Original Research Article

Assessment of Genetic Variability for Yield andYield Contributing Characters in Rice (*Oryza sativa* L.)

ABSTRACT

The study was conducted at the Department of Genetics and Plant Breeding, Patuakhali Science and Technology University, Bangladesh during the period from April 2018 to August 2018 to study variability, heritability, genetic advance, theinterrelationship among 14 important characteristics among the15 popular rice genotypes of Bangladesh. Significant variation in plant height of BRRI dhan43, in 50% flowering BRRI dhan42 and BRRI dhan43, for days to maturity BRRI dhan42 and BRRI dhan43, for number of unfilled grain per panicleBRRI dhan48, for flag leaf length Lakhi Lata, for flag leaf width LoharGura, for panicle plant^{-1} BRRI dhan27, for number of filled grain per panicleKalo Jamvi, number of filled grain per panicleLakhi Lata, for 100-grain weight BRRI dhan48, for yield plant^{-1} BRRI dhan48 were found. Besides, yield per plant and 100-grain weight showed high genotypic and phenotypic co-efficient of variation while other characters showed moderate genotypic and phenotypic co-efficient of variation, except days to 50% flowering, days to maturity, panicle length, flag leaf length, flag leaf width, dry matter, and harvest index. All but, plant height and spikelet per panicle, all other characters studied in this experiment showed high heritability and high genetic advance in percent of themean. Panicle per plant, no. of filled grain, 100-seed wt., and harvest index are positively correlated. Yield per plant is also significantly and positively correlated with flag leaf length at the genotypic level but non-significant at thephenotypic level. Grain yield showed anon-significant positive association with flag leaf widthandpanicle length. The above information suggests that yield per plant would increase with theincrease of these characteristics. Path co-efficient analysis suggested that flag leaf length, panicle per plant, and flag leaf width showed moderate to low direct effect but 100-seed weight showed thehighest positive direct effect toward yield per plant. Plant height showed a low negative direct effect on grain yield per plant while days to maturity, panicle length, no. of filled grain, no. of unfilled grain per panicle, anddry matter had considerable negative direct effect on grain yield per plant and showed a negligible indirect effect.Thus, selection based on maturity period, number of panicles per plant, panicle length, and higher number of filled grains per panicle might be effective for improving theyield of rice.

Keywords: Oryza sativa, yield, south Asia, heritability

1. INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important cereal crops of the world meeting the dietary requirements of the people living in the tropics and sub-tropics. It is the main source of calories for almost 40% of the world's population (Hoffman, 1991). It is most strongly associated with the South, Southeast, and East Asian countries, extending from Pakistan to Japan. Of the 26 major rice-producing countries that account for 96% of global production, 18 are located within the region. Rice continues to be the major source of livelihood, especially in rural areas, and the main staple food of the population. In most Asian countries, therefore, thegovernment development agenda has always been geared toward achieving self-sufficiency in rice. Among the major cereal crops, rice is unique, it can be grown in a wide range of agroecological conditions. Rice is avery versatile tropical and sub-tropical or warm season temperate crop and is cultivated in 111 countries of all continents, from 53°N to 40°S latitude and from sea level to over 3000 m in the Himalayas (Lu and Chang, 1980). Rice is a semi-aquatic plant and can grow successfully in standing water. Rice cultivation appears to be limited to those areas where the annual rainfall exceeds 1000 mm (Yoshida, 1983). In Bangladesh, rice is grown in three overlapping seasons and farmers use a large number of varieties that fit various agroecological and climatic niches (Hossain, 1998). And farmers grow four distinct kinds of rice varieties: namely Aus, Deepwater Aman, Transplant Aman, and Boro (Rashid, 1994).

Rice is the leading cereal globally and a staple food crop in Bangladesh. Over 90% of Myanmar, Sri Lanka, Vietnam, Cambodia, and Bangladesh rely on rice as their primary food source (IRRI, 1981). For many farmers in Bangladesh, rice is the sole cash income (BARC, 1983). In 1994-95, rice covered approximately 74.35% of the total cropped area (BBS, 1996). Bangladesh imports 11,600 m tons of rice annually to meet its demand (BBS, 1999). At the beginning of the 21st century, total rice production was about 590 million tons, a significant increase compared to the late 1970s (FAO, 2013). Bangladesh ranks fourth in acreage and production (FAO, 2013) and 39th in yield among rice-growing countries (IRRI, 1995). The national average yield in Bangladesh is 2.3 tons ha^{-1}, much lower than inother countries like Japan, Korea, and Australia (Karim, 1992).

Rice plays a vital role in Bangladesh's agro-economy and national health. Per capita, rice consumption is estimated at 153.4 kg $year^{-1}$ (BBS, 1998), covering 94% of cereals consumed in the country (Rashid, 1994). However, rice lacks beta-carotene, leading to vitamin A deficiency in populations dependent on rice as a staple food. Researchers have developed a modified grain with sufficient beta-carotene to address this issue (Swiss Federal Institute of Technology).Rice production in Bangladesh faces challenges due to variable monsoon rainfall. The country's average rice yield is 2852 kg ha^{-1}, lower than the Asia average of 3906 kg ha^{-1} (FAO, 1999). Despite a growth rate of 1.8% in rice production from 1985 to 1995, population growth at 2% per year poses difficulties in overcoming food demands (Hossain, 1998). Therefore, the introduction and development of high-yielding rice varieties are crucial for increasing production (Patwary, 1991).

Yield is the complex end product of many factors that jointly or singly influence the seed yield (Chowdhury et al. 1994). Rice yield is dependent on many important characteristics as well as on environmental influence (Das, et al. 1992). For yield improvement, it is essential to have knowledge ofthegenetic variability of different characters. Knowledge of the nature and magnitude of genetic variation governing the inheritance of quantitative characteristics like yield and its components is essential for effecting genetic improvement. A critical analysis of genetic variability is a prerequisite for initiating any crop improvement program and for adopting appropriate selection techniques. The variability of a biological population is an outcome of thegenetic constitution of the individuals making up that population in relation to theprevailing environment. A survey of genetic variability with the help of suitable parameters such as genotypic co-efficient of variation, habitability, and genetic advance is necessary to start an efficient breeding program (Mishra et al. 1988).

The yield of high-yielding rice varieties has reached a certain level, about 5 tons ha^{-1} (Saha et al. 1989). Yield contributing characters are to be emphasized to overcome that level. Thus, the study of character is also essential for ascertaining their contribution towards yield. Direct and indirect effects of yield contributing characters on yield are also important in selecting high-yielding genotypes. Path co-efficient analysis is used to detect characters having direct and indirect effects on yield. Several studies had been reported on variability (Singh et al. 1986; Maurya et al. 1986; Das and Miah, 1991 and Mehetre et al. 1994) and characters association (Thiagarajan, 1989 and Bashar et al. 1991).

