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Character Association Studies in Lowland Rice Cultivars of Bihar

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Authors' contributions

This work was carried out in collaboration among all authors. Author NK carried out on field research work and took observation and authors DS, TAM, NS and RC assisted during observations and data recording. Authors Ravi Kant, Rajesh Kumar and Nilanjaya outlined the research plan with author NK and supervised the work during the entire crop season and also helped in collection of review.

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ABSTRACT

The present investigation was carried out with aim to deduce the association among different characters with grain yield, i.e. their mutual relation with help of correlation analysis as well as to identify the component trait which are directly or indirectly contributing to the yield. The experiment was carried out at Rice Breeding Section, Pusa, Samastipur in kharif, 2018 from June, 26 to December 28. Total of twenty-two lowland rice accessions were sown in Randomized complete Block design Fashion (R.C.B.D.), with three replications. Fifteen characters including grain yield were observed for the experiment and data was collected at respective stages. The correlation coefficient analysis revealed that grain length, root volume, panicle length of main axis, number of panicles per hill, showed positive significant correlation with grain yield per plant. Hence, emphasis should be given to these traits in selection process during yield improvement programs. Grain length, root volume, panicle length of main axis and leaf length showed high direct effect on grain yield per plant. Hence, selection based on these characters would be more effective for yield improvement.

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Keywords: Correlation coefficient; phenotypic path coefficient; genotypic path coefficient analysis.

1. INTRODUCTION

Rice is the world's most important food crop and a primary food source for more than one third of world's population [1]. Over 90 percent of the world's rice is produced and consumed in the Asia-Pacific Region.It belongs to the family *Poaceae* and sub family *Oryzoidea* and tribe *Oryzeae* [2]. This genus comprises more than 22 species distributed through the Tropical and Sub-tropical regions of Asia, Africa, central and south America and Australia, of which, there are only two cultivated species; *Oryza glaberrima* (Steud.) and *Oryza sativa* L. [3], The estimated world rice production for the year 2019-20 is 496.67 million metric tons [4].

Increase in yield of crops is the single most important objective of plant breeders to meet the food requirement of ever-increasing population and further to maintain the identity of these landraces and cultivars, the yield of these ecologically important accessions must be increased. In order to protect these landraces and cultivars from being replaced by other varieties the yield of these important accessions must be increased. Yield being complex polygenic genetic characters cannot be improved directly, rather improvement in component trait affecting the yield should pe improved. To study the relation between traits and their effect on the yield can be through statistics of correlation analysis and path coefficient analysis. The correlation coefficient analysis is the index of association between two variables. Grain yield is an ultimate product being influenced by a number of independent traits. Unless the yield components influencing directly or indirectly are taken into the consideration, selection for grain yield on per se performance may not be much effective. Therefore, the knowledge of degree and direction of association amongst the character under study is essential while aiming for a rational genetic improvement in yield. Path coefficient analysis is a tool which permits the partitioning of the correlation coefficient into its components, one component being the path coefficient that measures the direct effect of a predictor variable upon its response variable; the second component being the indirect effect of a predictor variable on the response variable through other predictor variables. In agriculture, path analysis has been used by plant breeders to assist in identifying traits that are useful as selection criteria to improve crop yield. Similar type of studies was done by [5] and [6].

Landraces and cultivars are important sources of different genes for biotic and abiotic stresses, yet lower grain yield had caused them to be replaced by higher yielding varieties. To maintain the identity of these useful germplasms their yield must be increased. Therefore, experiment was conducted to study association between dependent and independent variables, which will eventually help future breeding programs for increasing grain yield of these cultivars.

