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The inter-relationship among yield and yield attributing traits of rice (*Oryza sativa* L.) under Irrigated condition through correlation coefficient studies and path analysis

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Abstract
A set of 48 rice genotypes were evaluated to study the inter-relationship among yield and yield attributing traits under irrigated condition during *Kharif* 2018 at Rice Research Farm, Bihar Agricultural University, Sabour (Bhagalpur), India. The analysis of variance revealed highly significant variation among the genotypes for all the traits studied. Grain yield per plant showed highly significant and positive association with effective tillers per hill, 1000 grain weight, biological yield, harvest index (%) and significant and positive association with number of fertile grains per panicle, root biomass and chlorophyll index. However, it exhibited highly significant and negative correlation with spikelet sterility %. Path coefficient analysis revealed that total number of grains per panicle, number of fertile grains per panicle, panicle density index, panicle length, biological yield and harvest index (%) had high positive direct effects on grain yield per plant. Hence, selection based on these traits could help to bring simultaneous improvement of yield and yield attributes. In rest of the characters studied, correlation was mainly due to indirect effects through component characters and hence indirect selection will lead to yield improvement in rice.

Keywords: Association, correlation, path coefficient, yield, rice

Introduction
Rice (*Oryza sativa* L.) is the most important food crop and a primary food source for more than one third of the world's population. It plays a major role in India's food security. Globally rice is grown over an area of about 164 million hectares with an annual production of 723 million tons. The area, production and productivity of rice in India is 43.19 million hectares, 110.15 million tonnes and 2550 kg/hectare, respectively (Dept. of Agriculture, Annual Report 2016-17). Grain yield is a complex trait and influenced by many genetic as well as environmental factors. Therefore, use of direct selection for yield could be misleading. A successful selection depends upon the information on the association of seed yield with morpho-agronomic traits. The inter-relationship between important yield components is best estimated by correlation coupled with path coefficient analysis. Correlation is the mutual relationship between the variables; it helps in determination of the most effective procedures for selecting superior genotypes. In the case of positive correlation between major yield components, breeding strategies would be very effective but on the reverse, selection becomes very difficult. The estimates of correlation coefficients alone may be often misleading due to mutual cancellation of component characters. So, study of correlation along with path analysis is more effective in the study of yield contributing characters. Path coefficient analysis is an important statistical tool for dividing the correlation coefficient into direct and indirect effect of the causal components on the complex component.

Materials and methods
The present investigation was conducted in *Kharif* season, 2018-19, in Randomized Block Design, at area specified to the rice section of Bihar Agricultural University, Sabour (Bhagalpur), Bihar, India. Bihar has the geographical location of the Middle Gangetic Plain

region occupying agro-climatic zone IIIA. It is situated 46 meters above sea level and it lies between 25°'15'40'' N latitude to 87°' 2'42" E longitude. The list of 48 genotypes is displayed in Table 1.

Table 1: List of genotypes

S. No.	Genotypes	S. No.	Genotypes
1	IR 95785-31-2-1-2	25	IRRI 123
2	IR 14L155	26	IR 107891-B-B-111-2-1
3	IR 107891-B-B-845-1-1	27	IR 107891-B-B-1019-1-1
4	IR 90257-B-577-1-1-B	28	IR 107891-B-B-548-1-1
5	IR 14L157	29	IR 107891-B-B-664-3-1
6	IR 107891-B-B-846-2-1	30	DRR dhan 44
7	IR 107891-B-B-1110-3-1	31	IR 107891-B-B-1394-1-1
8	IR 14L362	32	Sahabagidhan
9	IR 90257-B-577-1-1-B-1	33	IR 108198-23-1-1-B
10	IR 95817-5-1-1-2	34	SWARNA
11	Sabour Deep	35	IF 14L613
12	MTU 1010	36	IR 107891-B-B-359-3-1
13	IR 106312-50-1-1-1	37	IR 107891-B-B-1284-2-1
14	IR 107891-B-B-785-2-1	38	IR 107891-B-B-1023-1-1
15	IR 107891-B-B-1253-1-1	39	IR 90257-B-577-2-1-3-B
16	Sambha Mahsuri	40	IR 108198-23-24-1-B
17	IR 107891-B-B-90-3-1	41	IR 64
18	IR 107891-B-B-379-2-1	42	TRP-20-7-1-B-2-B
19	IR 106516-1-2-2-2	43	IR 107891-B-B-1304-1-1
20	IR 107891-B-B-447-2-2	44	IR 127363-76-1
21	IR 103587-22-5-5-B	45	IR 13L378
22	IR 108199-24-32-1-1-B	46	IR 107891-B-B-1216-1-1
23	IR 107891-B-B-1432-2-1	47	IR 107891-B-B-447-3-1
24	IR 93827-29-1-1-4	48	IR 93827-29-2-1-3

