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CORRELATION AND PATH COEFFICIENT ANALYSIS OF YIELD COMPONENTS IN AEROBIC RICE (*ORYZA SATIVA* L.)

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ABSTRACT

A study of interrelationship and cause-effect analysis of grain yield and its component traits was carried out using thirty aerobic rice genotypes. The results indicated that relative water content (0.528), chlorophyll content (0.495), root length (0.478), panicle per plant (0.437), 1000 grain weight (0.366), grains per panicle (0.355), spikelet fertility (0.372), root volume (0.256) showed significant and positive association with grain yield per plant. Path analysis revealed that chlorophyll content, tillers per plant, panicles per plant, root volume, grains per panicle and 1000 grain weight were the major contributor of grain yield per plant and these important plant traits must be taken into consideration when any breeding program for higher paddy yield in rice under aerobic condition is to be planned.

INTRODUCTION

Grain yield is a complex character and is controlled by many factors. Selection for desirable types should not only be restricted to grain yield alone but other components related to grain yield should also be considered. The correlation coefficient may also help to identify characters that have little or no importance in the selection programme. The existence of correlation may be attributed to the presence of linkage or pleiotropic effect of genes or physiological and development relationship or environmental effect or in combination of all (Oad *et al.*, 2002). Path coefficient analysis is a statistical technique of partitioning the correlation coefficients into its direct and indirect effects (Dewey and Lu, 1959) so that the contribution of each character to yield could be estimated. It is used in plant breeding programs to determine the nature of the relationships between yield and yield components that are useful as selection criteria to improve the crop yield. The goal of the path analysis is to accept descriptions of the correlation between the traits, based on a model of cause and effect relationship and to estimate the importance of the affecting traits on a specific traits (Milligan *et al.*, 1990) .This study was conducted to determine the nature of relationship between grain yield and yield components, direct and indirect contribution of these parameters towards paddy yield and to identify better combination as selection criteria for developing high yielding rice genotypes under aerobic condition.

MATERIALS AND METHODS

The experimental material for the present study comprised of thirty genotypes of rice suitable for aerobic condition procured from directorate of rice research, Hyderabad laid in randomized block design (RBD) with three replications at the Field Experimentation Centre of Department of Plant Breeding and Genetics, Rajendra Agricultural University, Pusa Samastipur Bihar during *kharif,* 2013. Standard agronomic practices and plant protection measures were taken as per schedule. Each genotype was grown in a plot of 5 x 2 square meters with the spacing 20 x 15 cm row to row and plant to plant respectively. Observations were recorded on five randomly selected plants per replication for different quantitative traits viz. plant height (cm), tillers per plant, panicle length (cm), panicles per plant, spikelet fertility (%), chlorophyll content (SPAD VALUE), relative water content, canopy temperature (^{0}C), critical temperature for reproductive stage (^{0}C), root length (cm), root volume (cm^3), grains per panicle, 1000 grain weight (g), and grain yield per plant (g) while traits like seedling vigour, days to 50% flowering and days to physiological maturity were recorded on plot basis. Observations were recorded and the data was subjected to statistical analysis. Statistical analyses for the above characters were done following Singh and Chaudhary (1995) for correlation coefficient and Dewey and Lu (1959) for path analysis.

Trait	Scale		Criteria
Seedling Vigor	1	(Extra Vigorous)	Very fast growing, Plants at 5-leaf stage having 2 or more tillers in majority of population.
	3	(Vigorous)	Fast growing plants at 4-5 leaf stage have 1-2 tillers in majority of population
	5	(Normal)	Plants at 4 leaf stage
	7	(Weak)	Plants somewhat stunted, 3-4 leaves, thin population, no tiller formation.
	9	(Very weak)	Stunted growth, Yellowing of leaves.

Seedling vigor

Seedling vigor was measured on 1 to 9 scale under standard evaluation system (SES) as proposed by IRRI (1996):

Canopy temperature was measured using a hand-held infrared thermometer (Talebi, 2011).

Critical temperature for reproductive stage was measured by recording accumulated daily temperature till flowering and accumulated daily temperature till maturity and calculated using the equation as proposed Arnold (1960):

$$CRT = \frac{\text{Accumlulated daily temp. till maturity - Accumulated daily temp. Till flowering}}{\text{Number of days to maturity - number of days to flowering}}$$

Accumlulated daily temp. till maturity = Sum of daily average temperature × No. of days upto maturity

Accumulated daily temp. till flowering = Sum of daily average temperature × No. of days upto flowering

Root length and Root volume was measured by digital root scanner using WinRHIZO software (V5.0), Regent Instruments, Quebec, Canada.