2. MATERIALS AND METHODS

The present research work was conducted at Rice Breeding Section, Pusa Farm, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar during *kharif* 2018, from June, 26 to December 28. Geographically university farm is situated between 25.98□N latitude and 85.67□E longitudes at 51.8 above mean sea level. Twenty-two lowland rice cultivars were taken for current investigation. The experimental design adopted was R.C.B.D., with three replications. Firstly, the rice seedlings were raised in nursery seedbeds for 25 days and then the seedlings were transplanted manually in the puddled plots prepared for sowing. Standard spacing of 20 x 15 cm was maintained and all the recommended package of practices were followed during growth period. Observations were taken randomly from five plants within each replication. Data were recorded for fifteen traits viz. grain length (mm), grain width (mm), kernel length (mm), days to 50% flowering, plant height (cm), root volume (mm3), panicle length of main axis` (cm), leaf length (cm), leaf width (cm), no. of panicle per hill, days to maturity, stem thickness (mm), 1000 grain weight, kernel width(mm), grain yield per plant (g).The measurements were taken according to the guidelines given by Indian Institute of Rice Research, Hyderabad. Root volume was measured using water displacement method. Measuring tape and measuring scales were used to take the measurements in centimetres, grain length was measured on graph papers. The estimates of correlation coefficient were worked out according to [7] and path analysis was carried out according to [8].

3. RESULTS AND DISCUSSION

3.1 Correlation Analysis

Association analysis is an important approach in a breeding programme. It gives an idea about relationship among the various characters and determines the component characters, on which selection can be based for genetic improvement in the grain yield. Degree of association also affects the effectiveness of selection process. The correlation coefficient analysis is the index of association between two variables.

Table 1. List of Genotypes

Sl. no.	Genotypes	Sources
1	Santosh	R.P.C.A.U., Pusa
2	Kanak	R.P.C.A.U., Pusa
3	Radha	R.P.C.A.U., Pusa
4	Pankaj	O.U.A.T., Orissa
5	Satyam	R.P.C.A.U., Pusa
6	Rajshree	R.P.C.A.U., Pusa
7	Swarna	N.R.R.I, Cuttack
8	Sudha	R.P.C.A.U., Pusa
9	Vaidehi	R.P.C.A.U., Pusa
10	Janaki	R.P.C.A.U., Pusa
11	Barogar	R.P.C.A.U., Pusa
12	Madhukar	N.D.U.A.T, U.P.
13	Singhara	R.P.C.A.U., Pusa
14	Ujaladhusarisa	Landrace, BIHAR
15	Sagar samba	O.U.A.T., Orissa
16	Jagannath ballava	O.U.A.T., Orissa
17	Brasali	N.D.U.A.T, U.P.
18	Meghnad	N.D.U.A.T, U.P.
19	Silhat	N.D.U.A.T, U.P.

Correlation estimates among various characters have been represented in Table 2, In the present investigation nearly in all 15 characters, magnitude of genetic correlation was recorded higher than corresponding phenotypic correlation coefficient indicating the effect of external factors was negligible on association pattern. Persual of the Table 2 revealed that panicle length of main axis (0.464**), grain length (0.288*), number of panicles (0.257*) were positively correlated with the grain yield per plant and these correlations were significant. Stem thickness (-0.325**) showed negative and significant correlation with grain yield per plant. Grain length showed highly positive significant correlation with kernel length (0.832**), whereas it showed non-significant negative correlation with leaf width(-0.201). Days to 50 per cent flowering showed highly significant positive correlation with days to maturity. Panicle length of main axis showed significant positive correlation with yield per plant(0.464)and leaf width(0.332) while it showed significant negative correlation with test weight(-0.297*). Number of panicles per hill showed significant positive correlation with leaf length(0.288*) and yield per plant(0.257*).Plant height showed highly significant positive correlation with leaf length (0.563**) followed by days to maturity(0.539**) and test weight(0.330**) whereas it also exhibited highly significant negative correlation with root volume(-0.752**) and panicle length of main axis(-0.249*).Days to maturity showed significant positive correlation with leaf length(0.334**) only. Test weight showed significant positive correlation with kernel width (0.536**) and grain length (0.444**) and non-significant negative correlation with yield per plant (-0.131). Similar finding were reported by researchers [9-13].