The observations recorded were days to 50% flowering, days to maturity, number of effective tillers per hill, plant height, panicle length, number of fertile grains per panicle, number of sterile grains per panicle, spikelet sterility percentage, total number of spikelets per panicle, panicle density index, 1000 grain weight, biological yield, harvest index, proline content, chlorophyll index, leaf area, relative water content, root biomass and grain yield per plant. The days to 50% flowering and days to maturity were accounted on a plot basis whereas other characters were documented from random sample of five plants in each plot. Chlorophyll index was recorded in terms of SPAD value by using SPAD-502 meter (Minolta Konica Co. Ltd., Japan). The chlorophyll index was recorded from the flag leaf in the direction of sun at 1.00 pm.

$$\text{Spikelet sterility (\%)} = \frac{number\ of\ sterile\ spikelets}{total\ number\ of\ spikelets} * 100$$

$$\text{Panicle density index} = \frac{number\ of\ grains\ per\ panicle}{length\ of\ panicle\ in\ cm} * 100$$

$$\text{HI (\%)} = \frac{economic\ yield}{biological\ yield} * 100$$

$$\text{µmoles proline per gram tissue} = \frac{\mu g\ proline\ per\ ml\ x\ ml\ toulene\ used}{115.5} x \frac{5}{gram\ sample\ used}$$

$$\text{Relative Water Content (\%)} = \frac{fresh\ weight - dry\ weight}{turgid\ weight - dry\ weight} * 100$$

Result and discussion

The analysis of variance revealed highly significant variation among the genotypes for all quatitative and physiological traits studied (Table 2).

Table 2: Analysis of variance for nineteen different characters in forty-eight rice genotypes

S. No.	Characters	Mean sum OF squares		
		Replication	Treatment	Error
		(d.f. =02)	(d.f. =47)	(d.f. =94)
1	Days to 50% flowering	10.54	18.191**	7.32
2	Days to maturity	5.15	23.786**	13.61
3	Effective tillers per hill	1.79	3.359**	0.35
4	Plant height (cm)	88.73	157.206**	32.68
5	Panicle length (cm)	0.49	7.527**	2.01
6	No. of fertile grains panicle^{-1}	53.24	1128.890**	91.29
7	No. of sterile grains panicle^{-1}	1.01	92.410**	3.30
8	Spikelets Sterility %	1.96	40.423**	2.28
9	Total no. of spikelets panicle^{-1}	41.47	1318.710**	92.34
10	Panicle density index	0.18	1.972**	0.23
11	1000 grain weight	1.15	13.919**	1.38
12	Biological yield (g)	14.88	45.945**	12.07
13	H.I. (%)	9.73	19.097**	11.05
14	Grain yield plant^{-1}	2.89	20.919**	3.58
15	Leaf area	13.15	110.514**	2.99
16	RWC	1.59	46.047**	2.98
17	Proline	1.46	7.246**	0.31
18	Root biomass	1.36	66.496**	3.50
19	Chlorophyll Index	9.77	26.627**	12.69