The present study was conducted to estimate and analyze the performance of 15 rice genotypes concerning yield and yield-contributing characters. Additionally, the study aimed to evaluate the interrelationship between yield and various yield-contributing characters. The ultimate goal was to identify the most promising genotypes for potential utilization in future agricultural endeavors.

2. MATERIAL AND METHODS

2.1 Experimentation

The experiment was conducted at the rooftop of the Department of Genetics and Plant Breeding, Patuakhali Science and Technology University, Dumki, Patuakhali, during the period from April to August 2018 in ‘Chari’(22cm) under irrigated conditions. The experimental site belongs to the sub-tropical monsoon climate and is characterized by elevated temperature and heavy rainfall during ~~the months of~~ April to August and scant~~ly~~ rainfall associated with moderate low temperature during the rest period of the year. The soil of the experimental area was silty loam in texture belonging to the Gangas Flood Plain of AEZ 13 having non-calcareous dark grey floodplain soil. The selected area was medium-high land. It was fertile, well-drained, and slightly acidic with the pH varying from 5.5 to 6.8 (BARC, 1989). The experiment was laid out in a Completely Randomized Design (CRD) with three replications. Seeds of fifteen rice genotypeswere sown on March 10, 2018, followed by transplantation at the rate of 2 seedling $hill^{-1}$ in the main plot when they were 32 days old maintaining plant-to-plant distances of 15 cm. The Chari were made by earthen, containing 2-3 aeration holes at thebottom for removal of excess water. A totalof45 experimental pots were filled with soil & well decompose cow dung at the ratio of 2:1. Urea, Triple super phosphate (TSP), Muriate of potash (MP), and Gypsum were applied at the rate of 150, 100, 70 and 60 kg ha^{-1}, respectively. One-third of the urea and theentire TSP. MP and Gypsum were applied during the final land preparation. The remainingtwo-thirds of the urea was applied in two splits, one at 10 days after transplanting and the other before panicle initiation. Two weeding were done and only one irrigation was given. The other intercultural operations of exigent nature were done as and when needed.

The crops were protected from the attack of insect pests by spraying diaginon @ 2ml per liter. Harvesting wasstarted when 80% of the plant population of each “chari” reached at maturity.

2.2 Data recording

Data were recorded on anindividual hill basis from each hill from each ‘chari’ (pot). Data on days to 50% flowering, plant height, and days to maturity (80%) were recorded in the field and the remaining i.e. length of flag leaf, thewidth of flag leaf, number of panicles/plant, panicle length, number of filled grain/panicle, 100-grain weight, and yield/plant were recorded in the laboratory after harvesting.

2.3 Statistical analyses

Analysis of variance was done for all the characters under study using the mean values (Singh and Chaudhury, 1985). Duncan's Multiple Range Test (DMRT) was used for all the characters to test the difference between the means of the genotypes following Steal and Torrie (1960).
Genotypic and phenotypic variances were estimated according to the formula given by Johnson et al. (1955). Genotypic and phenotypic co-efficient of variation were estimated according to Burton, 1952; Singh and Chaudhury, 1985. Heritability in abroad sense was estimated using the formula suggested by Johnson et al. (1955) and Hanson, et al. (1956). Expected genetic advance under selection was estimated using the formula suggested by Johnson et al. (1955). Genetic advance in percent of mean was calculated as proposed by Comstock and Robinson (1952). Genotypic and phenotypic correlation coefficients were estimated using the formula suggested by Johnson et al. 1955; Miller et al. 1958; Singh and Chaudhury, 1985.The components of thecorrelation coefficient of different yield attributes with grain yield hill^{-1} were partitioned into components of direct and indirect effects by path coefficient analysis. Path co-efficient analysis was done according to the procedure stated by Singh and Chaudhury (1985) and Dabholkar (1992) was originally suggested by Dewy and Lu (1959).In the present study, yield hill^{-1} was considered as theresulting characters (effect), and the yield attributes were considered as the causal factors.
The following sets of simulators equations were used depending on the cause-and-effect relationship-

$r_{1Y} = P_{1y} + r_{1.2}P_{2y} + r_{1.3}P_{3y} + r_{1.4}P_{4y} + r_{1.5}P_{5y} + r_{1.6}P_{6y} + r_{1.7}P_{7y} + \ldots + r_{1.14}P_{14y}$

$r_{2Y} = r_{2.1}P_{1y} + P_{2y} + r_{2.3}P_{3y} + r_{2.4}P_{4y} + r_{2.5}P_{5y} + r_{2.6}P_{6y} + r_{2.7}P_{7y} + \ldots\ldots + r_{2.14}P_{14y}$

$r_{3Y} = r_{3.1}P_{1y} + r_{3.2}P_{2y} + P_{3y} + r_{3.4}P_{4y} + r_{3.5}P_{5y} + r_{3.6}P_{6y} + r_{3.7}P_{7y} + \ldots\ldots + r_{3.14}P_{14y}$

$r_{4Y} = r_{4.1}P_{1y} + r_{4.2}P_{2y} + r_{4.3}P_{3y} + P_{4y} + r_{4.5}P_{5y} + r_{4.6}P_{6y} + r_{4.7}P_{7y} + \ldots\ldots + r_{4.14}P_{14y}$

$r_{5Y} = r_{5.1}P_{1y} + r_{5.2}P_{2y} + r_{5.3}P_{3y} + r_{5.4}P_{4y} + P_{5y} + r_{5.6}P_{6y} + r_{5.7}P_{7y} + \ldots\ldots + r_{5.14}P_{14y}$

$r_{6Y} = r_{6.1}P_{1y} + r_{6.2}P_{2y} + r_{6.3}P_{3y} + r_{6.4}P_{4y} + r_{6.5}P_{5y} + P_{6y} + r_{6.7}P_{7y} + \ldots\ldots + r_{6.14}P_{14y}$

$r_{7Y} = r_{7.1}P_{1y} + r_{7.2}P_{2y} + r_{7.3}P_{3y} + r_{7.4}P_{4y} + r_{7.5}P_{5y} + r_{7.6}P_{6y} + P_{7y} + \ldots\ldots + r_{7.14}P_{14y}$