3.2 Path Coefficient Analysis

Path analysis is simply standardized partial regression coefficient partitioning the correlation coefficients into the measures of direct and indirect effects of set of independent variables on the dependent variable. It is also known as cause and effect relationship. Table (3) represents the phenotypic path coefficient values and genotypic path coefficient values respectively. Fig. 1, shows phenotypic path diagram and Fig. 2 depicts genotypic path diagram. Grain length (0.866) had positive direct effect on grain yield per plant and indirect positive effect via leaf length (0.118). Grain width(-0.143) had negative direct effect on grain yield per plant and indirect positive effect via grain length(0.078) and indirect negative effect via kernel length(-0.151).Days to 50 per cent flowering (-0.014) showed direct negative effect on grain yield per plant and showed indirect positive effect via leaf length(0.119)and kernel length(0.120).Plant height(0.031) showed direct positive effect on grain yield per plant and indirect positive exhibited via leaf length(0.216). Root volume (0.291) exhibited direct positive effect on grain yield per plant and showed indirect positive effect via panicle length of main axis (0.046). Panicle length of main axis(0.268) had direct positive effect on grain yield per plant and showed indirect positive effect via root volume(0.050) and indirect negative effect via number of panicles per hill (-0.032). Number of panicles per hill(-0.160) had direct negative effect on grain yield per plant and indirect positive effect via grain length(0.331) followed by leaf length(0.110). Days to maturity (-0.133) showed direct negative effect on grain yield per plant and exhibited indirect positive effect via leaf length (0.128). 1000 grain weight (-0.088) showed direct negative effect on grain yield per plant and showed indirect positive effect via grain length (0.384). Leaf length (0.383) showed high direct effect on grain yield per plant and indirect positive effect via grain length (0.267). The experimental findings were supported by work of [12,14-18].

Table 2. Phenotypic correlation between pairs of quantitative characters in rice

riceTRAITS		GL (mm.)	GW (mm.)	KL (mm.)	DFL (Days)	PLH (cm.)	RV (mm^3)	PLMA (cm.)	LW (cm.)	NP	DTM (Days)	ST (mm.)	TW (g)	KW (mm.)	LL (cm.)
GL	P	1													
	G	1													
GW	P	0.09													
	G	0.097													
KL	P	0.832**	0.277*												
	G	0.876**	0.368**												
DFL	P	-0.121	-0.255*	-0.22											
	G	-0.141	-0.320**	-0.250*											
PLH	P	-0.105	-0.013	-0.106	0.424**										
	G	-0.103	-0.035	-0.134	0.450**										
RV	P	-0.098	0.106	-0.049	-0.323**	-0.752**									
	G	-0.101	0.017	-0.039	-0.380**	-0.923**									
PLMA	P	0.046	-0.108	-0.071	-0.124	-0.249*	0.171								
	G	-0.005	-0.136	-0.191	-0.218	-0.471**	0.920**								
LW	P	-0.201	0.089	-0.137	-0.123	0.105	-0.038	0.332**							
	G	-0.302*	0.304*	-0.297*	-0.239	0.113	0.173	0.734**							
NP	P	0.382**	-0.257*	0.153	0.048	-0.211	0.101	0.2	-0.037						
	G	0.524**	-0.301*	0.205	0.033	-0.278*	0.191	0.687**	0.076						
DTM	P	-0.003	-0.286*	-0.064	0.700**	0.539**	-0.430**	-0.022	-0.114	-0.021					
	G	-0.034	-0.417**	-0.06	0.874**	0.629**	-0.600**	-0.214	-0.058	-0.009					
ST	P	0.248*	0.066	0.284*	0.014	0.08	-0.091	-0.142	-0.325**	0.235	-0.026				
	G	0.297*	0.006	0.355**	0.052	0.113	-0.291*	-0.416**	-0.362**	0.391**	0.061				
TW	P	0.444**	0.310*	0.536**	-0.271*	0.330**	-0.356**	-0.297*	-0.088	-0.195	-0.001	0.126			
	G	0.456**	0.388**	0.557**	-0.285*	0.340**	-0.452**	-0.586**	-0.192	-0.226	0.007	0.208			
KW	P	0.248*	0.202	0.344**	-0.203	-0.027	-0.016	-0.198	-0.096	-0.182	-0.107	-0.163	0.395**		
	G	0.601**	0.487**	0.662**	-0.328**	-0.077	0.081	-0.179	-0.228	-0.438**	-0.023	-0.166	0.738**		
LL	P	0.308*	-0.001	0.122	0.309*	0.563**	-0.573**	-0.055	-0.103	0.288*	0.334**	0.241	0.311*	0.053	
	G	0.355**	-0.087	0.112	0.363**	0.627**	-0.77**	-0.176	-0.042	0.337**	0.433**	0.262*	0.368**	0.007	
YLD	P	0.288*	-0.188	-0.041	-0.036	-0.163	0.128	0.464**	0.141	0.257*	-0.044	-0.325**	-0.131	-0.035	0.204
	G	0.292*	-0.212	-0.027	-0.032	-0.189	0.256*	0.931**	0.141	0.358**	-0.014	-0.444**	-0.152	0.071	0.233

