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Study on Genetic Variability, Heritability and Genetic Advance for Seed Yield and Component Traits in Rice

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ABSTRACT

A study on genetic variability, heritability and genetic advance for seed yield and component traits was made in 40 genotypes of rice during kharif 2011-2012 at SHIATS, Allahabad. The analysis of variance showed highly significant differences among the treatments for all the 13 traits under study. The genotypes namely CN 1446-5-8-17-1-MLD4 and CR 2706 recorded highest mean performance for panicles per hill and grain yield. The highest genotypic and phenotypic variances (VG and VP) were recorded for spikelets per panicle (3595.78 and 3642.41) followed by biological yield (355.72 and 360.62) and plant height (231.48 and 234.35).High heritability (broad sense) coupled with high genetic advance was observed for plant height, flag leaf length, panicles per hill, tillers per hill, days to maturity, spikelet's per panicle, biological yield, harvest index, 1000 grain weight and grain yield, indicating that selection will be effective based on these traits because they were under the influence of additive and additive x additive type of gene action. Highest coefficient of variation (PCV and GCV) was recorded for tillers per hill (18.42% and 17.23%), panicle per hill (19.76 % and 18.68%), spikelet's per panicle (34.30 and34.07 %), biological yield (28.31 % and 28.12 %), 1000 grain weight (15.57 % and 15 31 %) and grain yield (46.66% and 23.54 %), indicating that these traits are under the major influence of genetic control, therefore the above mentioned traits contributed maximum to higher grain yield compared to other traits, indicating grain yield improvement through the associated traits.

Keywords: Rice, Genetic variability, Heritability, Genetic advance, Yield, Yield components

INTRODUCTION

Rice, the staple food crop of about 3 billion people, is nutritionally superior to many carbohydrate rich foods and contributes about 40 to 80 % of calories and 40 % of the protein in the Asian Diet. India is the second largest producer and consumer of rice in the world after China and it is equal to wheat in importance for human being. During 2015-16, the area, production and productivity of rice in India was reported 43.39 mha, 104.32 mtand 2404 kg/ha respectively (Anonymous, 2016). Due to better adaptation and higher economic yield, rice is cultivated on a large scale in different parts of the world. In the recent years the yield of paddy is reached at its plateau; further improvement can be done only by heterosis breeding. Grain yield is a complex polygenic trait controlled by many genes interacting with the environment and is the product of many factors called yield components. However, direct selection for yield alone is usually not very effective, thus selection should be done based on its contributing traits. In the present scenario, there is an urgent need to evolve of short duration and high yielding rice varieties for different agroclimatic conditions of the country. It is a well-established fact that the genetic variability is the base of any crop improvement programme and in the absence of this, there is no scope of genetic improvement in crop plants. The choice of plant breeding methodology for upgrading the yield potential with preference quality traits largely depends on the availability of reliable information on the nature and magnitude of genetic variability present in the population. Therefore, keeping in view the importance of different genetic parameters in a well-defined breeding programme, the present study was undertaken to workout genetic variability, heritability and genetic advance for seed yield and its attributes in Rice.

MATERIALS AND METHODS

The experiment was conducted in kharif season 2011-2012 at the field experimentation Centre of Department of Genetics & Plant Breeding, SHIATS (Allahabad Agriculture Institute deemed-to-be University), Allahabad. The experimental materials consisting of forty genotypes of rice received under AICRIP from DRR (Directorate of Rice Research), Hyderabad. The trial was conducted in a randomized block design. Twenty-nine days old seedlings were transplanted in 2 x 5 m plot size following 20 and 15 cm space between rows and plants respectively. Fertilizers were applied @120:60:40 Kg N: P: K per hectare respectively. Nitrogen was applied in three equal splits, at 15 days after transplanting (DAT), at 35 DAT

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and at the time of flowering. The other intercultural operation was done to raise the crop uniformly. Observation were recorded on five randomly selected plants for thirteen characters viz, days to 50% flowering, plant height, flag leaf length, flag leaf width, number of tillers per hill, number of panicle per hill, panicle length, days to maturity, number of spikelets per panicle, biological yield per hill, harvest index, 1000 grain weight and grain yield per hill. The mean values from each replication were subjected to statistical analysis using SAS and CROPSTAT (commercial version) computer software.