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$R_{14Y} = r_{14.1}P_{1y} + r_{14.2}P_{2y} + r_{14.3}P_{3y} + r_{14.4}P_{4y} + r_{14.5}P_{5y} + r_{14.6}P_{6y} + r_{14.7}P_{7y} + \ldots\ldots + P_{7y}$

where,
r_{iy} = genotypic correlation co-efficient between y and ith character(i- 1, 2, 3…… 14)
P_{iy} = Path co-efficient due to ith character (i = 1, 2, 3……..14)
Total genotypic correlation say, between 1 and y, i.e. r_{1y} was thus partitioned as follows-

$r_{1Y} = P_{1y} + r_{1.2}P_{2y} + r_{1.3}P_{3y} + r_{1.4}P_{4y} + r_{1.5}P_{5y} + r_{1.6}P_{6y} + r_{1.7}P_{7y} + \ldots\ldots\ldots + r_{1.14}P_{14y}$

P_{1y} = the direct effect of 1 on y
$r_{1.2}P_{2y}$ = the indirect effect of 1 via 2 on y
$r_{1.3}P_{3y}$ = the indirect effect of 1 via 3 on y
$r_{1.4}P_{4y}$ = the indirect effect of 1 via 4 on y
$r_{1.5}P_{5y}$ = the indirect effect of I via 5 on y
$r_{1.6}P_{6y}$ = the indirect effect of 1 via 6 on y
$r_{1.7}P_{7y}$ = the indirect effect of 1 via 7 on y
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$r_{1.14}P_{14y}$ = the indirect effect of 1 via 14 on y
After calculating the direct and indirect effects of the characters, residual effect (R) was calculated using the following formula (Singh and Chaudhury, 1985):

$$P_{RY}^2 = 1 - \sum p_{iy} r_{iy}$$

where,
$P^2_{RY} = R_2$
P_{iy} = direct effect of the characters on yield
r_{iy} = correlation co-efficient of the characters with yield
Therefore,

$$\text{Residual effect} = \sqrt{p_{RY}^2} = \sqrt{1 - \sum p_{iy} r_{iy}}$$

3. RESULTS

3.1 Genotypic performance

Significant variations were observed among the rice genotypes for all studied traits. The genotypes were generally of medium to tall stature. BRRI dhan 43 was the shortest, similar to BRRI 42. Lemma was the tallest, similar to Matiya and Ratul. Lemma took the longest time for 50% flowering, similar to Kalo Jamvi, Boilla, and Mari Dhan. BRRI 42 and BRRI 43 flowered earlier than others. Kalo Sathi, LoharGura, Munsi Murali, and Ratul had a medium flowering duration. Flag leaf length showed a wide range, with Lakhi Lata having the longest, and Lemma and BRRI 42 having the shortest. Flag leaf width didn't very much, with LoharGura being the broadest and Lemma the narrowest. Days to maturity also varied widely, with BRRI 42 and BRRI 43 maturing earliest. Mari Dhan was late-maturing, similar to Lemma, Boilla, Matiya, Lakhi Lata, and Kalo Jamvi. Panicle length didn't show significant variation, with Lakhi Lata and Kalo Jamvi having the longest, and BRRI 42 and Lemma the shortest, similar to Parija. Kalo Jamvi had the highest number of Spikelet panicle^{-1}, while Lemma had the least. BRRI 27 had the highest Panicle plant^{-1}, while Lakhi Lata had the least. Kalo Jamvi produced the most filled grain panicle^{-1}, similar to Lakhi Lata. Lemma produced the fewest filled grain panicle^{-1}. Lakhi Lata had the highest number of unfilled grain panicle^{-1}, significantly different from others. BRRI 48 had the lowest unfilled grain panicle^{-1}. The highest 1000-grain weight was observed in BRRI 48, similar to Lakhi Lata, LoharGura, Kalo Jamvi, Munsi Murali, and BRRI 42. Mari Dhan had the lowest 1000-grain weight, similar to BRRI 48, Lemma, Parija, and Ratul. BRRI 48 had the highest yield plant^{-1}, while Mari Dhan had the lowest, similar to Lemma, LoharGura, Munsi Murali, Parija, and Ratul. Lakhi Lata and Parija had the highest dry matter plant^{-1}, similar to most genotypes. BRRI 42 had the lowest dry matter plant^{-1}, similar toBoilla. BRRI 42 had the highest harvest index, not significantly different from BRRI 48. Mari Dhan had the lowest harvest index, followed by Parija, Ratul, LoharGura, Munsi Murali, Lakhi Lata, and Matiya, not significantly different from each other. All of these are presented in table 1.

3.2 Variability and character association

3.2.1 Variability, Heritability, and Genetic Advance

The genotypic (σ^2g), phenotypic (σ^2p) and environmental variance (σ^2e), genotypic co-efficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability in thebroad sense (h^2b %), genetic advance (GA) and genetic advance in percent of themean (GA %) for all the quantitative characters under study are presented in table 4. The PCV were higher than their corresponding GCV for all the characters studied indicating that they all interacted with the environment with some intent. Results revealed that thehighest GCV and PCV were found in no unfilled grain per panicle while thelowest GCV and PCV were showed by 1000 grain weight and dry matter, respectively. The value of GA ranged from 12.19% to 76.41% where minimum and maximum values wererepresented by the character of dry matter and no unfilled grain per panicle. The studied characters showed medium to high heritability. However, flag leaf width showed high heritability (.588) and low genetic advance (28.40%) in percent of themean, indicating non-¬additive genetic control of these characters.