Leaf relative water content (RWC) of the flag leaves was determined using the equation given by Barr and Weatherley (1962):

$$RWC = \frac{F.W - D.W.}{T.W. - D.W.} \times 100$$

Where,

F.W. = Fresh Weight of flag leaf (g)

D.W. = Dry Weight of flag leaf (g)

T.W. = Turgid Weight of flag leaf (g)

The data were analyzed using WINDOSTAT version 8.6 software for computation of correlation coefficients and path coefficient analysis.

RESULTS AND DISCUSSION

Phenotypic and genotypic correlation coefficients among the seventeen characters were assessed and are presented in Table 1. The present investigation indicated that the genotypic correlation coefficients were higher than the phenotypic correlation coefficients demonstrating that the observed relationships among the various characters were due to genetic causes. This is also in confirmation with the findings of Najeeb and Wani (2004), Radhidevi *et al.* (2002), Sabesan *et al.* (2009) and Sarkar *et al.* (2007).

In present investigation, it is evident that there were significant and positive association of panicles per plant, spikelet fertility, chlorophyll content, relative water content, root length, root volume, grains per panicle and 1000 grain weight with grain yield per plant at both genotypic and phenotypic level. Therefore, these characters should be considered for selection for better performance of genotypes in aerobic condition. These results were in agreement with that of Kato *et al.* (2008) and Süerk (2003).

Seedling vigor showed significant and negative association with grain yield per plant at both genotypic and phenotypic level. Zhao *et al.* (2006) reported strong association observed between early seedling vigor and yield, which supports the findings of the present investigation.

Grain yield per plant had significant and negative association with days to 50% flowering (genotypic level), days to physiological maturity, plant height, panicle length, canopy temperature, and critical temperature for reproductive stage at both genotypic and phenotypic level.This indicates delay in flowering under stress is caused by a combination of slower floral development and reduced panicle elongation rate, Lafitte *et al.* (2004).

The inter correlation between yield contributing characters may affect the selection for component traits either in favorable or unfavorable direction. Hence, the knowledge of inter relationship between yield component traits may facilitate breeders to decide upon the intensity and direction of selection pressure to be given on related traits for the simultaneous improvement of these traits. Correlation among various yield attributing characters is presented in Table 1.

Seedling vigour exhibited highly significant and positive association with days to 50% flowering, days to physiological maturity, panicles length, canopy temperature and critical temperature for reproductive stage at both genotypic and phenotypic level. It was highly significantly and negatively correlated with tillers per plant, panicles per plant, spikelet fertility, chlorophyll content, relative water content, root length, root volume and grains per panicle at both genotypic and phenotypic level. It exhibited significant and positive association with plant height and significant and negative association with 1000 grain weight at genotypic level only. These results were in accordance with Zhao *et al.* (2006).

Days to 50% flowering showed significant and positive association with days to physiological maturity, plant height, panicle length, canopy temperature and critical temperature for reproductive stage at both genotypic and phenotypic level whereas had significant and negative association with tillers per plant, panicles per plant, spikelet fertility, chlorophyll content, relative water content, root length, root volume, grains per panicle, 1000 grain weight at both genotypic and phenotypic level.

Days to physiological maturity showed significant and positive association with panicle length, canopy temperature and critical temperature for reproductive stage at both genotypic and phenotypic level while it showed significant and negative association with spikelet fertility, relative water content, root length, root volume, grains per panicle and 1000 grain weight at both genotypic and phenotypic level. It had highly significant and positive association with plant height at genotypic level whereas significant and negative association with tillers per plant, panicles per plant and chlorophyll content at genotypic level. These results indicated earliness is a critical trait for performance under reproductive stage stress as was detailed by Jonaliza *et al.* (2004), Manickavelu *et al.* (2006), Pantuwan *et al.* (2001).

