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Exploring genetic diversity in yield attributing traits of rice (*Oryza sativa* L.)

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Abstract
Rice (*Oryza sativa* L.) is one of the major food crops, feeding more than half of the world's population. Major aim of rice breeding program is to enhance the yield potential by utilizing genetically diverse parent. The study was conducted in Kharif 2016 and Rabi 2016-17 at the Research and Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Chhattisgarh and Kharif 2017 at Research Farm of National Rice Research Institute (NRRI), Cuttack, Odisha (India). 10 rice parental genotypes, Chandrahasini, Samleshwari, Durgeshwari, IC-134022, IC-388728, IC-389860, IC-390376, IC-548384, Indira Barani Dhan1, IRHTN-105 and seven F3-F4 populations were taken for the study of genetic diversity e.g. plant height, flag leaf length, flag leaf width, no. of effective tillers, panicle length in rice. It was reported that out of 306 genotypes, plant was classified in to short (3 genotypes) and tall (22 genotypes). 5 genotypes having broad flag leaf, 28 genotypes having more than 12 ear bearing tillers whereas 87 genotypes having at par with largest panicle length. Hence, based on the results obtained in the present study the maximizing genetic gain in breeding population can be inferred to be playing important role in further enhancement in farm productivity of rice.

Keywords: Genetic diversity, genotype, flag leaf length, flag leaf width, panicle length

Introduction
Rice (*Oryza sativa* L.) is one of the major food crops, feeding more than half of the world's population (Ricepedia, 2020) [10]. Genetically diverse parents are essential tool for improving yield and overall agronomic performance of improved variety (Choudhury *et al*., 2013) [3]. Grain yield is the interaction of many quantitative traits e.g. plant height, days to flowering, flag leaf length, flag leaf width, no. of effective tillers, panicle length, spikelet fertility, grain shape, grain weight etc. (Singh *et al*., 2015a) [11]. Heritability, nature and amount of variability in genetic stock are essential for the genetic improvement (Namrata *et al*., 2016) [8]. A well understanding about variability in yield contributing traits and the correlation among the genotypes are paramount. Magnitude and direction of association of different yield traits are requisite to contribute higher yield in rice.

Dwarf genotypes of rice essential to avoid lodging in but a significant amount of yield is also reduced. Tall genotypes are also required to increase the yield potential but lodging will be limitation. So it is required to identify an optimum plant to enhance yield in rice (Palme *et al*., 2014) [9]. Uppermost three leaves are essential to enhance a significant amount of yield in rice as these are the main source of photosynthetic products for the developing grain (Li *et al*. 1998) [5]. However, a higher flag leaf length and width are essential for rice breeding program (Yang and Yang, 1998) [14]. Flag leaf length (FLL), FLW and flag leaf area (FLA) were exhibited more than 60% genetic heritability and controlled by two pair of genes (Yan and Wang, 1990) [13].

Panicle bearing tillers number per unit area greatly influences the grain yield. However, no. of panicle bearing tillers add to grain yield, but excessive tillering ability reduces the grain setting, smaller panicle and yield reduction (Ahmad *et al*., 2005) [1]. Tillering ability in rice is influenced by environment, agronomic practices. In addition to that it is also affected by light intensity, temperature and carbohydrate metabolism (Yoshida, 1973) [15]. Panicle length is one of essential trait influencing the panicle architecture and grain yield in rice (Liu *et al*., 2016) [6]. It is a quantitative trait and controlled by both major and minor genes (Liu *et al*., 2011) [7].

It is crucial for breeder to well-known with genetic diversity of various genotypes to select parents for initiating parental crosses (Belaj *et al*., 2002) [2] which will enhance the grain yield in the improved varieties.

Material and Methods

The experimental materials comprised altogether 10 rice parental genotypes, Chandrahasini, Samleshwari, Durgeshwari, IC-134022, IC-388728, IC-389860, IC-390376, IC-548384, Indira Barani Dhan1, IRHTN-105 and seven F3-F4 populations. The experimental material was acquired from the Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur. In F2, individual plant harvested separately and sown following panicle progeny manner on raised nursery. Twenty one days old seedlings were transplanted in well pudlled field at NRRI, Cuttack under standard agronomic practices and recommendations.

The five plants were randomly chosen from each entry or generation and data were used for the statistical analysis. The plants were selected from the middle rows to minimize error due to the border effect. The details 5 quantitative observations taken from are given below.

