

## Evaluation of Genetic variability, Heritability and Genetic Advance for Grain Yield components in Rice (*Oryza sativa* L.)

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**ABSTRACT:** Higher grain yield/production is the primary requirement to feed the fast growing population in the world, and the improvement of any trait mainly depends on magnitude of genetic variability present in base population. In this regard present investigation consists of 25 rice varieties and the experiment was conducted during *Kharif* 2020 and 2021 in Randomized Block Design with three replications. The data were recorded for 7 quantitative characters to study genetic variability, heritability, genetic advance and varieties performance. On the basis of mean performance, high seed yield per plant were exhibited by the varieties NDR-8002, CR Sugandha dhan-908, HUR-105, CR Sugandha dhan-910 and HUR-3022. Analysis of variance among 25 varieties showed significant difference for all characters studied. Highest genotypic coefficient of variation (GCV) & phenotypic coefficient variation (PCV) was observed for seed yield per plant that these characters could be used as selection for crop improvement. High evaluation of heritability was observed for traits days to 50% flowering, Plant height (cm), Number of tillers/plant, Panicle length (cm), Number of grains/panicle, Test weight (g) and yield/plant. High genetic advance were observed for number of traits days to 50% flowering, Plant height (cm), Number of tillers/plant, Panicle length (cm), Number of grains/panicle, Test weight (g) and yield/plant indicating predominance of additive gene effects and possibilities of effective selection for the improvement of these characters.

**Keywords:** Genetic variability, Heritability, Rice, Genetic advance, GCV and PCV.

### INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important field crops after wheat in the world providing staple food to the basket of millions. It is an indispensable source of calories for almost half of the population within Asia. Almost 95% of the rice production happens in Asian countries and nearly half of the global population consumes it. Rice cultivation ranks third in agricultural commodity production, after sugarcane and maize (Priya *et al.*, 2019). Rice is grown in more than a hundred countries with a total harvested area of approximately 166.47 million hectares producing around 513.03 MMT annually (World Agriculture Production, USDA, 2022). For any crop improvement it depends on magnitude of genetic variability present in base population. Environmental effects influence the total observable variations of quantitative traits. Therefore, partitioning of overall variance due to

genetic and non-genetic causes becomes necessary for effective breeding programme. The genotypic coefficient of variation estimates the heritable variability, whereas phenotypic component measures the role of environment on the genotype. High PCV and low GCV for a character indicated high influence of environment in its expression. The phenomenon of transmission of characters from parents to offspring is usually measured in terms of heritability. Therefore the estimates of heritability and genetic advance would help to formulate a sound breeding programme. In view of above facts, the present investigation was carried out to estimate the variability, heritability and genetic advance present in germplasm collection.

### MATERIALS AND METHODS

The experimental material for the present study consisted of 25 rice varieties which studies were

conducted during Kharif Season 2020 and 2021 at Crop Research Station, Masodha, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya. The experimental material for the present investigation consisted of Twenty five rice varieties which were obtained from CRS, Masodha, Ayodhya, BHU, Varanasi and NRRI, Cuttack. The varieties are sown in a randomized block design with three replications with spacing of 20 × 15 cm. The nursery was raised on first week of August and transplanted after 24 days. Data were recorded on five randomly selected plants in each entry in each replications for the

traits days to 50% flowering, Plant height (cm), Number of tillers/plant, Panicle length (cm), Number of grains/panicle, Test weight (g) and yield/plant. The data subjected to INDOSTAT software to estimate Genetic coefficient of variation (%), phenotypic coefficient of variation (%), Heritability (%) (Broadsense) and Genetic Advance as percent of mean. The estimates for variability treated as per the categorization proposed by Siva Subramanian and Madhavamenon 4, heritability and genetic advance as percent of mean estimates according to criteria proposed by Johnson *et al.* (1955).

**Table 1: List of rice genotypes used in the study.**

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

## RESULTS AND DISCUSSIONS

On the basis of mean performance of yield and yield contributing traits NDR-8002 was highest yielder followed by CR Sugandha dhan-908, HUR-105, CR Sugandha dhan-910 and HUR-3022. For 1000-grain weight (g) Narendra- 3112 and HUR-11-3 were good. Plant height of NDR-2064 was best followed by Nua Chinikamini and Geetanjali (Table 3).

