis establish the extent of association between yield and yield components and also bring out relative importance of their direct and indirect effects, thus giving an obvious understanding of their association with grain yield. Ultimately, this kind of analysis could help the breeder to design his selection strategies to improve grain yield. In the light of the above scenario, the present investigation is carried out with the objective of studying the character associations in rice for yield improvement.

Comment [A2]: 10000-year-old

Materials and methods

The present experiment was carried out at Student's Instructional Farm (SIF), Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, India. Seeds of the 26 genotypes were sown in raised nursery bed. The seedlings were transplanted to the main field at the rate of one seedling per hill, after 21 days, with a spacing of 20cm x 15cm. The experiment was arranged in a randomized block design (RBD) with thrice replications. The recommended agronomical practices and plant protection measures were followed to ensure a normal crop growth and development. Observations were recorded on five randomly selected plants in each replication from the two centre rows. 14 traits *viz.*

Days to flowering Initiation (DFIT), days to 50% flowering (DFF), days to100% flowering (DHF), Plant hieght@15, 30, 45, Maturity (PH), no. of tillers (NOT), panicle length (PL), Spiklete's per panicle (SPP), ear bearing tillers (EBT), grain per panicle (GPP), Chlorophyll (Chl), Grain yield per plant (GYP). Correlation coefficient at the genotypes and phenotypic levels was computed by Singh and Chaudhary (1995) and Dewey and Lu (1959) for path analysis.

Table 1. Detailed list of selected rice genotypes and their origin:

Name of variety	Parentage	Year of release	Duration (in days)	Eco-System	Salient Features	Recommended for cultivation
Pusa Basmati-1	Pusa-150 x Karnal Local	1989	135	Irrigated Areas	Semi dwarf (85-95 cm), grains: super fine aromatic, Yield: 45 Q/ha.	Goa, Mizoram and Uttar Pradesh
NDR-359	BG-90-2-4 x 08677	1994	115-125	Irrigated Areas	Semi dwarf (90-95 cm), grains: short tipped, Yield: 50 Q/ha.	Uttar Pradesh, Bihar and Orissa
Pusa 1121 (Pusa Sugandha-5)		2005	135-140	Irrigated saline soils	Medium (97.3 cm); Grain-slender, mod. resit. to RTV, sheath rot, & BLB; Yield: 55-65 q/ha.	AP and Kerala
DRR Dhan-44	IR93376-B-B-130	2014	120	Upland and drought prone	Drought tolerant, HYV, Semi tall	Uttrakhand, Haryana and Bihar
Sahbhagi dhan		2009	105	Rainfed upland/ lowland	LB grain, tolerant to drought. Res to leaf blast, mod. res to brown spot, sheath rot, SB and leaf folder, 3.5-4 t/ha	Orissa and Jharkhand
Swarna Sub-1	Swarna 3/IR 49830-7-1-2-3	2009	145	Flood prone shallow lowlands	Plant height- 83.3cm Tolerant to complete submergence between 15-17 days, 5.2 t/ha yield	UP, Uttrakhand, Haryana and Bihar
NDR 2064	Pant Dhan 4/Saket4 // NDR 2017	2007	115	irrigated areas	50-55 Q/ha yield grains are (M.S)Medium Size, High yielding	UP, Orissa and West Bengal
NDR 2065	Pant Dhan 4/Saket 4// NDR 2018	2011	120-125	irrigated areas	50-55Q/ha grains are LB(Long Bold), High yielding	UP, Orissa and West Bengal
NDR 97	Nanina-22 x Ratna	1992	90-95	Rain fed Uplands	Dwarf (75-80 cm), Yield: 25-30 Q/ha.	UP, Orissa and West Bengal
IR-64	IR-5857-33- 2-1 x IR-2061-465-1-5-5	1991	115-120	Irrigated Areas	Semi dwarf (100 cm), grains: Yield: 58 Q/ha.	All India
Sarjoo-52	T(N)1 x Kashi	1982	130-133	Irrigated	Semi dwarf (98 cm), erect, grains: long bold, white, moderately resistant to Bacterial Leaf Blight, Yield: 50-60 Q/ha.	Uttar Pradesh.