1. Plant height (cm): The plant height was measured in centimeter on the main culm (or the tallest tiller) at or following anthesis from ground level to the tip of the panicle. The data was recorded on five random plants from each of accessions and averaged.
2. Flag leaf length (cm): Length of flag leaf was measured from main culm of 5 randomly selected plans at physical maturity stage.
3. Flag leaf breadth (cm): Mid-region of flag leaf of main culm from 5 randomly selected plants was measured at physical maturity stage.
4. Number of ear bearing tillers: The number of panicle bearing tillers of individual plant was counted in five randomly selected plants of each accession and averaged.
5. Panicle Length (cm): The length of panicle was measured from the base of panicle to the topmost spikelet or tip of the panicle, excluding the awns, and it expressed as in centimeter (cm).

Data Analysis

The data recorded in respect of 12 quantitative characters on 306 breeding lines.

Mean: The mean value of each trait was determined by summing up all the observations and dividing them by corresponding number of observations.

Range: The lowest and highest value for each trait was taken as the range.

Analysis of Variance: The characters studied were analysed using analysis of variance techniques suggested by Federer (1956) [4].

Result and Discussion

Analysis of variance (ANOVA) for 5 quantitative Characters: The analysis of variance for augmented design in respect of all the 5 quantitative characters is presented in Table 1. The variation due to blocks was significant for plant height and Number of ear bearing tillers. The differences among the checks were found to be highly significant (at $p< 0.01$) for plant height and significant (at $p< 0.05$) for the panicle length. Plant height and panicle length are very crucial trait, balancing source and sink n rice, hence, genotypes involved in the study are useful to be utilized as parents in maximization of genetic gain for respective traits and grain yield directly.

Mean performance of the genotypes: Success of parental selection is depends upon magnitude of heritable portion of genetic variability. Hence, the assessment of genetic variability was done by computing mean value, range and coefficient of variation. The adjusted mean of the 306 genotypes, checks means, range and least significant differences for 5 characters are given in Table 2 & 3.

Plant height in rice is a crucial trait directly involved in balancing source and sinks of the plant canopy and hence found to be major determinant of yield (Xue *et al* 2008). The overall mean value for plant height of 306 studied genotypes was recorded 106.12 cm with a range of 41.04 cm in (IC-548384 × Chandrahasini) 4 to 145.10 cm in (IC388728 × Chandrahasini) 15. Out of 306 genotypes, 3 were found in non-significant group of short height which is statistically at par with shortest genotype (IC-548384 × Chandrahasini) 4. However, 22 out of the total genotypes were found in tall heights group which are being statistically at par with tallest plant (IC-388728 × Chandrahasini) 15. The genotypes found at par with short height plant were (IC548384 × Chandrahasini) 4, (IC-548384 × Chandrahasini) 5 and (IC-390376 × Samleshwari) 35; and genotypes among tall height group were (IC-390376 × Chandrahasini) 9, (IC-390376 × Chandrahasini) 10, (IC-390376 × Chandrahasini) 11, (IC-390376 × Chandrahasini) 14, (IC-390376 × Chandrahasini) 20, (IC-390376 × Chandrahasini) 21, (IC-390376 × Chandrahasini) 22, (IC-390376 × Chandrahasini) 23, (IC-390376 × Chandrahasini) 30, (IC-390376 × Chandrahasini) (31), (IC-390376 × Chandrahasini) 32, (IC-390376 × Chandrahasini) 35, (IC-390376 × Chandrahasini) 42, (IC-390376 × Chandrahasini) 44, (IC-390376 × Samleshwari) 2, (IC-390376 × Samleshwari) 41, (IC-134022 × Durgeshwari) 5, (IC-388728 × Chandrahasini) 21, (IC-388728 × Chandrahasini) 28, (IC-388728 × Chandrahasini) 29 and (IC-388728 × Chandrahasini) 32.

Flag leaf size and orientation is one of the trait which is directly associated with the extent and efficiency of photosynthesis rate, an ultimate yield determinant in rice (Yang and Yang, 1998) [14]. The overall mean value for flag leaf length was recorded 32.50 cm with a range of 13.2 cm in genotype (IC-548384 × Chandrahasini) 4 to 55.0 cm in genotype (IC-390376 × Samleshwari) 2 reveals substantial variation in the population. Amongst, 6 genotypes were found non-significantly at par with genotype possessing shortest flag leaf being statistically at par with the plant having shortest flag leaf. Whereas, 2 genotypes were found at par in leaf length with the genotype possessing largest leaf. The genotypes (IC- 548384 × Chandrahasini) 4, (IC-548384 × Chandrahasini) 5, (IC-548384 × Chandrahasini) 34, (IC-390376 × Chandrahasini) 39, (IC-390376 × Samleshwari) 35, (IC-389860 × Samleshwari) 1 were statistically at par with the genotype having shortest leaf and (IC-390376 × Samleshwari) 32 and (IC-548384 × Chandrahasini) 24 were found statistically at par with the genotypes having largest leaf. The width of flag leaf is ranged from 0.6 cm in (IC-548384 × Chandrahasini) 4 to 2.8 cm in (IC-548384 × Chandrahasini) 46 with a mean value of 1.51cm. Among the genotypes, 2 were in non-significant group for narrow flag leaf being statistically at par with narrow flag leaf bearing genotype (IC-548384 × Chandrahasini) 4. The genotypes bearing narrow flag leaf were (IC-390376 × Samleshwari) 35, (IC-388728 ×