**Days to 50% flowering:** The statistical analysis of data showed that's there was wide variability among the twenty-five varieties during both the years' basis data. During the year 2020, days to 50% flowering among the twenty five varieties was ranged from 81.67 – 122.67 days while the general mean calculated for the same was 106.16. During 2021, variety NDR-97 took minimum days (81.67) while variety Nua Kalajeera took maximum days (122.67) to attain 50% flowering. During the year 2021, the general mean calculated for days to 50% flowering of all the twenty five varieties was 106.89 and it ranged from 82.00 to 121.67. Variety NDR-97 showed least number of days (82 days) while Nua Kalajeera showed maximum number of days (121.67 days) to 50% flowering as presented in (Table 3). The graphs regarding these findings have been shown in Fig. 2, 3, 4.

**Plant Height (cm):** Plant height of all twenty five varieties varied significantly during both the year of

experimentation. During the year 2020, plant height (cm) of all the varieties ranged from 90.67cm to 148.73cm while the average plant height of all the varieties was found to be 118.07cm. Maximum plant height (148.73cm) was recorded in variety NDR-2064 whereas minimum plant height (90.67cm) was recorded in CR Sugandha dhan-907.

During the year 2021, plant height of all the varieties ranged from 92.03cm to 150.80cm and the average plant height of these twenty five varieties was 119.20cm. Minimum plant height (92.03cm) was attained by variety CR Sugandha dhan-907 while maximum plant height (150.80cm) was attained by variety Nua Dhusara as presented in (Table 3). The graphs regarding these findings have been shown in Fig. 2, 3, 4.

**Number of tillers per plant:** Analysis of data pertaining to number of tillers per plant among twenty five varieties was found to be significantly variable during both the years basis. During the year 2020, overall mean of number of tillers per plant of all twenty five varieties was 13.77 and it ranged from 9.33 to 24.33 with maximum number of tillers per plant (24.33) in variety HUR-3022 and minimum (9.33) in Sarjoo-52. During the year 2021, the general mean calculated for number of tillers of all the varieties was 14.32 and it ranged from 10.33 to 24.33. Maximum number of tillers per plant (24.33) during the year 2021 was

recorded in HUR-3022 while it was minimum (10.33) in Sarjoo-52 as presented in (Table 3). The graphs regarding these findings have been shown in Fig. 2, 3, 4.

**Panicle Length (cm):** The interpretation of data regarding panicle length (cm) of both the years basis showed that there was wide variability among the twenty-five varieties. During the year 2020, panicle length of twenty five varieties ranged from 21.50cm–29.97cm while the general mean calculated for the panicle length of all the twenty five varieties was 25.13cm. Maximum panicle length (29.97cm) was recorded in varieties Poorna Bhog while minimum (21.50cm) in NDGR-201.

During the year 2021, the general mean calculated for panicle length (cm) of all the twenty five varieties was 24.76cm and it ranged from 21.13cm to 29.20 cm. Maximum panicle length (29.20cm) was recorded in Poorna Bhog whereas minimum panicle length (21.13cm) was recorded in variety CR Sugandha Dhan -907 as presented in (Table 3). The graphs regarding these findings have been shown in Fig. 2, 3, 4.

**Number of grains per panicle:** Statistical analysis of data of both the years and on pooled basis showed that there was significant difference in the number of grains per panicle among the twenty-five varieties. During the year 2020, number of grains per panicle in all the twenty five varieties ranged from 128 to 208 while the general mean calculated for the number of grains per panicle for all the twenty five varieties was 159.96. Maximum number of grains per panicle (208) was recorded in varieties Keteki Joha while minimum (128) in NDR-359.

During the year 2021, the general mean calculated for number of grains per panicle of all the twenty five varieties was 159.39 and it ranged from 125 to 206. Maximum number of grains per panicle (206) was recorded in Keteki Joha whereas minimum panicle length (125) was recorded in variety CR Sugandha Dhan-907 as presented in (Table 3). The graphs regarding these findings have been shown in Fig. 2, 3, 4.

