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Correlation and path coefficient analysis in seed and seedling characters for yield in popular rice varieties (*Oryza sativa* L.)

Mohammad Salman, SC Vimal, Tarkeshwar, Govind Mishra, Deepak Jangid and Mukut Bihari Meena

Abstract
Twenty five rice varieties were evaluated for seed yield and its components for seventeen characters under irrigated condition during *Kharif* 2020 and 2021 at Crop Research Station, Masodha, ANDUAT, Ayodhya. Seed yield per plant showed highly significant and positive correlation with no. of tillers per plant, harvest index and panicle bearing tillers per plant. Seedling dry weight indicated highly significant and positive correlation with seedling length and germination percentage. Seedling length noted highly significant and positive correlation with germination percentage, Germination percentage highly significant and positive correlation with speed of germination, Harvest index highly significant and positive correlation with numbers of tillers per plant and Plant height exhibited significant and positive association with days of maturity components suggested that selection would be highly effective and efficient in improving these traits due to possibility of correlation response. Path coefficient analysis identified highest positive direct effect on seed yield per plant was exerted by vigour indx-I, harvest index, biological yield, number of panicle bearing tillers per plant, number of grains per panicle, seedling dry weigh, days of 50% flowering and plant height were indicated height negative direct contribution to seed yield per plant. The characters identified above as important direct and indirect yield components merit due to consideration in formulating effective selection strategy for developing high yielding rice varieties.

Keywords: Rice, *Oryza sativa*, correlation coefficients, path analysis and yield

Introduction
Rice is the staple food for two thirds of the Indian population. It contributes 43 per cent of caloric requirement and 20-25% of agricultural income. In India, rice is grown in an area of 43.5 million ha (23% of gross cropped area) with an annual production of 90 million tons (Viraktamath and Sundaram, 2010). It is an indispensable source of calories for almost half of the population within Asia. Almost 95% of the rice production happens in Asian countries and nearly half of the global population consumes it. Rice cultivation ranks third in agricultural commodity production, after sugarcane and maize (Priya *et al.* 2019) [15]. Rice is grown in more than a hundred countries with a total harvested area of approximately 166.47 million hectares producing around 513.03 MMT annually (World Agriculture Production, USDA, April 2022). China stands first in rice production with a total production of 148.99 MMT followed by India which stands second in rice production with a total production of 129.00 MMT in 2021-22. In India, rice is almost grown in all the states. From the total cultivated area of 141.00 million hectare nearly 40.95 million hectare area has been reported to be used for rice cultivation with a production of 127.93 MT with an average productivity of 2584 Kg per hectare (Ministry of Agriculture and Farmer's Welfare, 2021-22). The top three states in rice production in India are West Bengal, Uttar Pradesh and Punjab with a production of 116.65 MT, 15.66 MT and 12.18 MT respectively (Economic Survey 2021-22). Uttar-Pradesh stood second in rice production among major rice producing states in India. Uttar Pradesh has the largest area under rice cultivation *i.e.* 6.02 million hectares with a production of 15.66 million tones contributing about 12.81 % of total rice production of all India. The average productivity of Uttar Pradesh is about 2601 Kg per hectare. However, India ranks first in area under rice; its productivity is nearly half than that of China. The data obtained from correlation coefficient can be randomized block design by path analysis. Path coefficient analysis the genotypic correlation coefficient into the measure of direct and indirect effects.

Therefore, the present investigation was undertaken to Correlation and Path coefficient analysis in seed and seedling characters for yield in popular rice varieties (*Oryza sativa* L.). The concept of path analysis was developed by Wright (1921) but the technique was first used for plant selection by Dewey and Lu (1959). Path-coefficient is simply a standardized partial regression coefficient, which splits the correlation coefficient into the measures of direct and indirect effects. In other words, it measures the direct and indirect contribution of various

Materials and methods

The experimental material consisted of 25 rice varieties obtained from CRS, Masodha, Ayodhya, BHU, Varanasi and NRRI, Cuttack. The experiment was conducted in randomized block design with three replications with spacing of 20 X 15 cm during *kharif* 2020 and 2021 under rain fed situation at Crop Research Station, (CRS) Masodha, Ayodhya (U.P). All recommended agronomic practices were followed to ensure a normal healthy crop. Observations on different characters were recorded on five randomly selected plants from the two central rows of each plot. To determine the degree of association of the seed and seedling characters with yield, the lab experiment was conducted in Department of Seed Science and Technology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya. The data recorded traits days to 50% flowering, days of maturity, Plant height (cm), Number of tillers/plant, No. of panicle bearing tillers/plant, Panicle length (cm), Number of grains/panicle, Biological yield (g), Harvest index, Test weight (g), Speed of Germination, Germination (%),Seedling Length (cm), Seedling dry weight (g), Vigour Index-I, Vigour Index-II and yield/plant. The pooled data were calculated from the data obtained in both years and then the calculation was done by using SPSS 16.0 software. The Correlation and Path coefficient analysis was done according to methods suggested by Searle (1961) and Dewey and Lu (1959) respectively.