* and ** significant at 5% and 1% probability level

Phenotypic correlation coefficient

Correlation estimates showed the possibility of improvement of a character through selection for other characters (Table 3). Grain yield per plant showed highly significant and positive association with effective tillers per hill, 1000 grain weight, biological yield, harvest index (%) and significant and positive association with number of fertile grains per panicle, root biomass and chlorophyll index. Therefore, it is suggested that these traits should be used as selection criteria for yield improvement in rice under irrigated condition. The positive correlation of grain yield with 1000 grain weight is in agreement with earlier reports of Kishore *et al.* (2018) [18], Chakravarty and Ghosh (2014) [9] for number of fertile grains per panicle, Krishnaveni *et al.* (2013) [29] for effective tillers per hill and Sathya and Jebaraj (2013) [28] for chlorophyll index. Days to 50% flowering showed significant and positive association with days to maturity, leaf area and root biomass, while significantly negative association with number of sterile grains per panicle. Archana (2018) [6] reported similar relation of days to 50% flowering with days to maturity. Days to maturity was found to be significantly and positively associated with leaf area, root biomass and chlorophyll index. Effective tillers per hill showed significant and positive association with biological yield while significantly negative correlation with plant height. Plant height showed significantly positive association with panicle length, while significant and negative association with proline content and root biomass. Selvaraj *et al.* (2011) [14], Nagendra Rao *et al.* (2010) [22] and Kole *et al.* (2008) [19] have also reported similar results for plant height with panicle length. The association of panicle length with proline content was significant and positive, while significant and negative with 1000 grain weight, panicle density index and chlorophyll index. Number of fertile grains per panicle showed positive and significant association with total number of spikelets per panicle, panicle density index and leaf area. Spikelet sterility (%) and root biomass showed negative significant association with fertile grains per panicle. Number of sterile grains per panicle showed positive and significant association with spikelet sterility (%), total number of spikelets per panicle, panicle density index, whereas significant negative association with root biomass. Spikelet sterility (%) exhibited significantly negative association with biological yield and root biomass. Total number of spikelets per panicle showed positive and significant association with panicle density index and leaf area whereas negative significant association with root biomass. Panicle density index showed positive significant association with leaf area and chlorophyll index and negative significant association with root biomass. 1000 grain weight showed positive and significant association with leaf area and root biomass whereas with proline content, it had negative significant association. Biological yield showed significantly negative association with harvest index. Root biomass showed significant positive association with leaf area. Similar results were reported by Satheeshkumar and Saravanan (2012) [27] Bhatt *et al.* (2016) [7], Premkumar *et al.* (2016) and Priya *et al.* (2017) [25].

Path coefficient analysis

Considering grain yield as effect and other quantitative characters as causes, phenotypic correlation coefficient were partitioned by using method of path analysis to investigate direct and indirect effect of yield contributing characters towards grain yield per plant (Table 4). The results revealed high residual effect (0.3676) for phenotypic path coefficients, indicating that variables studied in the present investigation explained more than 50% of the variability in yield and therefore, other attributes besides the characters studied are also contributing for grain yield. Path coefficient analysis revealed that total number of grains per panicle, number of fertile grains per panicle, panicle density index, panicle length, biological yield and harvest index (%) had high positive direct effects on grain yield per plant. The results were in agreement with the previous findings of Kishore *et al.* (2018) [18] for number of fertile grains per panicle and harvest index (%), Jambhulkar and Bose (2014) [15] for panicle length and Guru *et al.* (2016) [12] for effective tillers per plant.

Days to 50% flowering had a negative direct effect on grain yield per plant. However, an indirect positive effect was observed on grain yield per plant via effective tillers per hill, plant height, panicle length, number of fertile grains per panicle, number of sterile grains per panicle, spikelet sterility (%), total number of spikelets per panicle, panicle density index, biological yield and relative water content and indirect negative effect via days to maturity, 1000 grain weight, harvest index (%), leaf area, proline content, root biomass and chlorophyll index.

