

Original Research Article

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## Genetic Variability and Correlation Studies for Yield and Yield Related Traits in Rice (*Oryza sativa* L.) Genotypes

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### ABSTRACT

The present study consist of 29 rice genotypes including one check variety that were evaluated at Field Experimentation Centre of the Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj U.P. to study genetic variability, heritability, genetic advance, correlation and path coefficient for 13 quantitative characters. The experiment was conducted by using Randomized Block Design with three replications during *Kharif - 2019*. Observation recorded to study the genetic variability parameters, correlation coefficient and path coefficient for yield and its attributing traits. Significant variability reported for all the characters. On the basis of mean performance IRR1-156 was found to be superior in grain yield per hill followed by TP- 30441 and NDR-1045. High to moderate GCV and PCV were recorded for grain yield per hill followed by number of spikelets per panicle, biological yield, test weight and flag leaf length. Grain yield indicated significant positive correlation with days to 50% flowering, panicle length, number of spikelets per panicle at phenotypic level whereas at genotypic level it showed positive and significant correlation with number of panicle and plant height. Path coefficient analysis showed positive significant direct effects on grain yield per hill were exhibited by plant height and number of panicles at genotypic level whereas it showed positive and significant direct effect for panicle length and number of spikelets per panicle at phenotypic level. Thus, these traits are identified as the efficient and potential for indirect selection for the improvement of rice productivity in the present experimental materials.

#### Keywords

Rice (*Oryza sativa* L.), GCV, PCV, Variability, Heritability, Correlation and Path analysis

#### Article Info

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### Introduction

Rice (*Oryza sativa* L.) is one of the staple cereal crops of the world and it is one of the main sources of carbohydrate for nearly one half of the world population. However, more than 90% of this rice is produced and consumed in Asia, where it is a staple for a

majority of the population, including the region's 560 million hungry people. Cultivation of rice is important for the food security of Asia. India has a long history of rice cultivation and stands first in rice area and second in rice production, after China. Rice belongs to the genus *Oryza* and the tribe *Oryzaceae* of the family Gramineae (Poaceae).

The genus *Oryza* contains 25 recognized species, of which 23 are wild species and two, *O. sativa* and *O. glaberrima* are cultivated (Morishima, 1984; Vaughan, 1994; Brar and Khush, 2003). *O. sativa* is the most widely grown of the two cultivated species. It is grown worldwide including in Asian, North and South American, European Union, Middle Eastern and African countries. However, *O. glaberrima* is grown solely in West African countries.

The current global population of 7.7 billion is expected to reach 9.7 billion by 2050 (Department of Economics and Social Affairs-2018-19). Globally rice is cultivated now on 166.5 million hectares with annual production of around 760 million tons and average productivity of 2.65 tons/ha (Food and Agriculture Organization, 2018). In India the production of rice was 116.42 Million tons from 43.79 million ha of area and it stands in second position in the world production after china. In Uttar Pradesh area, production and productivity is 5.75 million ha, 15.54 Million tons and 2.70 q/ha respectively. It is estimated that in India, the demand for rice will be 129.6 million tons by 2040 and 137.3 million tons by 2050 for internal consumption. (Directorate of Economics and Statistics, 2018-19).

As per the present scenario, the population of our country continuously increasing at an alarming pace, so there is a need for identification and releasing of the promising germplasm having higher yield and would be able to serve as a source of nutritional security in the near future.

## **Materials and Methods**

The experimental material consist of 29 rice genotypes which were obtained from department of Genetics and Plant Breeding,

Naini Agricultural Institute, Sam Higginbottom University of Agriculture and Sciences, Prayagraj were grown during *Kharif* season of 2018 at Field Experimentation Centre, SHUATS, Prayagraj (U.P), India. These genotypes were planted in Randomized Block Design with three replications. Thirty days old seedlings were transplanted in the experimental site with the spacing of 15 cm between plants and 20 cm between the rows, keeping single seedling per hill. Fertilizer dose of 120 kg N, 60 kg P<sub>2</sub>O<sub>5</sub> and 40 kg K<sub>2</sub>O was applied. The standard agronomic practices were adopted for normal crop growth.