Table 1: List of rice varirties used in the study

S. No.	Varieties	S. No.	Varieties
1.	NDR 2064	14.	HUR-917
2.	NDR 97	15.	HUBR-2-1
3.	NDR 8002	16.	Nua Dhusara
4.	NDR 3112	17.	Nua Chinikamini
5.	Sambha Sub 1	18.	Keteki joha
6.	NDGR 201	19.	CR Sugandha dhan-907
7.	NDR 359	20.	CR Sugandha dhan-908
8.	Sarjoo 52	21.	Poorna Bhog
9.	HUR-11-3	22.	Geetanjali
10.	HUR-1309	23.	CR Sugandha dhan-909
11.	HUR-1304	24.	CR Sugandha dhan-910
12.	HUR-105	25.	Nua Kalajeera
13.	HUR-3022		

Results and discussions

Correlation

Analysis of variance was significant for all the traits among the entries, indicting the presence of considerable genetic variation in the experimental material (Table-2).

The estimates of genotypic and phenotypic correlation coefficients computed between 17 characters of indigenous and exotic lines of rice under study are presented in (Table- 3 and Table- 4)

The present study revealed that the seed yield per plant had highly significant and positive correlation with No. of tillers/plant, Harvest index and Panicle bearing tillers/plant but negatively significant correlated with Biological yield (g), Germination (%), Vigour Index-I, Vigour Index–II, and Seedling Length (cm**).** The correlation coefficients of seed yield per plant with some characters were registered significant. Seedling length noted highly significant and positive correlation with germination percentage, speed of germination, biological yield and days of maturity but negatively significant correlated with harvest index, number of tillers per plant and numbers of panicle bearing tillers per plant at phenotypic as well as level genotypic also been reported earlier findings of Prasad *et al.* (2013), Shiva *et al.* (2000) [17], Madhavilatha *et al.* (2005) [10], Sarangi *et al.* (2009), panwar (2006), and Saravani and Sabesan (2000).

Germination percentage highly significant and positive correlation with speed of germination (0.353), biological yield, days of maturity and days of 50% flowering but negatively significant correlated with harvest index. Plant height exhibited significant and positive association with days of maturity and day of 50% flowering, 1000-grain weight highly significant and positive correlation with

Table 2: Analysis of variance of Randomized Block Design for 17 characters of rice varieties pooled

Characters	Source of Variation		
	Replication d.f.(2)	Treatment d.f.(24)	Error d.f.(48)
	Pooled	Pooled	Pooled
Days of 50% flowering	3.61	280.73**	1.52
Days of maturity	3.64	488.78**	1.45
Plant height (cm)	1.90	1118.65**	2.90
No. of tillers/plant	3.05	49.05**	1.05
No. of panicle bearing tillers/plant	3.88	43.64**	0.60
Panicle length (cm)	1.23	16.36**	0.23
No. of grains/panicle	6.97	2005.66**	6.69
1000- grain weight (g)	0.06	8.98**	0.08
Biological yield (g)	0.11	610.76**	1.87
Harvest index	0.43	140.97**	0.88
Speed of Germination	1.91	6.10**	1.35
Germination (%)	1.14	54.39**	3.04
Seedling Length (cm)	1.15	20.86**	1.84
Seedling dry weight (g)	0.00000	0.00025**	0.00002
Vigour Index-I	595.6	266643.6**	22123.7
Vigour Index –II	0.04	2.77**	0.06
Seed yield /plant (g)	0.68	36.23**	0.62

Table 3: Genotypic of simple correlation coefficient among different characters in rice varieties- Pooled