***Significant at 1% level of significance; *Significant at 5% level of significance*

P = Phenotype, G = Genotype, GL= Grain length, GW= Grain width, KL= Kernel length, DFL= Days to 50% flowering, RV= Root volume, PLMA= Panicle length of main axis, LW= Leaf width, NP= number of panicles per hill, DTM= Days to maturity, ST= Stem thickness, TW=1000 grain weight, KW =Kernel width, LL= Leaf length, YLD= Grain yield per plant

Table 3. Phenotypic path coefficient and genotypic path coefficient analysis of 14 characters on Yield in rice

TRAITS		GL (mm.)	GW (mm.)	KL (mm.)	DFL (Days)	PLH (cm.)	RV (mm^3)	PLMA (cm.)	LW (cm.)	NP	DTM (Days)	ST (mm.)	TW (g)	KW (mm.)	LL (cm.)
GL	P	0.866	0.078	0.721	-0.105	-0.091	-0.085	0.040	-0.174	0.331	-0.003	0.215	0.384	0.215	0.267
	G	0.091	0.009	0.080	-0.013	-0.009	-0.009	-0.001	-0.028	0.048	-0.003	0.027	0.042	0.055	0.032
GW	P	-0.013	-0.143	-0.040	0.036	0.002	-0.015	0.015	-0.013	0.037	0.041	-0.009	-0.044	-0.029	0.000
	G	-0.084	-0.868	-0.320	0.277	0.031	-0.015	0.118	-0.264	0.261	0.362	-0.005	-0.336	-0.423	0.076
KL	P	-0.453	-0.151	-0.545	0.120	0.058	0.027	0.039	0.075	-0.084	0.035	-0.154	-0.292	-0.188	-0.066
	G	0.489	0.206	0.558	-0.140	-0.075	-0.022	-0.107	-0.166	0.114	-0.034	0.198	0.311	0.369	0.063
DFL	P	0.002	0.004	0.003	-0.014	-0.006	0.004	0.002	0.002	-0.001	-0.010	0.000	0.004	0.003	-0.004
	G	-0.105	-0.238	-0.187	0.746	0.336	-0.283	-0.163	-0.178	0.024	0.652	0.039	-0.213	-0.244	0.271
PLH	P	-0.003	0.000	-0.003	0.013	0.031	-0.023	-0.008	0.003	-0.007	0.017	0.003	0.010	-0.001	0.018
	G	-0.038	-0.013	-0.049	0.163	0.363	-0.335	-0.171	0.041	-0.101	0.228	0.041	0.123	-0.028	0.228
RV	P	-0.029	0.031	-0.014	-0.094	-0.219	0.291	0.050	-0.011	0.029	-0.125	-0.027	-0.104	-0.005	-0.167
	G	-0.115	0.020	-0.045	-0.432	-1.051	1.138	1.048	0.197	0.217	-0.683	-0.331	-0.514	0.092	-0.884
PLMA	P	0.013	-0.029	-0.019	-0.033	-0.067	0.046	0.268	0.089	0.054	-0.006	-0.038	-0.080	-0.053	-0.015
	G	0.001	0.021	0.029	0.033	0.072	-0.140	-0.153	-0.112	-0.105	0.033	0.064	0.089	0.027	0.027