**1000-seed weight (g):** Statistical analysis of data of both the years basis showed that 1000-seed weight differed significantly and variably among all twenty-five varieties. During the year 2020, 1000-seed weight of all the twenty five varieties ranged from 20g to 26.03g, while the general mean calculated for the 1000-seed weight of all the twenty five varieties was 23.32g. Maximum 1000-seed weight (26.03g) was recorded in variety NDR-3112 while minimum (20g) in CR Sugandhadhan 907.

During the year 2021, the general mean calculated for 1000-seed weight of all the twenty five varieties was 23.77g and it ranged from 20.77g to 26.47g. Maximum 1000-seed weight (26.47g) was recorded in NDR-3112 whereas minimum 1000-seed weight (20.77g) was

recorded in variety CR Sugandha Dhan-908 as presented in (Table 3). The graphs regarding these findings have been shown in Fig. 2, 3, 4.

**Seed Yield/Plant (g):** Statistical analysis of data collected during both the year of experiment analysis presented in (Table 3) revealed that there was wide variability in the yield/plant (g) of all twenty five varieties. During the year 2020, yield/plant of all the varieties used in the experiment ranged from 34.28g to 51.30g. The general mean for the yield/plant (g) of all the varieties was 39.76g. Maximum yield/plant (51.30g) was obtained in NDR-8002 while lowest yield/plant (34.28g) was obtained in Sarjoo-52.

During the year 2021, yield/plant in all the varieties ranged from 35.89g to 46.16g and the average yield/plant of all the varieties was 41.05g. During this year, maximum yield/plant (46.16g) was obtained from variety CR Sugandha Dhan -908 while minimum (35.89g) in CR Sugandha Dhan -907 as presented in (Table 3). The graphs regarding these findings have been shown in Fig. 2, 3, 4.

**Coefficient of variation:** In the present study analysis of variance revealed the existence of significant differences among varieties for all traits studied. The mean, variability estimates *i.e.*, Genetic coefficient of Variation (%), phenotypic coefficient of variation (%), Heritability (%) (Broad sense), Genetic Advance as percent of means are presented in (Table 1). The high estimates (>15%) of phenotypic PCV and genotypic GCV coefficients of variation were recorded in case of Number of tillers/plant (Y1 PCV=31.44%, GCV=30.20% and Y2 PCV=27.94%, GCV=26.88%), Number of grains/panicle (Y1 PCV=15.94%, GCV=15.88% and Y2 PCV=16.65%, GCV=16.47%), Plant height (cm) (Y1 PCV=16.48%, GCV=16.40% and Y2 PCV=16.21%, GCV=16.11%). Moderates estimates (<10%) of PCV and GCV were noted for Days of 50% flowering (Y1 PCV=9.46%, GCV=9.33% and Y2 PCV=9.06%, GCV=8.92%), Panicle length (cm) (Y1 PCV=9.38%, GCV=9.18% and Y2 PCV=9.84%, GCV=9.49%), Seed yield /plant (g) (Y1 PCV=8.12%, GCV=7.66%) and Y2 PCV=8.75%, GCV=8.53%), 1000- grain weight (g) (Y1 PCV=7.68%, GCV=7.44% and Y2 PCV=7.47%, GCV=7.21%) as presented in (Table 2). The existence of high variability for above characters in rice has also been reported earlier by Shukla *et al.* (2005); Aditya and Bhartiya (2013); Ashish *et al.* (2016); Kumar *et al.* (2017); Barhate *et al.* (2021); Singh (2021) findings have been shown in Fig. 1.