Days to maturity had a positive direct effect on grain yield per plant. An indirect positive effect was observed on grain yield per plant via days to 50% flowering, 1000 grain weight, harvest index (%), leaf area, root biomass and chlorophyll index.

Effective tillers per hill had a positive direct effect on grain yield per plant, however an indirect positive effect was observed on grain yield per plant via all the studied characters except days to 50% flowering, days to maturity, plant height, number of number of sterile grains per panicle, spikelet sterility (%) and chlorophyll index.

Plant height had a positive direct effect on grain yield per plant. However an indirect positive effect was observed on grain yield per plant via panicle length, number of fertile grains per panicle, number of number of sterile grains per panicle, spikelet sterility (%), total number of spikelets per panicle, harvest index (%) and chlorophyll index.

Panicle length had a positive direct effect on grain yield per plant and indirect positive effect via all the characters except days to 50% flowering, days to maturity, panicle density index, 1000 grain weight, leaf area, root biomass and chlorophyll index.

Number of fertile grains per panicle had a positive direct effect on grain yield per plant. An indirect positive effect was observed on grain yield per plant via days to 50% flowering, days to maturity, spikelet sterility (%) and root biomass.

Number of sterile grains per panicle had positive direct effect on grain yield per plant. An indirect positive effect was observed on grain yield per plant via plant height, panicle length, number of fertile grains per panicle, spikelet sterility %, total number of spikelet per panicle, panicle density index and leaf area.

Spikelet sterility (%) had a negative direct effect on grain yield per plant. An indirect negative effect was observed on grain yield per plant via plant height, panicle length and number of number of sterile grains per panicle.

Total number of spikelets per panicle had a positive direct effect on grain yield per plant. An indirect positive effect was observed on grain yield per plant via days to 50% flowering, days to maturity, spikelet sterility (%) and root biomass.

Panicle density index had a positive direct effect on grain yield per plant. An indirect positive effect was observed on grain yield per plant via effective tillers per hill, number of

fertile grains per panicle, number of number of sterile grains per panicle, total number of spikelets per panicle, 1000 grain weight, harvest index%, leaf area, relative water content, proline content and chlorophyll index.

1000 grain weight had a positive direct effect on grain yield per plant. An indirect negative effect was observed on grain yield per plant via plant height, panicle length, number of number of sterile grains per panicle, spikelet sterility (%) and proline content.

Biological yield had a positive direct effect on grain yield per plant. An indirect positive effect was observed on grain yield per plant via effective tillers per hill, panicle length, number of fertile grains per panicle, total number of spikelets per panicle, 1000 grain weight, proline content and root biomass.

Harvest index (%) had a positive direct effect on grain yield per plant. An indirect negative effect was observed on grain yield per plant via number of number of sterile grains per panicle, spikelet sterility (%), biological yield, proline content and chlorophyll index.

Leaf area had a positive direct effect on grain yield per plant. An indirect negative effect was observed on grain yield per plant via plant height, panicle length, spikelet sterility (%), biological yield and chlorophyll index.

Relative water content showed positive direct effect on grain yield per plant. All the characters exhibited indirect positive effect except days to 50% flowering, days to maturity, plant height, number of sterile grains per panicle, spikelet sterility (%), biological yield and root biomass.

Proline content had a positive direct effect on grain yield per plant. Root biomass showed positive direct effect on grain yield per plant. An indirect positive effect was imposed by days to 50% flowering, days to maturity, effective tillers per hill, 1000 grain weight, biological yield, harvest index (%) and leaf area.

Chlorophyll index showed negative direct effect on grain yield per plant. An indirect positive effect was imposed by effective tillers per hill, panicle length, number of sterile grains per panicle, spikelet sterility (%), biological yield, harvest index (%), leaf area and root biomass.