Table 2: Details of Rice landraces and their area of collection:

S No.	Local Name	Village	District	Characteristics
1.	Local Selection 1(LS 1)	Tisuhi	Mirzapur, Uttar Pradesh	Brown grain, Semi long, Drought tolerant, short stature, early maturity
2.	Local Selection 3(LS 3)	Bharko	Mirzapur, Uttar Pradesh	Brown grain, elongated, Drought tolerant, medium stature
3.	Local Selection 4(LS 4)	Pochkhora	Mirzapur, Uttar Pradesh	Red grain, late maturity
4.	Local Selection 5(LS 5)	Jamunia	Mirzapur, Uttar Pradesh	Brown grain, Semi long, short stature, late maturity
5.	Local Selection 6(LS 6)	Bharko	Mirzapur, Uttar Pradesh	Brown grain, semi spherical, medium stature
6.	Local Selection 7(LS 7)	Pochkhora	Mirzapur, Uttar Pradesh	Brown grain, bold grain, Semi long, Drought tolerant, short stature, early maturity
7.	Local Selection 8(LS 8)	Manihan	Mirzapur, Uttar Pradesh	Brown grain, semi long, medium stature
8.	Local Selection 9(LS 9)	Deep Nagar	Mirzapur, Uttar Pradesh	Brown grain, Semi long, Drought tolerant, short stature, early maturity
9.	Local Selection 10(LS 10)	Jamunia	Mirzapur, Uttar Pradesh	Brown grain, semi long, medium stature, early maturity
10.	Local Selection 11(LS 11)	Tisuhi	Mirzapur, Uttar Pradesh	Brown grain, elongated, long stature, late maturity
11.	Local Selection 12(LS 12)	Mugal sarai	Chaundali, Uttar Pradesh	Black grain, elongated, Drought tolerant, long stature, late maturity

Results and Discussion

Phenotypic correlation coefficients

In the present investigation, the genotypic correlation coefficients were generally higher than their respective phenotypic correlation coefficients (Table 3). At phenotypic level, YPP showed highly positive significant correlation by GPP (0.603), Chl (0.326). Similar trends of results were also reported by Kishore *et al.* 2007. Positive significant correlation was obtained in EBT (0.249). Highly negative significant correlation was showed with PH@ maturity (0.341). Negative significant correlation was showed by PH @45DAT (0.223). Positive non-significant correlation was showed with DFF (0.149), DHF (0.102), DTFI (0.095), PL (0.088), SPP (0.072), PH @30DAS (0.006). Negative non-significant correlation was with PH@15DAS (0.012), NOT (0.088). Chl content showed highly negative significant correlation by PH@15DAS, Positive significant correlation with GPP. Positive non-significant correlation with PL, SPP and PH@ maturity, PH @ 30 DAS, PH @ 45 DAT show with Negative non-significant correlation. GPP showed highly negative significant correlation with PH@ maturity, NOT. Positive non-significant correlation was obtained in GPP, PH@15DAS, PH @45DAT. Negative non-significant correlation in DHF, followed by EBT, PH @30DAS and EBT showed positive significant correlation in DHF. Positive non-significant correlation with DFF, PH@15DAS, DTFI, SPP, PH @45DAT, PH @30DAS, PH@ maturity, PL. SPP showed highly negative significant correlation in PH@ maturity and Negative significant correlation was showed with PH @45DAT. Positive non-significant correlation was obtained in NOT, DHF, DFF, DTFI, PL. Negative non- significant was obtained in PH @30DAS, PH@15DAS. PL showed positive significant correlation in PH @ 45DAS. Positive non-significant correlation was obtained in NOT, DFF, PH @30DAS, DTFI, PH@ maturity. Negative non-significant correlation was obtained in PH@15DAS, DHF. Similar results were reported by Lalitha and Shreedhar (1996) .NOT showed positive non-significant correlation in PH@ maturity. Negative non-significant correlation was obtained in PH @30DAS, PH @45DAT, DTFI, DHF, DFF, PH@15DAS. PH@ maturity showed highly positive significant correlation in DTFI, PH @45DAT, DFF. Positive significant correlation was obtained in PH@15DAS, DHF. Positive non-significant correlation was obtained in PH @30DAS. PH@ 45DAT showed highly positive correlation in DHF. Positive significant correlation was showed in PH@15DAS. Positive non-significant correlation was obtained in DTFI, DFF. PH@ 30DAS showed highly positive significant correlation in DHF. Positive significant correlation was obtained in PH@15DAS. Positive non-significant correlation was obtained in DTFI, DFF(0.054). PH @15DAS showed highly positive significant correlation with DFF, DHF. DTFI showed positive significant correlation. DHF showed highly positive significant correlation with DTFI, DFF. DFF showed highly positive significant correlation with DTFI. These positive association between these characters have also been reported by Chand *et. al.,* 2007, Borbora *et. al.,* 2005.