**Heritability and genetic advance:** The high estimates of  $h^2$  broad sense (>80%) were noted for Plant height (cm) (Y1 99.10%) (Y2 98.84%), Number of grains/panicle (Y1 99.22% and Y2 97.94%), days of 50% flowering (Y1 97.21% and Y2 96.92%), Panicle length (cm) (Y1 95.72% and Y2 92.95%), Seed yield /plant (g) (Y1 89.02% and Y2 95.04%), 1000- grain

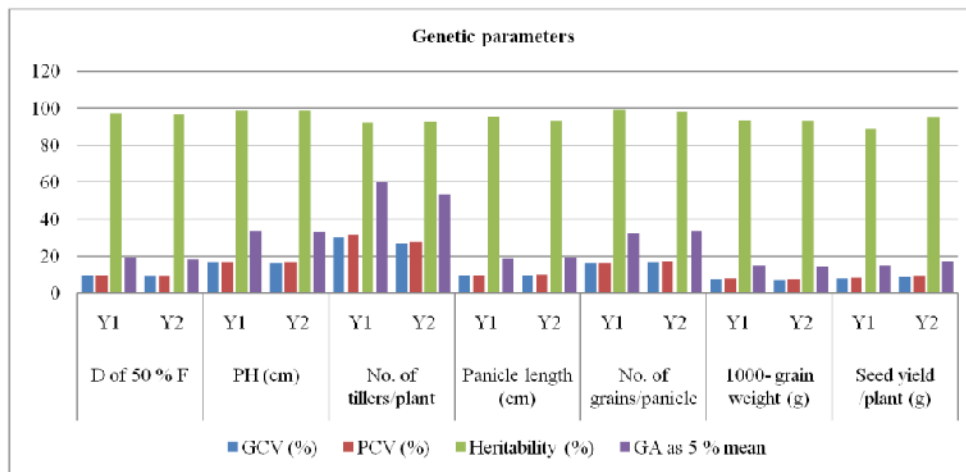
weight (g) (Y1 93.67% and Y2 93.11%) and Number of tillers/plant (Y1 92.23% and Y2 92.55%) as presented in (Table 2). The results obtained under present study are in accordance with earlier reports of Kumar *et al.* (2017); Goswami *et al.* (2018); Kishore *et al.* (2018); Ganapati *et al.*(2020); Rahman *et al.* (2021); Singh

(2021); Singh, (2021). Findings have been shown in Fig. 1. The genetic advance in per cent the very high estimates of (>30%) genetic advance were recorded for Number of tillers/plant (Y1 59.74% and Y2 53.28%), Plant height (cm) (Y1 33.63% and Y2 33.00%), Number of grains/panicle (Y1 32.58% and Y2 33.59%).

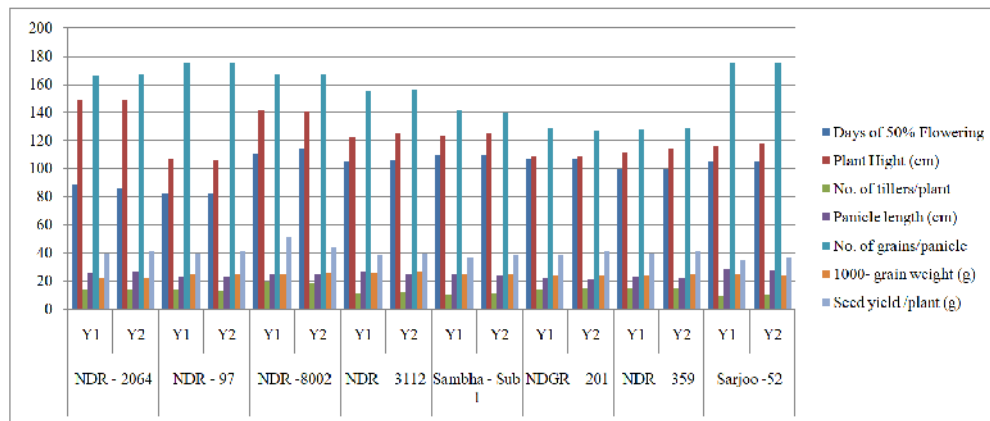
**Table 2: Variability, heritability and genetic advance for quantitative traits in rice.**