Plant height showed significant and positive association with

Table 1: Inter-relationship of different yield attributing characters at Genotypic and Phenotypic levels under Aerobic condition

Sl.no.	Characters		SV	DF	DPM	PH	TPP	PL	PP	SF	CC	RWC	CT	CRT	RL	RV	G/PA	**TGW**	**GY/PL**
1.	SV	G	1	0.522**	0.466**	0.650**	-0.977**	0.716**	-0.905**	-0.790**	-0.755**	-0.540**	0.613**	0.841**	-0.930**	-0.823**	-0.688**	-0.684**	-0.845 **
		P	1	0.288*	0.351**	0.097	-0.354**	0.345*	-0.340*	-0.279*	-0.379**	-0.286*	0.411**	0.266*	-0.406**	-0.331*	-0.384**	-0.168	-0.300 **
2.	DF	G		1	0.9861**	0.430**	-0.493**	0.759**	-0.558**	-0.515**	-0.666**	-0.680**	0.726**	0.860**	-0.767**	-0.816**	-0.833**	-0.561**	-0.590**
		P		1	0.682**	0.269*	-0.249*	0.478**	-0.259*	-0.213*	-0.237*	-0.362**	0.328*	0.426**	-0.435**	-0.351**	-0.490**	-0.274*	-0.116
3.	DPM	G			1	0.226*	-0.857**	0.851**	-0.954**	-0.968**	-0.787**	-0.941**	0.781**	0.966**	-0.945**	-0.801**	-0.997**	-0.736**	-0.790 **
		P			1	0.172	-0.141	0.428**	-0.080	-0.231*	-0.187	-0.381**	0.313**	0.259*	-0.394**	-0.266*	-0.324**	-0.306**	-0.228 *
4.	PH	G				1	-0.593**	0.549**	-0.554**	0.006	-0.739**	-0.346**	0.544**	0.614**	-0.845**	-0.844**	-0.707**	0.100	-0.572 **
		P				1	-0.262*	0.405**	-0.096	-0.055	-0.286**	-0.160	0.256*	0.172	-0.267*	-0.193	-0.301**	-0.064	-0.269 *
5.	TPP	G					1	-0.802**	0.9568**	0.918**	0.810**	0.717**	-0.859**	-0.892**	0.951**	0.887**	0.485**	0.877**	0.985 **
		P					1	-0.406**	0.781**	0.347*	0.355**	0.475**	-0.464**	-0.472**	0.536**	0.507**	0.262*	0.393**	-0.556 **
6.	PL	G						1	-0.834**	-0.956**	-0.793**	-0.685**	0.993**	0.948**	-0.976**	-0.984**	-0.977**	-0.798**	-0.912 **
		P						1	-0.354**	-0.359**	-0.432**	-0.398**	0.590**	0.556**	-0.493**	-0.412**	-0.610**	-0.301**	-0.576 **
7.	PP	G							1	0.822**	0.697**	0.715**	-0.844**	-0.884**	0.931**	0.912**	0.409**	0.985**	0.892**
		P							1	0.431**	0.348*	0.446**	-0.442**	-0.385**	0.482**	0.431**	0.261*	0.409**	0.437 **
8.	SF	G								1	0.717**	0.783**	-0.988**	-0.928**	0.742**	0.912**	0.533**	0.965**	0.985**
		P								1	0.287*	0.282*	-0.404**	-0.211*	0.452**	0.173	0.266*	0.303**	0.372 **
9.	CC	G									1	0.557**	-0.826**	-0.943**	0.947**	0.976**	0.603**	0.878**	0.830 **
		P									1	0.408**	-0.509**	-0.447**	0.542**	0.273*	0.441**	0.343**	0.495 **
10	RWC	G										1	-0.731**	-0.900**	0.752**	0.953**	0.535**	0.784**	0.702 **
		P										1	-0.542**	-0.456**	0.528**	0.285*	0.346**	0.373**	0.528 **
11	CT	G											1	0.905**	-0.893**	-0.796**	-0.713**	-0.863**	-0.986 **
		P											1	0.625**	-0.456**	-0.356**	-0.474**	-0.423**	-0.607 **
12	CRT	G												1	-0.982**	-0.950**	-0.964**	-0.976**	-0.954 **
		P												1	-0.409**	-0.432**	-0.479**	-0.348**	-0.535 **
13	RL	G												.	1	0.936**	0.682**	0.798**	0.928**
		P													1	0.521**	0.450**	0.320**	0.478 **
14	RV	G														1	0.918**	0.912**	0.844 **
		P														1	0.304*	0.365**	0.256 *
15	G/PA	G															1	0.313**	0.714 **
		P															1	0.094**	0.355 **
16	TGW	G																1	0.972 **
		P																1	0.366 **

G – Genotypic, P-phenotypic / significant at 1% (**), 5% (*)

Table 2: Genotypic path coefficient analysis of seventeen characters on grain yield of rice under Aerobic condition