3.2.2 Correlation study

Table 3 displays genotypic and phenotypic correlation coefficients for yield and yield-contributing characters in rice. Genotypic coefficients were generally higher, indicating a strong inherent relationship among the characters, while lower phenotypic coefficients suggested environmental influences. Grain yield plant^{-1} significantly correlated with panicle plant^{-1}, filled grains, 1000-seed weight, and harvest index. Days to 50% flowering showed a significant correlation with days to maturity but not with plant height, unfilled grains panicle^{-1}, or dry matter. Harvest index, yield plant^{-1}, and panicle plant^{-1} had non-significant negative correlations with the number of panicle plant^{-1}. At the genotypic level, days to maturity positively correlated with plant height, days to 50% flowering, and unfilled grains panicle^{-1} but negatively correlated with harvest index, yield plant^{-1}, and panicle plant^{-1}. Phenotypically, plant height, days to 50% flowering, and unfilled grains panicle^{-1} showed positive correlations, while harvest index, yield plant^{-1}, and panicle plant^{-1} showed negative correlations with days to maturity. Plant height significantly correlated with days to 50% flowering, days to maturity, and dry matter. Genotypically, harvest index, yield (g plant^{-1}), filled grains, and 1000-seed weight had negative correlations. The number of panicle plant^{-1} significantly and negatively correlated with days to 50% flowering, flag leaf length, flag leaf width, days to maturity, panicle length, spikelet panicle^{-1}, filled grains, unfilled grains panicle^{-1}, and dry matter. Panicle length significantly correlated with flag leaf length, flag leaf width, spikelet panicle^{-1}, filled grains, unfilled grains panicle^{-1}, 1000-seed weight, and dry matter. Previous studies (Mohammad et al., 1980; Cheema et al., 1998) found significant positive correlations between panicle length and filled grains panicle^{-1}. Spikelet panicle^{-1} significantly correlated with flag leaf length, flag leaf width, panicle length, filled grains, unfilled grains panicle^{-1}, 1000-seed weight, and dry matter, while panicle plant^{-1} showed a negative genotypic correlation. Unfilled grains panicle^{-1} exhibited significant negative correlations with panicle plant^{-1}, while days to 50% flowering, flag leaf length, days to maturity, panicle length, spikelet panicle^{-1}, filled grains, and dry matter had positive correlations. Moreover, 1000-seed weight significantly correlated with flag leaf length, panicle length, spikelet panicle^{-1}, filled grains, harvest index, and yield (g plant^{-1}). Plant height and dry matter had negative genotypic correlations. Dry matter significantly and negatively correlated with panicle plant^{-1}, 1000-seed weight, harvest index, and yield (g plant^{-1}). However, plant height, days to 50% flowering, days to maturity, and unfilled grains panicle^{-1} showed positive correlations at the genotypic level. Lastly, theharvest index significantly correlated with panicle plant^{-1}, 1000-seed weight (g), and yield (g plant^{-1}). Genotypically, plant height, days to 50% flowering, days to maturity, and dry matter showed negative correlations with harvest index.

Table 1: Mean performance of 15 rice genotypesconsidering 14 important characters.

**, *, ns denotes significant at 1% level of significance, significant at 5% level of significance, and non-significant respectively.

Variety	Plant height (cm)	Days to 50% flowering	Flag leaf length (cm)	Flag leaf width (cm)	Days to maturity	Panicle length (cm)	Spikelet panicle^{-1}	Panicle plant^{-1}	Number of filled grain panicle^{-1}	Number of unfilled grainspanicle^{-1}	1000 seed wt. (g)	Yield plant^{-1}(g)	Dry matter plant^{-1}(g)	Harvest index
BRRI 27	141.3 b	83.00 f	28.78 bc	1.111 b	114.7 d	22.56 b	67.56 b-d	13.33 a	52.33 b-d	15.22 cd	18.48 b-e	12.81 b	21.47 ab	0.5975 bc
BRRI 42	102.0 g	66.00 h	17.89 d	1.000 b	100.3 f	16.44 f	64.78 cd	11.00 c	51.00 c-e	13.78 cd	20.76 a-c	11.62 bc	15.45 c	0.7523 a
BRRI 43	101.7 g	68.67 h	29.56 bc	1.222 ab	101.3 f	21.78 bc	76.78 b	11.33 c	60.67 b	16.11 cd	16.25 ef	11.09 cd	25.04 ab	0.4463 de
BRRI 48	108.7 f	79.67 g	30.78 b	1.000 b	109.7 e	21.11 b-d	69.67 b-d	12.33 b	60.67 b	9.000 d	22.03 a	16.41 a	25.25 ab	0.6502 ab
Boilla	117.7 e	114.3 a-c	30.33 b	1.316 ab	145.3 ab	20.22 c-e	76.44 b	8.333 e-g	58.33 bc	18.11 c	19.43 bc	9.407 d-f	19.86 a-c	0.4978 cd
Kalo Jamvi	123.5 de	115.7 ab	29.78 bc	1.333 ab	144.0 a-c	26.00 a	108.3 a	7.333 gh	76.67 a	31.67 b	19.59 a-c	10.99 cd	23.29 ab	0.4798 d
Kalo Sathi	129.3 cd	102.0 e	24.56 bc	1.111 b	141.7 bc	20.44 b-e	68.67 b-d	9.000 e	54.67 b-d	14.00 cd	18.91 b-d	9.334 d-f	22.40 ab	0.4177 de
Lakhi Lata	131.1 c	112.0 c	36.78 a	1.167 ab	143.7 a-c	26.00 a	114.3 a	6.667 h	74.00 a	40.33 a	20.91 ab	10.22 cd	26.32 a	0.3910 d-f
Lemma	150.7 a	116.0 a	13.33 d	0.500 c	145.7 ab	16.89 f	59.33 d	11.33 c	42.33 e	17.00 cd	16.18 ef	7.751 fg	19.18 bc	0.4136 de
LoharGura	141.7 b	103.3 e	25.44 bc	1.444 a	141.7 bc	21.00 b-d	67.22 b-d	7.667 fg	56.33 b-d	10.89 cd	19.55 a-c	8.397 e-g	24.89 ab	0.3357 ef
Mari Dhan	139.8 b	113.7 a-c	26.33 bc	1.333 ab	147.0 a	21.00 b-d	73.11 bc	8.333 e-g	56.00 b-d	17.11 cd	15.43 f	7.178 g	25.40 ab	0.2888 f
Matiya	149.4 a	112.3 bc	23.89 c	1.316 ab	143.7 a-c	19.22 de	76.56 b	8.667 ef	61.00 b	15.56 cd	18.25 c-e	9.630 de	24.04 ab	0.4006 d-f
Munsi Murali	150.9 a	106.7 d	26.33 bc	1.039 b	142.3 bc	21.28 b-d	66.22 b-d	8.333 e-g	48.67 de	17.56 c	20.29 a-c	7.997 e-g	22.80 ab	0.3569 ef
Parija	141.7 b	112.3 bc	24.89 bc	1.000 b	144.7 a-c	18.44 ef	63.33 cd	10.00 d	49.33 c-e	14.00 cd	15.68 f	7.665 fg	26.34 a	0.2927 f
Ratul	149.0 a	108.7 d	26.11 bc	1.111 b	141.0 c	20.22 c-e	69.44 b-d	9.333 de	52.67 b-d	16.78 cd	1649 d-f	8.010 e-g	24.08 ab	0.3348 ef
LSD Value	6.079	3.231	5.491	0.2848	3.521	1.997	9.331	0.9520	8.145	7.103	2.244	1.564	5.484	0.1058

Figures followed by thesame letter(s) are statistically similar as per DMRT at 5%.