Table 1: Analysis of variance for grain yield and various agro-morphological traits of rice germplasm

Character	Mean Sum of Squares		
	Replication (d.f=2)	Treatment (d.f.=39)	Error (d.f.=78)
Days to 50% flowering	1.80	163.15**	3.69
Plant height	0.20	697.32**	2.86
Tillers per hill	2.49	15.23**	0.69
Flag leaf length	0.10	68.45**	1.26
Flag leaf width	0.019	0.024**	0.006
Panicle per hill	0.84	14.13**	0.54
Panicle length	1.98	14.28**	0.73
Days to maturity	31.42	544.90**	11.20
Spikelets per panicle	18.14	10833.97**	46.63
Biological yield per hill	16.94	1072.05**	4.90
Harvest index	12.45	107.80**	4.85
Test weight	1.65	46.37**	0.52
Grain yield per hill	4.43	135.69**	2.14

** Significant at 1% level of significance respectively

The analysis of variance (ANOVA) was done (Table 1) based on the method suggested by Panse and Sukhatme (1969). The PCV and GCV were calculated by the formula suggested by Burton and De Vane (1953). Heritability and genetic advance as percent of means for each character was calculated following formula as suggested by Johnson *et al.* (1955).

RESULTS AND DISCUSSION

Analysis of variance for grain yield and various agro-morphological traits

The analysis of variance was highly significant among the treatments for the traits namely days to 50 % flowering, days to maturity, plant height, panicle length, tillers per hill, panicle per hill, spikelets per panicle, 1000 grain weight, harvest index, 1000 grain weight, biological yield and grain yield. This indicated that considerable amount of variability is present among the present set of breeding materials. Significant variability for grain yield and various agro-morphological traits in rice were also reported (Dhurai *et al.*, 2014; Patel *et al.*, 2014; Kumari *et al.*, 2015; Allam *et al.*, 2015; Kumar *et al.*, 2016). The understanding of variability and genetic architecture of population is essential for the implementation of suitable breeding method.

Mean performance of genotypes for grain yield and various agro-morphological traits

The variability exploited in breeding programme is desired from the naturally occurring variants and wild relative of main crop species as well as from strains and genetic stocks artificially developed by human efforts. Through this study an attempt was made to assess the mean performance and extent of variability in 40 rice germplasms. The range of variability among material gives high chance of selection for desirable genotypes. The mean performance and range of mean of all genotypes for grain yield and various agro-morphological traits are presented in (Table 2).

Table 2: Estimates of genetic parameters for grain yield and various agro-morphological traits in rice

Character	VG	VP	Coefficient of variation		Heritability (Broad sense)	Genetic advance as % of mean 5%
			PCV	GCV		
Days to 50% flowering	53.15	56.85	7.96	7.70	93.00	15.33
Plant height	231.48	234.35	14.06	13.98	99.00	28.61
Flag leaf length	22.39	23.66	14.35	13.96	95.00	27.98
Flag leaf width	0.01	0.02	8.07	7.57	48.00	7.91
Tillers per hill	4.85	5.54	18.42	17.23	87.00	33.18
Panicle per hill	4.53	5.07	19.76	18.68	89.00	36.65
Panicle length	4.52	5.25	8.74	8.10	86.00	15.48
Days to ma turity	177.90	189.11	10.92	10.59	94.00	21.16
Spikelets per panicle	3595.78	3642.41	34.30	34.07	99.00	69.74
Biological yield	355.72	360.62	28.31	28.12	99.00	57.53
Harvest index	34.32	39.17	14.76	13.82	88.00	26.64
Test weight	15.28	15.81	15.57	15.31	97 .00	31.02
Grain yield	44.52	46.66	23.54	22.99	95.00	46.27