S.no.	Characters	SV	DF	DPM	PH	TPP	PL	PP	SF	CC	RWC	CT	CRT	RL	RV	G/PA	TGW
1.	SV	1.251	0.968	0.886	1.120	-1.302	1.101	-1.121	-1.106	-0.996	-0.897	0.812	1.234	-1.234	-0.923	-1.105	-0.865
2.	DF	0.877	0.954	1.143	0.755	-0.956	0.754	-0.845	-0.856	-0.863	-0.776	0.766	0.866	-0.812	-1.234	-0.798	-0.664
3.	DPM	-0.978	-0.913	-0.798	-0.461	0.892	-0.776	0.896	0.955	0.812	0.854	-0.719	-0.812	0.798	0.712	0.812	0.766
4.	PH	-0.895	-0.881	-0.644	-0.877	0.863	-0.564	0.755	-0.318	0.947	0.987	-0.702	-0.750	0.843	0.816	0.843	-0.285
5.	TPP	-1.070	-1.212	-1.241	-1.211	1.213	-1.031	0.977	2.050	0.788	0.943	-0.966	-1.234	0.812	1.234	0.781	1.230
6.	PL	0.989	1.371	1.465	0.893	-1.295	1.210	-1.667	-1.456	-0.886	-0.962	1.234	1.102	-0.956	-1.340	-0.941	-0.986
7.	PP	-0.901	-0.899	-1.121	-0.755	1.213	-0.898	1.134	0.967	0.688	0.801	-0.899	-0.977	0.766	0.877	0.553	0.962
8.	SPF	0.885	0.700	0.808	-0.061	-0.843	0.467	-0.787	-0.866	-0.975	-0.876	0.776	0.778	-0.780	-0.667	-0.724	-0.712
9.	CC	-0.906	-0.529	-1.101	-1.240	0.886	-0.928	0.923	0.866	1.345	0.865	-0.899	-0.864	1.345	1.213	0.876	0.852
10	RWC	-0.014	-0.207	-0.024	-0.009	0.082	-0.196	0.086	0.086	0.014	0.026	-0.078	-0.523	0.025	0.043	0.014	0.202
11	CT	0.560	0.421	0.178	0.624	-0.196	0.526	-0.652	-0.435	-0.788	-0.667	0.728	0.289	-0.804	-0.548	-0.463	-0.597
12	CRT	0.315	0.272	0.452	0.420	-0.319	0.434	-0.595	-0.504	-0.697	-0.722	0.454	0.358	-0.360	-0.608	-0.640	-0.385
13	RL	1.231	2.101	2.101	1.330	-1.251	2.247	-0.946	-1.024	-0.896	-0.965	1.234	2.160	-1.013	-2.050	-0.964	-0.963
14	RV	-0.708	-0.684	-1.070	-0.566	0.788	-0.878	0.777	0.848	0.688	0.715	-0.839	-0.786	0.746	0.941	0.863	0.858
15	G/PA	-0.803	-1.256	-0.966	-0.988	0.703	-1.598	1.086	0.896	0.879	0.790	-1.063	-0.963	0.786	1.567	0.892	0.774
16	TGW	-0.678	-0.796	-0.864	0.454	0.506	-0.783	0.871	0.882	0.778	0.585	-0.825	-0.832	0.766	0.812	0.715	0.785
17	GY/PL	-0.845	-0.590	-0.796	-0.572	0.985	-0.912	0.892	0.985	0.838	0.702	-0.986	-0.954	0.928	0.844	0.714	0.972

canopy temperature at both genotypic and phenotypic level while it showed significant and negative association with tillers per plant, chlorophyll content, root length and grains per panicle at both genotypic and phenotypic level. Critical temperature for reproductive stage and panicle length showed highly significant and positive association with grain yield per plant at genotypic level and phenotypic level respectively whereas panicle per plant, relative water content and root volume showed highly significant and negative association at genotypic level only.

Panicles per plant showed significant and positive association with spikelet fertility, chlorophyll content, relative water content, root length, root volume, grains per panicle and 1000 grain weight at both genotypic level and phenotypic level whereas it was significantly and negatively correlated with canopy temperature and critical temperature for reproductive stage at both genotypic and phenotypic level. These results for plant height and panicles per plant were in accordance with Ganesan *et al.* (1997), Janardhanam *et al.* (2001) Lalitha and Sreedhar (1996), Kavitha and Reddi (2001), Sharma and Sharma (2007) and Yogameenakshi *et al.* (2004).