Table 2. Maximum, minimum, mean, standard deviation, and variance of fifteen rice genotypes for different characters.

Parameters	Plant height(cm)	Days to 50% flowering	Flag leaf length (cm)	Flag leaf width(cm)	Days to maturity	Panicle length(cm)	Spikelet/panicle	Panicle/plant	Number of filled grain	Number of unfilled grain/panicles	1000 seed wt. (g)	Dry matter(g)	Harvest index	Yield (g/plant)
Maximum	154.60	118.00	40.33	1.50	149.00	28.00	120.67	15.00	81.00	47.67	23.0	29.19	0.79	17.39
Minimum	98.00	64.00	11.67	0.50	98.00	14.67	54.33	5.00	37.00	8.00	13.8	14.49	0.24	6.59
Mean	131.89	100.96	26.32	1.13	133.78	20.84	74.79	9.53	56.98	17.81	18.5	23.05	0.44	9.90
Standard deviation	17.15	17.03	5.95	0.26	16.91	2.78	15.79	2.11	9.57	8.40	0.23	3.94	0.14	2.51
Variance	300.75	296.45	36.18	0.07	292.49	7.92	254.99	4.57	93.70	72.10	0.06	15.88	0.02	6.47
% CV	2.76%	1.57%	12.47%	15.05%	1.91%	5.73%	7.46%	12.07%	8.55%	23.85%	7.16%	14.22%	14.24%	9.44%

Table 3. Analysis of variance (mean squares) for different characters of fifteen genotypes of rice.

Parameters	df	Panicle/plant	Number of filled grain	1000 seed wt. (g)	Yield (g/plant)	Spikelet/panicle	Number of unfilled grain/panicles	Panicle length(cm)	Flag leaf length (cm)	Flag leaf width(cm)	Dry matter(g)	Harvest index	Plant height(cm)	Days to 50% flowering	Days to maturity
Replication	2	2.467	8.622	0.59	4.472	3.262	2.921	1.864	6.965	0.078	8.027	0.004	11.603	18.956	15.089
Genotype	14	11.371**	245.832	1.32	17.932	738.685	190.103	21.771	91.164	0.154	27.256*	0.054	917.129	907.698	922.089
Error	28	1.324	23.717	0.18	0.874	31.124	18.037	1.426	10.778	0.029	10.753	0.004	13.211	4.432	3.732
% CV		12.07%	8.55%	7.16%	9.44%	7.46%	23.85%	5.73%	12.47%	15.05%	14.22%	14.24%	2.76%	1.57%	1.91%

Table 4: Heritability, genetic advance, and genetic advance in thepercentage of mean in respect of 14 yield and yield contributing characters of rice.

Characters	S^2G	S^2E	S^2P	PCV	GCV	GA	% GA
Plant height(cm)	301.306	13.211	314.517	13.446	13.161	34.999	26.536
Days to 50% flowering	306.119	3.732	309.851	17.436	17.331	35.825	35.486
Flag leaf length(cm)	26.795	10.778	37.573	23.290	19.668	9.005	34.216
Flag leaf width(cm)	0.042	0.029	0.071	23.449	17.982	0.322	28.407
Days to maturity	301.089	4.432	305.521	13.066	12.971	35.485	26.525
Panicle length(cm)	6.782	1.426	8.208	13.747	12.496	4.876	23.399
Spikelet panicle^{-1}	235.854	31.124	266.978	21.849	20.536	29.735	39.761
Panicle plant^{-1}	3.349	1.324	4.673	22.675	19.197	3.192	33.478
No.of filled grain	74.038	23.717	97.756	17.353	15.102	15.426	27.074
No. of unfilled grain panicle^{-1}	57.355	18.037	75.393	48.760	42.529	13.607	76.414
1000-seed wt.(g)	0.038	0.018	0.056	12.748	10.544	0.333	17.966
Dry matter(g)	5.501	10.753	16.254	17.487	10.173	2.811	12.192
Harvest index	0.017	0.004	0.021	32.274	28.961	0.238	53.537
Yield (g plant^{-1})	5.686	0.874	6.560	25.869	24.084	4.573	46.189

$\sigma^2{}_g$ = Genotypic Variation, $\sigma^2{}_e$ = Environmental Variation, $\sigma^2{}_p$ = Phenotypic Variation, GCV =Genotypic Coefficient of Variance, GCV = Phenotypic Coefficient of Variance, GA =Genetic Advance, % GA= Genetic Advance in Percent of Mean.

3.2.3 Path co-efficient

From the results of path analysis (Table 4), it was evident that direct effects contributed by 1000 seed wt. (0.704), Days to 50% flowering (0.398), andspikelet panicle^{-1} (0.241) were high indicating that among the component traits, these three characters contributed themaximum for yield plant^{-1}. The direct effects of 1000 seed wt., Days to 50% flowering, spikelet panicle^{-1} were higher than their respective correlation co-efficient but lower for thenumber of filled grains panicle^{-1}. The indirect effect of the above three characters was not important. Thus, direct selection for these traits will be effective. Although the character, harvest index was positively correlated with yield its direct effect on grain yield plant^{-1} was negative (-0.549). It indicated that this character influenced grain yield by its indirect positive effects through days to maturity, 1000-grain weight, and panicle plant^{-1}. Plant height showed a low negative direct effect (-0.041) on grain yield plant^{-1} but the correlation coefficient was significantly negative. Flag leaf length (0.215), panicle plant^{-1} (0.139), and flag leaf width (0.043) showed moderate to low direct effect as the correlation coefficient was moderate to low for these characters. Days to maturity (-0.429), panicle length (-0.342), no. of filled grain (-0.135), no. of unfilled grain panicle^{-1} (-0.119), dry matter (-0.158) had considerable negative direct effect on grain yield plant^{-1} and showed negligible indirect effect. Therefore, the positive correlation between panicle length, no. of filled grain, and grain yield plant^{-1} may be explained by positive indirect effect via days to 50% flowering, harvest index and flag leaf width (cm), andspikelet panicle^{-1} respectively.

The residual effect was 0.496 (Fig. 1), indicating that the eight characters contributed 51% percent of the variability in yield hill^{-1} studied in path analysis. The residual effect towards grain yield in this study may be due to a variety of reasons such as causal factors (characters) not studied and sampling errors etc. Das *et al*. (1992) observed a residual effect of 0.364 indicating 64 percent of the variability in the yield plant^{-1} contributed by 8 characters studied in path analysis. The correlation and path co-efficient studies revealed that thenumber of filled grains panicle^{-1}, 1000-grain weight, days to maturity, and days to 50% flowering are the most important yield components. The present study suggested that aprolonged maturity period, higher number of panicles plant^{-1}, longer panicle length, and higher number of filled grains panicle^{-1} should be given the importance in selection of genotypes for higher grain yield in rice.

