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Variability assessment in Rice (*Oryza sativa* L.) under direct seeded condition

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Abstract
The present work was conducted at research farm of TCA, Dholi, Bihar during Kharif 2020-2021. The 15 rice genotypes including a check namely Rajendra Nilam were sown under direct seeded condition in RBD with three replications. Investigation was carried out on genetic variability, heritability, genetic advance and mean performance of genotypes for eleven certain quantitative characters. Mean performance was tested statistically and the change was bidirectional. Genotypes were found to have one or more desirable traits over the check but none of the genotypes performed superiority for grain yield plant^{-1}. The genotypes Rajendra Neelam, IR-127364-46-2-1 and IR-127339-11-1-1-1-1 were found superior for grain yield plant^{-1}. The genotypes IR-64, Sahabhagi Dhan were found most early in flowering.
Analysis of variance revealed highly significant variation among the genotypes for all the characters and suggested an extensive scope of selection. The estimates of genetic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) indicated the presence of considerable amount variability for all the traits. In general the estimate of phenotypic coefficient of variability recorded higher than genotypic coefficient of variability indicating less effect to environment. A high estimate of heritability was found for all parameter. The presence of high heritability coupled with high genetic advance as per cent of mean for plant height (cm), number of tillers plant^{-1}, panicle length (cm), number of panicles plant^{-1}, 1000 grain weight (g) and number of grains panicle^{-1} indicated that heritability of these traits mainly due to preponderance of additive gene effect. Thus these traits can be improved through direct selection. The moderate broad sense heritability with low genetic advance in per cent of means were observed for biological yield indicating presence of non-additive gene action suggesting heterosis breeding may be useful for rice improvement under direct seeded condition. Thus these characters were identified as most important yield attributing component under direct seeded condition and simultaneous selection for these characters might bring an improvement in seed yield. Hence, selection for these traits may be effective.

Keywords: Genetic variability, genetic advance, heritability, genotypes

Introduction
Rice (*Oryza sativa* L.) is the stable food for millions of people. It is one of the most important food crops and feeds for more than 70 percent population of India. It is known as the "Global Grain" because it is a stable meal in more than hundred nations and more than half of the world's population is fed through rice. India has the biggest rice growing area and is the second-largest rice producing country in world next to China.
In India, Direct seeded rice is grown on an area of about 43.5 m ha with a total production of 105.5 million tonnes and productivity of 2.4 tonnes per ha during 2014-15. Direct seeded rice require relatively less water, labor and energy compared to transplanted rice as these resources are becoming highly scares. Rice occupies a pivotal role in Indian agriculture .It is the stable food for more than 70 percent Indians, and a source of livelihood for 120-150 million rural house hold. It contributes to 43 per cent of total food grain production and 53 per cent of cereal production, thus continues to hold the key to sustain food sufficiency in the country (Siddiq *et al.* 2004) [16].
At the current rate of population growth of 1.5 per cent, rice requirement by 2020 would be around 110 million tonnes. However, at the present level of 93 million tonnes we would be requiring to add annually not less than 2.0 to 2.5 million tonnes of milled rice to sustain the present level of self sufficiency in rice. It is therefore, a challenging task to achieve this targeted production levels in the next few decades. As the productivity increases has to come from the declining and degrading recourse base in term of land, water, labor and other inputs and demand for environmentally sound rice variety for direct seeded rice condition.

Rice is cultivated in all the agro climatic zones from below sea level area of Kerala in Kuttanda to the hills of Kashmir and Uttaranchal. No other crop is adopted as rice to varying agro climatic conditions and farming situations (Mohapatra 2005) [13]. The tribal peoples, who in ancient past domesticated rice, first cultivated dry land rice on the tops and slopes of hills, the cultivation of wet land rice in the valleys and in the plains was of later origin. The systems of rice cultivations evolved after centuries of practices have not undergone much change. Variety grown and seedling/planting method vary with the ecosystem and rainfall pattern (Mohanty *et al.* 1995) [14].