The range of mean performance for days to 50% flowering varied from 82.00 days (CR 648-13-673-1-13) to 110.00 days (CR 2927-42-2-3-2) with grand mean of 94.72 days. The genotype CR 648-13-673-1-13 (82.00 days) showed early flowering genotype followed by IR 64 (83.00 days), CR 2933-12-3-2-1 (84.30 days) and UPR 3528-12-1-12 (84.67 days). The wide range indicated the presence of sufficient variability and a better scope for improvement of this character in present set of breeding materials. Among the genotypes the range for days to maturity was from 107.87 to 155.00 days with a grand mean of 125.24 days. The genotypes CRR 648-13-673-1-13 (107.87 days), UPR 3528-12-1-12 (111.08 days) and CCR 648-13-838-1-13 (113.33 days) are early maturing varieties. Plant height varied from 86.13 (CR 2928-21-5-3-1) to 149.53 cm (CR 2706) with grand mean of 108.87 cm. The lowest plants height was observed in CR 2928-21-5-3-1 (86.13 cm).

The flag leaf length ranged from 23.77 cm to 43.70 cm with grand mean of 33.89 cm. The highest value was recorded in the genotype IR 78090-6-2-3-1-1 (43.70 cm). However, it was statistically at par with genotypes CR 2706 (42.73 cm) and R 1582-814-1-258-1 (42.52 cm). A perusal of mean values for flag leaf width depicted that it ranged from 1.22 cm to 1.60 cm with a mean of 1.39 cm. Maximum flag leaf width was observed in IR 64 (1.60 cm) which was statistically at par with R 1582-814-1-258-1 (1.55 cm), CN 1446-5-8-17-1-MLD4 (1.52 cm) and NDR 359 (1.51 cm).

The data revealed that tillers per hill ranged from 9.77 to 17.60 with a mean value of 12.78. The highest number of tillers per hill was exhibited in genotype R 1528-1058-1-110-1 (17.60) followed by NDR 359 (17.00) and IR 78090-6-2-3-1-1 (16.40). Number of panicles per hill was recorded from 8.77 to 16.33 with a mean value of 11.30. The genotype R 1528-1058-1-110-1 exhibited highest number of panicles per hill (16.33).

The experimental data on panicle length revealed that this character ranged from 18.93 cm to 30.37 cm with a mean value of 26.23 cm. The longest panicle was observed in genotype UPR 3528-12-1-12 (30.37 cm). However, it was statistically at par with genotype CN 1446-5-8-17-1-MLD4 (29.77 cm) and NDR 370133 (28.93 cm).The number of spikelets per panicle was varied from 101.60 to 394.33 with a mean value of 173.59. The genotype NP 128-8 had highest number of spikelets (394.33) followed by RP 5130-12-3-5-21-3 (274.27), CN 1446-5-8-17-1-MLD4 (269.73) and NDR 370133 (251.27).

The data revealed that biological yield ranged from 28.00 g to 104.33 g with a mean value of 67.08 g. The genotype CN 1446-5-8-17-1-MLD4 (104.33 g) exhibited highest biological yield which was significantly differed by CR 2706 (101.00 g), CR 2641-26-1-2-2 (101.00 g) and IR 78090-6-2-3-1-1 (94.00 g). The character 1000-grain weight varied from 17.17 g to 32.90 g with a mean value of 25.53 g. Maximum 1000-grain weight was observed in R 1535-1382-1-1667-1 (32.90 g), which was statistically at par with NVSR 178 (32.67 g) and MGD 107 (31.89 g). The estimates of harvest index varied from 27.40 to 51.38 with a mean value of 42.40. The genotype UPR 3425-11-1-1 (51.38) had highest harvest index which was at par with CRR 624-207-B-1-B (50.85), CR 2933-12-3-2-1 (50.43) and R 1582-814-1-258-1 (49.70).

