



## Variability, heritability, genetic advance analysis in aerobic rice

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### Abstract

Genetic variability studies provide basic information concerning the genetic properties of the population based on which breeding methods could be formulated for further improvement of the crop. Twenty two aerobic genotype and four checks were evaluated for variability, heritability and genetic advance in different yield and yield contributing traits in Rice Research Station, O.U.A.T., Bhubaneswar during 2015 kharif season. The data was recorded on five randomly selected plants for ten quantitative characters i.e. days to 50% flowering, Plant height, effective tillers/m<sup>2</sup>, flag leaf area, panicle length, fertile grains/panicle, fertility percentage, 1000 grain weight, L/B ratio & plot yield. The result reveal that mean sum of squares due to genotypes showed significant differences for all ten characters studied, indicating the presence of high genetic variability among the genotypes. PCV and GCV was high for effective tiller/panicle (gcv-22.51, pcv-22.84), flag leaf area (gcv-30.86, pcv-31.31), fertile grain/panicle (gcv-38.12, pcv-38.83), fertility percentage (gcv-28.50, pcv-29.57), grain yield (gcv-49.53, pcv-51.07) and moderate for 1000 grain weight (gcv-13.53, pcv-15.35), L/B ratio (gcv-13.69, pcv-15.27) and low in rest of the characters. High degree of heritability estimates were obtained in case of flag leaf area (97.16), effective tiller per panicle (97.09), number of fertile grains/panicle (96.41), plot yield (94.08), panicle length (93.88). For the rest of the characters heritability estimates were moderate. Genetic advance (%) over mean was high for plot yield (84.56), number of fertile grains per panicle (65.89), flag leaf area (53.55), fertility percentage (48.35) and it was moderate too low for rest of the characters. Mean performance of the rice genotypes indicated that PA 6129 (2588.33 kg/ha) was promising with respect to the yield performance associated with high panicle length, number of fertile grains / panicle, fertility percentage and 100 grain weight followed by TRC 2014-14/IR82589-B-B-2-2 (2399 kg/ha), then RCPR-19-IR 84899-B-179-13-1-1-1(2399 kg/ha), then CR DHAN 202, then RAU1484-Are-04 (1957 kg/ha).

**Keywords:** phenotypic variance, genotypic variance, genetic advance, heritability, aerobic rice

### Introduction

Increasing scarcity of water has threatened the traditional rice cultivation practices all over the world (Tuong and Bouman 2003) [17]. The situation is further aggravated by drought, global warming, methane emission, adverse climatic changes, over-pumping of ground water causing aquifer resources to decline and the high “cost” of water (Tuong and Bouman 2003) [17]. Irrigation for agriculture consumes 2/3 of world’s fresh water and rice alone consumes more than 50 percent of the water used for irrigation in Asia. By 2050, a “physical water scarcity” is projected for more than 2 million ha. of irrigated dry season rice and 13 million ha. of irrigated wet season rice in Asia, and an ‘economic water scarcity’ is expected to hamper most of Asia’s 22 million ha. of irrigated dry-season rice (Tuong and Bouman 2002) [16]. Decrease water scarcity has prompted the research on development of water efficient “aerobic rice” varieties. Aerobic rice is a water-saving rice production system in which potentially high yielding, fertilizer responsive adapted rice varieties are grown in fertile aerobic soils that are non-puddled and have no standing water. Supplementary irrigation, however, can be supplied in the same way as to any other upland cereal crop (Wang *et al.*, 2002; Bouman *et al.*, 2005) [19, 2]. For the tropics, the aerobic rice system is still under development. But also here, high yields can be obtained; in transplanted aerobic rice, e.g. up to 6 t ha<sup>-1</sup> (Bouman *et al.*, 2008) [2]. Water input in

aerobic rice were less than 50% (only 470-650mm), water productivities were 64-88% higher, gross returns were lower by 28-44% (345-633ha.) and labour use were 55% lower. Aerobic rice may find its place in water-short irrigated lowlands, fields on upper slopes or terraces in undulating, rainfed lowlands, favourable uplands etc. The present study, therefore, is aimed at assessing genetic variability, heritability & genetic advance of yield and yield components in some aerobic rice genotypes that contributed to increase yield potential.