Hence, a number of high yielding rice varieties combining high yield potential plus multiple resistance are require. High yielding photo-insensitive varieties with maturity duration of 110-125 days in the dry season and 120-135 days in wet season are ideal in this ecosystem. Genetic variability is fundamental requirement of any crop breeding programme to develop suitable cultivar. The objective of this study was to estimate the genetic variability, heritability, genotypic and phenotypic coefficient of variation among the different quantitative traits for direct seeded rice that can be utilized in determination of strong dry season tolerant assortments (Rahman *et al.* 2016) [15].

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Result and Discussion

Analysis of variance (ANOVA) had done separately for eleven characters to test the significance differences which are presented in table - 1. The Some of mean square of different genotypes for all the eleven characters under study namely Days to 50% flowering, days to maturity, plant height (cm), panicle length (cm), number of panicles plant^{-1}, number of tillers plant^{-1}, 1000 seed weight, biological yield (g), number of grains panicle^{-1}, harvest index, and grain yield plant^{-1} showed highly significant which clearly suggested the existence of sufficient amount of variability in the experimental material. It is also suggested that the variation among these genotypes might have resulted due to differences in their pedigree. The result of the present study corroborate with the earlier result of Hasan *et al*. (2014) and Kumari and Parmar (2020) [10] in rice.

The mean performance of genotypes presented in table-2 was tested statistically and the change was bidirectional. Genotypes were found to have one or more desirable traits over the check but none of the genotypes performed superiority for grain yield plant^{-1}. The genotypes Rajendra Neelam, IR-127364-46-2-1 and IR-127339-11-1-1-1-1 were found superior for grain yield plant^{-1}. The genotypes IR-64, Sahabhagi Dhan were found most early in flowering.

The success of selection to improve plant characters depends on presence of substantial genetic variability, nature of heritability and gene action. The phenotypic and genotypic coefficient of variation can be used for assessing and comparing the nature and magnitude of variability existing for different characters in the breeding materials. Heritability in broad sense quantifies the proportion of heritable genetic variance to phenotypic variance, while heritability in narrow sense represents the ratio fixable additive genetic variance to total phenotypic variance. The genetic advance in per cent of mean provides indication of expected selection response by taking into account of existing genetic variability and heritability of the character.

The estimates of genotypic and phenotypic variances presented in table-3 revealed that genotypic variance contributed larger in phenotypic variance, which indicate less influence of environmental factor on the expression of these characters. The difference between genotypic and phenotypic coefficient of variation was less for all characters studied, indication of the more influence of the environment over the characters. It is also suggested that the variation among these genotypes might have resulted due to differences in their pedigree. The slight difference between genotypic coefficient of variation and phenotypic coefficient of variation was also reported by Tiwari *et al.* (2019) [17], Kumari and Parmar (2020) [10] in rice.

The estimates of genetic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) indicated the presence of considerable amount variability for all the traits presented in table-3. In general the estimate of phenotypic coefficient of variability recorded higher than genotypic coefficient of variability indicating less effect to environment. A wide range of genetic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were recorded from 2.3 and 1.9 (days to maturity) to 18.51 and 18.43% (number of grain penicle^{-1}) respectively.

The high estimate of broad sense heritability was found for all the characters and high genetic advance as per cent of mean was recorded for number of panicles plant^{-1} (26.11), plant height (26.11), number of tillers plant^{-1} (30.67), 1000 grain weight (32.38), panicle length (20.16), and number of grain panicle^{-1} (48.47). Moderate genetic advance as per cent of mean was recorded for days to 50% flowering (17.79) and grain yield plant^{-1} (17.53) and low for days to maturity (4.71), biological yield plant^{-1} (8.33) and harvest index % (13.40).