Therefore, effective tillers per hill, 1000 grain weight, number fertile grains per panicle, biological yield, harvest index (%) and root biomass had significant positive association as well as direct effect on grain yield and indirectly influenced via various traits. Hence, these traits may be prioritized as important selection criteria in all rice improvement programmes. The potential for indirect selection under irrigated condition using these associated characters may be useful to the breeder to formulate appropriate breeding plans for the selection of the genotypes. These findings are in accordance with the result of Nandan *et al.* (2010) [23] Haider *et al.* (2012) [13] and Katiyar *et al.* (2019) [17].

Conclusion

A perusal of the results of both correlation and path analysis revealed that most important characters accounting for cause and effect relationship on yield are effective tillers per hill, number fertile grains per panicle, 1000 grain weight, biological yield, harvest index (%) and root biomass. Thus, these traits were identified to be the major yield factors and major emphasis may be given towards selection of these traits for improvement of grain yield in rice under irrigated condition. Hence, emphasis should be given to these traits while formulating selection criteria for improvement in grain yield.

Table 3: Phenotypic correlation of different characters in rice genotypes

	DFF	DM	EBT	PHT	PL	NFGPP	NSGPP	SS%	TNSPP	PDI	1000 GR WT	BY	H.I %	LA	RWC	Proline	RB	CI	GYPP
DFF																			-0.03
DM	0.815**																		-0.042
EBT	-0.063	-0.114																	0.418**
PHT	-0.077	-0.006	-0.325**																-0.069
PL	-0.117	-0.071	0.063	0.353**															0.149
NFGPP	-0.046	-0.054	0.157	0.078	0.029														0.187*
NSGPP	-0.188*	-0.155	-0.009	0.092	0.13	0.129													-0.137
SS%	-0.145	-0.11	-0.075	0.054	0.1	-0.276**	0.907**												-0.219**
TNSPP	-0.091	-0.09	0.144	0.097	0.06	0.967**	0.377**	-0.025											0.139
PDI	-0.048	-0.065	0.099	-0.052	-0.372**	0.885**	0.290**	-0.067	0.901**										0.069
1000 GR WT	0.004	0.023	0.022	-0.108	-0.180*	0.079	-0.11	-0.126	0.046	0.125									0.230**
BY	-0.0001	-0.103	0.189*	-0.023	0.153	0.106	-0.134	-0.187*	0.064	-0.007	0.046								0.513**
H.I %	0.004	0.027	0.1	0.014	0.003	0.072	-0.01	-0.033	0.065	0.057	0.153	-0.353**							0.340**
LA	0.175*	0.240**	0.043	-0.102	-0.109	0.196*	0.07	-0.019	0.202*	0.228**	0.213*	-0.037	0.035						0.1
RWC	-0.088	-0.037	0.045	-0.117	0.049	0.078	-0.162	-0.193*	0.031	0.018	0.012	-0.122	0.115	0.161					0.054
Proline	0.058	-0.04	0.101	-0.193*	0.169*	0.148	-0.102	-0.189*	0.112	0.025	-0.194*	0.085	-0.04	0.034	0.280**				0.062
RB	0.224**	0.206*	0.148	-0.256**	-0.052	-0.196*	-0.279**	-0.186*	-0.255**	-0.209*	0.334**	0.013	0.045	0.266**	-0.051	-0.065			0.197*
CI	0.119	0.181*	-0.13	0.062	-0.194*	0.096	-0.024	-0.047	0.084	0.165*	0.016	-0.135	-0.074	-0.009	0.041	0.009	-0.027		0.181*

DFF= days to 50% flowering; DM=days to maturity; EBT= number of effective tillers per hill; PHT= plant height; PL= panicle length; NFGPP= number of fertile grains per panicle; NSGPP= number of sterile grains per panicle; SS%= spikelet sterility %; TNSPP= total number of spikelets per panicle; PDI= panicle density index; GR WT= grain weight; BY= biological yield; HI= harvest index; LA= leaf area; RWC= relative water content; RB= root biomass; CI= chlorophyll index; GYPP= grain yield per plant; * and ** significant at 5% and 1% probability level

Table 4: Direct (diagonal) and indirect (off diagonal) effects of contributing characters on grain yield of rice