Table 5. Genotypic and phenotypic correlations between fifteen characters of 15 genotypes of rice.

Diagonal bold and underline values show heritability of respective character. Above diagonal values are genotypic correlation and below diagonal values are phenotypic correlation.

Characters	Plant height(cm)	Days to 50% flowering	Flag leaf length (cm)	Flag leaf width(cm)	Days to maturity	Panicle length(cm)	Spikelet panicle^{-1}	Panicle plant^{-1}	No. of filled grain	No. of unfilled grain panicle^{-1}	1000 seed wt.(g)	Dry matter(g)	Harvest Index	yield (g plant^{-1})
Plant height(cm)	**0.958**	0.700**	-0.271	-0.158	0.724**	-0.077	-0.196	-0.254	-0.368*	0.021	-0.412**	0.310*	-0.701**	-0.648**
Days to 50% flowering	0.682**	**0.988**	0.020	0.087	0.986**	0.169	0.265	-0.724**	0.114	0.408**	-0.290	0.359*	-0.749**	-0.689**
Flag leaf length (cm)	-0.199	0.019	**0.713**	0.668**	-0.005	0.918**	0.758**	-0.383**	0.854**	0.568**	0.424**	0.832**	-0.059	0.387**
Flag leaf width(cm)	-0.109	0.068	0.487**	**0.588**	0.133	0.576**	0.481**	-0.601**	0.660**	0.225	0.225	0.554**	-0.191	0.023
Days to maturity	0.704**	0.982**	-0.009	0.096	**0.985**	0.138	0.199	-0.768**	0.052	0.344*	-0.276	0.366*	-0.799**	-0.753**
Panicle length(cm)	-0.073	0.145	0.717**	0.400**	0.112	**0.826**	0.893**	-0.442**	0.895**	0.794**	0.338*	0.669**	-0.109	0.263
Spikelet panicle^{-1}	-0.188	0.249	0.546**	0.328	0.193	0.737**	**0.883**	-0.601**	0.956**	0.942**	0.353*	0.456**	-0.068	0.153
Panicle plant^{-1}	-0.245	-0.602**	-0.204	-0.450**	-0.643**	-0.371	-0.536**	**0.717**	-0.488**	-0.665**	-0.105	-0.468**	0.602**	0.531**
No. of filled grain	-0.325*	0.089	0.569**	0.510**	0.045	0.708**	0.896**	-0.506**	**0.757**	0.802**	0.471**	0.540**	0.061	0.372*
No. of unfilled grain panicle^{-1}	0.016	0.368**	0.379*	0.037	0.312*	0.581**	0.862**	-0.432**	0.546**	**0.761**	0.180	0.312*	-0.207	-0.112
1000 seed wt.(g)	-0.338*	-0.226	0.230	0.013	-0.221	0.259	0.264	-0.143	0.283	0.174	**0.684**	-0.323*	0.655**	0.657**
Dry matter(g)	0.155	0.221	0.407**	0.256	0.216	0.391**	0.213	-0.169	0.289	0.072	-0.077	**0.338**	-0.668**	-0.156
Harvest index	-0.640**	-0.670**	-0.064	-0.180	-0.709**	-0.139	-0.010	0.516**	0.054	-0.081	0.482**	-0.611*	**0.805**	0.839**
Yield (g plant^{-1})	-0.630**	-0.634**	0.280	-0.060	-0.691**	0.199	0.158	0.541**	0.304*	-0.049	0.541**	0.010	0.763**	**0.867**

Table 6. Partitioning of genotypic correlations into direct and indirect effects of the studied morpho–physiological and yield contributing characters as influenced by fifteen genotypes by path analysis.

Characters	Plant height(cm)	Days to 50% flowering	Flag leaf length (cm)	Flag leaf width (cm)	Days to maturity	Panicle length (cm)	Spikelet panicle^{-1}	Panicle plant^{-1}	No. of filled grain	No. of unfilled grain panicle^{-1}	1000 seed wt. (g)	Dry matter(g)	Harvest index	Yield (g plant^{-1})
Plant height(cm)	**-0.041**	0.279	-0.058	-0.007	-0.310	0.026	-0.472	-0.289	0.496	-0.318	-0.290	-0.049	0.385	-0.648
Days to 50% flowering	-0.029	**0.398**	0.004	0.004	-0.423	-0.058	0.711	-0.825	-0.132	-0.484	-0.204	-0.057	0.411	-0.689
Flag leaf length(cm)	0.011	0.008	**0.215**	0.199	0.602	-0.314	0.410	-0.437	-0.115	-0.396	0.298	-0.131	0.033	0.387
Flag leaf width(cm)	0.501	0.035	0.150	**0.043**	-0.057	-0.197	0.572	-0.685	-0.289	-0.267	0.159	-0.087	0.146	0.023
Days to maturity	-0.030	0.392	-0.001	0.006	**-0.429**	-0.047	0.479	-0.875	-0.030	-0.408	-0.195	-0.058	0.438	-0.753
Panicle length(cm)	0.400	0.673	0.197	0.025	-0.059	**-0.342**	0.215	-0.504	-0.421	-0.642	0.238	-0.106	0.586	0.263
Spikelet panicle^{-1}	0.008	0.105	0.150	0.021	-0.205	-0.306	**0.241**	-0.168	-0.129	-0.112	0.248	-0.072	0.373	0.153
Panicle plant^{-1}	0.010	-0.288	-0.082	-0.026	0.329	0.151	-0.145	**0.139**	0.085	0.689	-0.074	0.074	-0.330	0.531
No.of filled grain	0.015	0.075	0.183	0.428	-0.022	-0.306	0.630	-0.555	**-0.135**	-0.151	0.331	-0.085	-0.034	0.372
No unfilled grain panicle^{-1}	-0.001	0.162	0.122	0.010	-0.148	-0.272	0.227	-0.184	-0.108	**-0.119**	0.127	-0.049	0.114	-0.112
1000-seed wt.(g)	0.017	-0.116	0.091	0.010	0.119	-0.116	0.849	-0.120	-0.347	-0.214	**0.704**	0.142	-0.359	0.657
Dry matter(g)	-0.013	0.143	0.179	0.024	-0.157	-0.229	0.110	-0.153	-0.023	-0.037	-0.208	**-0.158**	0.367	-0.156
Harvest index	0.029	-0.298	-0.013	-0.008	0.428	0.037	-0.163	0.657	-0.086	0.236	0.461	0.105	**-0.549**	0.839

The bold and underlined figures are direct effect toward yield per plant.