A high estimate of heritability was found for all the parameters. The presence of high heritability coupled with high genetic advance as per cent of mean showed in characters for plant height (cm), panicle length (cm), number of panicles plant^{-1}, number of tillers plant^{-1}, 1000 grain weight (g) and number of grains panicle^{-1} indicated that heritability of these traits mainly due to preponderance of additive gene effect. Thus these traits can be improved through direct selection. The moderate broad sense heritability with low genetic advance in per cent of means were observed for days to 50% flowering , grain yield plant^{-1} , days to maturity, biological yield plant^{-1}, and harvest index % indicating presence of non-additive gene action suggesting heterosis breeding may be useful for rice improvement under direct seeded condition. Thus these characters were identified as most important yield attributing component and simultaneous selection for these characters might bring an improvement in seed yield. Hence, selection for these traits may be effective. The existence of high variability for above characters has been reported earlier by Manjunatha *et al.* (2017) [12], Adhikari *et al.* (2018) [1], Tiwari *et al.* (2019) [17] and Kumari and Parmar (2020) [10]. The high estimate of heritability and genetic advance observe in present study are in agreement with available literature in rice Hasan *et al.* (2011) [5], Iqbal *et al.* (2018) [7], Fentie *et al.* (2014) [3], Kalyan *et al.* (2017) [9] and Longjam *et al.* (2019) [11].

Table 1: Analysis of variance (ANOVA) for different quantitative character

S. No	Characters	Replication (df = 2)	Genotype (df = 14)	Error (df = 28)
1	Days to 50% flowering	9.68	92.80**	0.49
2	Days to maturity	1.75	16.46**	0.73
3	Plant height (cm)	4.97	384.86**	2.74
4	Panicle length (cm)	0.18	10.76**	0.36
5	No. of panicles plant^{-1}	0.27	1.95**	0.06
6	No. of tillers plant^{-1}	1.93	7.09**	0.22
7	1000 grain weight (g)	4.98	42.01**	1.02
8	Biological yield plant^{-1} (g)	3.13	5.85**	0.84
9	Number of grains panicle^{-1}	13.85	1128.66**	3.14
10	Harvest index (%)	4.54	31.98**	1.46
11	Grain yield plant^{-1} (g)	1.71	5.82**	0.24

** Significant of P = 0.05

Table 2: Mean performance of 15 Genotypes of Rice under direct seeded condition

Sl. No	Genotypes Characters	Ch-1	Ch-2	Ch-3	Ch-4	Ch-5	Ch-6	Ch-7	Ch-8	Ch-9	Ch-10	Ch-11
1	IR-127339-11-1-1-1-1	84.67	120.33	097.48	25.20	9.53	15.83	22.53	31.02	120.43	60.57	19.31
2	IR-125026-108-1-1	81.00	118.33	119.08	24.93	7.30	10.43	25.40	30.95	120.97	60.53	18.67
3	IR-127293-69-1-1	82.67	120.67	113.03	23.41	7.20	10.27	31.27	32.33	100.13	58.77	18.64
4	IR-127299-32-2-2	92.00	124.33	099.27	21.23	7.83	10.57	22.53	32.87	153.57	54.04	18.11
5	IR-127285-124-2-1	90.67	124.00	118.72	22.50	7.37	12.83	24.83	32.43	113.80	57.51	18.71
6	IR-127361-196-2-1-B	74.67	118.00	119.14	20.35	6.90	11.70	31.30	33.69	120.80	58.53	18.83
7	IR-127364-46-2-1	82.33	120.00	120.22	27.47	6.27	11.67	30.17	35.17	106.33	62.06	20.28
8	IR-127367-107-1-B-B	80.33	119.33	102.11	24.27	8.00	12.60	31.97	34.81	100.60	55.93	19.29
9	IR-127335-106-2-2-1-1	82.67	117.67	113.85	22.60	7.83	12.63	35.90	32.81	091.83	54.43	18.43
10	IR-127290-B-B-293-1	80.00	123.33	112.50	22.57	7.23	12.43	28.67	34.04	107.10	58.39	18.92
11	Sabhangi Dhan	73.67	118.33	132.77	23.18	7.47	10.97	28.27	34.37	086.30	54.88	18.69
12	DRR DHAN-44	77.67	120.00	117.88	22.58	7.37	13.77	31.20	33.17	086.87	59.97	18.86
13	IR-64	72.67	118.00	093.75	20.28	7.80	13.99	30.50	33.77	074.30	57.19	19.21
14	IR-154	84.00	122.00	099.63	22.91	8.00	13.33	31.10	33.16	089.47	62.13	19.50
15	Rajendra Nilam	85.33	117.33	098.27	24.47	9.10	13.37	30.33	35.88	103.20	65.89	23.98
Mean		81.62	120.11	110.51	23.20	7.68	12.43	29.06	33.36	105.05	58.72	19.30
C.V.		00.86	00.71	001.50	02.60	3.21	03.82	03.48	02.75	001.69	02.06	02.57
C.D. 5%		01.18	01.43	002.77	01.01	0.41	00.79	01.69	01.54	002.96	02.02	00.83
Range lowest		72.67	117.33	093.75	20.28	6.27	10.27	22.53	30.95	074.30	54.04	18.11
Range highest		92.00	124.33	132.77	27.47	9.53	15.83	35.90	35.88	153.57	65.89	23.98