Genotypic correlation coefficient

Yield per plant showed highly positive significant correlation with GPP(0.637), Chl(0.417), EBT(0.356). Highly negative significant correlation was obtained in PH@ maturity(0.375). Negative non-significant correlation was obtained with PH @45DAT(0.251), NOT (0.246). Positive non-significant correlation was showed by PL (0.199), DFF(0.154), DHF(0.122), SPP (0.117), DTFI (0.100). Negative non-significant correlation was obtained in PH@15DAS (0.002), PH @30DAS (0.070). Chl showed highly positive significant correlation by GPP (0.280). Positive significant correlation with PH@15DAS, PH @30DAS, DHF, DTFI(0.339), DFF, NOT and positive non- significant correlation was showed by EBT, PL, SPP. Negative non-significant correlation was obtained with PH@ maturity, PH @45DAT.

Characters mentioned above has also being reported in rice by earlier workers (Qamar *et al.* 2005; Ram Krishan *et al.* 2006) GPP showed highly positive significant correlation was obtained in EBT and negative highly significant correlation was obtained in NOT, PH @45DAT, PH@ maturity. Positive non-significant correlation was obtained in PH @30DAS, SPP, DHF. Negative non-significant correlation was found in DFF, DTFI, PH@15DAS, PL. EBT showed highly positive significant correlation in PH @30DAS, PH@15DAS, DHF, DTFI, DFF, SPP, PH @45DAT. Negative non-significant correlation was obtained in NOT, PL. Positive non-significant correlation was obtained in PH@ maturity(0.082). SPP showed highly positive significant correlation in NOT. Highly negative significant correlation was found in PH @30DAS, PH@ maturity, PH @45DAT. Positive non-significant correlation was obtained in PL, DFF, DTFI, DHF. Negative significant correlation was obtained in PH@15DAS and PL showed highly significant correlation was obtained in PH @45DAT. Highly negative significant correlation was obtained in PH @30DAS. Negative significant correlation was obtained in NOT. Positive non-significant correlation was obtained in DFF, DTFI, PH@ maturity. Negative non-significant correlation was obtained in PH@15DAS, DHF. NOT showed highly negative significant correlation was obtained in PH @30DAS(1.088), PH@15DAS, DFF, DHF. Positive non-significant correlation was obtained with PH @maturity. Negative non-significant correlation was found in PH @45DAT, DTFI. PH@maturity showed highly positive significant correlation in PH @45DAT, PH@15DAS, DTFI, DFF. Positive significant correlation was showed in DHF, PH @30DAS. PH@ 45DAT showed highly positive significant correlation was obtained in PH @30DAS, PH@15DAS. Positive significant correlation was obtained in DFF. Positive non-significant correlation was obtained in DHF, DTFI. PH@ 30DAS showed highly positive significant correlation in DHF, PH@15DAS. Positive significant correlation was obtained in DTFI, DFF. In PH @15DAS showed highly positive significant correlation with DTFI, DFF, DHF. DHF showed highly positive significant correlation with DTFI, DFF. DFF showed highly positive significant correlation with DTFI. (Mahto *et al.* (2003), Chand *et al.* 2007)