Chandrahasini) 10. Whereas, 5 genotypes (IC-548384 × Chandrahasini) 41, (IC548384 × Chandrahasini) 42, (IC-548384 × Chandrahasini) 44, (IC- 548384 × Chandrahasini) 45 and (IC-548384 × Chandrahasini) 47 were found to bearing broad flag leaf being statistically at par with the genotype having broader flag leaf. Genotypes with shortest as well as longest flag leaf with semi-erect orientation are quite useful for making future breeding strategies in more precise way (Jiao *et al* 2010) [16]. Number of ear bearing tillers is found to have direct contribution to yield. The overall mean value for ear bearing tillers in test entries was recorded to be 6.56 with a range of 2.2 numbers in genotype (IC-548384 × Chandrahasini) 5 to 14.0 in the genotype Indira Barani Dhan1 shows vast variability. Amongst studied genotypes, 34 were sown statistically at par with genotype (IC-548384 × Chandrahasini) 5, possessed lowest number of ear bearing tillers. Whereas, 28 were found with the at par mean value of genotype possessing highest number of ear bearing tillers. The results indicate the breeding populations including parentage have substantial range of variability to utilize.

The panicle length is one of the most important trait, has greater role to play in ideotype breeding in rice (Liu *et al*., 2016) [6]. The overall mean recorded for panicle length was 23.60cm with a range from 14.2 cm in (IC-388728 × Chandrahasini) 10 to 30.3 cm in the genotype (IC-390376 × Chandrahasini) 30. Twenty four out of the 306 genotypes involved in the study were found in non-significant group of small panicle being statistically at par with smallest panicle bearing genotype. The genotypes possessed smaller panicle were (IC-548384 × Chandrahasini) 3, (IC-548384 × Chandrahasini) 7, (IC-548384 × Chandrahasini) 9, (IC-548384 × Chandrahasini) 18, (IC- 548384 × Chandrahasini) 19, (IC-548384 ×Chandrahasini) 33, (IC-548384 × Chandrahasini) 34, (IC-548384 × Chandrahasini) 35¸ (IC-548384 × Chandrahasini) 38, 9IC- 548384 × Chandrahasini) 43, (IC-390376 X Chandrahasini) 7, (IC-390376 × Samleshwari) 5, (IC-390376 × Samleshwari) 9, (IC-390376 × Samleshwari) 35, (IC-134022 × Durgeshwari) 17, (IC-134022 × Durgeshwari) 20, (IC-134022 × Durgeshwari) 22, (IC-388728 × Chandrahasini) 7, (IC-388728 × Chandrahasini) 16, (IC-388728 × Chandrahasini) 39, (IC-388728 × Chandrahasini) 48, (IC-389860 × Samleshwari) 1, (IC-389860 × Samleshwari) 4 and (IC-389860 × Samleshwari) 30. The large numbers of genotypes (87) were found in large panicle group having at par panicle size with largest panicle bearing genotype (IC-390376 × Chandrahasini) 30. The genotypes possessed larger panicle size were (IC- 548384 × Chandrahasini) 22, (IC-548384 × Chandrahasini) 24, (IC-548384 × Chandrahasini) 25, (IC-548384 × Chandrahasini) 26, (IC-390376 × Chandrahasini) 1, (IC -390376 × Chandrahasini) 9, (IC-390376 × Chandrahasini) 10, (IC-390376 × Samleshwari) 1, (IC-390376 × Samleshwari) 13, (IC-390376 × Samleshwari)19, (IC-390376 × Samleshwari) 38, (IC-134022 × Durgeshwari) 26, (IC-134022 × Durgeshwari) 48, (IC-388728 × Chandrahasini) 15, (IC-388728 × Chandrahasini) 29, (IC-389860 × Samleshwari) 13 etc. This vast diversity for this trait among parentage as well as in derivatives is good sign for rice improvement programme.