Characters	Days of maturity	Plant height (cm)	No. of tillers/ plant	No. of panicle bearing tillers/plant	Panicle length (cm)	No. of grains/ panicle	Biological yield (g)	Harvest index	1000-grain weight (g)	Speed of Germination	Germination (%)	Seedling Length (cm)	Seedling dry weight (g)	Vigour Index-I	Vigour Index -II	Seed yield /plant (g)
Days of 50% flowering	0.924**	0.307**	-0.001	-0.013	0.217	0.025	0.148	-0.019	-0.082	-0.081	0.301**	0.156	0.275*	0.264*	0.316**	0.098
Days of maturity		0.329**	-0.034	-0.058	0.223	0.060	0.202	-0.086	-0.147	-0.096	0.311**	0.245*	0.274*	0.326**	0.324**	0.047
Plant height (cm)			-0.056	-0.094	0.520**	0.448**	0.352**	-0.125	-0.041	0.073	0.054	-0.105	-0.024	-0.022	-0.041	0.147
No. of tillers/plant				1.000**	-0.065	-0.034	-0.437**	0.709**	0.000	-0.008	-0.190	-0.243*	-0.185	-0.230*	-0.216	0.836**
Panicle bearing tillers/plant					-0.096	-0.055	-0.448**	0.705**	0.016	0.006	-0.178	-0.239*	-0.181	-0.224*	-0.209	0.817**
Panicle length (cm)						0.878**	0.192	-0.107	0.249*	-0.190	0.023	0.078	0.174	0.120	0.160	-0.026
No. of grains/panicle							0.069	-0.016	0.307**	-0.135	-0.086	0.084	0.091	0.059	0.058	0.017
Biological yield (g)								-0.880**	-0.331**	0.027	0.245*	0.346**	0.401**	0.372**	0.351**	-0.503**
Harvest index									0.157	0.114	-0.296**	-0.300**	-0.317**	-0.344**	-0.326**	0.834**
1000- grain weight (g)										0.141	-0.027	-0.148	-0.238*	-0.105	-0.155	-0.150
Speed of Germination											0.353**	0.500**	0.472**	0.495**	0.491**	0.104
Germination (%)												0.538**	0.517**	0.784**	0.779**	-0.288*
Seedling Length (cm)													0.919**	0.941**	0.875**	-0.228*
Seedling dry weight (g)														0.909**	0.938**	-0.188
Vigour Index-I															0.974**	-0.282*
Vigour Index –II																-0.253*

*, ** significant at 5% and 1% level, respectively

Table 4: Phenotypic of simple correlation coefficient among different characters in rice varieties- Pooled

Characters	Days of maturity	Plant height (cm)	No. of tillers/ plant	No. of panicle bearing tillers/plant	Panicle length (cm)	No. of grains/ panicle	Biological yield (g)	Harvest index	1000-grain weight (g)	Speed of Germination	Germination (%)	Seedling Length (cm)	Seedling dry weight (g)	Vigour Index-I	Vigour Index -II	Seed yield /plant (g)
Days of 50% flowering	0.912**	0.303**	-0.005	-0.015	0.218	0.025	0.146	-0.017	-0.084	-0.047	0.272*	0.125	0.257*	0.222	0.300**	0.098
Days of maturity		0.324**	-0.037	-0.059	0.219	0.059	0.198	-0.087	-0.147	-0.069	0.278*	0.223	0.260*	0.292**	0.314**	0.040
Plant height (cm)			-0.052	-0.089	0.504**	0.444**	0.349**	-0.124	-0.038	0.055	0.049	-0.098	-0.030	-0.023	-0.043	0.141
No. of tillers/plant				0.989**	-0.063	-0.038	-0.416**	0.685**	0.001	0.051	-0.168	-0.231*	-0.194	-0.224	-0.215	0.804**
Panicle bearing tillers/plant					-0.092	-0.054	-0.435**	0.690**	0.019	0.041	-0.168	-0.220	-0.195	-0.212	-0.212	0.794**
Panicle length (cm)						0.860**	0.185	-0.107	0.231*	-0.093	0.009	0.060	0.178	0.094	0.149	-0.037
No. of grains/panicle							0.066	-0.017	0.301**	-0.108	-0.074	0.081	0.092	0.066	0.060	0.014
Biological yield (g)								-0.876**	-0.325**	0.021	0.223	0.300**	0.365**	0.323**	0.335**	-0.495**
Harvest index									0.151	0.079	-0.267*	-0.268*	-0.297**	-0.304**	-0.315**	0.832**
1000- grain weight (g)										0.118	-0.020	-0.124	-0.223	-0.090	-0.144	-0.145
Speed of Germination											0.253*	0.326**	0.344**	0.318**	0.354**	0.080
Germination (%)												0.453**	0.460**	0.712**	0.762**	-0.245*
Seedling Length (cm)													0.822**	0.918**	0.811**	-0.213
Seedling dry weight (g)														0.819**	0.901**	-0.194
Vigour Index-I															0.910**	-0.253*
Vigour Index –II																-0.244*

*, ** significant at 5% and 1% level, respectively.

number of grains per panicle and panicle length but negatively significant correlated with biological yield at phenotypic as well as level genotypic Present results are supported by earlier findings of Jayasudha and Shram (2010) [6], Prasad *et al.*. (2013), Wattoo *et al.* (2010) [18], Anand Kumar, *et al.* (2017), Kumari and Parmar (2020) [9].

