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Study of genetic variability, heritability and genetic advance in Submergent tolerant rice genotypes

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Abstract
Considering the status of India, there is 5.0 million hactre/16.1 million hectare are affected pretentious by submergence. There are either flash floods with full submergence ranging water depth from 25-50cm or deep flooding with more than 50cm stagnated water for some weeks. The study was carried out at the Research Farm of 'Tirhut College of Agriculture, Dholi, Dr Rajendra Prasad Central Agricultural University', Bihar. A total number of 24 genotypes are taken for the experiment in RBD design having three replications of each treatment. The lower difference value between PCV and GCV indicating lower influence of environment. High heritability coupled with high genetic advance as percent of mean were recorded maximum for Crop growth rate at 30days after sowing followed by Crop growth rate at 15days after sowing, Days to 50% flowering, Seedling vigour, indicates there may be presence of Additive Gene Action and direct selection for these traits will be effective. Low Heritability coupled with high Genetic Advance found in Scoring for Submergence Tolerance indicates there may be presence of Additive Gene Action and selection will be effective.

Keywords: Heritability, Genetic Advance, PCV, GCV

Introduction
Rice (*Oryza sativa* L.,2n=24) basically a monocotyledonous, short day angiospermic plant which is being placed with genus '*Oryza*' of Gramineae(Poaceae) family. It is semi aquatic plant in nature and can be grown over a vast range of water condition like long term flooded area to dry hilly regions. The remarkable diversity of this crop made it adaptable to various condition of climatic factors like temperature, humidity, rainfall etc. There are also less favorable situations for growth and development of rice in case of rainfed upland and rainfed low land.

An annual production of 497.6million tons (2019-2020) with acreage of 161.1 million hectare is forecasted out of which, only Asia will contribute 90% of total production (United States Department of Agriculture, 2019) [21]. In the year 2018-19 there was production of 60lakh metric tonnes in India with a productivity of 4517kg/ha and for the session 2019-20 it is estimated to produce 114 lakh metric tons of rice. As per the ranking China is the largest producer of rice followed by India. If we consider the states of India, Eastern region like Bihar, Odisha, Chhattisgarh, Madhya Pradesh, Uttar Pradesh, West Bengal found to be greater producer of rice.

Considering the whole country there is also significant coverage of area by flood. There is 5.0 million hactre are affected out of 16.1 million hectare are pretentious by submergence. (Bailey-Serres *et al.*, 2010; Mackil *et al.*, 2012) [2, 12]. There are either flash floods with full submergence ranging water depth from 25-50cm or deep flooding with more than 50cm stagnated water for some weeks. (Khush, 1984; Sarkar *et al.*, 2006) [7, 15]. Depending upon depth of stagnated water, submergence period, climatic temperature, soil type and intensity of light, there is loss of yield ranging from 10-100% (Das *et al*. 2009) [3].

The essential goal of plant breeding is to assess the variable germplasms. Genetic diversity of course plays a crucial role in breeding programme since the progeny which is obtained from the diversified parent may exhibit higher heterosis and may provide a good variability in the segregated population. Besides this diversity also causes new recombinations in a gene pool. Notably a better classification of the genotypes will ultimately help the breeder for identification of best suitable parent with broad genetic diversity from which some of the selected individuals can be used for hybridization programme.

Material and Methods

The study was carried out at the Research Farm of 'Tirhut College of Agriculture, Dholi, Dr. Rajendra Prasad Central Agricultural University', Bihar.

According to climatic zone of Muzaffarpur, Bihar the site of experiment belongs to sub-tropical in nature having high summer as well as high winter with moderate rainfall. Rainfall about 1050mm, mostly precipitated in the month of June to October. During crop season of Kharif 2019, weather condition was almost normal. However, the monsoon was slightly below than the average. Low rainfall was received during the month of July to September as per weather graph report of university.

Nursery seed beds are raised up to 5-10 cm from the field surface. Seeds are sown in the bed with proper maintenance. After 21 days seedlings were transplanted from nursery to field in RBD. Experiment was done in 3 replications for reducing error by taking three rows of 1.65 m with a spacing of 20 cm between rows and 15cm between plants. Randomization of check varieties was also done along with the accessions. For maintaining uniformity gap filling was done. NPK fertilization was done at the ratio of 60:30:30 kg/ha with Phosphorus and Potassium (K) in full dose and 1/3rd of N at last ploughing 1/3rd of Nitrogen at 30 DAT and rest at 45 DAT.

A total number of 16 observations are taken in both pre and post harvest stage. Those are Days to 50% Panicle emergence, Seedling Vigour, Plant Height, Leaf Area, Number of pubescence per square centimeter, Number of effective tillers/plant, Number of Spikelets/panicle, Number of Fertile Spikelets/panicle, days to maturity, Scoring of Submergence Tolerant, Root length, Root Volume, Crop Growth Rate, 1000 Grain weight, Harvest Index, Grain Yield/Plant.