LW	P	-0.012	0.005	-0.008	-0.008	0.006	-0.002	0.020	0.061	-0.002	-0.007	-0.020	-0.005	-0.006	-0.006
	G	-0.175	0.177	-0.172	-0.139	0.066	0.101	0.426	0.581	0.044	-0.034	-0.21	-0.112	-0.132	-0.025
NP	P	-0.061	0.041	-0.025	-0.008	0.034	-0.016	-0.032	0.006	-0.16	0.003	-0.038	0.031	0.029	-0.046
	G	-0.181	0.104	-0.071	-0.011	0.096	-0.066	-0.237	-0.026	-0.345	0.003	-0.135	0.078	0.151	-0.116
DTM	P	0	0.038	0.009	-0.094	-0.072	0.057	0.003	0.015	0.003	-0.133	0.003	0	0.014	-0.045
	G	0.034	0.415	0.06	-0.869	-0.626	0.597	0.212	0.058	0.009	-0.995	-0.061	-0.007	0.023	-0.431
ST	P	-0.087	-0.023	-0.1	-0.005	-0.028	0.032	0.05	0.114	-0.083	0.009	-0.351	-0.044	0.057	-0.085
	G	-0.091	-0.002	-0.108	-0.016	-0.035	0.089	0.127	0.111	-0.119	-0.019	-0.305	-0.064	0.051	-0.08
TW	P	-0.039	-0.027	-0.047	0.024	-0.029	0.031	0.026	0.008	0.017	0	-0.011	-0.088	-0.035	-0.027
	G	-0.049	-0.041	-0.059	0.03	-0.036	0.048	0.062	0.02	0.024	-0.001	-0.022	-0.106	-0.078	-0.039
KW	P	-0.014	-0.012	-0.02	0.012	0.002	0.001	0.011	0.006	0.01	0.006	0.009	-0.023	-0.057	-0.003
	G	0.12	0.098	0.133	-0.066	-0.015	0.016	-0.036	-0.046	-0.088	-0.005	-0.033	0.148	0.2	0.001
LL	P	0.118	0	0.047	0.119	0.216	-0.22	-0.021	-0.04	0.11	0.128	0.093	0.119	0.02	0.383
	G	0.394	-0.097	0.124	0.403	0.696	-0.862	-0.196	-0.047	0.374	0.481	0.291	0.409	0.008	1.11
YLD	P	0.288*	-0.188	-0.041	-0.036	-0.163	0.128	0.464**	0.141	0.257*	-0.044	-0.325**	-0.131	-0.035	0.204
	G	0.292*	-0.212	-0.027	-0.032	-0.189	0.256*	0.931**	0.141	0.358**	-0.014	-0.444**	-0.152	0.071	0.233

***Significant at 1% level of significance; *Significant at 5% level of significance;*

Phenotype (P): R square= 0.6349 Residual effect= 0.6042; Genotype (G): R square= 0.6483 Residual effect= 0.5931

P = Phenotype, G = Genotype, GL= Grain length, GW= Grain width, KL= Kernel length, DFL= Days to 50% flowering, RV= Root volume, PLMA= Panicle length of main axis, LW= Leaf width, NP= number of panicles per hill, DTM= Days to maturity, ST= Stem thickness, TW=1000 grain weight, KW =Kernel width, LL= Leaf length, YLD= Grain yield per plant