Residual effect = 0.49

4. DISCUSSION

4.1 Performance of the genotypes

The genotypes varied in stature, with BRRI 43 being the shortest, statistically similar to BRRI 42. Lemma was the tallest and not significantly different from Matiya and Ratul. Lemma took the longest time to reach 50% flowering, similar to Kalo Jamvi, Boilla, and Mari Dhan. BRRI 42 and BRRI 43 reached 50% flowering earlier, not significantly different from each other. Kalo Sathi, LoharGura, Munsi Murali, and Ratul had a medium flowering duration. Flag leaf length showed a wide range, with Lakhi Lata having the longest, and Lemma and BRRI 42 having the shortest. Flag leaf width did not vary significantly, except for LoharGura, which produced the broadest, and Lemma, the narrowest. Days to maturity had a wide range, with BRRI 42 and BRRI 43 being the earliest, and Mari Dhan being late maturing, similar to Lemma, Boilla, Matiya, Lakhi Lata, and Kalo Jamvi. Panicle length did not vary significantly, but Lakhi Lata and Kalo Jamvi had the longest, while BRRI 42 and Lemma had the shortest, similar toParija. Kalo Jamvi produced the highest number of spikeletspanicle^{-1}, while Lemma had the least. BRRI 27 produced the highest number of Panicle plant^{-1}, while Lakhi Lata had the least, similar to Kalo Jamvi. Kalo Jamvi also produced the highest number of filled grain panicle^{-1}, similar to Lakhi Lata. Lemma produced the lowest number of filled grain panicle^{-1}.Lakhi Lata had the highest number of unfilled grainspanicle^{-1}, significantly different from others. BRRI 48 had the lowest number of unfilled grainspanicle^{-1}.BRRI 48 had the highest 1000-grain weight, similar toLakhi Lata, LoharGura, Kalo Jamvi, Munsi Murali, and BRRI 42. Mari Dhan had the lowest 1000-grain weight, not significantly different from BRRI 48, Lemma, Parija, and Ratul.BRRI 48 had the highest yield plant^{-1}, while Mari Dhan had the lowest, similar to Lemma, LoharGura, Munsi Murali, Parija, and Ratul.Lakhi Lata and Parija produced the highest dry matter plant^{-1}, not significantly different from most genotypes. BRRI 42 produced the lowest dry matter plant^{-1}, similar toBoilla.Among the genotypes, BRRI 42 had the highest harvest index, not significantly different from BRRI 48. Mari Dhan had the lowest harvest index, followed by Parija, Ratul, LoharGura, Munsi Murali, Lakhi Lata, and Matiya, which were not significantly different from each other.

4.2 Studies on variability and character association

4.2.1 Variability, heritability, and genetic advance

The study focused on the assessment of different agronomic traits in rice genotypes and their variation, heritability, and genetic advance. The results indicated that some traits were influenced more by genetic factors, while others showed considerable environmental influence. Yield plant^{-1} and 1000-grain weight exhibited high genotypic and phenotypic coefficients of variation, suggesting aminimal environmental influence on these characters, thus providing a better scope for selection. The study concurred with Chauhan et al. (1993), who found similar estimates for phenotypic (11.4%) and genotypic (11.1%) coefficients of variation for 1000-grain weight. For plant height, panicle plant^{-1}, number of filled grains panicle^{-1}, spikelet panicle^{-1}, and number of unfilled grain panicle^{-1}, moderate genotypic (13.161%) and phenotypic (13.446%) coefficients of variation were observed, indicating a considerable impact of the environment on these traits. Maurya et al. (1986) reported comparable results for genotypic (10.4%) and phenotypic (11.7%) coefficients of variation. Similarly, Borbora and Hazarika (1999) found moderate genetic and phenotypic coefficients of variation for the number of filled grains panicle^{-1} in rice. Maurya et al. (1986) also reported moderate genotypic (10.4%) and phenotypic (11.7%) coefficients of variation for spikelet panicle^{-1}. Conversely, days to 50% flowering, days to maturity, panicle length, flag leaf length, flag leaf width, dry matter, and harvest index showed low genotypic and phenotypic coefficients of variation, indicating minor environmental influence on these traits. Similar observations were made by Sarma et al. (1996) for days to flowering, and by Rao and Shrivastav (1994) for panicle length and dry matter. High heritability and genetic advance were found for days to maturity, the number of panicles plant^{-1}, number of unfilled grain panicle^{-1}, yield plant^{-1}, flag leaf length, flag leaf width, dry matter, and harvest index in rice, suggesting a substantial non-additive genetic control for these traits. Yadav (1992) reported high heritability for yield plant^{-1}, while Gupta et al. (1999) found similar results for days to flowering. The 1000-grain weight exhibited high heritability (97.77%) and genetic advance (22.9%) in percent of themean, consistent with the findings of Chauhan et al. (1993). Sawant and Patil (1995) also reported high coefficients of variation for yield plant^{-1} in rice, as did Li et al. (1991) and Das et al. (1992). Medium heritability (.958) and moderate genetic advance (26.53%) in percent of mean were observed for medium plant height and spikelet panicle^{-1}, suggesting a balanced contribution of additive and non-additive gene actions in these traits. This finding was in line with Kumar et al. (1994) who reported similar genetic advance for plant height and spikelet panicle^{-1}. In conclusion, the study highlighted varying degrees of genetic and environmental influences on different agronomic traits in rice. Traits like 1000-grain weight and yield plant^{-1} exhibited high heritability and low environmental influence, making them favorable targets for selection in breeding programs, while traits such as days to 50% flowering and panicle length showed low heritability and were more affected by environmental factors. Understanding these variations is crucial for effective trait improvement and breeding strategies in rice cultivation.