Table 1: Analysis of variance of augmented design for 12 quantitative characters of rice genotypes

S. No.	Characters	Blocks	Checks	Error
d. f.		17	2	34
1	Plant height (cm)	14.17*	26.77**	20.61
2	Flag leaf length (cm)	0.018	5.050	19.52
3	Flag leaf width (cm)	2.925	0.0083	0.009
4	No. of ear bearing tillers	14.73*	5.65	14.16
5	Panicle length (cm)	5.76	10.33*	3.91

*, ** significant at 5% and 1% probability levels, respectively

Table 2: Adjusted mean, range, coefficient of variance and least significant difference for 12 characters

S. No.	Characters	Mean	Range	C.V.%	LSD 1		LSD 2		LSD 3	
					5%	1%	5%	1%	5%	1%
1	Plant Height (cm)	106.12	41.04-145.1	22.53	14.48	17.51	16.02	18.20	23.26	26.74
2	Flag leaf length (cm)	32.50	13.2-55.0	23.20	11.40	15.71	13.24	18.25	15.29	21.07
3	Flag leaf width (cm)	1.51	0.6-2.8	14.77	0.25	0.35	0.29	0.41	0.34	0.47
4	No. of ear bearing tillers	6.56	2.2-14.0	2.84	13.38	9.71	11.28	15.54	13.02	17.95
5	Panicle length (cm)	23.60	14.2-30.3	13.11	5.10	7.03	5.93	8.17	6.85	9.44

Table 3: Mean value of parents and F_4 derivatives

Crosses	Plant Height (cm)	Flag leaf length (cm)	Flag leaf width (cm)	No. of ear bearing tillers	Panicle length (cm)
C1-1	99.00	31.00	1.50	2.60	22.04
C1-2	75.20	29.10	1.00	3.00	20.50
C1-3	46.40	18.00	1.00	3.40	17.74
C1-4	41.40	13.20	0.60	4.40	19.80
C1-5	89.40	22.80	1.30	2.20	21.90
C1-6	91.20	33.20	1.40	3.80	22.70
C1-7	71.40	27.30	1.20	5.60	19.10
C1-8	70.00	25.30	1.20	3.40	19.40
C1-9	59.80	26.00	1.40	6.40	17.90
C1-10	89.40	25.80	1.00	5.60	21.70
C1-11	92.20	40.20	1.90	5.20	25.22
C1-12	93.60	28.80	2.20	8.80	20.90
C1-13	86.00	31.20	1.80	6.00	19.54
C1-14	112.60	28.10	2.20	6.00	23.04
C1-15	100.40	27.40	1.40	5.20	20.12
C1-16	96.80	36.00	1.00	6.20	21.80
C1-17	96.80	30.40	1.00	4.20	20.00
C1-18	98.60	31.30	1.40	5.00	17.40
C1-19	95.20	29.20	1.60	7.00	18.10
C1-20	88.40	25.40	1.00	5.20	20.50
C1-21	90.20	28.60	1.00	4.80	23.28
C1-22	88.40	34.60	1.20	3.80	25.34
C1-23	57.80	22.00	1.00	4.00	21.06
C1-24	98.00	49.00	1.40	3.60	26.52
C1-25	103.40	32.40	1.20	4.20	25.20
C1-26	104.20	35.40	1.20	7.60	25.96
C1-27	83.00	32.60	1.20	3.60	24.92
C1-28	109.00	29.00	1.20	4.60	27.30
C1-29	92.40	33.40	1.60	5.20	23.80
C1-30	96.20	32.00	1.00	6.80	25.64
C1-31	89.20	26.60	1.00	5.00	20.70
C1-32	81.20	34.20	1.00	3.40	20.70
C1-33	67.80	24.20	1.00	3.40	19.10
C1-34	72.00	19.20	1.00	5.40	16.60
C1-35	78.40	26.80	1.00	3.20	19.20
C1-36	82.80	29.60	1.40	3.40	23.40
C1-37	100.80	35.80	2.30	5.80	23.90
C1-38	70.80	26.20	1.00	3.20	17.40
C1-39	103.20	32.40	1.00	6.20	21.08
C1-40	107.20	22.80	1.00	5.60	22.60
C1-41	79.80	37.20	2.70	6.00	24.30
C1-42	84.60	35.00	2.75	5.00	22.90
C1-43	60.40	20.80	1.60	6.20	15.80
C1-44	80.20	37.20	2.78	6.80	24.60
C1-45	84.20	35.00	2.70	6.60	22.00
C1-46	84.80	35.40	2.80	6.20	24.70
C1-47	85.40	46.20	2.60	9.00	24.20
C1-48	83.80	32.80	2.30	7.60	22.30
C1-49	86.00	43.40	2.40	8.60	24.40
C2-1	114.80	45.00	2.00	6.00	28.50
C2-2	92.20	29.40	1.20	6.80	20.60
C2-3	91.60	31.20	1.00	6.20	21.60
C2-4	90.00	26.80	1.00	5.00	20.10
C2-5	112.40	25.00	1.00	6.00	24.00
C2-6	98.20	28.20	1.00	5.60	20.10
C2-7	94.80	27.80	1.30	5.00	18.90
C2-8	88.40	27.30	1.20	3.80	21.60
C2-9	126.20	41.50	2.00	6.00	28.88
C2-10	131.80	40.90	2.00	5.20	26.70
C2-11	131.00	33.00	1.80	6.40	24.40
C2-12	117.60	29.00	1.80	4.80	21.30
C2-13	109.20	29.00	2.00	8.00	24.90
C2-14	129.20	33.20	2.00	7.40	26.80
C2-15	111.00	31.00	1.40	7.40	23.60