Thirteen quantitative characters were used to characterize and assess the genetic variability, heritability, genetic advance, correlation coefficient and path analysis. Five plants were randomly selected from each replication in each genotype for the analysis of menition parameters. The observations were recorded as per the standard procedure and subjected to statistical analysis using mean values of five randomly selected plants.

## **Statistical analysis**

The data on quantitative characters were statistically analysed on the basis of model described by Panse and Sukhatme (1967) for randomized block design. Parameters of genetic variability include mean, range, genotypic and phenotypic coefficient of variation were calculated by the method suggested by Burton and De Vane (1953) and th estimate of PCV and GCV were classified as low, moderate and high according to Sivasubramanian and Madhavamenon (1973).

Heritability for broad sense is the ratio of genotypic variance to the total phenotypic variance. Expected genetic advance was calculated by the method suggested by Burton and De Vane (1955) and genetic advance as

percentage of mean was calculated by the following formula:

$$\text{GA \% M} = \frac{\text{GA}}{\text{X}} \times 100$$

Correlation coefficients were calculated for all quantitative character combinations at phenotypic and genotypic level by the formula given by Johnson *et al.*, (1958).

Genotypic correlation between traits X and Y:

$$R_{xy(g)} = \frac{\sigma_g^2(xy)}{\sqrt{\sigma_g^2x\sigma_g^2y}}$$

Phenotypic correlation between traits X and Y:

$$R_{xy(p)} = \frac{\sigma_p^2(xy)}{\sqrt{\sigma_p^2x\sigma_p^2y}}$$

The direct and indirect contribution of various characters to yield were calculated through path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959). The path coefficients were rated based on the scales given below

- >1.00 - Very High
- 0.3-0.99 - High
- 0.2-0.29 - Moderate
- 0.1-0.19 - Low
- 0.0-0.09 - Negligible

## Results and Discussion

The analysis of variance exhibited the presence of significant differences among the tested genotypes for all the characters indicating the existence of variability. The analysis of variance showed that the genotypes differed significantly ( $p < 0.05$ ) for all the studied characters. The presence of large amount of variability might be due to diverse source of materials taken as well as

environmental influence affecting the phenotypes. Kumar and Saravanan *et al.*, (2012); Osman *et al.*, (2014) and Fentie *et al.*, (2014) reported significance differences among rice genotypes evaluated in different locations.

## Genetic variability

The magnitude of variation between was reflected by high values of mean and range for the traits studied (Table 2). The value of GCV and PCV were obtained high for number of spikelets per panicle, number of tillers and number of panicles. This was in agreement with the finding reported by Roy *et al* (2017), Kishore *et al* (2018) and Sandeep *et al* (2018). In this study moderate value of PCV and GCV were recorded in test weight, flag leaf width, flag leaf length and harvest index.

These results are in accordance with Dhurai *et al* (2014) and Rashid *et al* (2019). Low magnitude of genotypic and phenotypic coefficient of variation for days to maturity, days to 50% flowering, plant height and panicle length was observed. Difference between the magnitude of GCV and PCV was very low for these characters indicate the role of genotypic in expression of these characters.

## Heritability and genetic advance

In our study, The estimates of heritability coupled with high genetic advance as percent of mean was observed for number of spikelets per panicle, biological yield flag leaf length, flag leaf width, harvest index, test weight and grain yield suggesting the scope of selection for improvement of these characters. The results in respect to heritability and genetic advance are in agreement with earlier reports on rice by Meena *et al.*, (2016), Nandan *et al.*, (2018), Nuruzzaman *et al.*, (2017), Lingaiah *et al.*, (2019), Barik *et al.*, (2020).