Path-coefficient Analysis

Phenotypic path coefficients

The direct and indirect effect of different characters on grain yield/plant computed by using phenotypic correlations are presented in Table-**4**. The highest positive direct effect on grain yield per plant was exhibited by GPP(0.485), DFF(0.414), PH @45DAT(0.255), Chl(0.255), EBT(0.173), PH @30DAS(0.042), NOT(0.029), PL(0.024) the direct effects of remaining characters were too low to be considered important. GPP exhibited indirect positive effect on grain yield per plant *via* PH@ maturity(0.161), Chl(0.064), EBT(0.02), DTFI(0.002), PH@ 15 DAS(0.002), PH @30 DAS(0.001), SPP(0.001), High direct effect of filled spikelets/panicle on single plant yield was reported by Eidi kohnaki *et al.,* (2013), Kiani and Nematzadeh (2012), Seyoum *et al*., (2012), Bagheri *et al*., (2011), Bhadru *et al*., (2011) and Chandra *et al*., (2009).

Genotypic path coefficients

The highest positive direct effect on grain yield per plant was exhibited by DTFI (1.034), GPP(0.372), SPP(0.358), PL(0.295), PH @maturity(0.187), EBT(0.135), PH @30DAS (0.100), Chl (0.046). DTFI exhibited indirect positive effect on grain yield per plant *via* EBT, PH @ maturity , NOT, SPP, PL, PH @ 30 DAS, similar result supported that Bhadru *et al*., (2011) and Chandra *et al*., (2009) reported positive direct effect of days to 50% flowering and Eidi kohnaki *et al.,* (2013) and Nematzadeh (2012) found the positive direct effect.

Table 3: Estimation of phenotypic correlation coefficient for 14 characters in selected rice germplasm

Traits	DTFI	DFF	DHF	PH @15 DAS	PH @30 DAS	PH @45 DAT	PH @ Maturity	NOT	PL	SPP	EBT	GPP	Chl	GYP
DTFI	**1.000**	0.968**	0.865**	0.268*	0.068	0.187	0.315**	-0.041	0.051	0.079	0.172	-0.039	-0.307**	0.095
DFF		**1.000**	0.832**	0.322**	0.054	0.224*	0.305**	-0.090	0.136	0.112	0.184	-0.010	-0.275*	0.149
DHF			**1.000**	0.300**	0.311**	0.206	0.255*	-0.072	-0.034	0.114	0.246*	0.012	-0.301**	0.102
PH @15 DAS				**1.000**	0.262*	0.484**	0.288*	-0.171	-0.018	-0.188	0.177	-0.033	-0.342**	-0.012
PH @30 DAS					**1.000**	0.222*	0.107	-0.037	0.057	-0.071	0.061	0.012	-0.169	0.006
PH @ 45 DAS						**1.000**	0.740**	-0.039	0.237*	-0.283*	0.086	-0.480**	-0.189	-0.223*
PH @ Maturity							**1.000**	0.002	0.024	-0.347**	0.022	-0.439**	-0.160	-0.341**
NOT								**1.000**	0.201	0.193	-0.124	-0.120	-0.009	-0.088
PL									**1.000**	0.046	0.001	-0.133	0.051	0.088
SPP										**1.000**	0.170	-0.023	0.045	0.072
EBT											**1.000**	0.117	-0.051	0.249*
GPP												**1.000**	0.251*	0.603**
Chl													**1.000**	0.326**