### Material and Method

The experiment was conducted at Rice Research Station, O.U.A.T., Bhubaneswar during 2015 kharif season. 22 aerobic rice genotypes and 4 check varieties were collected from AICRP trails on aerobic rice, conducted in a Randomized Block Design with three replications. The plot size was 5.28 meter square with spacing 20 x 15 cm. Observations were recorded for ten metric traits taking five competitive plants selected randomly from middle rows of each plot; where as, characters like plot yield and days to 50 % flowering were recorded on plot basis and number of effective tillers was observed on square meter basis. The characters studied were days to 50% flowering, Plant height, effective tillers/m<sup>2</sup>, flag leaf area, panicle length, fertile grains/panicle, fertility percentage, 1000 grain weight, L/B ratio & plot yield. The

replicated data recorded on the above characters were subjected to the following statistical analysis: Analysis of variance (ANOVA), Variance and Co-efficient of Variance, Heritability (Broad sense), and Genetic Advance. The whole details of genotypes and their parentage are given in table 1.

### Result

The analysis of variance in respect of ten different characters was carried out in the present investigation and has been presented in Table 2. From the analysis of variance it was observed that there exists a highly significant difference among the test genotypes for all the characters under study. The result obtained from the study of genotypic and phenotypic co-efficient of variation is presented in Table 3. From the investigation, it was observed that the phenotypic co-efficient of variation was found to be higher than that of genotypic coefficient of variation for all the characters in the set of materials. Among all the characters studied, GCV ranged from 6.11 for days to 50% flowering to 49.53 in plot yield and PCV ranged from 6.33 for days to 50% flowering to 51.07 for plot yield. PCV and GCV was high for effective tiller/panicle(gcv-22.51,pcv-22.84), flag leaf area(gcv-30.86,pcv-31.31), fertile grain/panicle(gcv-38.12,pcv-38.83), fertility percentage(gcv-28.50,pcv-29.57), grain yield(gcv-49.53,pcv-51.07) and moderate for 1000 grain weight(gcv-13.53,pcv-15.35), L/B ratio(gcv-13.69,pcv-15.27) and low in rest of the characters.

The heritability in broad sense and genetic advance for all the characters are presented in Table 3. High degree of heritability estimates were obtained in case of flag leaf area(97.16), effective tiller per panicle(97.09), number of fertile grains/panicle(96.41), plot yield(94.08), panicle length(93.88). For the rest of the characters heritability estimates were moderate.

Genetic advance (%) over mean was high for plot yield (84.56), number of fertile grains per panicle(65.89), flag leaf area(53.55), fertility percentage(48.35) and it was moderate to low for rest of the characters.

The mean performance of 26 aerobic rice for 10 characters is presented in Table 4. The overall mean of each character along with its range obtained. Mean performance of various genotypes with respect to various characters for 26 aerobic rice genotypes are presented in table 5. And the result is given below.

#### i) Days to 50% flowering

The varietal mean for days to 50% flowering ranged from 78.00 days in CR Dhan 202 and mandakini to 103.00 days in CR 3580-3-1-1-1-1-1 with over all mean of 83.14 days.

#### ii) Plant height

The overall mean of plant height was 104.65 cm, with a range of 91.20 cm to 115.60 cm in CR 3947-1-3-1-1-1 and RCPR 8(IR 84899-B-179-16-1-1-1) respectively.

#### iii) No. of tiller/ m<sup>2</sup>

The observed range for no. of tiller/m<sup>2</sup> was highest i.e. 108.00 in TRC- 2015-14 to 319.67 in RCPR-20-IR83929-B-B-291-2-1-1-2 with over all mean of all the genotypes was 223.05.