**Table.1** Analysis of variance for 13 different quantitative characters in rice genotypes

Characters	Mean Sum of Squares		
	Replications	Treatments	Error
	(df= 2)	(df= 28)	(df=56)
<b>Days to 50% Flowering</b>	6.85	85.94**	5.80
<b>Plant Height</b>	82.43	218.99**	24.98
<b>Number of Tillers/ Plant</b>	1.66	8.87**	2.54
<b>Number of Panicles/ Plant</b>	1.78	8.80**	1.69
<b>Panicle Length</b>	1.73	6.96**	1.17
<b>Flag Leaf Length</b>	2.60	52.11**	8.43
<b>Flag Leaf Width</b>	0.00026	0.072**	0.009
<b>Number of spikelets per Panicle</b>	26.51	3818.34**	6.59
<b>Days to Maturity</b>	0.87	102.52**	1.17
<b>Biological Yield</b>	8.52	556.66**	10.22
<b>Harvest Index</b>	30.42	49.82**	6.26
<b>Test Weight</b>	1.10	24.36**	2.20
<b>Grain Yield/Plant</b>	10.59	148.55**	4.19

\*\*1% level of significance

**Table.2** Estimation of Genetic parameters for 13 quantitative characters in rice genotypes

S. No.	Characters	$\sigma^2_g$	$\sigma^2_p$	GCV	PCV	$h^2$ (%)	GA	GA % Mean
1.	Days to 50% Flowering	26.71	32.57	5.51	6.08	82.16	9.65	10.29
2.	Plant Height	64.67	89.65	6.72	7.91	72.13	14.07	11.76
3.	Tillers per Hill	2.11	4.65	13.95	20.70	45.38	2.01	19.35
4.	Panicles per Hill	2.37	4.06	15.72	20.60	58.30	2.42	24.74
5.	Panicle Length	1.93	3.10	5.23	6.63	62.18	2.25	8.49
6.	Flag Leaf Length	14.56	22.99	10.13	12.73	63.31	6.25	16.61
7.	Flag Leaf Width	0.02	0.03	9.88	11.86	69.43	0.24	16.96
8.	Spikelet's per Panicle	1270.58	1271.71	18.36	18.41	99.48	73.23	37.73
9.	Days to Maturity	33.78	34.95	4.71	4.79	96.65	11.71	9.54
10.	Biological Yield	182.14	192.37	15.46	15.89	94.68	27.05	31.00
11.	Harvest Index	14.52	20.78	9.15	10.95	69.87	6.56	15.77
12.	Test Weight	7.38	9.60	10.74	12.25	76.87	4.90	19.41
13.	Grain Yield	48.12	52.31	19.08	19.89	91.99	13.70	37.69

$\sigma^2_g$  = Genotypic variance.  $\sigma^2_p$  = Phenotypic variance.  $H^2$  = Heritability

GCV = Genotypic coefficient of variation.

PCV = Phenotypic coefficient of variation

**Table.3** Correlation coefficient between yield and its components characters in rice genotypes at phenotypic level

Character	Days to 50% Flowering	Plant Height	No of Tillers/ plant	No of Panicles/ Plant	Panicle Length	Flag Leaf Length	Flag Leaf Width	No of spikelets per Panicle	Days to maturity	Biological yield	Harvest Index	Test weight	Grain Yield/ Plant
Days to 50% Flowering	1.00	-0.10	-0.009	0.003	0.30**	-0.15	0.21*	0.31**	0.79***	0.29**	0.80	0.01	0.278*
Plant Height		1.00	0.05	0.59	0.21	0.44**	0.46**	0.70	-0.07	0.22*	0.008	0.065	0.186
No of Tillers/ plant			1.00	0.92**	0.20	0.10	0.02	0.15	0.41	0.03	0.24*	-0.13	0.140
No of Panicles/ Plant				1.00	0.10	0.07	-0.01	0.20	0.08	0.08	0.27*	-0.17	0.187
Panicle Length (cm)					1.00	0.14	0.23*	0.207	0.202	0.209	0.208	-0.88	0.284**
Flag Leaf Length						1.00	0.46**	0.14	-0.03	-0.07	-0.14	-0.63	-0.127
Flag Leaf Width							1.00	0.20	0.34**	0.03	-0.14	-0.21*	-0.106
No of spikelets per Panicle								1.00	0.33**	0.38**	0.03	-0.21*	0.332**
Days to maturity									1.00	0.14	0.02	-0.14	0.009
Biological yield										1.00	0.11	0.10	0.855
Harvest Index											1.00	0.13	0.603
Test weight												1.00	0.175
Grain Yield/ Plant													1.00