Statistical Analysis

Mean values of all the traits of each single genotype per replication were used for Analysis of Variance as suggested by Panse and Sukhatme (1967) [13]. Broad sense heritability was calculated by the method given by Johnson *et al* (1955) [4]. Similarly Genetic Advance was obtained by the formula given by Lush (1949) [11].

Results and Discussion

The studies of genetic variability among twenty-four genotypes for seventeen characters revealed that the genotypes differed significantly for all the characters which suggested that the materials selected for the studies might be of diverse origin and can be used for breeding programme. Earlier several workers, who worked on rice, have reported the presence of variability amongst the genotypes of rice for different quantitative and qualitative traits. These findings are very similar with the findings of Namita *et al.* (2016) and Adhikari *et al.* (2018) [6, 1].

Table 1: Analysis of Variance (ANOVA) for design of experiment for seventeen morphophysioloigcal characters of 24 genotypes in Rice

	Character	Mean Sum Of Square		
		Replications (df = 2)	Genotypes (df = 23)	Error (df = 46)
1	Days to 50% Panicle Emergencce	6.84	209.11**	2.61
2	Seedling Vigour	3.19	31.28**	2.11
3	Plant Height	168.90	186.45**	71.69
4	Leaf Area	7.64	79.98**	2.39
5	Number of pubescence/sq cm	73.16	728.69**	35.36
6	Number Effective tillers/Plant	10.02	16.07**	1.65
7	Number of Spikelets/Plant	206.15	3178.27**	175.11
8	Number of Fertile Spikelets/Plant	282.32	2948.59**	220.74
9	Days to Maturity	5.19	129.02**	2.98
10	Scoring for Submergence Tolerant	0.06	2.67**	1.04
11	Root Length	25.42	35.60**	12.47
12	Root Volume	38.90	43.00**	8.45
13	Crop Growth Rate at 15 Days after sowing	0.001	0.08**	0.001
14	Crop Growth Rate at 30 Days after sowing	0.06	0.10**	0.001
15	1000Seed weight	0.27	19.38**	0.62
16	Harvest Index	4.90	23.51**	5.16
17	Grain Yield/Plant	60.81	261.70**	11.55

Glance of mean data for different yield and other traits remarkably showed the ranking order of the genotypes for the traits under consideration. Superiority of one genotype over other can be concluded by mean performance.

IR 88789 SUB 64-2-2-3, RAU 1531 IR 95133, CN 2124, PSBRc 68 found to be significantly superior than the both checks for the Seedling vigour trait. For CGR at 15DAS and CGR at 30DAS traits, IR 88789 SUB 64-2-2-3 was found to be significantly superior than both checks. IR 88789 SUB 64-2-2-3,IR 89262 SUB 5-2-3-2, IR 14D 201, IR 88243-17-1-1-3,IR 88228-33-5-2, NDR 9066, NDR 9077,CN 2124, PSBRc 68 for Submergent tolerance trait found at par to the check IR 64 SUB 1. For Grain yield/Plant, CN 2124 and PSBRc68 found at par to the check CHEHIRANG SUB 1 but significantly superior than IR 64 SUB 1. These two genotypes were also found at par to the superior check for maximum traits under study.

Table 2: Range and mean performance of seventeen different morphophysiological characters in Rice

SN	Character	Range		Mean
		Min	Max	
1	Days to 50% Panicle Emergencce	70.67	101.15	83.26
2	Seedling Vigour	8.98	18.96	14.10
3	Plant Height	96.26	132.03	111.83
4	Leaf Area	13.20	32.25	23.07
5	Number of pubescence/sq cm	50.87	107.83	72.63
6	Number Effective tillers/Plant	10.60	19.40	16.18
7	Number of Spikelets/Plant	99.40	205.50	153.18
8	Number of Fertile Spikelets/Plant	86.21	190.94	137.26
9	Days to Maturity	102.51	126.67	113.23
10	Scoring for Submergence Tolerant	2.33	5.67	4.19
11	Root Length	32.27	42.93	37.21
12	Root Volume	22.93	42.40	35.90
13	Crop Growth Rate at 15 Days after sowing	0.13	0.90	0.29
14	Crop Growth Rate at 30 Days after sowing	0.42	1.20	0.61
15	1000Seed weight	24.90	34.19	28.87
16	Harvest Index	36.03	46.30	40.54
17	Grain Yield/Plant	30.55	61.32	43.96

The results of analysis of PCV was recorded highest for Crop Growth Rate at 15 Days after sowing, Crop Growth Rate at 30 Days after sowing, Scoring for Submergence Tolerance, Number of Fertile Spikelets/ Plant, Seedling Vigour, Number of Pubescence/Square centimetre, Number of Spikelets/Plant, Grain Yield/Plant.

