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CONTENTS

Assessment of genetic parameters in F_5 recombinants derived from *Indica* rice (*Oryza sativa* L.) line Pusa 6A

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ABSTRACT: Availability of superior restorer lines is prerequisite for hybrid rice development. The present study was conducted on half-sib recombinants in F_5 generation derived from the scented rice CMS line Pusa 6A, in order to isolate promising restorer lines. Fifty-one such recombinants were evaluated along with 5 check varieties in an Alpha-lattice design during 2019 and observations were recorded for 13 agro-economically important traits. Results of the phenotypic assessment of the genotypes revealed that genotypic coefficient of variance and phenotypic coefficient of variance were moderate to high for different traits used in the study, whereas environmental coefficient of variance was found to be low. The study revealed high heritability coupled with high genetic advance as per cent of mean for important phenotypic traits. It could be effectively used for selection of promising genotypes for better genetic gain in the next generations.

Key words: Genetic parameters, Half-sibs, recombinants, rice

Rice (*Oryza sativa* L.) is the second important staple food for more than 50 per cent population of the world. Almost every person on this globe uses rice in one or the other form (http://ricepedia.org/rice-as-food/the-global-staple-rice-consumers). During 2017-18, total production of rice in the world is 494.9 million tonnes with productivity of 4.56 tonnes per hectare, while that in India is a total of 112.91 million tonnes with a productivity of 2.57 tonnes/hectare (Directorate of Economics and Statistics; and Department of Agriculture, Cooperation and Farmers Welfare, Government of India). Systematic hybrid rice research was initiated in India during 1989 and the first hybrid rice was released in during 1993–94. With this, India became the second country after China to commercialize hybrid rice. Subsequently, India has made substantial progress and developed total 117 rice hybrids having 15–20% yield superiority with 115–150 days duration for various rice ecosystems (https://www.intechopen.com/online-first/hybrid-rice-research-current-status-and-prospects). For commercial production of hybrids in rice, two systems are prevalent namely three-line and two-line system (Sinha *et al.*, 2020). In case of three line system, WA-type cytoplasm is found to be restored by two dominant *Rf* genes (Tan *et al.*, 2008). Despite of having significant importance for the rice farming in India, there are several bottlenecks in the hybrid rice technology like lack of cytoplasmic diversity outside china, less amount of heterosis in intra-subspecific crosses and poor grain quality etc. Now, the plant breeders are using several methods and techniques for overcoming these problems, diversification of male and female parental material is continued to be one of the most important aspect in this regard. The present study was carried out to find out more diverse and suitable male parental lines from half-sibs derived from scented rice CMS line Pusa 6A. The half-sibs were evaluated in F_5 generation for genetic variation and parameters. Genetic parameters provide basis for the genetic variation available in the germplasm.

MATERIALS AND METHODS

Genetic materials

The experimental materials comprised of 51 half-sib recombinants in F_5 generation selected from different crosses having well known rice CMS line Pusa 6A as female parent in common and five famous check varieties of different maturity duration. Detail of the genotypes and checks are presented in Table 1**.**

Experimental design and field layouts: The genotypes along with checks were evaluated in Alpha-lattice design with 3 replications at the research farm of Rice Section of Bihar Agricultural College, Sabour during *Kharif* 2019. The materials were grown with a spacing of 20 x 20 cm (both row to row and plan to plant) keeping a plot size of 3.60 m^2 perentry / per replication. All the standard crop management practices were followed to raise a healthy crop.

Sampling, data recording and statistical analysis: Data were recorded from five randomly selected plants of each genotype from middle rows and averaged for each replication, leaving the first two border rows from all the four sides to avoid sampling error. Observations for 13 important agronomical traits namely, days to 50% flowering, plant height (cm), panicle length (cm), number of effective tillers per hill, flag leaf length (cm), flag leaf width (cm), panicle exertion rate (PER) (%), spikelet fertility percentage, Grain decorticated length (mm), grain decorticated width (mm), 1000 grain weight (g), and grain yield per plot (kg) were recorded. The analysis of variance was worked out to test the differences among genotypes by F-test as per methodology advocated by Patterson and Williams (1976). Critical difference (C.D.) was calculated in order to compare two treatments mean. Other statistical parameters such as mean, range, variance and coefficient of variance (CV) were calculated as per standard procedure. Genotypic and Phenotypic coefficients of variation were calculated by the method proposed by Burton and Devane (1953) and categorized by Sivasubramanian and Menon (1973). Heritability in broad sense was calculated by the formula specified by Lush (1940) and the estimations of genetic advance were obtained by the method as suggested by Lush (1949) and Johnson *et al.* (1955).

RESULTS AND DISCUSSION

ANOVA for Alpha-Lattice design revealed significant differences among the genotypes for all traits under study (Table 2). Analysis of variance showed almost all genotypes to be significantly varying among each other for all the traits in observation. Thus they can be subjected to selection. A wide range of mean performance was observed for different characters under study. The highest and the lowest values for different traits are given in Table 3. Similar results were observed by Sabagh *et al.* (2019) while working on hybrids. Kiani, 2012 found 68.22% variation among the rice restorer lines, based on the different agronomic traits. Devi *et al.,* 2017 also reported similar results while studied the variability on different diverse rice genotypes.