**Table.4** Correlation coefficient between yield and its components characters in rice genotypes at genotypic level

Character	Days to 50% Flowering	Plant Height	No of Tillers/ plant	No of Panicles/ Plant	Panicle Length	Flag Leaf Length	Flag Leaf Width	No of spikelets per Panicle	Days to maturity	Biological yield	Harvest Index	Test weight	Grain Yield/ Plant
Days to 50% Flowering	1.00	-0.182	-0.016	-0.031	0.424	-0.172	0.309**	0.351	0.889	0.337**	0.164	0.017	0.348
Plant Height		1.00	0.195	0.186	0.136	0.615	0.536	0.084	-0.081	0.282**	0.025	0.149	0.242*
No of Tillers/ plant			1.00	0.998	0.148	0.293**	0.178	0.228*	0.046	-0.008	0.452	-0.214*	0.188
No of Panicles/ Plant				1.00	0.264*	0.222*	0.215*	0.265*	0.090	0.080	0.478	-0.246*	0.271*
Panicle Length (cm)					1.00	0.13	0.146	0.275**	0.255*	0.304**	0.426	0.238	0.445
Flag Leaf Length						1.00	0.563	0.180	-0.056	-0.100	-0.211*	-0.081	-0.165
Flag Leaf Width							1.00	0.247*	0.412	-0.033	-0.194	-0.234*	-0.119
No of spikelets per Panicle								1.00	0.342**	0.397	0.037	-0.242*	-0.347
Days to maturity									1.00	0.148	-0.025	-0.134	0.103
Biological yield										1.00	0.171	0.119	0.886
Harvest Index											1.00	-0.122	0.602
Test weight												1.00	0.170
Grain Yield/ Plant													1.00

**Table.5** Estimation of path coefficient at phenotypic level for 13 quantitative characters with grain yield in rice genotypes

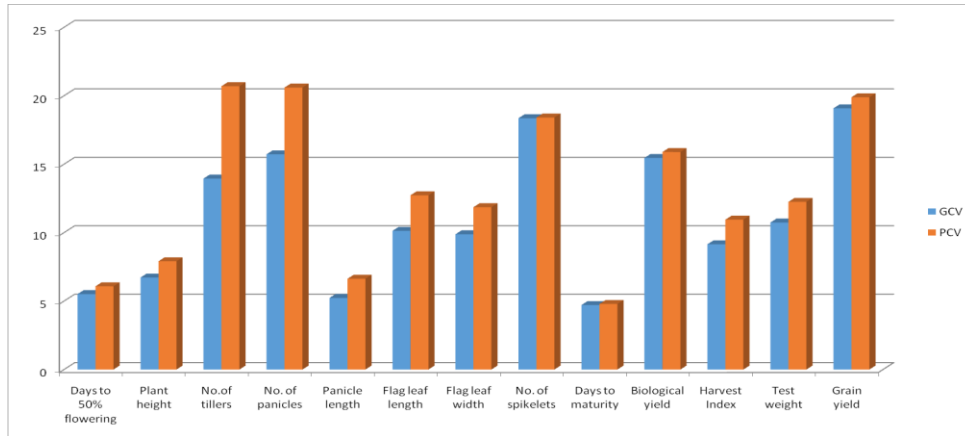
Character	Days to 50% Flowering	Plant Height	No of Tillers/ plant	No of Panicles/ Plant	Panicle Length	Flag Leaf Length	Flag Leaf Width	No of spikelets per Panicle	Days to maturity	Biological yield	Harvest Index	Test weight	Grain Yield/ Plant
Days to 50% Flowering	<b>-0.028</b>	0.005	0.0005	-0.0009	-0.012	0.004	-0.008	-0.009	-0.025	-0.009	-0.0004	-0.0005	0.348
Plant Height	0.006	<b>-0.033</b>	-0.006	-0.006	-0.004	-0.020	-0.017	-0.002	0.002	-0.009	-0.0009	-0.005	0.246
No of Tillers/ plant	-0.0007	0.008	<b>0.041</b>	0.041	0.006	0.012	0.007	0.009	0.002	-0.003	0.018	-0.009	0.188
No of Panicles/ Plant	-0.002	-0.014	-0.075	<b>-0.075</b>	-0.020	-0.016	-0.016	-0.020	-0.006	-0.006	-0.036	0.018	0.271
Panicle Length	-0.002	-0.0008	-0.0009	-0.001	<b>-0.005</b>	-0.008	-0.008	-0.001	-0.001	-0.001	-0.002	-0.001	0.445
Flag Leaf Length	-0.005	0.020	0.009	0.007	0.004	<b>0.032</b>	0.018	0.005	-0.001	-0.003	-0.006	-0.002	-0.165
Flag Leaf Width	0.005	0.009	0.003	0.003	0.002	0.09	<b>0.017</b>	0.004	0.007	-0.006	-0.003	-0.004	-0.119
No of spikelets per Panicle	0.006	0.001	0.004	0.004	0.004	0.003	0.004	<b>0.018</b>	0.006	0.007	0.0007	-0.004	0.347
Days to maturity	0.012	-0.001	0.0006	0.001	0.003	-0.008	0.005	0.004	<b>0.013</b>	0.002	-0.0004	-0.001	0.103
Biological yield	0.278	0.231	-0.0068	0.066	0.249	-0.082	-0.027	0.326	0.122	<b>0.821</b>	0.140	0.097	0.886
Harvest Index	0.081	0.012	0.223	0.236	0.210	-0.10	-0.096	0.018	-0.012	0.084	<b>0.494</b>	0.060	0.602
Test weight	0.0004	0.003	-0.004	-0.005	0.005	-0.001	-0.005	-0.005	-0.003	0.002	0.002	<b>0.022</b>	0.170