Table 4: Estimation of genotypic correlation coefficient for 14 characters in selected rice germplasm

Traits	DTFI	DFF	DHF	PH @15 DAS	PH @30 DAS	PH @45 DAT	PH @ Maturity	NOT	PL	SPP	EBT	GPP	Chl	GYP
DTFI	**1.000**	0.972**	0.875**	0.307**	0.171	0.188	0.319**	-0.185	0.062	0.123	1.130**	-0.043	-0.339**	0.100
DFF		**1.000**	0.845**	0.379**	0.088	0.230*	0.309**	-0.367**	0.202	0.127	1.121**	-0.009	-0.306**	0.154
DHF			**1.000**	0.353**	0.755**	0.205	0.262*	-0.300**	-0.014	0.122	1.752**	0.010	-0.340**	0.122
PH @15 DAS				**1.000**	0.481**	0.561**	0.343**	-0.455**	-0.004	-0.166	1.986**	-0.080	-0.485**	-0.002
PH @30 DAS					**1.000**	0.592**	0.229*	-1.088**	-0.423**	-0.589**	2.599**	0.018	-0.390**	-0.070
PH @ 45 DAS						**1.000**	0.757**	-0.173	0.326**	-0.374**	0.561**	-0.509**	-0.203	-0.251*
PH @ Maturity							**1.000**	0.123	0.036	-0.485**	0.082	-0.457**	-0.183	-0.375**
NOT								**1.000**	-0.284*	0.978**	-1.707**	-0.570**	-0.280**	-0.246*
PL									**1.000**	0.204	-0.429**	-0.169	0.138	0.199
SPP										**1.000**	0.592**	0.014	0.042	0.117
EBT											**1.000**	1.121**	0.177	0.356**
GPP												**1.000**	0.280**	0.637**
Chl													**1.000**	0.417**

Table 5. Phenotypic Path Coefficient for 14 character in selected rice germplasm

Trait	DTFI	DHF	DHF	PH@ 15 DAS	PH @30 DAS	PH @45 DAS	PH@ maturity	NOT	PL	SPP	EBT	GPP	Chl	GYP
DTFI	**-0.055**	0.343	-0.095	-0.015	0.003	0.047	-0.116	-0.001	0.001	-0.005	0.030	-0.019	-0.078	0.095
DFF	-0.053	**0.414**	-0.092	-0.019	0.002	0.057	-0.112	-0.003	0.003	-0.007	0.032	-0.005	-0.070	0.149
DHF	-0.048	0.343	**-0.110**	-0.017	0.013	0.052	-0.094	-0.002	-0.001	-0.007	0.042	0.006	-0.077	0.102
PH @15 DAS	-0.015	0.133	-0.034	**-0.058**	0.011	0.122	-0.106	-0.005	0.000	0.011	0.031	-0.016	-0.087	-0.012
PH @30 DAS	-0.004	0.022	-0.034	-0.015	**0.042**	0.056	-0.039	-0.001	0.001	0.004	0.010	0.006	-0.043	0.006
PH @45 DAT	-0.010	0.088	-0.024	-0.028	0.009	**0.252**	-0.272	-0.001	0.006	0.017	0.015	-0.233	-0.048	-0.223*
PH @maturity	-0.012	0.129	-0.031	-0.017	0.005	0.187	**-0.367**	0.000	0.001	0.020	0.004	-0.213	-0.041	-0.341**
NOT	0.002	-0.037	0.008	0.010	-0.002	-0.010	-0.001	**0.029**	0.005	-0.011	-0.021	-0.058	-0.002	-0.088
PL	-0.003	0.056	0.005	0.001	0.002	0.060	-0.009	0.006	**0.024**	-0.003	0.000	-0.064	0.013	0.088
SPP	-0.005	0.043	-0.013	0.011	-0.003	-0.071	0.127	0.006	0.001	**-0.058**	0.029	-0.011	0.012	0.072
EBT	-0.009	0.087	-0.027	-0.010	0.003	0.022	-0.008	-0.004	0.000	-0.010	**0.173**	0.057	-0.013	0.249*
GPP	0.002	-0.003	-0.001	0.002	0.001	-0.121	0.161	-0.004	-0.003	0.001	0.020	**0.485**	0.064	0.603**
Chl	0.017	-0.115	0.033	0.020	-0.007	-0.048	0.059	0.000	0.001	-0.003	-0.009	0.122	**0.255**	0.326**