	DFF	DM	EBT	PHT	PL	NFGPP	NSGPP	SS%	TNSPP	PDI	1000 GR WT	BY	H.I %	LA	RWC	Proline	RB	CI
DFF	**-0.1273**	-0.1037	0.008	0.0098	0.0149	0.0059	0.0239	0.0184	0.0116	0.0061	-0.0005	0.0001	-0.0005	-0.0223	0.0112	-0.0074	-0.0285	-0.0151
DM	0.1159	**0.1422**	-0.0162	-0.0008	-0.01	-0.0076	-0.022	-0.0157	-0.0128	-0.0092	0.0032	-0.0147	0.0039	0.0342	-0.0052	-0.0057	0.0293	0.0257
EBT	-0.0146	-0.0266	**0.233**	-0.0757	0.0148	0.0365	-0.0021	-0.0176	0.0336	0.0231	0.0052	0.0441	0.0233	0.0101	0.0104	0.0235	0.0344	-0.0304
PHT	-0.0022	-0.0002	-0.0095	**0.0292**	0.0103	0.0023	0.0027	0.0016	0.0028	-0.0015	-0.0032	-0.0007	0.0004	-0.003	-0.0034	-0.0056	-0.0075	0.0018
PL	-0.0765	-0.046	0.0413	0.2301	**0.6516**	0.0186	0.0844	0.065	0.039	-0.2424	-0.1174	0.0994	0.0017	-0.0709	0.032	0.1103	-0.034	-0.1264
NFGPP	0.0167	0.0194	-0.0567	-0.0283	-0.0103	**0.362**	-0.0467	0.0997	-0.3501	-0.3205	-0.0286	-0.0383	-0.0262	-0.0711	-0.0283	-0.0538	0.0709	-0.0348
NSGPP	-0.041	-0.0338	-0.0019	0.02	0.0283	0.0281	**0.2183**	0.198	0.0823	0.0634	-0.0239	-0.0292	-0.0021	0.0154	-0.0354	-0.0223	-0.0608	-0.0052
SS%	0.0462	0.0352	0.0241	-0.0172	-0.0319	0.088	-0.2898	**-0.3195**	0.0078	0.0213	0.0404	0.0597	0.0107	0.006	0.0618	0.0604	0.0596	0.0149
TNSPP	0.0964	0.0949	-0.1521	-0.1021	-0.0632	-1.0212	-0.3981	0.0259	**1.056**	-0.9519	-0.0483	-0.068	-0.0689	-0.2128	-0.0331	-0.1188	0.2688	-0.0883
PDI	-0.07	-0.0949	0.1454	-0.0766	-0.5457	1.2988	0.4261	-0.098	1.3225	**1.4671**	0.1827	-0.0109	0.084	0.3344	0.0261	0.0366	-0.3073	0.2416
1000 GR WT	0.0003	0.0016	0.0016	-0.0078	-0.0129	0.0057	-0.0079	-0.0091	0.0033	0.0089	**0.0719**	0.0033	0.011	0.0153	0.0008	-0.014	0.024	0.0012
BY	-0.0003	-0.0669	0.1226	-0.0149	0.0989	0.0685	-0.0866	-0.1211	0.0417	-0.0048	0.0295	**0.6479**	-0.2285	-0.0237	-0.0787	0.0549	0.0081	-0.0877
H.I %	0.0021	0.0143	0.0518	0.0072	0.0014	0.0376	-0.005	-0.0173	0.0339	0.0297	0.0796	-0.1831	**0.5192**	0.018	0.0597	-0.021	0.0236	-0.0382
LA	0.0062	0.0086	0.0015	-0.0036	-0.0039	0.007	0.0025	-0.0007	0.0072	0.0081	0.0076	-0.0013	0.0012	**0.0356**	0.0057	0.0012	0.0095	-0.0003
RWC	-0.0027	-0.0011	0.0014	-0.0036	0.0015	0.0024	-0.0051	-0.006	0.001	0.0006	0.0004	-0.0038	0.0036	0.005	**0.0312**	0.0087	-0.0016	0.0013
Proline	0.0013	-0.0009	0.0022	-0.0043	0.0038	0.0033	-0.0023	-0.0042	0.0025	0.0006	-0.0043	0.0019	-0.0009	0.0008	0.0063	**0.0223**	-0.0014	0.0002
RB	0.0244	0.0224	0.0161	-0.0279	-0.0057	-0.0213	-0.0303	-0.0203	-0.0277	-0.0228	0.0364	0.0014	0.0049	0.029	-0.0056	-0.007	**0.1089**	-0.0029
CI	-0.0046	-0.007	0.005	-0.0024	0.0075	-0.0037	0.0009	0.0018	-0.0032	-0.0064	-0.0006	0.0052	0.0028	0.0004	-0.0016	-0.0003	0.001	**-0.0386**
GYPP	-0.0296	-0.0425	0.4177	-0.069	0.1492	0.1869	-0.137	-0.2189	0.1394	0.0695	0.2299	0.5131	0.3396	0.1003	0.0539	0.0622	0.1969	-0.1813
Residual effect = 0.3676																		