The genotypic correlation coefficients between different characters were generally similar in nature to the corresponding phenotypic correlation coefficients this experimentation. However, the genotypic correlations were greater in magnitude than their corresponding phenotypic correlations. Similar results have been reported in rice by various workers Shivani and Reddy (2000) [17], Watto *et al.* (2010) [18] and Kumar *et al*. (2015).

Path coefficient analysis

Path coefficient analysis was worked out by using simple correlations among 17 characters to resolve the direct and indirect effects of different characters on seed yield per plant. The results of path coefficient analysis are presented in (Table- 5 and Table- 6).

Path coefficient analysis is a tool to partition the observed correlation coefficient into direct and indirect effects of yield components on grain yield. Path analysis provides clear picture of character associations for formulating efficient selection strategy. The concept of Path coefficient analysis was developed which differs from simple correlation in that it points out the causes and their relative importance, whereas, the later measures simply the mutual association ignoring the causation. The direct and indirect effects of different characters on seed yield pr plant at phenotypic level. The highest positive direct effect on seed yield per plant was existed by harvest index, biological yield, vigour index-II, number of panicle bearing tillers per plant, seedling length, plant height, number of grains per panicle, days of 50% flowering, and germination percentage. The highest positive direct effect on seed yield per plant was existed by vigour indx-1, seedling dry weight, 1000-grains weight, panicle length, speed of germination, days of maturity and number of tillers per plant were indicated height negative direct contribution to seed yield per.

Substantial negative indirect effects were exerted by vigour index- II, seedling length, seedling dry weight, germination percentage via. vigour index-I, number of tillers per plant via. Harvest index, speed of germination, biological yield, days of maturity, days of 50% flowering via. vigour index-I, vigour index-I via. Biological yield, harvest index *via* Seedling length, plant height *via* Biological yield; 1000-grain weight *via* Harvest index; numbers of panicle bearing tillers per plant *via* Seedling length; panicle length and number of grains per panicle *via* vigour index-I also been reported earlier findings of Madhavilatha *et al.* (2013), Naseer *et al*. (2013) [12], Babu *et al.* (2015), Kishore *et al.* (2018) [7], Kumar *et al*. (2018) [8], Manohora *et al*. (2015) Kumari and Parmar (2020) [9].

The direct and indirect effects of different characters on seed yield per plant at genotypic level and phenotypic level are presented tables. In the path analysis at genotypic level, the highest positive direct effect on seed yield per plant was existed by vigour indx-1, harvest index, biological yield,

Table 5: Genotypic direct and indirect effect of different characters on grain yield per plant in rice varieties- Pooled