R SQUARE = 0.5292 RESIDUAL EFFECT = 0.686

Table 6. Genotypic path coefficient for 14 character in selected rice genotypes

Traits	DTFI	DFF	DHF	PH@ 15 DAS	PH @ 30 DAS	PH @ 45 DAS	PH @ maturity	NOT	PL	SPP	EBT	GPP	Chl	GYP
DTFI	**1.034**	-0.598	-0.576	-0.051	0.017	-0.032	0.060	0.057	0.018	0.044	0.152	-0.016	-0.016	0.100
DFF	1.004	**-0.619**	-0.546	-0.063	0.009	-0.039	0.058	0.112	0.060	0.046	0.151	-0.004	-0.014	0.154
DHF	0.905	-0.525	**-0.648**	-0.059	0.076	-0.035	0.049	0.092	-0.004	0.044	0.236	0.004	-0.016	0.122
PH@ 15 DAS	0.308	-0.237	-0.233	**-0.167**	0.048	-0.095	0.064	0.139	-0.001	-0.059	0.268	-0.030	-0.023	-0.002
PH@ 30 DAS	0.176	-0.056	-0.492	-0.080	**0.100**	-0.101	0.043	0.332	-0.125	-0.211	0.350	0.007	-0.018	-0.070
PH@ 45 DAT	0.188	-0.145	-0.143	-0.094	0.059	**-0.170**	0.142	0.053	0.096	-0.134	0.076	-0.189	-0.009	-0.251*
PH@ Maturity	0.330	-0.191	-0.170	-0.057	0.023	-0.129	**0.187**	-0.038	0.011	-0.174	0.011	-0.170	-0.009	-0.375**
NOT	-0.192	0.243	0.195	0.076	-0.109	0.029	0.023	**-0.306**	-0.084	0.350	-0.230	-0.212	-0.013	-0.246*
PL	0.064	-0.125	0.009	0.001	-0.042	-0.055	0.007	0.087	**0.295**	0.073	-0.058	-0.063	0.006	0.199
SPP	0.132	-0.083	-0.079	0.028	-0.059	0.063	-0.091	-0.299	0.060	**0.358**	0.080	0.005	0.002	0.117
EBT	1.173	-0.644	-1.143	-0.332	0.261	-0.095	0.015	0.522	-0.127	0.212	**0.135**	0.417	0.008	0.356**
GPP	-0.045	0.006	-0.067	0.013	0.002	0.087	-0.086	0.174	-0.050	0.005	0.151	**0.372**	0.013	0.637**
Chl	-0.364	0.193	0.220	0.081	-0.039	0.034	-0.034	0.086	0.041	0.015	0.024	0.104	**0.046**	0.417**

R SQUARE = 0.3750 RESIDUAL EFFECT = 0.7906

The estimated residual effect was 0.790 indicating that about 80% of the variability in grain yield was contributed by the characters studied in path analysis. This residual effect towards yield in the present study might be due to many reasons, such as other characters, which are not included in the investigation, environmental factor and sampling errors. Within the scope of path analysis carried out in the present study, it is therefore, suggested that number of spikelets per panicle (SPP) and number of tillers (NOT), the main components of grain yield should be given high priority in the selection programme.

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