#### iv) Panicle length

The overall mean of all the genotypes for panicle length was 23.62 cm and range was 20.22 cm to 28.90 cm. The genotype TRC-2015-12 was having the lowest panicle length and genotype BRR0006(IR87759-2-2-1-1) was having the highest panicle length.

#### v) Flag leaf area

The range of variability for flag leaf area among the test genotype was 17.76 cm<sup>2</sup> to 62.40 cm<sup>2</sup> with an overall mean of 28.81 cm<sup>2</sup>. Among the genotype, R 1973-206-2-86-1 had the lowest flag leaf area and the highest flag leaf area was present in CR 3580-3-1-1-1-1-1.

#### vi) No. of fertile grains / panicle

The observed range was 11.67-131.00 and the mean was 73.50. The highest and lowest values were observed in genotypes MC13 and TRC-2015-14 respectively.

#### vii) Fertility %

The overall mean of fertility % was 66.05 and the range was highest in RCPR 8(IR 84899-B-179-16-1-1-1) i.e. 91.59 and 21.81 in TRC-2015-14 which is lowest.

#### viii) L-B Ratio

The overall mean of all the genotypes was 3.55 and the range was 2.72 to 5.12 in NDR CR 3580-3-1-1-1-1-1 and CR 3947-1-3-1-1-1 respectively.

#### ix) 100 Grain weight

The overall mean of 100 grain weight of all the genotypes was 2.18 gm and the range was 1.47gm to 2.89gm in CR 3580-3-1-1-1-1-1 and RCPR 8(IR 84899-B-179-16-1-1-1) respectively.

#### x) Plot yield

The plot yield varied from 455 Kg/ha in RP 5587-B-B-B-305-13 & CR 3580-3-1-1-1-1-1 to 2588.33 kg/ha in PA 6129(HC) with over all mean of 1328.18 kg/ha.

**Table 1:** Details of rice germplasm for 26 aerobic rice genotypes used in the study.

S. No.	Designation	Cross combination
1.	TRC 2014-14/IR 82589-B-B-2-2	IRRI-1321/ IR 74371-54-1-1
2.	TRC2014-11/ IR83377-B-B-123-2	IR 71700-247-1-1-2/ Sambha Mahsuri
3.	CR DHAN202(ZC)	
4.	RCPR-19-IR 84899-B-179-13-1-1-1	IR 78877-208-B-1-1/ IRR1 134
5.	MANDAKINI	
6.	BRR0006(IR87759-2-2-1-1)	IR 80463-B-39-3/ IR 81421-B-B-66
7.	RCPR8(IR84899-B-179-16-1-1-1)	IR 78877-208-B-1-1/ IRR1 132
8.	CR DHAN201(NC)	

9.	KMP 128	IR 64/ Bharani
10.	KPH 272(HYBRID)	
11.	NPH912(HYBRID)	NPS 2001A/ NPS 2334
12.	NPH8899(HYBRID)	NPS 8001A/ NP1001R
13.	PA6129(HC)	
14.	RAU1484-Aer-04	OG 6709-7/APO
15.	BRR0007(IR87638-10-1-1-3)	Dhagaddeshi/ ir 78585-98-2-2
16.	R1973-206-2-86-1	MTU 1010 x RP 4092
17.	MC13	MC 13A/ MC13R
18.	RCPR-20-IR83929-B-B-291-2-1-1-2	IR 78878-53-2-2-2/ CT6510-24-1-2
19.	TRC-2015-14	Naveen/ Fulbadam
20.	CR3856-44-22-2-1-10-3-1	IR 73963-86-1-5-2-2/ CR 2324
21.	R1986-296-2-86-1	Dateswari/ R 1493
22.	CR 3948-2-1-2-2-1	Lalat/ CR 2340-11
23.	RP5587-B-B-B-305-13	IR 64/ IR 75870-5-8-5-B-2-B
24.	CR3947-1-3-1-1-1	IR 64/ PSB RC18
25.	CR3580-3-1-1-1-1-1	Lalat/ N22
26.	TRC-2015-12	Naveen/ Katak tara