Characters	Days of 50% flowering	Days of maturity	Plant height (cm)	No. of tillers/ plant	No. of panicle bearing tillers/plant	Panicle length (cm)	No. of grains/panicle	Biological yield (g)	Harvest index	1000-grain weight (g)	Speed of Germination	Germination (%)	Seedling Length (cm)	Seedling dry weight (g)	Vigour Index-I	Vigour Index - II	Seed yield /plant (g)
Days of 50% flowering	0.0667	-0.0575	0.0043	0.0004	-0.0090	-0.0118	0.0023	0.1105	-0.0277	0.0172	0.0010	-0.1105	-0.1420	0.0185	0.4249	-0.1891	0.0667
Days of maturity	0.0616	-0.0623	0.0046	0.0199	-0.0395	-0.0121	0.0054	0.1507	-0.1252	0.0308	0.0012	-0.1143	-0.2232	0.0185	0.5250	-0.1941	0.0616
Plant height (cm)	0.0205	-0.0205	0.0139	0.0327	-0.0639	-0.0283	0.0407	0.2624	-0.1825	0.0086	-0.0009	-0.0199	0.0956	-0.0016	-0.0349	0.0247	0.0205
No. of tillers/plant	0.0000	0.0021	-0.0008	-0.5870	0.6794	0.0035	-0.0031	-0.3259	1.0315	0.0001	0.0001	0.0697	0.2207	-0.0124	-0.3708	0.1290	0.0000
Panicle bearing tillers/plant	-0.0009	0.0036	-0.0013	-0.5867	0.6797	0.0052	-0.0050	-0.3342	1.0258	-0.0033	-0.0001	0.0654	0.2177	-0.0122	-0.3615	0.1250	-0.0009
Panicle length (cm)	0.0145	-0.0139	0.0073	0.0381	-0.0652	-0.0543	0.0799	0.1433	-0.1551	-0.0521	0.0023	-0.0086	-0.0712	0.0117	0.1931	-0.0957	0.0145
No. of grains/panicle	0.0017	-0.0037	0.0062	0.0198	-0.0375	-0.0477	0.0909	0.0515	-0.0236	-0.0643	0.0017	0.0316	-0.0765	0.0062	0.0957	-0.0344	0.0017
Biological yield (g)	0.0099	-0.0126	0.0049	0.2565	-0.3045	-0.0104	0.0063	0.7460	-1.2801	0.0695	-0.0003	-0.0901	-0.3149	0.0269	0.5997	-0.2100	0.0099
Harvest index	-0.0013	0.0054	-0.0018	-0.4164	0.4795	0.0058	-0.0015	-0.6567	1.4542	-0.0330	-0.0014	0.1087	0.2729	-0.0214	-0.5544	0.1953	-0.0013
1000- grain weight (g)	-0.0055	0.0091	-0.0006	0.0002	0.0107	-0.0135	0.0279	-0.2473	0.2287	-0.2096	-0.0017	0.0097	0.1350	-0.0160	-0.1699	0.0930	-0.0055
Speed of Germination	-0.0054	0.0060	0.0010	0.0047	0.0044	0.0103	-0.0123	0.0204	0.1656	-0.0295	-0.0122	-0.1295	-0.4550	0.0318	0.7978	-0.2939	-0.0054
Germination (%)	0.0201	-0.0194	0.0008	0.1115	-0.1211	-0.0013	-0.0078	0.1831	-0.4308	0.0056	-0.0043	-0.3670	-0.4896	0.0348	1.2635	-0.4661	0.0201
Seedling Length (cm)	0.0104	-0.0153	-0.0015	0.1424	-0.1626	-0.0043	0.0076	0.2581	-0.4361	0.0311	-0.0061	-0.1974	**-0.9102**	0.0618	1.5179	-0.5238	0.0104
Seedling dry weight (g)	0.0183	-0.0171	-0.0003	0.1085	-0.1229	-0.0094	0.0083	0.2988	-0.4615	0.0499	-0.0058	-0.1897	-0.8364	0.0673	1.4657	-0.5614	0.0183
Vigour Index-I	0.0176	-0.0203	-0.0003	0.1350	-0.1524	-0.0065	0.0054	0.2775	-0.5001	0.0221	-0.0060	-0.2876	-0.8569	0.0612	1.6122	-0.5828	0.0176
Vigour Index –II	0.0211	-0.0202	-0.0006	0.1265	-0.1419	-0.0087	0.0052	0.2617	-0.4745	0.0326	-0.0060	-0.2858	-0.7966	0.0631	1.5699	-0.5985	0.0211

Resi- 0.0621,*, ** significant at 5% and 1% level, respectively

Table 6: Phenotypic direct and indirect effect of different characters on grain yield per plant in rice varieties- Pooled