4.2.2 Correlation study

Genotypic correlation coefficients were generally higher than phenotypic correlation coefficients, indicating a strong inherent relationship among the characters (Chaubey and Singh, 1994; Chauhan et al., 1993). Grain yield per plant showed significant positive correlations with panicle per plant, number of filled grains, 1000-seed weight, and harvest index (Mirza et al., 1992; Chauhan et al., 1986). Days to 50% flowering showed asignificant positive correlation with days to maturity, but anon-significant correlation with plant height, number of unfilled grains per panicle, and dry matter (Das et al., 1996; Chauhan et al., 1993). On the other hand, theharvest index, yield per plant, and panicles per plant showed non-significant negative correlations with the number of panicles per plant (Rao and Shrivastava, 1994).Plant height exhibited significant positive associations with days to 50% flowering, days to maturity, and dry matter, while harvest index, yield per plant, number of filled grains, and 1000-seed weight showed negative correlations at the genotypic level (Chaubey and Singh, 1994; Mirza et al., 1992). The number of panicles per plant showed significant negative associations with days to 50% flowering, flag leaf length, flag leaf width, days to maturity, panicle length, spikelet per panicle, panicles per plant, number of filled grains, and number of unfilled grains per panicle (Shaha et al., 1993).Flag leaf length, flag leaf width, panicle length, spikelet per panicle, number of filled grains, 1000-seed weight, dry matter, and yield per plant showed significant positive correlations with each other (Mohammad et al., 1980; Cheema et al., 1998). Spikelet per panicle exhibited significant positive associations with flag leaf length, flag leaf width, panicle length, number of filled grains, 1000-seed weight, and dry matter, while panicles per plant showed anegative correlation at the genotypic level (Chaubey and Singh, 1994; Mirza et al., 1992).The number of unfilled grains per panicle showed negative and significant associations with panicles per plant. On the other hand, days to 50% flowering, flag leaf length, days to maturity, panicle length, spikelet per panicle, number of filled grains, and dry matter showed positive significant correlations (Chaudhury et al., 1980; Debi et al., 1997).1000-seed weight exhibited significant positive associations with flag leaf length, panicle length, spikelet per panicle, number of filled grains, harvest index, and yield per plant, while plant height and dry matter showed negative correlations at the genotypic level.Dry matter showed negative and significant associations with panicles per plant, 1000-seed weight, harvest index, and yield per plant. On the other hand, plant height, days to 50% flowering, flag leaf length, flag leaf width, days to maturity, panicle length, spikelet per panicle, number of filled grains, and number of unfilled grains per panicle showed positive significant correlations (Chaudhury et al., 1980; Debi et al., 1997).TheHarvest index showed significant positive associations with panicles per plant, 1000-seed weight, and yield per plant. On the other hand, plant height, days to 50% flowering, days to maturity, and dry matter showed negative correlations at the genotypic level (Chaubey and Singh, 1994; Mirza et al., 1992).In conclusion, plant height, number of panicles per plant, and number of filled grains per panicle were the most important characteristics showing significant positive correlations with grain yield per plant. Therefore, selecting based on these traits can lead to improved grain yield in rice.

4.2.3 Path coefficient study

From the results of path analysis (Table 4), it was evident that direct effects contributed by 1000-seed wt., days to 50% flowering, spikelet panicle^{-1} (0.241) were high indicating that among the component traits, these three characters contributed themaximum for yield plant^{-1}. The direct effects of 1000-seed wt., days to 50% flowering, spikelet panicle^{-1} were higher than their respective correlation co-efficient but lower for thenumber of filled grains panicle^{-1}.The indirect effect of the above three characters was not important. Thus, direct selection for these traits will be effective. Chaudhury and Das (1998) observed ahigh positive direct effect of days to maturity toward grain yield. Li *et al.* (1991) reported thehighest positive direct effect of grains panicle^{-1} on yield plant^{-1} followed by 1000-grain weight and number of panicle plant^{-1}. Chaubey and Singh (1994) observed amaximum positive direct effect of thenumber of panicles plant^{-1} followed by plant height and 100-grain weight. Samonte*et al.* (1998) reported themajor influence of grain number panicle^{-1} on yield.Although the character, harvest index was positively correlated with yield its direct effect on grain yield plant^{-1} was negative (-0.549). It indicated that this character influenced grain yield by its indirect positive effects through days to maturity, 1000-grain weight, and panicle plant^{-1}. Mehetrc*et al.* (1994) reported anegative direct effect of days to harvest index on grain yield.Plant height showed a low negative direct effect (-0.041) on grain yield plant^{-1} but the correlation coefficient was significantly negative. Kumar *et al.* (1998) reported amoderate direct effect of plant height on grain yield.Flag leaf length (0.215), panicle plant^{-1} (0.139), and flag leaf width (0.043) showed moderate to low direct effect as the correlation coefficient was moderate to low for these characters.Days to maturity (-0.429), panicle length (-0.342), no. of filled grain (-0.135), no. of unfilled grain panicle^{-1} (-0.119), dry matter (-0.158) had considerable negative direct effect on grain yield plant^{-1} and showed negligible indirect effect. Therefore, the positive correlation between panicle length, no. of filled grain, and grain yield plant^{-1} may be explained by positive indirect effect via days to 50% flowering, harvest index and flag leaf width (cm), andspikelet panicle^{-1} respectively.The residual effect was 0.496, indicating that the eight characters contributed 51% percent of the variability in yield hill^{-1} studied in path analysis. The residual effect towards grain yield in this study may be due to a variety of reasons such as causal factors (characters) not studied and sampling errors etc. Das *et al.* 1992) observed a residual effect of 0.364 indicating 64 percent of the variability in the yield plant^{-1} contributed by 8 characters studied in path analysis. The correlation and path co-efficient studies revealed that thenumber of filled grains panicle^{-1}, 1000-grain weight, and days to maturity and days to 50% flowering are the most important yield components. Recent breeding research has also emphasized the importance of these characteristics (Chaudhury and Das, 1998 and Debi *et al.*, 1997).

5. CONCLUSION

The study found varying genotypes in height, flowering time, and leaf characteristics. Days to maturity and panicle length showed notable differences among genotypes. Yield plant^{-1} and 100-grain weight displayed high variation, while plant height, panicles plant^{-1}, filled grains panicle^{-1}, spikelet panicle^{-1}, and unfilled grains panicle^{-1} showed moderate variation. Days to 50% flowering, days to maturity, number of panicles plant^{-1}, panicle length, filled grains panicle^{-1}, yield plant^{-1}, and other traits exhibited high heritability and genetic advance. Positive correlations were observed between yield plant^{-1} and certain traits like panicle plant^{-1}, filled grains, 100-seed weight, and harvest index. Selecting traits such as 100-seed weight, days to 50% flowering, and spikelet panicle^{-1} could effectively increase theyield plant^{-1}. Harvest index influenced yield indirectly through other traits. Path coefficient analysis revealed specific direct and indirect effects of traits on yield plant^{-1}, with some traits showing negative direct effects and positive indirect effects.

The present study suggested that aprolonged maturity period, higher number of panicles plant^{-1}, longer panicle length, and higher number of filled grains panicle^{-1} should be given the importance in selection of genotypes for higher grain yield in rice.

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