Grain yield per hill varied from 20.67 to 46.67 with a mean value of 29.37. Maximum grain yield was observed in CN 1446-5-8-17-1-MLD4 (46.67). However, it was at par with CR 2706 (41.60), NDR 370133 (40.65) which were significantly different from rest of the genotypes. A wide range of mean performance for grain yield and its contributing traits in rice were also reported by Das *et al.* (2015) and Kumar *et al.* (2015).

Estimates of phenotypic and genotypic variances

Wide range of phenotypic (σ2p) and genotypic variance (σ2g) were observed in the experimental material for all the traits studied. The highest variability (σ2p and σ2g) was recorded for number of spikelets per panicle (3595.78 and 3642.41) followed by biological yield per hill (355.72 and 360.62), plant height (231.48 and 234.35) and days to maturity (177.90 and 189.11), while moderate values were observed for days to 50% flowering (53.15 and 56.85), grain yield per hill (44.52 and 46.66), harvest index (34.32 and 39.17), 1000-grain weight (15.28 and 15.81).

Whereas number of tillers per hill (4.85 and 5.54), number of panicles per hill (4.53 and 5.07) and panicle length (4.52 and 5.25) showed low variance. High estimates of phenotypic (σ2p) and genotypic variance (σ2g) were reported by Kumar *et al.* (2015) for number of spikelets per panicle and plant height whereas moderate for days to 50% flowering, grain yield, harvest index and 1000 grain weight. While low value for number of tillers per hill, number of panicles per hill and panicle length. High value of phenotypic and genotypic variance were also reported by Allam *et al.* (2015) for spikelets per panicle and plant height whereas moderate for days to 50% flowering and low value for number of panicles per hill and panicle length. Phenotypic variance was higher than genotypic variance for all the yield and yield contributing characters which indicates the influence of environmental factors on these traits. Similar findings were reported by Chaubey and Singh (1994) and Kumar *et al.* (2015) in rice.

Less difference in the estimates of genotypic and phenotypic variance and higher genotypic values compared to environmental variances for all the characters suggested that the variability present among the genotypes were mainly due to genetic reason with minimum influence of environment and hence heritable. The genotypic estimates of variability (Vg) being the most important, helps in the measurement of the contribution of the genotype to the expression of a particular character and gives clue to compare the genetic variability for different characters.

Phenotypic and genotypic coefficient of variation

The estimation of phenotypic coefficient of variation and genotypic coefficient of variation for all the characters are presented in (Table 3). In general, estimates of PCV were higher than their corresponding GCV however good correspondence was observed between GCV and PCV for all characters. Kumar *et al.* (2015) also reported that the PCV was higher than GCV and indicated the influence of environments on these characters. The estimates of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were ranged from 7.96 % and 7.70%in days to 50% flowering

Table 3: Mean performance of 40 rice genotypes for grain yield and various agro-morphological traits in rice