C2-16	105.40	31.80	1.60	9.60	23.00
C2-17	115.40	31.00	1.80	7.20	23.20
C2-18	100.40	25.60	1.80	5.80	22.70
C2-19	115.20	24.40	1.40	4.60	23.40
C2-20	134.00	34.10	2.00	8.00	25.20
C2-21	137.40	38.00	2.00	5.80	26.40
C2-22	136.40	41.50	2.00	6.60	28.70
C2-23	140.00	35.60	2.00	5.60	29.90
C2-24	75.20	23.50	1.00	3.20	20.00
C2-25	140.20	30.30	2.00	7.00	29.00
C2-26	118.00	37.20	2.00	5.20	27.50
C2-27	109.60	28.60	2.00	5.00	24.50
C2-28	141.00	38.60	2.00	5.40	30.20
C2-29	124.20	38.60	2.10	4.00	26.00
C2-30	137.80	41.70	2.00	5.80	30.30
C2-31	136.40	34.80	2.00	6.20	26.30
C2-32	131.20	29.60	2.00	6.40	23.60
C2-33	123.60	29.20	2.00	6.00	24.00
C2-34	121.60	32.60	2.10	7.00	25.50
C2-35	129.20	33.30	2.00	8.20	26.50
C2-36	92.40	30.60	1.00	4.80	21.60
C2-37	120.80	28.20	2.00	5.40	23.80
C2-38	97.00	27.40	1.40	5.20	20.80
C2-39	96.20	19.40	1.20	6.80	24.00
C2-40	118.60	29.60	2.10	7.00	23.70
C2-41	121.20	35.20	2.00	7.20	25.20
C2-42	132.40	35.12	1.40	6.00	23.40
C2-43	125.40	42.20	2.00	7.00	26.40
C2-44	127.00	31.80	2.00	7.40	25.70
C2-45	125.00	38.90	1.70	4.00	24.10
C2-46	117.80	40.00	2.00	6.60	24.90
C2-47	107.80	26.80	1.00	6.00	21.70
C2-48	90.60	35.00	1.60	7.20	22.60
C2-49	114.60	32.00	1.40	6.20	24.90
C2-50	107.00	27.50	1.40	3.60	23.70
C3-1	125.10	38.20	2.00	6.00	27.90
C3-2	126.80	55.00	2.20	5.80	30.50
C3-3	117.00	32.20	2.00	6.40	23.60
C3-4	117.80	43.70	2.10	9.20	28.10
C3-5	101.80	26.00	1.00	3.40	18.80
C3-6	121.80	37.80	2.00	9.00	24.60
C3-7	112.80	28.60	2.00	6.80	24.10
C3-8	109.00	23.70	2.00	6.00	22.00
C3-9	102.60	27.00	1.60	5.60	18.80
C3-10	75.80	31.90	2.00	4.80	26.60
C3-11	112.40	41.00	1.00	7.40	23.90
C3-12	102.20	30.00	1.14	4.80	24.70
C3-13	120.60	42.20	1.72	5.60	27.10
C3-14	107.14	40.90	1.44	7.20	27.00
C3-15	97.20	25.14	1.08	5.80	22.60
C3-16	96.00	36.10	1.30	4.80	22.30
C3-17	96.00	36.10	1.24	8.00	26.30
C3-18	106.30	37.04	1.46	6.40	23.60
C3-19	115.10	37.06	1.58	6.20	25.80
C3-20	104.80	36.32	1.26	7.60	24.10
C3-21	94.90	29.90	1.16	8.60	23.10
C3-22	112.40	34.80	1.40	5.00	24.00
C3-23	103.20	42.00	1.44	4.60	25.90
C3-24	73.20	32.60	1.92	11.60	27.10
C3-25	92.82	29.64	1.20	8.80	21.60
C3-26	102.00	34.50	1.20	7.00	23.50
C3-27	94.50	32.76	1.38	5.00	26.00
C3-28	104.80	35.50	1.62	5.40	24.10
C3-29	111.60	37.16	1.64	4.00	26.44
C3-30	117.80	32.56	1.50	7.20	26.00
C3-31	99.00	30.04	1.34	4.40	23.60
C3-32	105.70	50.22	1.86	6.60	24.10