Low magnitude of PCV was exhibited by Days to Maturity followed by, Harvest Index, 1000Seed Weight, Plant Height. Rest of the traits exhibited moderate values of PCV like Days to 50% panicle Emergence, Root Volume, Root Length, Number of effective Tillers/Plant.

Similarly, the analysis of results of GCV was recorded highest Crop Growth Rate at 15 Days after sowing, Crop Growth Rate at 30 Days after sowing, Seedling Vigour, Leaf Area, Number of Fertile Spikelets/ Plant, Number of Pubescence/Square centimetre, Grain Yield/Plant, Number of Spikelets/Plant. Low magnitude of GCV was exhibited by Plant Height, Days to 50% panicle Emergence, Root Volume, Root Length.

Rest of the traits exhibited moderate values of GCV like and Number of effective Tillers/Plant and Scoring for Submergence Tolerant.

Similar type of results were also obtained by Rai *et al.* (2014), Kumari *et al.* (2019), Tiwari *et al.* (2019) [14, 9, 20].

A quantifiable measure that delivers info about grade of correspondence between genotypic and phenotypic variance. It is the achievement of plant breeder is to change the characteristics of population subjected to heritability. Ultimate objective of a breeder is to heritable improvement in yield which will give a platform to select the yield attributing traits for further breeding programme. To select elite genotypes from the diverse population can be possible by estimation of h^2.

- High heritability united with high GA as % of mean were noted maximum for CGR at 30DAS followed by Crop Growth Rate at 15 Days after sowing, Days to 50% panicle Emergence, Seedling Vigour, Leaf Area, Number of Pubescence/Square centimetre, Number of effective Tillers/Plant, Number of Spikelets/Plant indicates there may be presence of Additive Gene Action along with direct choice for these traits will be useful.
- Low Heritability coupled with high GA found in Scoring for Submergence Tolerance indicates there may be presence of Additive Gene Action and selection can be useful.
- High heritability with low GA was found in Days to Maturity, which specifies there may be presence of Non Additive Gene action and Selection will be ineffective. Thus, heterosis breeding is useful.

Similar type observation were observed by Singh *et al.* (2015), Sarwar *et al.* (2015) [19, 16].

Table 3: Genotypic and phenotypic Coefficient of Variation and other genetic parameters for 17 morpho physiological characters in Rice

Character	Genotypic Variance (σ^2g)	Phenotypic Variance (σ^2p)	Genotypic coefficient of Variance (GCV)	Phenotypic coefficient of Variance (PCV)	Heritability Broad Sense (h^2)	Genetic Advance (GA) at 5%	Genetic Advance as percent Of mean (5%)
Days to 50% Panicle Emergencce	68.83	71.45	9.97	10.15	0.96	16.78	20.15
Seedling Vigour	9.72	11.84	22.12	24.40	0.82	5.82	41.30
Plant Height	38.25	109.95	5.53	9.38	0.35	7.52	6.72
Leaf Area	25.86	28.26	22.05	23.04	0.92	10.02	43.45
Number of pubescence/sq cm	231.11	266.47	20.93	22.48	0.87	29.17	40.16
Number Effective tillers/Plant	4.80	6.46	13.54	15.71	0.74	3.89	24.05
Number of Spikelets/Plant	1001.05	1176.17	20.57	22.30	0.85	60.13	39.01
Number of Fertile Spikelets/Plant	909.28	1130.03	21.97	24.49	0.81	55.72	40.60
Days to Maturity	42.02	45.00	5.72	5.92	0.93	12.90	11.40
Scoring for Submergence Tolerant	0.54	1.58	17.54	29.99	0.34	0.89	21.12
Root Length	10.80	20.41	8.83	12.14	0.53	4.92	13.22
Root Volume	11.51	19.98	9.06	11.94	0.58	5.31	14.17
Crop Growth Rate at 15 Days after sowing	0.03	0.03	57.24	58.30	0.96	0.33	115.74

Crop Growth Rate at 30 Days after sowing	0.04	0.04	30.72	31.27	0.97	0.38	62.14
1000Seed weight	6.25	6.88	8.66	9.08	0.91	4.91	17.00
Harvest Index	6.12	11.28	6.10	8.28	0.54	3.75	9.26
Grain Yield/Plant	83.38	94.93	20.77	22.16	0.88	17.63	40.01

Classes of Heriytability (%): High > 60%, Medium 30-60%, Low < 30%
Classes of Genetic Advance (%): High >20%, Medium 10-20%, Low <10%

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