Genotypes	Days to 50% flowering	Plant height	Flag leaf length	Flag leaf width	Tillers per hill	Panicles per hill	Panicle length	Days to maturity	Biological yield	Harvest index	Spikelets per spike	1000 grain weight	Grain yield
IR 64	83.00	106.57	31.80	1.60	14.00	12.80	28.73	114.33	62.67	37.75	149.73	26.09	23.67
CR 2706	92.67	149.53	42.73	1.45	15.40	14.03	25.77	118.67	101.00	41.25	193.47	25.54	41.60
NDR370133	96.00	107.20	32.47	1.36	12.13	10.17	28.93	122.67	93.00	43.76	251.27	24.89	40.65
UPR3413-8-2-1	97.67	95.80	34.17	1.49	10.20	9.47	27.00	124.33	70.33	42.64	217.67	17.17	30.00
UPR3425-11-1-1	96.67	122.67	34.33	1.34	11.53	10.00	28.10	124.00	62.33	51.38	189.20	26.41	33.00
CRR624-207-B-1-B	96.67	125.40	40.83	1.45	10.20	9.90	23.40	122.33	51.33	50.85	215.33	23.23	26.00
CN1446-5-8-17-1-MLD4	89.00	125.73	35.53	1.52	15.13	14.27	29.77	116.33	104.33	44.73	269.73	30.20	46.67
SASYASSREE	102.00	119.00	33.00	1.43	15.53	14.27	28.10	128.33	93.67	36.30	166.33	26.85	34.00
NDR359	95.00	110.00	35.00	1.51	17.00	14.00	26.00	125.00	55.00	39.61	240.00	23.96	25.00
NVSR-176	95.00	124.73	35.93	1.45	13.40	12.60	24.70	120.67	89.00	30.71	192.60	31.47	27.33
NVSR-178	94.00	128.63	39.37	1.51	15.20	13.47	22.67	118.67	87.00	41.01	182.53	32.67	35.67
IR78090-6-2-3-1-1	101.00	96.60	43.70	1.35	16.40	13.73	27.23	127.00	94.00	28.42	183.40	25.80	26.67
MGD-107	85.00	98.00	24.47	1.37	14.53	12.60	25.17	113.67	60.67	39.16	175.47	31.89	23.67
NP-128-8	87.33	115.80	35.20	1.40	13.47	11.27	28.40	115.33	74.67	46.88	394.33	29.84	35.00
TRC2008-5	100.33	114.97	31.30	1.45	13.53	11.87	25.10	124.67	89.00	33.36	153.73	17.42	29.67
CR2641-26-1-2-2	108.67	121.90	34.67	1.40	16.13	14.47	26.47	131.67	101.00	27.40	153.67	25.28	27.67
CR2644-2-6-4-3-2	106.67	120.20	29.80	1.39	12.53	12.00	25.20	134.00	71.00	44.15	202.60	25.05	31.33
PAU3879-87-1-1	91.00	115.17	37.77	1.40	12.87	12.00	26.03	117.67	70.00	44.36	174.80	30.81	31.00
R1535-1382-1-1667-1	101.33	96.73	31.00	1.41	12.00	11.00	25.17	128.33	83.67	39.41	249.47	32.90	33.00
R1528-1058-1-110-1	108.67	106.00	31.67	1.43	17.60	16.33	25.40	136.00	63.33	47.89	224.00	21.06	30.33
KAU-PTB-VAISAKH	89.00	147.87	33.87	1.49	10.53	9.87	26.13	116.33	60.67	36.33	180.33	31.77	22.00
OR1946-2	89.67	123.37	35.00	1.31	14.53	12.67	25.40	118.67	81.00	38.32	197.20	17.44	31.00
CR2701-1-47-2-IR84882-B-120	95.00	126.00	39.73	1.42	12.67	11.87	25.67	121.00	77.00	48.54	140.93	23.88	37.33
ORS-327	107.67	97.67	34.13	1.35	11.33	10.33	25.53	136.00	57.67	42.15	137.80	26.24	24.33
RP5130-12-3-5-21-3	94.00	97.39	35.10	1.32	11.27	9.87	26.13	121.33	28.00	39.33	274.27	21.27	25.00
RP5130-136-5-5-33-5	96.00	98.67	36.97	1.36	14.00	11.87	26.93	121.33	61.33	39.26	133.00	23.79	24.00
UPR3528-12-1-1	94.67	100.53	30.89	1.45	10.87	9.13	26.60	122.33	50.49	37.97	194.78	27.03	21.33
UPR3528-12-1-12	84.67	110.88	31.36	1.45	11.75	10.37	30.37	111.08	58.07	48.80	162.13	29.92	31.67
CR-2933-12-3-2-1	84.30	96.20	24.50	1.27	10.82	9.42	21.36	116.45	52.63	50.43	155.00	22.45	33.00
CRR648-13-673-1-13	82.00	91.53	39.41	1.45	9.77	8.83	27.61	107.87	52.68	44.60	101.60	25.18	25.67
CCR648-13-838-1-13	86.33	87.67	23.77	1.23	11.62	9.83	18.93	113.33	53.10	47.43	110.00	24.20	25.33
R1527-947-1-78-1	99.00	101.35	31.27	1.22	13.83	12.85	28.57	124.23	57.98	47.53	112.75	22.72	30.33
R1582-814-1-258-1	97.00	105.70	42.52	1.55	10.08	8.77	25.65	124.37	43.30	49.70	180.48	26.02	25.67
CR2926-15-3-4-2	91.33	95.82	31.65	1.43	10.68	9.53	28.58	122.85	51.13	47.38	122.62	23.83	26.00
CR2927-42-2-3-2	110.00	101.80	30.42	1.31	12.35	11.42	28.25	155.00	70.75	47.50	134.13	25.22	36.33
CR2928-21-5-3-1	96.00	86.13	31.58	1.28	10.50	9.28	25.20	131.03	45.87	41.63	128.05	23.95	20.67
CR2929-57-4-2-3	91.42	90.50	33.62	1.28	10.68	9.25	24.87	147.60	39.82	49.58	128.37	23.88	23.00
CR2930-26-2-2-1	98.00	94.94	38.87	1.35	11.90	10.58	27.05	135.22	70.43	44.05	129.67	22.72	35.33
CR-2995-2-6-1-1-1	86.88	104.07	27.68	1.25	10.52	9.00	26.08	152.82	41.63	40.60	115.73	25.15	21.00
CR2995-1-2-3-1-1	88.18	96.10	28.52	1.28	11.62	10.52	26.87	146.90	52.58	43.95	119.07	26.18	23.67
Mean	94.72	108.87	33.89	1.39	12.78	11.30	26.23	125.24	67.08	42.40	173.59	25.53	29.37
Range Lowest	82.00	86.13	23.77	1.22	9.77	8.77	18.93	107.87	28.00	27.40	101.60	17.17	20.67
Range Highest	110.00	149.53	43.70	1.60	17.60	16.33	30.37	155.00	104.33	51.38	394.33	32.90	46.67
C.D. 5%	3.13	2.75	1.83	0.13	1.36	1.20	1.39	5.44	3.60	3.58	11.10	1.17	2.38