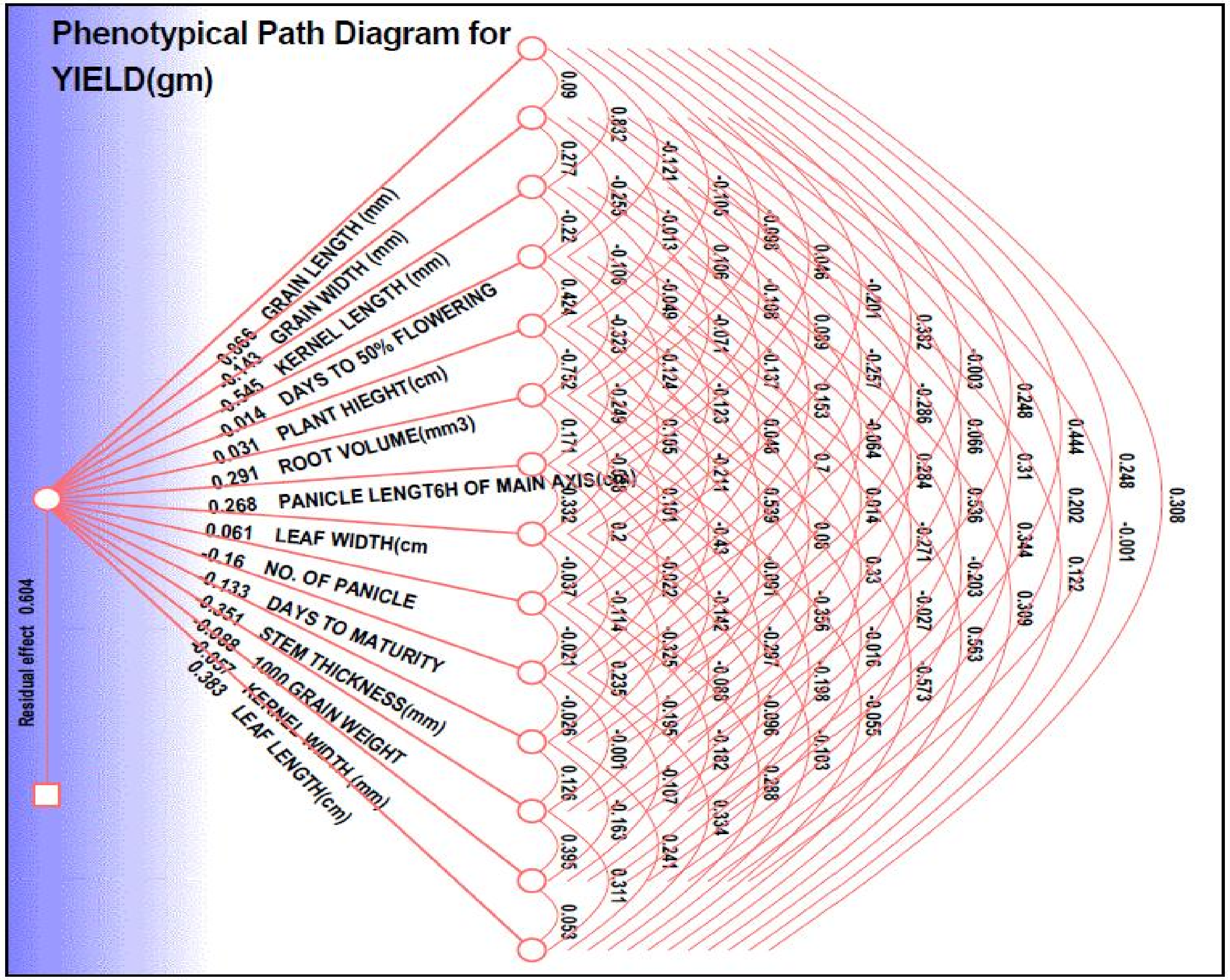

Fig. 1. Phenotypic path diagram for grain yield per plant

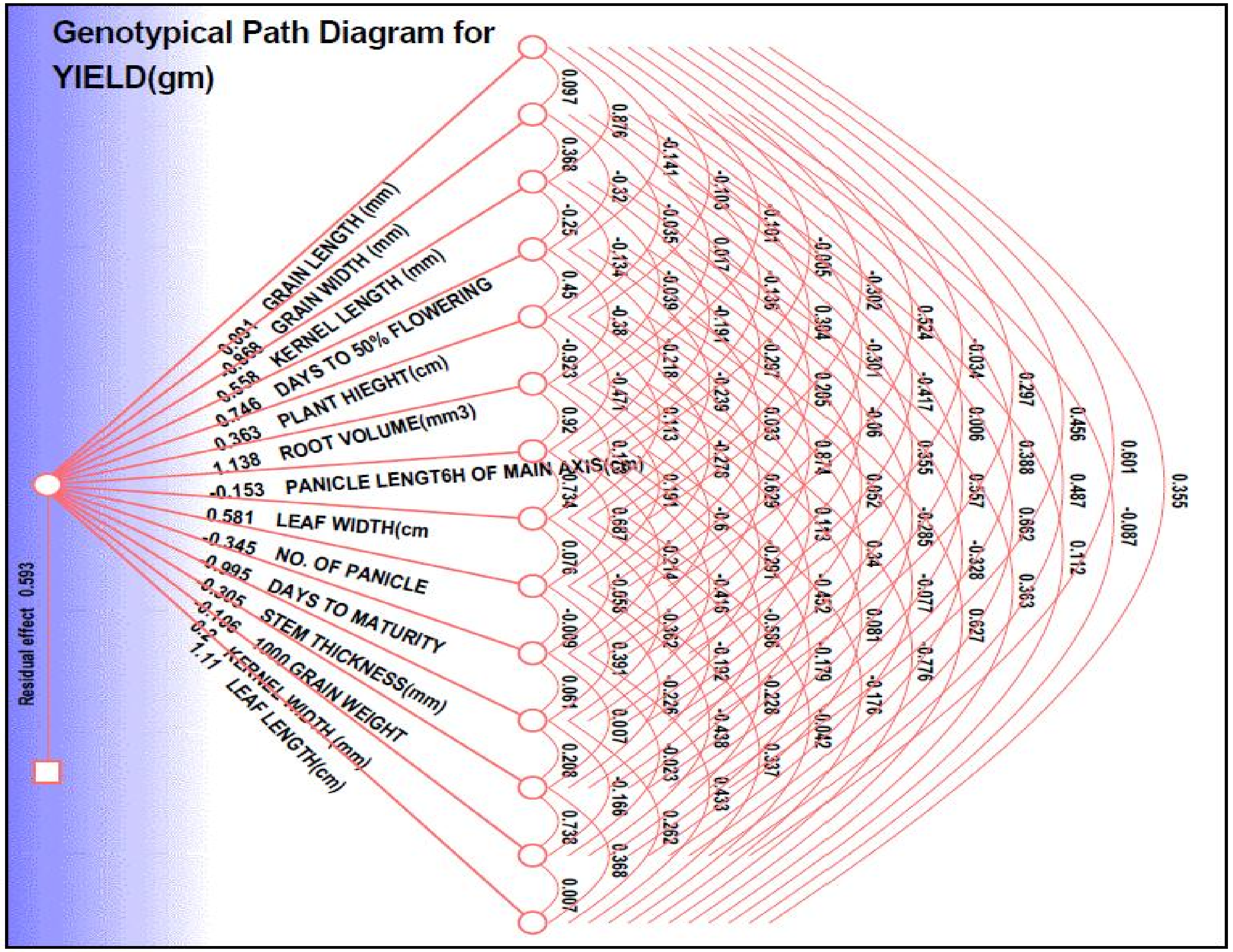

Fig. 2. Genotypic path diagram for grain yield per plant

4. CONCLUSION

Grain length (0.288*), panicle length of main axis (0.464**) number of panicles (0.257*), showed positive significant correlation with grain yield per plant. This indicates importance of these traits for enhancing the yield in these lowland rice cultivars. Hence, indirect selection for any one of these characters would ultimately bring improvement in grain yield.

Grain length (0.866), root volume (0.291), panicle length of main axis (0.268) and leaf length (0.383) showed high direct effect on grain yield per plant. Hence, selection based on these characters would be more effective for yield improvement.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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