References

1. Afrin W, Hossain MA, Islam MM. Evaluation of yield and yield contributing traits for submergence tolerance of rice. Progressive Agriculture. 2017; 28(1):7-11.
2. Akter K, Iftekharuddhault KM, Bashar MK, Kabir MH, Sarkar MZA. Genetic variability, correlation and path analysis in irrigated hybrid rice.h. of subtropical Agric. Res. And Development. 2004; 2(1):17-23.
3. Akinwale MG, Gregorio G, Nwilene F, Akinyele BO, Ogunbayo SA, Odiyi AC. Heritability and correlation coefficient analysis for yield and its components in rice (*Oryza sativa* L.). African Journal of Plant Science. 2011; 5(3):207-212.
4. Allam CR, Jaiswal HK, Qamar A. Character association and path analysis studies of yield and quality parameters in basmati rice (*Oryza sativa*L.). The Bioscan. 2015; 9(4):1733-1737.
5. Anis G, Sabagh AEL, Ghareb A, Rewainy AEL. Evaluation of promising lines in rice (*Oryza sativa*L.) to agronomic and genetic performance under Egyptian conditions. International Journal of Agronomy and Agricultural Research. 2016; 8(3):52-57.
6. Archana RS, Sudha Rani M, Vishnu Vardhan KM, Fareeda G. Correlation and path coefficient analysis for grain yield, yield components and nutritional traits in rice (*Oryza sativa*L.) International Journal of Chemical Studies. 2018; 6(4):189-195
7. Bhatt BP, Aryal N, Neupane SS, Poudel S. Variability, correlation and path coefficient analysis of rice (*Oryza sativa* L.). International Journal of Scientific & Engineering Research. 2016; 7(8):2107-2176.
8. Bhutta MA, Munir S, Qureshi MK, Shahzad AN, Aslam K, Manzoor H *et al*. Correlation and path analysis of morphological parameters contributing to yield in rice (Oryza sativa) under drought stress. Pakistan Journal of Botany. 2018; 1(28):1-8.
9. Chakravarty A, Ghosh P. Interrelationship and cause effect analysis among panicle yield attributing traits in lowland traditional rice. J. of control Europe an Agriculture. 2014; 15:213-224.
10. Dept. of Agriculture. Annual Report 2016-17, Cooperation & Farmers Welfare, New Delhi, India; 2016-2017.
11. Dewey DR, Lu KH. A correlation and path coefficient analysis components of crested wheat grass seed production. Agron, J. 1959; 51:575-81.
12. Guru T, Padma V, Reddy DVV, Rao PR, Rao DS. Correlation and path coefficient analysis for grain yield and other component traits in rice genotypes. International Journal of Agricultural Science and Research. 2016; 6(5):363-370.
13. Haider Z, Khan AS, Zia S. Correlation and path coefficient analysis of yield components in rice (*Oryza sativa* L.) under simulated drought stress condition. American-Eurasian Journal of Agricultural & Environmental Sciences. 2012; 12(1):100-104.
14. Immanuel Selvaraj C, Pothiraj Nagarajan, Thiyagarajan K, Bharathi M, Rabindran. Genetic parameters of variability, correlation and path coefficient studies for grain yield and other yield attributes among rice blast disease resistant genotypes of rice (*Oryza sativa*L.). Afr. J. Biotech. 2011; 10(17):3322-3334.
15. Jambhulkar NN, Bose LK. Genetic variability and association of yield attributing traits with grain yield in upland rice. Genetika. 2014; 46(3):831-838.