C3-33	78.10	29.30	1.60	7.20	20.30
C3-34	115.40	28.32	1.28	6.60	22.98
C3-35	52.36	16.00	0.84	1.60	14.70
C3-36	113.50	30.08	1.74	3.60	23.10
C3-37	109.20	38.14	1.66	7.20	25.00
C3-38	129.60	40.52	1.90	5.80	25.90
C3-39	96.20	38.10	1.42	6.20	25.40
C3-40	105.60	29.40	1.80	8.00	22.40
C3-41	132.30	36.40	1.32	7.00	26.00
C4-1	106.80	30.50	1.44	7.20	23.20
C4-2	116.20	32.80	1.60	7.60	24.20
C4-3	113.80	32.00	1.30	5.80	22.40
C4-4	126.40	49.44	1.84	5.60	23.80
C4-5	127.40	37.00	1.84	5.40	24.60
C4-6	115.20	28.70	1.42	6.80	23.30
C4-7	113.20	33.70	1.50	6.20	23.60
C4-8	115.20	43.00	1.54	5.60	22.60
C4-9	113.96	35.40	1.46	6.80	24.40
C4-10	98.80	40.80	1.38	4.00	22.50
C4-11	102.30	32.36	1.32	5.20	22.90
C4-12	125.00	38.06	1.60	7.20	25.00
C4-13	117.20	33.68	1.40	4.40	25.70
C4-14	100.00	36.10	1.50	7.20	23.40
C4-15	99.70	26.50	1.40	3.60	21.20
C4-16	107.80	33.68	1.26	5.60	24.00
C4-17	66.60	25.80	1.16	5.20	16.30
C4-18	119.90	37.18	1.54	8.80	23.50
C4-19	109.20	25.74	1.24	5.40	20.00
C4-20	95.60	31.00	1.12	5.20	17.90
C4-21	107.40	32.90	1.32	4.40	22.40
C4-22	83.00	24.60	1.26	4.20	19.80
C4-23	105.40	33.64	1.30	4.40	22.60
C4-24	108.40	31.60	1.24	4.60	21.26
C4-25	96.20	22.20	1.26	4.80	20.40
C4-26	130.20	38.00	1.74	4.60	27.90
C4-27	104.60	27.20	1.28	5.00	21.60
C4-28	118.00	25.64	1.28	3.60	21.10
C4-29	124.20	39.24	1.40	4.60	25.20
C4-30	115.40	30.20	1.54	5.80	25.00
C4-31	122.20	29.50	1.44	5.80	22.40
C4-32	122.10	34.70	1.56	5.60	23.30
C4-33	102.20	32.46	1.42	5.60	23.00
C4-34	109.70	31.14	1.42	6.20	23.00
C4-35	116.40	32.70	1.36	6.00	22.70
C4-36	118.20	30.36	1.44	9.60	22.50
C4-37	123.00	31.04	1.36	7.40	23.40
C4-38	106.20	28.90	1.34	6.80	22.50
C4-39	92.20	26.66	1.44	4.40	21.90
C4-40	106.00	26.24	1.22	8.40	20.80
C4-41	99.20	29.64	1.46	6.20	21.30
C4-42	113.00	35.24	1.60	7.80	24.80
C4-43	101.40	28.34	1.56	6.60	22.40
C4-44	112.50	31.74	1.52	6.60	24.40
C4-45	104.80	28.34	1.66	8.20	24.40
C4-46	115.14	32.94	1.54	7.00	24.50
C4-47	119.30	30.14	1.40	8.40	25.00
C4-48	123.90	36.66	1.34	8.00	26.30
C4-49	118.00	30.08	1.54	5.60	23.94
C4-50	124.10	38.42	1.56	5.40	25.50
C5-1	104.20	28.64	1.08	7.00	19.40
C5-2	105.60	32.00	1.16	7.00	20.60
C5-3	111.70	33.78	1.26	8.20	21.90
C5-4	116.20	35.40	1.34	8.20	25.00
C5-5	118.50	32.76	1.14	8.00	22.00
C5-6	121.00	39.58	1.32	8.60	23.60
C5-7	89.00	27.48	1.14	7.60	17.70
C5-8	107.10	29.88	1.30	5.60	20.60