**Table 2:** Analysis of variance for various characters (mean sum of squares) for 26 aerobic rice genotypes

S. No.	Characters	Mean sum of squares (df)		
		Replication (2)	Genotype(25)	Error (50)
1.	Days to 50% flowering	52.930 **	82.930**	5.336
2.	Plant height (cm)	346.875**	147.517**	17.888
3.	Effective tillers/m <sup>2</sup>	2280.875**	7789.510**	226.565
4.	Panicle length (cm)	35.500**	14.133**	0.865
5.	Flag leaf area (cm <sup>2</sup> )	154.528**	244.068**	6.920
6.	No. of fertile grains/panicle	53.577	2443.287**	27.88
7.	Fertility%	51.185	1144.224**	81.012
8.	L-B Ratio	2.231**	0.879**	0.173
9.	100 grain weight(gm)	0.714**	0.336**	0.075
10.	Plot yield (kg/ha)	437257.200**	1380101.000**	81668.830

\* Significant at 5% level \*\* Significant at 1% level

**Table 3:** PCV, GCV, h<sup>2</sup> and GA estimates for various characters for 26 aerobic rice genotypes

S. No.	Characters	PCV	GCV	h <sup>2</sup>	GA (10%)	GA % over mean
1.	Days to 50% flowering	6.32	6.11	93.56	8.65	10.41
2.	Plant height (cm)	6.70	6.28	87.87	10.85	10.36
3.	Effective tillers/plant	22.84	22.51	97.09	87.07	39.04
4.	Panicle length (cm)	9.19	8.91	93.88	3.59	15.19
5.	Flag leaf area (cm <sup>2</sup> )	31.31	30.86	97.16	15.42	53.55
6.	No. of fertile grains/panicle	38.83	38.12	96.41	48.43	65.89
7.	Fertility %	29.57	28.50	92.92	31.94	48.35
8.	L-B Ratio	15.27	13.69	80.36	0.77	21.59
9.	100 grains weight (gm)	15.35	13.53	77.71	0.46	21.00
10.	Plot yield (q/ha)	51.07	49.53	94.08	1123.09	84.56

PCV- phenotypic co-efficient of variance, GCV- genotypic co-efficient of variance, h<sup>2</sup>- heritability, G.A –genetic variance**Table 4:** Mean & range for various characters for 26 aerobic rice genotypes

S. No.	Characters	Mean	Range
1.	Days to 50% flowering	83.14	78.00-103.00
2.	Plant height (cm)	104.65	91.20-115.60
3.	Effective tillers/plant	223.05	108.00-319.67
4.	Panicle length (cm)	23.62	20.22-28.90
5.	Flag leaf area (cm <sup>2</sup> )	28.81	17.76-62.76
6.	No. of fertile grains/panicle	73.50	11.67-131.00
7.	Fertility %	66.05	21.81-91.59
8.	L-B Ratio	3.55	2.72-5.12
9.	100 grains weight (gm)	2.18	1.47-2.89
10.	Plot yield (kg/ha)	1328.18	455-2588.33