Character	year	Mean	Min	Max	GCV (%)	PCV (%)	Heritability (%)	GA as 5 % mean
Days of 50% flowering	Y1	106.16	81.67	122.67	9.33	9.46	97.21	18.95
	Y2	106.89	82.00	121.67	8.92	9.06	96.92	18.09
Plant height (cm)	Y1	118.07	90.67	148.73	16.40	16.48	99.10	33.63
	Y2	119.20	92.03	150.80	16.11	16.21	98.84	33.00
Number of tillers/plant	Y1	13.77	9.33	24.33	30.20	31.44	92.23	59.74
	Y2	14.32	10.33	24.33	26.88	27.94	92.55	53.28
Panicle length (cm)	Y1	25.13	21.50	29.97	9.18	9.38	95.72	18.50
	Y2	24.76	21.13	29.20	9.49	9.84	92.95	18.84
Number of grains/panicle	Y1	159.96	128.00	208.00	15.88	15.94	99.22	32.58
	Y2	159.39	125.00	206.00	16.47	16.65	97.94	33.59
1000- grain weight (g)	Y1	23.32	20.00	26.03	7.44	7.68	93.67	14.82
	Y2	23.77	20.77	26.47	7.21	7.47	93.11	14.33
Seed yield /plant (g)	Y1	39.76	34.28	51.30	7.66	8.12	89.02	14.88
	Y2	41.05	35.89	46.16	8.53	8.75	95.04	17.12

Y1= year 2020, Y2= 2022



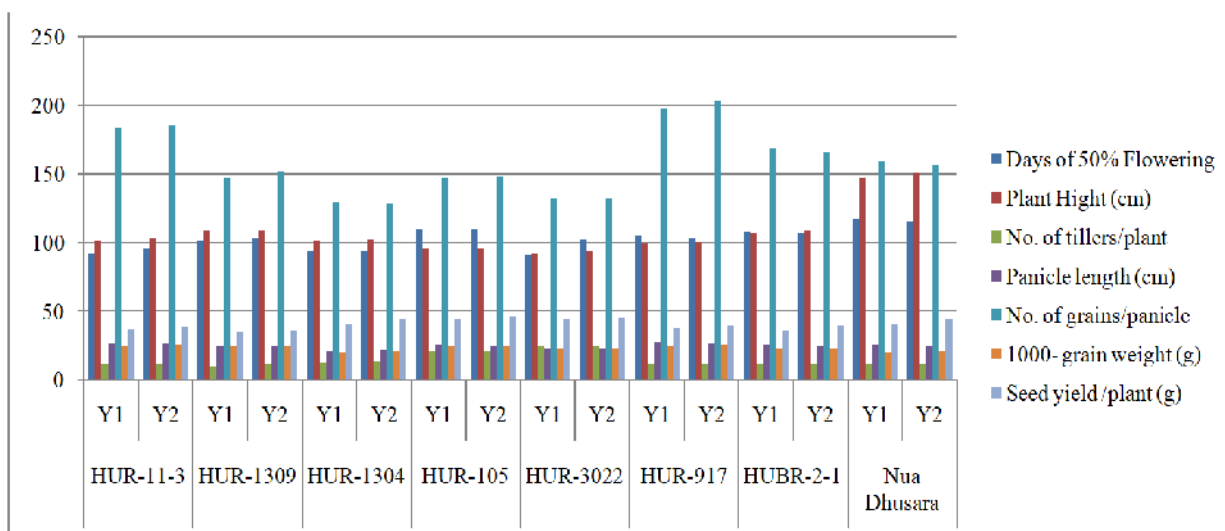
**Fig. 1.** Representing GCV, PCV, genetic advance in percent and h<sup>2</sup> (broad sense).