C5-9	96.20	32.74	1.16	8.40	18.20
C5-10	80.40	24.32	0.78	8.40	14.20
C5-11	125.70	35.70	1.46	8.60	27.00
C5-12	135.64	35.42	1.54	8.60	25.40
C5-13	131.90	38.88	1.72	6.80	25.00
C5-14	117.60	26.60	1.50	5.40	22.70
C5-15	145.10	42.96	1.82	7.00	28.40
C5-16	96.00	31.24	1.18	8.40	16.20
C5-17	121.00	35.00	1.50	5.00	26.60
C5-18	102.80	31.90	1.24	9.80	21.30
C5-19	124.80	28.94	1.46	7.40	22.30
C5-20	111.90	40.46	1.32	5.60	23.60
C5-21	134.70	41.52	1.58	8.60	27.60
C5-22	110.00	28.08	1.44	7.20	21.10
C5-23	110.00	34.92	1.72	8.40	25.40
C5-24	125.20	44.36	1.42	6.80	29.40
C5-25	121.70	35.44	1.54	11.20	26.40
C5-26	126.70	36.08	1.44	10.20	28.20
C5-27	123.40	29.96	1.70	5.40	23.60
C5-28	139.40	42.62	1.50	8.60	29.70
C5-29	138.60	36.84	1.74	7.60	29.10
C5-30	123.50	28.00	1.54	5.80	24.50
C5-31	107.90	29.42	1.38	7.60	22.60
C5-32	138.90	37.02	1.52	7.80	32.20
C5-33	114.40	24.90	1.66	7.80	22.60
C5-34	102.00	25.14	1.44	6.20	21.70
C5-35	84.40	33.14	1.38	7.20	22.10
C5-36	121.50	34.02	1.52	6.20	27.80
C5-37	128.20	37.72	1.64	8.40	28.80
C5-38	106.30	26.26	1.30	7.20	22.80
C5-39	99.00	32.62	1.30	6.00	18.90
C5-40	101.40	29.52	1.46	6.80	21.50
C5-41	104.40	27.98	1.26	8.40	24.60
C5-42	126.30	40.82	1.42	8.60	27.90
C5-43	90.20	24.64	1.16	5.80	19.80
C5-44	111.80	37.52	1.40	8.80	24.50
C5-45	110.60	28.46	1.26	7.40	22.00
C5-46	106.70	29.94	1.32	8.20	23.80
C5-47	124.10	37.34	1.64	8.60	25.20
C5-48	87.50	19.52	1.24	6.60	17.80
C5-49	98.20	30.08	1.36	6.60	23.10
C5-50	92.90	21.86	1.16	8.20	19.40
C6-1	78.30	17.50	1.16	6.20	18.30
C6-2	79.10	18.50	0.94	5.80	17.40
C6-3	94.40	35.46	1.40	8.60	25.00
C6-4	90.60	25.60	1.38	5.80	19.00
C6-5	113.50	30.62	1.54	7.00	22.00
C6-6	100.80	26.08	1.42	7.40	23.50
C6-7	83.20	27.58	1.28	8.20	20.00
C6-8	104.40	32.20	1.36	5.00	22.30
C6-9	115.00	37.16	1.50	7.60	25.20
C6-10	99.40	29.68	1.44	7.00	19.80
C6-11	126.40	37.70	1.42	10.40	25.70
C6-12	111.80	34.36	1.68	6.60	25.80
C6-13	123.50	38.68	1.74	7.20	27.20
C6-14	122.20	38.48	1.44	9.00	24.50
C6-15	95.80	31.42	1.52	6.20	22.20
C6-16	122.50	34.06	1.56	6.00	26.30
C6-17	111.80	32.66	1.40	9.40	23.70
C6-18	123.80	35.06	1.80	5.20	26.30
C6-19	107.60	36.52	1.84	7.00	27.10
C6-20	122.40	32.34	1.80	5.40	26.50
C6-21	108.80	33.34	1.32	7.60	25.30
C6-22	105.10	38.40	1.56	6.40	26.06
C6-23	95.20	29.54	1.18	7.60	20.80
C6-24	102.34	32.62	1.38	7.60	24.90
C6-25	122.60	40.02	1.72	6.80	28.40