**Table 5:** Mean performance of various genotypes with respect to various characters for 26 aerobic rice genotypes

S. No.	Designation	Days to 50% flowering	Plant height (cm)	No. of Tillers/m <sup>2</sup>	Panicle length (cm)	Flag leaf Area(cm <sup>2</sup> )	Fertile grains/panicle	Fertility %	L-B Ratio	100 grains Weight(gm)	Plot Yield (kg/ha)
1.	TRC 2014-14/IR 82589-B-B-2-2	78.67	112.42	211.00	23.90	27.68	84.33	84.21	3.00	2.24	2399.00
2.	TRC2014-11/ IR83377-B-B-123-2	80.00	109.77	212.00	23.37	21.12	63.33	63.43	3.80	2.11	947.00
3.	CR DHAN202(ZC)	78.00	114.60	205.00	24.65	25.34	81.33	81.37	3.40	2.41	2335.67
4.	RCPR-19-IR 84899-B-179-13-1-1-1	78.67	110.65	238.33	23.80	24.20	74.33	74.13	3.16	2.39	2399.00
5.	MANDAKINI	78.00	108.42	211.00	25.15	25.97	59.33	59.25	3.37	2.39	1199.33
6.	BRR0006(IR87759-2-2-1-1)	83.00	115.00	238.00	28.90	28.72	48.00	47.99	3.92	2.15	1010.00
7.	RCPR8(IR84899-B-179-16-1-1-1)	80.00	115.60	255.00	23.07	24.90	91.67	91.59	2.98	2.89	1515.33
8.	CR DHAN201(NC)	80.00	106.13	251.00	24.73	23.56	68.33	68.13	3.30	2.24	1262.67
9.	KMP 128	80.00	106.73	238.00	24.77	18.67	51.67	52.67	3.85	2.30	820.67
10.	KPH 272(HYBRID)	86.00	97.63	286.00	23.23	27.74	79.00	78.76	3.53	2.09	1830.67
11.	NPH912(HYBRID)	86.67	100.33	276.67	26.73	30.46	66.33	66.48	4.36	2.13	946.67
12.	NPH8899(HYBRID)	90.00	98.07	233.00	22.20	30.50	45.00	45.16	3.50	1.52	378.67
13.	PA6129(HC)	80.00	106.33	229.33	25.73	28.57	81.00	80.89	3.26	2.83	2588.33
14.	RAU1484-Aer-04	81.00	110.60	233.00	21.97	25.03	88.00	87.79	3.00	2.52	1957.00
15.	BRR0007(IR87638-10-1-1-3)	83.00	105.23	292.33	27.80	22.63	39.00	38.90	4.07	2.02	820.67
16.	R1973-206-2-86-1	85.00	96.00	225.00	20.40	17.76	120.00	68.30	3.99	2.00	1818.00
17.	MC13	80.00	103.40	253.33	25.08	26.32	131.00	88.39	3.08	2.38	1818.00
18.	RCPR-20-IR83929-B-B-291-2-1-1-2	83.00	113.40	319.67	22.40	27.56	87.00	90.81	3.02	2.19	1591.00
19.	TRC-2015-14	87.67	93.20	108.00	20.68	33.89	11.67	21.81	4.21	2.08	341.00
20.	CR3856-44-22-2-1-10-3-1	85.00	103.60	134.33	24.16	24.72	71.00	48.00	3.32	1.68	909.00
21.	R1986-296-2-86-1	82.00	99.80	213.33	21.80	35.84	86.33	76.03	3.70	1.76	1022.67
22.	CR 3948-2-1-2-2-1	82.00	100.60	119.67	23.40	42.00	108.00	55.84	3.19	2.19	1136.33
23.	RP5587-B-B-B-305-13	88.00	94.40	238.67	22.68	41.44	20.67	25.93	4.06	1.96	455.00
24.	CR3947-1-3-1-1-1	84.00	91.20	238.33	21.78	22.27	53.33	72.60	5.12	2.30	682.00
25.	CR3580-3-1-1-1-1	103.00	103.00	197.00	21.42	62.40	84.33	62.96	2.72	1.47	455.00
26.	TRC-2015-12	79.00	104.60	142.33	20.22	29.68	117.00	85.95	3.28	2.38	1894.00

## Discussion

Presence of genetic variability is a prime requirement in any crop improvement programme. The set of genotypes used in the present study indicated existence of significant differences among themselves of all the character studied, as evidenced from the analysis of variance (Table 2).

Mean performance of the rice genotypes indicated that PA 6129(HC) was promising with respect to the yield performance associated with high panicle length, number of fertile grains / panicle, fertility percentage and 100 grain weight.