Characters	Days of 50% flowering	Days of maturity	Plant height (cm)	No. of tillers/ plant	No. of panicle bearing tillers/plant	Panicle length (cm)	No. of grains/ panicle	Biological yield (g)	Harvest index	1000-grain weight (g)	Speed of Germination	Germination (%)	Seedling Length (cm)	Seedling dry weight (g)	Vigour Index-I	Vigour Index - II	Seed yield /plant (g)
Days of 50% flowering	0.0144	-0.0214	0.0287	0.0000	-0.0026	-0.0179	0.0014	0.1116	-0.0241	0.0088	0.0024	0.0029	0.0167	-0.0298	-0.0537	0.0611	0.0144
Days of maturity	0.0132	-0.0235	0.0308	0.0003	-0.0103	-0.0180	0.0033	0.1515	-0.1215	0.0153	0.0034	0.0029	0.0298	-0.0302	-0.0706	0.0638	0.0132
Plant height (cm)	0.0044	-0.0076	0.0949	0.0005	-0.0155	-0.0414	0.0248	0.2669	-0.1748	0.0040	-0.0028	0.0005	-0.0131	0.0035	0.0056	-0.0087	0.0044
No. of tillers/plant	-0.0001	0.0009	-0.0050	-0.0091	0.1724	0.0052	-0.0021	-0.3179	0.9616	-0.0001	-0.0025	-0.0018	-0.0309	0.0225	0.0541	-0.0437	-0.0001
Panicle bearing tillers/plant	-0.0002	0.0014	-0.0084	-0.0090	0.1743	0.0075	-0.0030	-0.3326	0.9689	-0.0020	-0.0021	-0.0018	-0.0295	0.0226	0.0512	-0.0431	-0.0002
Panicle length (cm)	0.0032	-0.0051	0.0479	0.0006	-0.0160	-0.0820	0.0480	0.1412	-0.1504	-0.0242	0.0047	0.0001	0.0080	-0.0207	-0.0228	0.0302	0.0032
No. of grains/panicle	0.0004	-0.0014	0.0422	0.0003	-0.0094	-0.0705	0.0558	0.0508	-0.0233	-0.0315	0.0054	-0.0008	0.0108	-0.0106	-0.0160	0.0122	0.0004

Biological yield (g)	0.0021	-0.0047	0.0331	0.0038	-0.0758	-0.0151	0.0037	0.7648	-1.2299	0.0340	-0.0011	0.0024	0.0401	-0.0423	-0.0782	0.0681	0.0021
Harvest index	-0.0003	0.0020	-0.0118	-0.0062	0.1203	0.0088	-0.0009	-0.6699	1.4040	-0.0158	-0.0039	-0.0028	-0.0358	0.0344	0.0735	-0.0640	-0.0003
1000- grain weight (g)	-0.0012	0.0035	-0.0036	0.0000	0.0033	-0.0190	0.0168	-0.2486	0.2125	-0.1046	-0.0059	-0.0002	-0.0166	0.0259	0.0218	-0.0293	-0.0012
Speed of Germination	-0.0007	0.0016	0.0053	-0.0005	0.0072	0.0076	-0.0060	0.0164	0.1103	-0.0124	-0.0502	0.0027	0.0437	-0.0399	-0.0768	0.0720	-0.0007
Germination (%)	0.0039	-0.0065	0.0047	0.0015	-0.0292	-0.0007	-0.0041	0.1706	-0.3748	0.0021	-0.0127	0.0105	0.0606	-0.0534	-0.1721	0.1549	0.0039
Seedling Length (cm)	0.0018	-0.0052	-0.0093	0.0021	-0.0384	-0.0049	0.0045	0.2294	-0.3758	0.0130	-0.0164	0.0048	0.1338	-0.0954	-0.2219	0.1649	0.0018
Seedling dry weight (g)	0.0037	-0.0061	-0.0029	0.0018	-0.0340	-0.0146	0.0051	0.2790	-0.4164	0.0233	-0.0172	0.0049	0.1099	-0.1160	-0.1980	0.1831	0.0037
Vigour Index-I	0.0032	-0.0069	-0.0022	0.0020	-0.0369	-0.0077	0.0037	0.2473	-0.4270	0.0094	-0.0159	0.0075	0.1227	-0.0950	-0.2418	0.1849	0.0032
Vigour Index -II	0.0043	-0.0074	-0.0041	0.0020	-0.0369	-0.0122	0.0034	0.2563	-0.4420	0.0151	-0.0178	0.0080	0.1085	-0.1045	-0.2200	0.2032	0.0043

Resi- 0.0480, *, ** significant at 5% and 1% level, respectively.

number of panicle bearing tillers per plant, number of grains per panicle, seedling dry weight, days of 50% flowering and plant height.

Substantial negative indirect effects was exerted by seedling length,vigour index-II, number of tillers per plant, germination percentage 1000-grains weight, days of maturity and panicle length, speed of germination were indicated height negative direct contribution to seed yield per plant also been reported earlier findings of Madhavilatha *et al.* (2013), Naseer *et al*. (2013) [12], Babu *et al.* (2015), Kishore *et al.* (2018) [7], Kumar *et al*. (2018) [8], Manohora *et al*. (2015) Kumari and Parmar (2020) [9].

Conclusion

The present study revealed the seed yield per plant showed highly significant and positive correlation with no. of tillers per plant, harvest index and panicle bearing tillers per plant. The direct and indirect effect revealed the vigour indx-I, harvest index, biological yield, number of panicle bearing tillers per plant and number of grains per panicle emerged as high contributing traits towards grain yield.

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