Ch-1. Days to 50% flowering, Ch-2. Days to maturity, Ch- 3. Plant height (cm), Ch- 4. Panicle length (cm), Ch-5. No. of panicle plant^{-1}, Ch- 6. No. of tillers plant^{-1}, Ch-7. 1000 grain weight (g), Ch-8. Biological yield plant^{-1}, Ch- 9. No. of grain panicle^{-1}, Ch-10. Harvest index (%), Ch-11. Grain yield plant^{-1}

Table 3: Genetic parameters of variation for seed yield and its contributing characters 15 Genotypes of Rice

Characters	Genetic Parameters							
	Grand	Range		PCV (%)	GCV (%)	h^2	GA	GA as %
	Mean	Minimum	Maximum					mean
Days to 50% Flowering	81.62	72.67	92.00	06.85	06.79	98	14.52	17.79
Days to Maturity	120.11	117.33	124.33	02.03	01.90	87	05.66	04.71
Plant height (cm)	110.51	93.75	132.77	10.32	10.21	97	29.47	26.67
Panicle length (cm)	23.20	20.28	27.47	08.43	08.02	90	04.67	20.16
No of panicle plant^{-1}	07.68	06.27	09.53	10.84	10.35	91	02.00	26.11
No of tillers plant^{-1}	12.43	10.27	15.83	12.76	12.17	91	03.81	30.67
1000 seed weight (g)	29.06	22.53	35.90	13.18	12.71	93	09.41	32.38
Biological yield plant^{-1} (g)	33.36	30.95	35.88	04.75	03.87	66	02.78	08.33
No. of grain panicle^{-1}	105.05	74.30	153.57	18.51	18.43	99	50.92	48.47
Harvest Index (%)	58.72	54.04	65.89	05.81	05.43	87	07.87	13.40
Grain yield plant^{-1} (g)	19.30	18.11	23.98	07.52	07.06	88	03.38	17.53

PCV-Phenotypic coefficient variation, GCV-Genotypic coefficient variation, h^2-Heritability, GA-Genetic advance,

Conclusion

On the basis of the above finding it can be concluded that, while imposing selection for genetic improvement of grain yield of rice under direct seeded condition, due weightage should be given to plant height (cm), panicle length (cm), number of panicle plant^{-1}, number of tillers plant^{-1}, 1000 grain weight (g) and number of grain panicle^{-1}. The presence of sufficient variability in the characters studied offer possibilities to explore the material for further genetic improvement programme to widen the genetic background of various rice genotypes. Considering the overall result it is apparent that certain information obtained here will help in future for development of new variety.

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