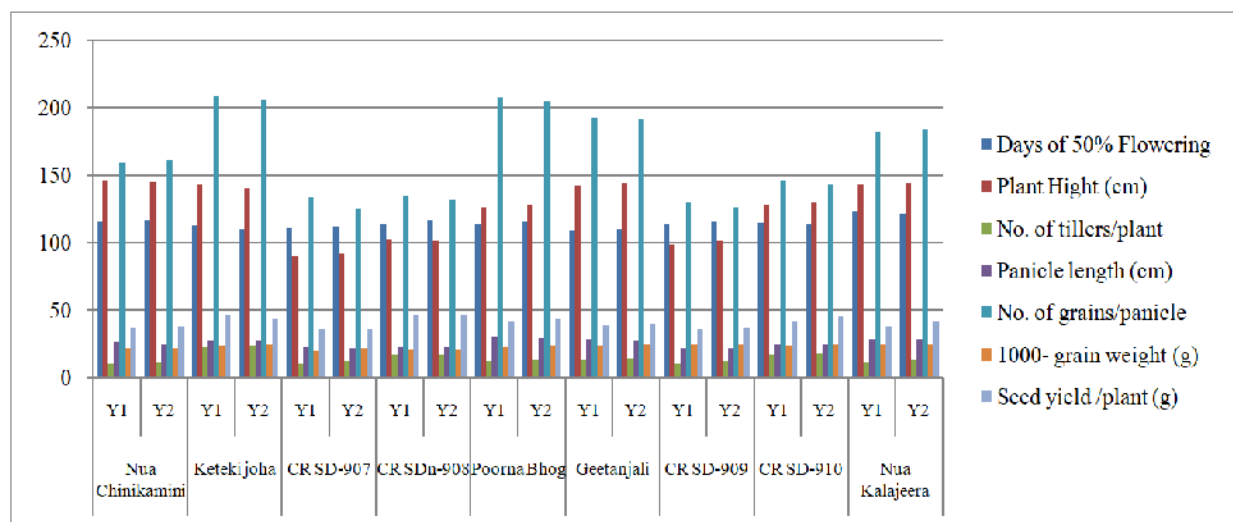
**Fig. 2.** Mean performance of eight rice varieties for their yield and grain quality characters.