**Table.6** Estimation of path coefficient at genotypic level for 13 quantitative characters with grain yield in rice genotypes

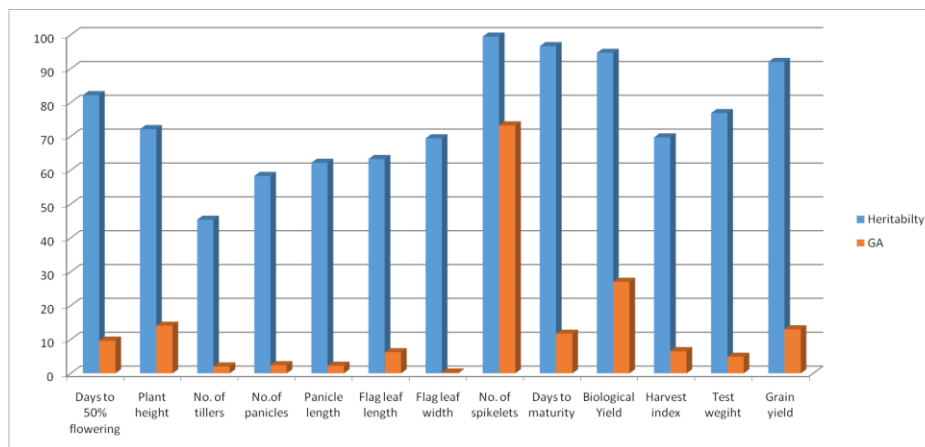
Character	Days to 50% Flowering	Plant Height	No of Tillers/ plant	No of Panicles/ Plant	Panicle Length	Flag Leaf Length	Flag Leaf Width	No of spikelets per Panicle	Days to maturity	Biological yield	Harvest Index	Test weight	Grain Yield/ Plant
Days to 50% Flowering	<b>-0.028</b>	0.005	0.0005	-0.0009	-0.012	0.004	-0.008	-0.009	-0.025	-0.009	-0.0004	-0.0005	0.348
Plant Height	0.006	<b>-0.033</b>	-0.006	-0.006	-0.004	-0.020	-0.017	-0.002	0.002	-0.009	-0.0009	-0.005	0.246
No of Tillers/ plant	-0.0007	0.008	<b>0.041</b>	0.041	0.006	0.012	0.007	0.009	0.002	-0.003	0.018	-0.009	0.188
No of Panicles/ Plant	-0.002	-0.014	-0.075	<b>-0.075</b>	-0.020	-0.016	-0.016	-0.020	-0.006	-0.006	-0.036	0.018	0.271
Panicle Length	-0.002	-0.0008	-0.0009	-0.001	<b>-0.005</b>	-0.008	-0.008	-0.001	-0.001	-0.001	-0.002	-0.001	0.445
Flag Leaf Length	-0.005	0.020	0.009	0.007	0.004	<b>0.032</b>	0.018	0.005	-0.001	-0.003	-0.006	-0.002	-0.165
Flag Leaf Width	0.005	0.009	0.003	0.003	0.002	0.09	<b>0.017</b>	0.004	0.007	-0.006	-0.003	-0.004	-0.119
No of spikelets per Panicle	0.006	0.001	0.004	0.004	0.004	0.003	0.004	<b>0.018</b>	0.006	0.007	0.0007	-0.004	0.347
Days to maturity	0.012	-0.001	0.0006	0.001	0.003	-0.008	0.005	0.004	<b>0.013</b>	0.002	-0.0004	-0.001	0.103
Biological yield	0.278	0.231	-0.0068	0.066	0.249	-0.082	-0.027	0.326	0.122	<b>0.821</b>	0.140	0.097	0.886
Harvest Index	0.081	0.012	0.223	0.236	0.210	-0.10	-0.096	0.018	-0.012	0.084	<b>0.494</b>	0.060	0.602
Test weight	0.0004	0.003	-0.004	-0.005	0.005	-0.001	-0.005	-0.005	-0.003	0.002	0.002	<b>0.022</b>	0.170