to 34.30%and 34.07% in spikelets per panicle respectively. Among all the traits, the highest phenotypic coefficient of variation (34.30%) and genotypic coefficient of variation (34.07%) were recorded for number of spikelets per panicle followed by biological yield per hill (28.31% and 28.12%) and grain yield per hill (23.54% and 22.99%). The high phenotypic coefficient of variation and genotypic coefficient of variation for these traits, suggesting that sufficient variability was present in the gene pool thus indicates ample scope for genetic improvement through selection for these traits. In this regards, Kumar *et al.* (2016) reported high PCV and GCV for spikelets per panicle, Allam *et al.* (2015) for grain yield per plant, Kumar *et al.* (2015) for spikelets per panicle and grain yield per hill and Das *et al.* (2015) for biological yield and grain yield in rice crop.

While moderate estimates of phenotypic coefficient of variation and genotypic coefficient of variation were observed for number of panicle per hill (19.76% and 18.68%), number of tillers per hill (18.42% and17.23%), 1000-grain weight (15.57% and 15.31%), harvest index (14.76% and 13.82%),plant height (14.06% and 13.98%) and days to maturity (10.92% and10.59%) whereas the traits namely days to 50% flowering (7.96% and 7.70%) and panicle length (8.74% and 8.10%), exhibited low estimates of phenotypic coefficient of variation and genotypic coefficient of variation.

Low estimates of PCV and GCV for days to 50% flowering were also reported by Kumar *et al.* (2015) and Kumar *et al.* (2016)whereas low PCV and GCV for days to 50% flowering and panicle length were reported by Kumar *et al.* (2015) and Kamboj *et al.* (2016). Moderate estimates of PCV and GCV for plant height, tillers per plant and 1000 grain weight by Kamboj *et al.* (2016) while for tillers per plant by Kumar *et al.* (2015) and for plant height and1000 grain weight by Allam *et al.* (2015). Kumar *et al.* (2015) also reported moderate type of PCV and GCV for plant height and tillers per meter. The results of study indicated that useful variability exits in the present set of breeding materials that can be utilized in breeding programme and selection of suitable genotypes carried out on the basis of different genetic parameters to get high yield in rice crop.