The estimates of mean, range, PCV, GCV, heritability and genetic advance as revealed from Table 3 indicated existence of considerable amount of variability among the genotypes for all the characters studied.

The expected amount of genetic advance can be estimated by genotypic coefficient of variation along with heritability as suggested by Burton. In the present study, all characters show high heritability except 100 grain weight and L-B ratio. Similar results have been obtained by Ganeshan and Subramanian (1990) [5], Bai *et al* (1992) [1], Hasib *et al.* (2004) [7], Das *et al.* (2005) [4], Jaiswal *et al.* (2007) [9], Immanuel Selvaraj C. *et al.* (2011) [8], M. K. Prajapati *et al.* (2011) [11] Satheshkumar *et al.* (2012) [14]. High heritability values indicated that criteria for selection might be chosen from among these characters on the basis of phenotypic performance.

The genotypic and phenotypic coefficient of variation in different characters maintained correspondence for all the characters under study. In general, the phenotypic coefficient

of variation was higher than the genotypic coefficient of variation suggesting influence of environment on the expression of these characters. Similar observation has also been noted by Bai *et al.* (1992) [1], Chand *et al.* (2004) [3], Singh *et al.* (2007) [15], Laxuman, P. M. Salimath, *et al.* (2010) [10], M. K. Prajapati *et al* (2011) [11]; Raghavendra P and S. Hittalmani (2015) [13]. Both GCV & PCV were high for number of fertile grains/panicle, flag leaf area, fertility percentage, effective tiller/m<sup>2</sup> and grain yield.

The genetic advance in percentage of mean was high for grain yield, number of fertile grains/panicle, flag leaf area, fertility percentage and moderate to low for all other characters. As genetic advance in conjunction with heritability gives more reliable selection index than heritability alone, efforts were made to indicate both heritability and genetic advance values for various traits. A high degree of heritability estimates were associated with high degree of genetic advance for fertile grains per panicle, flag leaf area, plot yield, fertility percentage and number of effective tillers per plant indicating presence of additive effect & hence selection based on phenotypic performance would be effective (Gomathi Nayagam *et al.*, 1990; Bai *et al.*, 1992, Ganesan *et al.*, 1995; Yadav *et al.*, (2010); Chand *et al.*, 2004; Das *et al.*, 2005; Jaiswal *et al.*, 2007; Prasad *et al.*, 2009 and M. K. Prajapati *et al.*(2011); B.A. Veerasha *et al.*(2014) [6, 1, 5, 20, 3, 4, 9, 12, 11, 18].

## Conclusion

Presence of genetic variability is a prime requirement in any crop improvement programme. The set of genotypes used in the present study indicated existence of significant differences

among themselves of all the character studied, as evidenced from the analysis of variance.

Mean performance of the rice genotypes indicated that PA 6129(HC) was promising with respect to the yield performance associated with high panicle length, number of fertile grains / panicle, fertility percentage and 100 grain weight.

The estimates of mean, range, PCV, GCV, heritability and genetic advance indicated existence of considerable amount of variability among the genotypes for all the characters studied. In the present study, all characters showed moderate to high heritability. High heritability values indicated that criteria for selection might be chosen from among these characters on the basis of phenotypic performance.

The genotypic and phenotypic coefficient of variation in different characters maintained correspondence for all the characters under study. Both GCV & PCV were high for number of fertile grains/panicle, flag leaf area, fertility percentage, effective tiller/m<sup>2</sup> and plot yield.

The genetic advance in percentage of mean was high for grain yield, number of fertile grains/panicle, flag leaf area, fertility percentage, plot yield and moderate to low for all other characters. A high degree of heritability estimates were associated with high degree of genetic advance for fertile grains per panicle, flag leaf area, plot yield, fertility percentage and number of effective tillers per plant indicating presence of additive effect & hence selection based on phenotypic performance would be effective.

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