**Fig.1** Histogram depicting GCV & PCV for 13 quantitative characters of rice genotypes



**Fig.4.2** Histogram depicting Heritability and Genetic advance for 13 quantitative characters of rice genotypes



**Fig.3** Phenotypic path diagram for grain yield per plant for 13 quantitative characters

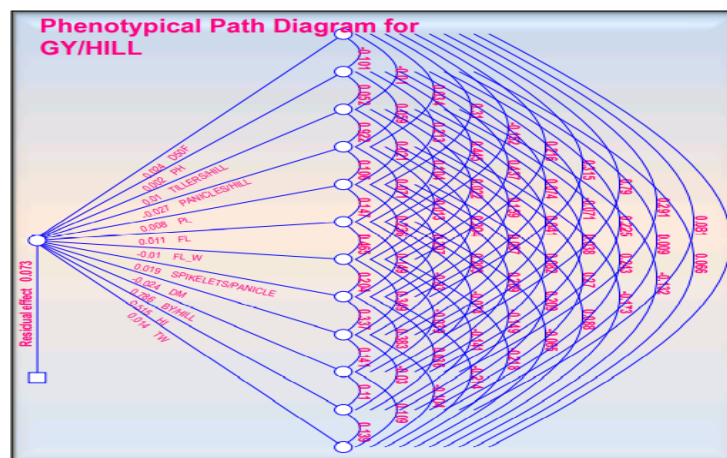
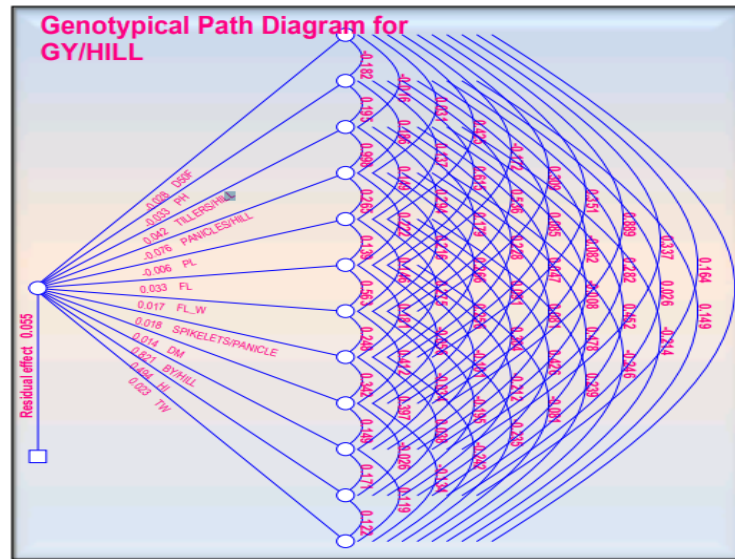


Fig.4 Genotypic path diagram for grain yield per plant for 12 quantitative characters



High estimates of Heritability coupled with moderate to low values of Genetic advance as per cent mean were observed for number of spikelets per panicle followed by days to maturity, biological yield, grain yield per hill and days to 50% flowering suggesting that there was preponderance of additive gene action for the expression of these characters.