Tillers per plant showed significant and positive association with panicles per plant, spikelet fertility, chlorophyll content, relative water content, root length, root volume, grains per panicle and 1000 grain weight at both genotypic and phenotypic level while it showed highly significant and negative association with panicle length, canopy temperature, critical temperature for reproductive stage at both genotypic and phenotypic level. The results were in unison with Reddy *et al.* (1995), Roy *et al.* (1995) and Reddy *et al.* (1997). It indicated that grain yield can be increased whenever there is an increase in characters that showed positive and significant association with grain yield. Hence, these characters can be considered as criteria for selection for higher yield as these were mutually and directly associated with yield.

Spikelet fertility showed significant and positive association with chlorophyll content, relative water content, root length, root volume, grains per panicle and 1000 grain weight at both genotypic and phenotypic level whereas it was significantly and negatively correlated with canopy temperature and critical temperature for reproductive stage at both genotypic and phenotypic level. This was in accordance with the findings of D. Malath *et al.* (2013).

Chlorophyll content showed highly significant and positive association with relative water content, root length, root volume, grains per panicle and 1000 grain weight at both genotypic and phenotypic level whereas it was highly significantly and negatively correlated with canopy temperature and critical temperature for reproductive stage at both genotypic and phenotypic level. Chlorophyll content, which indicates the nitrogen status of the plant is very important during the grain filling stage. The nitrogen content indicates the sink strength of plants, so high chlorophyll content indicates high sink strength of the plants higher sink strength would produce higher and rice yields. This was in conformity with the findings of Wankhade and Sanz, (2013) who observed total chlorophyll content was very important in determining rice yield in *Oryza sativa* L.

Relative water content showed significant and positive

Table 3: Genotypic Path coefficient (direct and indirect effects) of the estimated yield attributes of grain yield of rice under Aerobic condition

Characters	Direct effect	Indirect effect	Correlation with yield
Seedling vigour	1.250	-2.096	-0.845
Days to 50% flowering	0.954	-1.544	-0.590
Days to physiological maturity	-0.798	0.002	-0.796
Plant height	-0.877	0.305	-0.572
Tillers per plant	1.213	-0.299	0.985
Panicle length	1.210	-2.123	-0.912
Panicle per plant	1.134	-0.242	0.892
Spikelet fertility	-0.866	1.851	0.985
Chlorophyll content	1.345	-0.033	0.838
Relative water content	0.026	0.675	0.702
Canopy temperature	0.728	-1.174	-0.986
Critical temperature	0.358	-1.312	-0.954
Root length	-1.013	1.941	0.928
Root volume	0.941	-0.096	0.844
Grain per panicle	0.892	-0.178	0.714
1000-grain weight	0.785	0.187	0.972

ABBERVIATIONS;-
SV-seedling vigor, DF- days to 50% flowering, DPM-days to physiological maturity, PH-plant height, PL-panicle length, TPP- tillers per plant, PP- panicles per plant, SF-spikelet fertility, CC- chlorophyll content, RWC- relative water content, CT- canopy temperature, CRT- critical temperature for reproductive stage, RL-root length, RV-root volume, G/PA-grains per panicle, TGW-1000 grain weight GY/PL-grain yield per plant

association with root length, root volume, grains per panicle and 1000 grain weight (Zarei *et al.,* 2012) at both genotypic level and phenotypic level whereas it was significantly and negatively correlated with canopy temperature and critical temperature for reproductive stage at both genotypic and phenotypic level. It revealed that relative water content is a measure of carbon assimilation by photosynthesis per unit of water transpired. Turgor of cells is determined in part by osmotic potential. Plants can adjust osmotic potential (i.e., osmotic adjustment) to maintain turgor under stress conditions. This becomes possible through varieties having higher RWC under stress condition are more drought tolerant and gave higher yield than others. This was inconformity with the findings of Thangaraj and Siva Subramanian (1990).

Canopy temperature showed highly significant and positive association with critical temperature for reproductive stage at both genotypic level and phenotypic level whereas it was highly significantly and negatively correlated with root length, root volume, grains per panicle and 1000 grain weight at both genotypic and phenotypic level. This was in accordance with the findings of Liu *et al.* (2004).

Critical temperature for reproductive stage showed highly significant and negative association with root length, root volume, grains per panicle and 1000 grain weight at both genotypic level and phenotypic level. Booting and flowering are the stages most sensitive to high temperature, which may sometimes lead to complete sterility. Matsui *et al.* (2001) found variation of temperatures causing sterility between the most tolerant and most susceptible cultivars among japonica cultivars.