C6-26	111.00	44.78	1.76	7.20	25.10
C6-27	121.90	43.36	1.66	7.20	26.50
C6-28	105.80	28.52	1.46	9.20	22.70
C6-29	116.10	44.58	1.48	11.00	27.60
C6-30	111.20	20.72	1.34	3.60	18.20
C6-31	107.70	29.88	1.24	12.20	21.20
C6-32	108.40	32.60	1.70	5.00	25.90
C6-33	102.90	26.16	1.18	8.40	20.10
C6-34	114.10	30.20	1.54	5.60	24.50
C6-35	110.60	30.48	1.32	8.20	23.20
C6-36	118.10	31.76	1.68	8.60	24.00
C6-37	122.10	39.36	1.70	10.40	26.60
C6-38	118.60	29.90	1.44	8.00	23.40
C6-39	125.20	31.58	1.68	7.00	24.10
C6-40	118.00	28.48	1.56	7.60	24.70
C6-41	103.00	24.28	1.40	6.60	20.50
C6-42	122.40	41.12	1.66	6.20	29.30
C6-43	117.00	36.30	1.58	6.80	25.60
C6-44	127.80	34.82	1.46	7.40	27.40
C6-45	105.60	31.34	1.36	5.80	24.00
C6-46	121.00	36.70	1.74	10.80	27.00
C6-47	108.50	38.64	1.36	13.40	24.70
C6-48	110.40	35.98	1.46	7.80	26.10
C6-49	126.10	41.24	1.62	8.80	28.20
C6-50	91.40	25.50	1.32	11.20	22.90
C7-1705	99.40	41.60	1.56	9.40	26.20
C7-1706	100.80	39.76	1.54	8.00	26.30
C7-1707	82.80	31.66	1.52	8.40	27.30
C7-1708	95.60	34.42	1.64	7.60	27.30
C7-1709	93.60	34.22	1.54	6.80	25.40
C7-1710	92.60	35.18	1.50	7.40	25.70
C7-1711	94.60	39.24	1.60	7.40	26.60
C7-1712	95.00	36.74	1.46	7.56	23.60
C7-1713	92.60	39.08	1.54	8.80	25.20
C7-1714	95.00	38.86	1.54	9.00	25.00
C7-1715	91.40	36.54	1.50	11.00	26.20
IC-388728	86.00	27.00	1.10	7.00	19.50
IC-390376	112.00	32.00	1.40	3.00	22.00
IC-389660	100.00	27.00	1.70	4.00	20.00
IC-548384	101.00	44.00	2.00	4.00	25.00
IC-134022	115.00	26.00	1.30	6.00	21.00
Ind. Barani Dhan1	95.00	34.00	1.23	14.00	23.00
IRHTN105	80.00	27.00	1.10	12.00	28.00
1-Durgeshwari	84.00	27.00	1.60	10.00	23.50
2-Samleshwari	81.00	23.00	1.40	4.00	22.00
3-Chandrahasini	101.00	33.00	1.30	11.00	27.50
Mean	106.12	32.50	1.51	6.56	23.60
Maximum value	145.10	55.0	2.8	14	30.3
Minimum value	41.04	13.2	0.6	2.2	14.2

Note:

C1- IC- 548384 x Chandrahasini
C2- IC -390376 x Chandrahasini
C3- IC-390376 x Samleshwari
C4- IC-134022 x Durgeshwari
C5- IC-388728 x Chandrahasini
C6- IC-389860 x Samleshwari
C7- Indira Barani Dhan 1 x IRHTN-105

Conclusion

In breeding population (306 genotypes), vast genetic diversity for all the studied traits was reported. For the plant height, three genotypes (IC-548384 × Chandrahasini) 4, (IC-548384 × Chandrahasini) 5 and (IC-390376 × Samleshwari) 35 in short height group and 22 genotypes (IC-390376 × Chandrahasini) 9, (IC-390376 × Chandrahasini) 10, (IC390376 × Chandrahasini) 11, (IC-390376 × Chandrahasini) 14, (IC-390376 × Chandrahasini) 20, (IC -390376 × Chandrahasini) 21, (IC-390376 × Chandrahasini) 22, (IC-390376 × Chandrahasini) 23, (IC-390376 × Chandrahasini) 30, (IC-390376 × Chandrahasini) 31, (IC-390376 × Chandrahasini) 32, (IC-390376 × Chandrahasini) 35, (IC-390376 × Chandrahasini) 42, (IC-390376 × Chandrahasini) 44, (IC-390376 × Samleshwari) 2, (IC-390376 × Samleshwari) 41, (IC-134022 × Durgeshwari) 5, (IC388728 × Chandrahasini) 21, (IC-388728 × Chandrahasini) 28, (IC-388728 × Chandrahasini) 29 and (IC-388728 × Chandrahasini) 32 in tall category were reported.

Population has showed great genetic diversity for Flag leaf size which is a crucial trait for photosynthesis has two useful genotypes (IC-390376 × Samleshwari) 32 and (IC-548384 ×

Chandrahasini) 24. Flag leaf width on the other hand has also shown great genetic diversity, 5 genotypes (IC-548384 × Chandrahasini) 41, (IC-548384 × Chandrahasini) 42, (IC-548384 × Chandrahasini) 44, (IC-548384 × Chandrahasini) 45, and (IC-548384 × Chandrahasini) 47 were found to bearing broad flag leaf. Breeding population has substantial extant of variants for ear bearing tillers, more than 28 genotype found to have more than 12 ear bearing tillers. Panicle length which is the major yield determinant in rice having 87 lines at par with largest panicle recorded in this study.

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