**Correlation coefficient analysis**

In table 3 & 4 it is revealed that genotypic correlation coefficients were higher in magnitude than phenotypic correlation coefficients in the same direction and magnitude indicated that there is a strong inherent association between each pair of characters which might be due to masking or modifying effect of the environment. Correlation coefficient analysis at genotypic level revealed that plant height followed by number of panicles showed positive and significant correlation with grain yield per hill. The negative correlation with grain yield was reported for flag leaf length followed by flag leaf width. Correlation coefficient analysis at phenotypic level revealed that panicle length followed by days to 50%

flowering and number of spikelets per panicle showed positive and significant correlation with grain yield per hill. The negative and non significant correlation was reported for flag leaf length followed by flag leaf width. In the present investigation the related findings were carried out by Singh *et al.*, (2018), Srikanth *et al.*, (2017), Srujana *et al.*, (2017), Srilakshmi *et al.*, (2018), Tefera *et al.*, (2017), Vijaya *et al.*, (2016), Vincent *et al.*, (2017), Rashid *et al.*, (2017), Roy *et al.*, (2015) and Vinoth *et al.*, (2016).

**Path coefficient analysis**

In table 5 & 6 path coefficient revealed that the highest positive direct effect towards grain yield/plant was observed for plant height followed by number of panicles showed negative significant direct effect on grain yield per plant whereas biological yield, harvest index, number of tillers, flag leaf length, flag leaf width, day to maturity, harvest index and test weight at genotypic level. Path analysis at phenotypic level indicated that number of spikelets per panicle followed by panicle length showed positive significant direct effect on grain yield per hill

whereas days to 50% flowering followed by plant height, number of tillers, flag leaf length, biological yield, harvest index and test weight showed positive direct effect on grain yield per hill. From the path analysis these characters may serve as effective selection parameters in direct breeding program for yield improvement in rice.

It is concluded that among 29 genotypes of rice on the basis of mean performance IRRI-156 was found to be superior in grain yield per hill over the check variety followed by TP-30441 and NDR-1045 showed higher yield over the check. In days to 50% flowering OM-6070 is the earliest and CT-18148-6-9-5-1-2MMP is recorded as longest duration for days to 50% flowering for genotypes studied. Based on the mean performance, plant height is high for TP-30439 and low for CT-18148-6-9-S-4. For Days to maturity OM-6070 is the earliest and CT-18148-6-9-5-1-2MMP is the longest duration of days to maturity. For test weight the highest test weight is recorded for IRRI-181 and the lowest test weight test weight is depicted by IRRI-123 for genotypes studied. High to moderate estimates of GCV and PCV were recorded for grain yield per hill followed by number of spikelets per panicle, biological yield, test weight and flag leaf length. High estimates of Heritability coupled with moderate to low values of Genetic advance as per cent mean was observed for number of spikelets per panicle followed by days to maturity, biological yield, grain yield per hill and days to 50% flowering suggesting that there was preponderance of additive gene action for the expression of these characters. Grain yield indicated significant positive correlation with days to 50% flowering followed by panicle length, number of spikelets per panicle in terms of phenotypic correlation coefficient whereas in terms of genotypic coefficient grain yield per hill showed positive and significant correlation

with number of panicle and plant height. Path coefficient analysis showed positive significant direct effects on grain yield per hill were exhibited by plant height and number of panicles at genotypic level whereas it showed positive and significant direct effect for panicle length and number of spikelets per panicle at phenotypic level. Therefore, they seem to be primary yield contributing character and thus can be used as direct selection to improve genetic yield potential of rice.

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