Estimates of heritability and genetic advance

The coefficient of variation does not offer full scope of heritable variation; it provides a measure of comparison of variability and gives some indication of validity of trait for selection. The greater degree of accuracy for the selection of traits is obtained when estimates of high heritability along with high genetic advance studies together. Both heritability and genetic advance are important direct selection parameters therefore high heritability along with high genetic advance are more useful in predicting the gain under selection then heritability estimates alone. Johnson *et al.* (1955) also suggested that without genetic advance the estimates of heritability will not be of practical value and emphasized the concurrent use of genetic advance along with heritability. In the present investigation heritability and genetic advance have been worked out for all the quantitative characters and are presented in (Table 3).

In the present study, high genetic advance along with high heritability was exhibited by number of spikelets per panicle (GA=69.74and h2= 99.00), biological yield per hill (GA=57.53and h2= 99.00), plant height (GA=28.61and h2= 99.00), grain yield (GA=46.27 andh2= 95.00), number of panicle per hill (GA=36.65 andh^2= 89.00), number of tillers per hill (GA=33.18 andh^2= 87.00), 1000 grain weight (GA=31.02 andh^2= 97.00), harvest index (GA=^{2}6.64 andh^2= 88.00)and days to maturity (GA=21.16 and h^2= 94.00). The character which have high genetic advance along with high heritability governed by additive gene action and these types of characters could be improved by mass selection and other breeding methods based on progeny testing. High genetic advance along with high heritability were also reported by Kamboj *et al.* (2016) and Kumar *et al.* (2016) for plant height, productive tillers, biological yield, harvest index and grain yield; Kumar *et al.* (2016) for spikelets perpanicle and number of panicle per hill; Kumar *et al.* (2015) for tillers per plot, and plant biomass; Kumar *et al.* (2015) for plant height, tillers per meter, harvest index, spikelets per panicle. Allam *et al.* (2015) reported high genetic advance with high heritability for days to maturity, plant height and spikelets per panicle while Kumari *et al.* (2015) for grain yield and biomass. The estimates of moderate genetic advance as percent of mean along with high heritability found for days to 50% flowering (GA=15.33 & h2= 93.00), panicle length (GA=15.48 & h2= 86.00) suggesting greater role of non-additive gene action in their inheritance. Therefore, heterosis breeding could be used to improve these traits. Kamboj *et al.* (2016) reported moderate genetic advance along with high heritability for panicle length whereas Kumar *et al.* (2015a) and Kumar *et al.* (2016) for days to 50% flowering.

CONCLUSION

The genotypes namely CN 1446-5-8-17-1-MLD4 and CR 2706 recorded highest mean performance for panicles per hill and grain yield. The highest genotypic as well phenotypic variance (VG and VP) were recorded for spikelets per panicle (3595.78 and 3642.41) followed by biological yield (355.72 and 360.62) and plant height (231.48 and 234.35).

High heritability (broad sense) coupled with high genetic advance was observed for plant height, flag leaf length, panicles per hill, tillers per hill, days to maturity, spikelets per spike, biological yield, harvest index, 1000-grain weight and grain yield per plant, indicating selection will be 100 percent effective based on these traits because they were under the influence of additive and additive x additive type of gene action.

Highest coefficient of variation (PCV & GCV) was recorded for tillers per hill (18.42% and 17.23%), panicle per hill (19.76 % and 18.68%), spikelet's per panicle (34.30 % and 34.07 %), biological yield (28.31 % and 28.12 %), 1000-grain weight (15.57 % and 15 31 %) and grain yield (46.66% and 23.54 %), indicating that these traits are under the major influence of genetic control, therefore the above mentioned traits contributed maximum to higher grain yield compared to other traits indicating that we can improve grain yield by improving these traits as well as emphasis should be given based on these traits for the selection of elite genotypes from the segregating generation.

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