Root length showed highly significant and positive association with root volume, grains per panicle and 1000 grain weight at both genotypic level and phenotypic level. Root volume showed highly significant and positive correlation with grains per panicle and 1000 grain weight at both genotypic level and phenotypic level. This was in conformity with the findings of Michael Gomez and Rangasamy (2002), Sinha *et al.* (2000) and Yogameenakshi (2002). Results shows that a well-developed root system will help the plant in maintaining high plant water status (Kato *et al.,* 2007). Maintaining higher leaf water status under receding soil moisture conditions during grain filling is crucial for better grain yield.

Grains per panicle showed highly significant and positive association with 1000 grain weight at both genotypic level and phenotypic level. This was earlier found by Deepa Sankar *et al.* (2006).

The correlation coefficient of causal variable on the dependent variable may include in it the direct and indirect influences of component traits. Therefore, splitting the total correlation into direct and indirect effects of cause through path coefficient analysis, a statistical device developed by Wright, (1934) would give more meaningful interpretation to the cause of association between the variable like yield and independent variables like yield attributing traits.

Genotypic path coefficients among the seventeen characters were assessed and are presented in Table 2. From the table it is evident that strong positive direct effect exhibited by chlorophyll content followed by seedling vigour, tillers per plant, panicle length, panicles per plant, root volume, grains per panicle, 1000 grain weight, canopy temperature and critical temperature for reproductive stage. Positive direct effects of these traits on grain yield indicated their importance in determining this complex character and therefore, should be kept in mind while practicing selection aimed at the improvement of grain yield. These findings were also corroborated by Kole *et al.* (2008) and Sarawgi *et al.* (2000). Strong negative direct effect showed by root length, plant height, spikelet fertility and days to physiological maturity. Selection of plants on the basis of these traits would certainly lead to improvement in grain yield. Similar results had been reported by Ekka *et al.* (2011).

Among all the characters (Table 3) Seedling vigor, days to 50 % flowering, panicle length, canopy temperature, critical temperature for reproductive stage expresses significant and negative association with grain yield is mainly due to its indirect effect. Days to physiological maturity and plant height expresses negative association with grain yield mainly due to its high direct effect. Tillers per plant, panicles per plant, chlorophyll content, root volume and grains per panicle expresses positive association with grain yield mainly due to its high direct effect. Spikelet fertility and root length expresses positive association with grain yield mainly due to its indirect effect. Relative water content and 1000 grain weight expresses positive association with grain yield due to contribution of both direct and indirect effect.

Hence, selection based on these characters would be more effective for yield improvement under aerobic rice. The characters which have high direct effect and significant association with grain yield indicating that these traits were more contribute towards grain yield in these rice lines, therefore selection for these characters is likely to bring about an overall improvement in plant yield directly. This was similar to previous reports by, Ezeaku and Mohammed (2006), Mehetre *et al.* (1994), Samonte *et al.* (1998), Sundaram and Palanisamy (1994).

Seedling vigour, days to 50 % flowering, days to physiological maturity, panicle length, canopy temperature and critical temperature for reproductive stage expresses high indirect and negative effect on grain yield *via*. days to physiological maturity, plant height, tillers per plant, panicles per plant, chlorophyll content, relative water content, root volume, grains per panicle and 1000 grain weight. The indirect expression of panicle length on grain yield through all the foresaid characters were negative except spikelet fertility. Tillers per plant, panicles per plant, chlorophyll content, relative water content, root length, root volume, grains per panicle expresses high and positive indirect effect on grain yield *via*. days to physiological maturity, plant height, tillers per plant, panicles per plant, chlorophyll content, relative water content , root volume, grains per panicle and 1000 grain weight. The indirect effect expression of spikelet fertility and 1000 grain weight on grain yield through all the foresaid characters were negative except plant height. Similar results have been reported by Reddy *et al.* (2013), Reuben and Katouli (1989) Sarawagi *et al.* (2000) and Zahid *et al.* (2006).

Based on the studies on correlation and path-coefficient analysis, it may be concluded that days to physiological maturity, plant height, tillers per plant, panicles per plant, chlorophyll content, root volume, grains per panicle, 1000 grain weight exhibited significant association with grain yield due to its high direct effect seems to be primary yield contributing characters and could be relied upon for selection of genotypes to improve genetic yield potential of rice under aerobic condition. Hence, utmost importance should be given to these characters during selection for single plant yield improvement.

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