16. Karl Pearson. Tables for statisticians and biometricians, part II, Nature, 1932, 130.
17. Katiyar D, Srivastava KK, Prakash S, Kumar M Gupta M. Study correlation coefficients and path analysis for yield and its component characters in rice (*Oryza sativa* L.). Journal of Pharmacognosy and Phytochemistry. 2019; 8(1):1783-1787.
18. Kishore C, Kumar A, Pal AK, Kumar V, Prasad BD, Kumar A. Character association and path analysis for yield components in traditional rice (*Oryza sativa*L.) genotypes. International Journal of Current Microbiology and Applied Sciences. 2018; 7(3):283-291.
19. Kole PC, Chakraborty NR, Bhat JS. Analysis of variability, correlation and path coefficients in induced mutants of Aromatic non basmati rice. Tropical Agricultural Research and extension. 2008; 11:60-64.
20. Krishna Veni B, Vijaya Lakshmi B, Ramana JV. Variability and Association studies for yield components and quality parameters in rice genotypes. Journal of rice research. 2013; 6:16-23.
21. Nagaraju C, Sekhar MR, Reddy KH, Sudhakar P. Correlation between traits and path analysis coefficient for grain yield and other components in rice (*Oryza sativa* L.) genotypes. International Journal of Applied Biology and Pharmaceutical Technology. 2013; 4(3):137-142.
22. Nagendra Rao K, Bayyapa Reddy K, Krishna N. Studies on genetic variability, correlation and path coefficient analysis in rice under saline soil conditions. The Andhra Agric. J. 2010; 57(4):335-338.
23. Nandan R, Sweta, Singh SK. Character association and path analysis in rice (*Oryza sativa*L.) genotypes. World Journal of Agricultural Sciences. 2010; 6(2):201-206.
24. Pratap N, Singh PK, Shekhar R, Soni SK, Mall AK. Genetic variability, character association and diversity analyses for economic traits in rice (*Oryza sativa* L.). South Asian Association for Regional Cooperation Journal of Agriculture. 2012; 10(2):83-94.
25. Priya CS, Suneetha Y, Babu DR, Rao VR. Inter-relationship and path analysis for yield and quality characters in rice (*Oryza sativa*L.). International Journal of Science, Environment and Technology. 2017; 6(1):381-390.
26. Sameera SK, Srinivas T, Rajesh AP, Jayalakshmi V, Nirmala PJ. Variability and path co-efficient for yield and yield components in rice. Bangladesh journal of agricultural research. 2016; 41(2):259-271.
27. Satheeshkumar P, Saravanan K. Genetic variability, correlation and path analysis in rice (*Oryza sativa*L.). International Journal of Current Research. 2012; 4(09):082-085.
28. Sathya R, Jebaraj S. Genetic studies for yield and physiological traits in three-line aerobic rice hybrids. Plant Gene and Trait. 2013; 4(9):48-52.
29. Tushara M, Rao VS, Ahamed ML, Krishnaveni B, Rao KLN. Correlation of quantitative and qualitative characters with yield in medium and long duration genotypes of rice. The Andhra Agricultural Journal. 2013; 60(1):29-35.
30. Wright S. Correlation and causation. Journal of Agricultural Research. 1921; 20:257-287.