**Table 3: Mean performance of twenty Five rice genotypes for their yield and grain quality characters.**

Varieties	year	D of 50% F	PH (cm)	No. of tillers/plant	Panicle length (cm)	No. of grains/panicle	1000-grain weight (g)	Seed yield /plant (g)
NDR - 2064	Y1	89	148.73	13.67	25.8	166	21.6	39.4
	Y2	86.33	149.4	14	26.67	167.67	21.7	41.21
NDR - 97	Y1	81.67	106.67	13.33	22.6	175	25.1	39.5
	Y2	82	106.13	12.33	22.63	175.67	24.7	41.2
NDR -8002	Y1	111	141	19	24.27	167.67	24.87	51.3
	Y2	113.67	140.57	18	24.73	167	25.83	43.43
NDR – 3112	Y1	105.33	122.33	11.67	26.17	155.67	26.03	38.47
	Y2	106.33	124.77	12	24.93	156.33	26.47	39.31
Sambha - Sub 1	Y1	110	123.33	10.33	24.27	141.67	25.03	36.45
	Y2	109.67	125.4	11.33	23.7	140.33	24.77	38.36
NDGR – 201	Y1	106.67	108.67	13.67	21.5	129	23.27	38.47
	Y2	107.33	109.33	14.67	21.27	127.33	23.9	41.06
NDR – 359	Y1	100	111.67	14.33	22.87	128	23.97	39.79
	Y2	99.67	114.17	15	22.07	129.33	24.8	41.19
Sarjoo -52	Y1	104.67	116.33	9.33	28.07	175.67	24.4	34.28
	Y2	105.33	117.9	10.33	27.07	175	23.9	36.36
HUR-11-3	Y1	92	102	11.67	26.9	184	25.27	37.29
	Y2	95.33	103.53	11.67	27.17	185.33	25.77	39.16
HUR-1309	Y1	101.67	109	10	24.7	147.67	24.37	34.88
	Y2	103.67	109.5	11	24.8	152	25	35.89
HUR-1304	Y1	94	102	12.67	21.67	129.67	20.37	40.41
	Y2	93.67	102.43	13	21.83	128.67	20.77	43.93
HUR-105	Y1	110	95.67	21.67	25.87	147.67	24.3	44.1
	Y2	109.67	96.33	21.33	25.4	148.33	24.8	46.13
HUR-3022	Y1	91.33	92	24.33	23.47	132.67	22.5	43.95
	Y2	102.67	94.13	24.33	23.03	131.67	22.83	45.45
HUR-917	Y1	105.33	99	12	27.33	198	24.47	37.68
	Y2	103.67	100.67	12	27.17	203.67	25.97	39.31
HUBR-2-1	Y1	108	107	11.33	25.7	169	22.63	35.8
	Y2	107.67	108.37	12	25.17	165.67	23.1	39.34
Nua Dhusara	Y1	117	147.67	11.33	25.93	158.67	20.3	40.41
	Y2	115.33	150.8	11.33	24.93	156.67	20.97	43.97
Nua Chinikamini	Y1	115.33	146	10	26.3	159.67	21.53	36.72
	Y2	116.33	144.9	11.33	25.23	161	21.7	37.64
Keteki joha	Y1	112.67	142.33	23	27.4	208	23.63	46.68
	Y2	110	140.7	23.33	27.07	206	24.27	43.72
CR Sugandha dhan-907	Y1	110.67	90.67	10.33	22.43	133.67	20	35.89
	Y2	112	92.03	11.67	21.13	125	21.1	36.34
CR Sugandha dhan-908	Y1	114.33	102	17	22.93	134.67	20.3	46.16
	Y2	116.33	101.77	16.67	22.5	131.67	20.77	46.16
Poorna Bhog	Y1	113	126	12.33	29.97	207	22.93	41.1
	Y2	115.33	127.7	13.33	29.2	204.33	23.17	43.07
Geetanjali	Y1	108.67	142	13	27.7	193	23.37	38.9
	Y2	110	144.33	14	27.5	192	23.9	39.99
CR Sugandha dhan-909	Y1	114	98.67	10.33	21.87	129.33	24.73	36.05
	Y2	115.67	101.33	11.67	21.23	126.33	25.07	36.81
CR Sugandha dhan-910	Y1	115	128	17	24.5	146	23.47	41.83
	Y2	113	129.63	18.33	24.07	143.67	24.13	45.52
Nua Kalajeera	Y1	122.67	143	11	28.17	181.67	24.6	38.5
	Y2	121.67	144.27	13.33	28.5	184	24.77	41.76
SE(d)	Y1	1.37	1.5	0.99	0.4	1.84	0.37	0.87
	Y2	1.39	1.7	0.89	0.53	3.11	0.38	0.9
C.D.	Y1	2.76	3.03	1.99	0.8	3.71	0.74	1.75
	Y2	2.8	3.43	1.8	1.07	6.27	0.77	1.82
C.V.	Y1	1.58	1.56	8.76	1.94	1.41	1.93	2.67
	Y2	1.59	1.75	7.63	2.61	2.39	1.96	2.69



**Fig. 3.** Mean performance of eight rice varieties for their yield and grain quality characters.



**Fig. 4.** Mean performance of nine rice varieties for their yield and grain quality characters.

The moderate estimates of genetic advance (<20% to >10%) were observed for days of 50% flowering (Y1 18.95% and Y2 18.09%), Panicle length (cm) (Y1 18.50% and Y2 18.84%), 1000-grain weight (g) (Y1 14.82% Y2 14.33%) and Seed yield /plant (g) (Y1 14.88 Y2 17.12%) as presented in (Table 2).

Also been reported earlier findings by Dhurai *et al.* (2014); Ashok *et al.* (2016); Khaire *et al.* (2017); Behera *et al.* (2018); Amudha *et al.* (2020). The graphs regarding these findings have been shown in Fig. 1.

## CONCLUSION

The results of the investigation shows high heritability and along with high genetic advance for number of tillers per plant, number of grains per panicle and seed yield per plant, which are the main traits in regard to enhance the yield production in rice. These traits are governed by additive gene effects which indicating that Salman *et al.*, *Biological Forum – An International Journal* 14(2a): 13-19(2022)

improvement in these characters is possible through hybridization followed by selection with pedigree breeding.

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**Conflict of Interest.** None.

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