The genotypes showed moderate to high genotypic coefficient of variance (GCV) and phenotypic coefficient of variance (PCV) for most of the six traits including plant

Table 1: Genotypes (Test Entries and Checks) used in the study

S. No.	Code	Name/ Designation	S. No.	Code	Name/Designation
1	PPK1901	(Pusa 6A/CR 2713-179)-2-3-6	29	PPK1929	(Pusa 6A/MTU1001//Pusa 6B)-4-7-9
2	PPK1902	(Pusa 6A/IRRI 123)-1-4-7	30	PPK1930	(Pusa 6A/IRMT4472)-9-11-4
3	PPK1903	(Pusa 6A/SBR-Sel-A 1103-1)-5-7-9	31	PPK1931	(Pusa 6A/IRMT4480)-6-1-10
4	PPK1904	(Pusa 6A/CR 3622-7-3-1-1-1)-3-12-4	32	PPK1932	(Pusa 6A/LPD 104-B-B-1-8-2-1-1)-13-1-3
5	PPK1905	(Pusa 6A/PRR78//NDR 359)-7-2-6	33	PPK1933	(Pusa 6A/R 1700-2240-4-2295-1)-1-8-1
6	PPK1906	(Pusa 6A/NDR 359)-14-6-7	34	PPK1934	(Pusa 6A/HHZ 14-DT12-LI1-LI1)-7-3-8
7	PPK1907	(Pusa 6A/R 1240-913-2-1013-1)-6-7-1	35	PPK1935	(Pusa 6A/HUA 565)-8-7-2
8	PPK1908	(Pusa 6A/CR 3825-2-1-2-2-3)-5-3-4	36	PPK1936	(Pusa 6A/HHZ 12-Y4-DT1-Y2)-15-2-11
9	PPK1909	(Pusa 6A/PRR78//Akshyadhan)-6-7-3	37	PPK1937	(Pusa 6A/HHZ 10-SAL3-LI1-LI1)-13-5-7
10	PPK1910	(Pusa 6A/IR64// Akshyadhan)-17-3-17	38	PPK1938	(Pusa 6A/IR 87759-5-2-1-3)-7-1-1
11	PPK1911	(Pusa 6A/Akshyadhan)-2-8-7	39	PPK1939	(Pusa 6A/IR 06N132)-8-7-1
12	PPK1912	(Pusa 6A/RYC 674)-21-5-4	40	PPK1940	(Pusa 6A/Swarna Sub-1)-15-12-8
13	PPK1913	(Pusa 6A/RYC 692)-2-3-11	41	PPK1941	(Pusa 6A/IR 13K5134)-7-9-1
14	PPK1914	(Pusa 6A/IR 06N120)-2-4-8	42	PPK1942	(Pusa 6A/Samba Mahsuri)-8-9-11
15	PPK1915	(Pusa 6A/IRRYC457)-3-8-7	43	PPK1943	(Pusa 6A/WR 37-2-1-1)-17-1-8
16	PPK1916	(Pusa 6A/Katarni)-7-13-1	44	PPK1944	(Pusa 6A/WR 41-12-7-9)-10-8-14
17	PPK1917	(Pusa 6A/Narendra Usar Dhan-3)-5-4-9	45	PPK1945	(Pusa 6A/IRMT4491)-4-2-4
18	PPK1918	(Pusa 6A/KKMBRNS-2)-6-1-2	46	PPK1946	(Pusa 6A/SBR-TelSel-2-1)-2-4-5
19	PPK1919	(Pusa 6A/WGL 536)-7-2-4	47	PPK1947	(Pusa 6A/SBR-SSK16-1-14)-7-5-8
20	PPK1920	(Pusa 6A/MTU1010// Akshaydhan)-12-6-8	48	PPK1948	(Pusa 6A/SBR-SSK16-15-17)-4-2-1
21	PPK1921	(Pusa 6A/IRK4098)-3-1-3	49	PPK1949	(Pusa 6A/SBR-TelSel-1-5)-8-17-2
22	PPK1922	(Pusa 6A/CRL 74-89-2-4-2SBR-1)-2-4-3	50	PPK1950	(Pusa 6A/RM-1// NL-1-1)-6-1-7
23	PPK1923	(Pusa 6A/BCN16-4-3)-2-4-1	51	PPK1951	(Pusa 6A/SBR-Sel-CN 1603-1-1-3)-4-5-2
24	PPK1924	(Pusa 6A/BCN16-9-1)-4-8-2	52	PPK1952	Swarna (C_1)
25	PPK1925	(Pusa 6A/CSIDSEP121)-1-7-5	53	PPK1953	Rajendra Sweta (C_2)
26	PPK1926	(Pusa 6A/SBR-Sel-CN 1643-3-1-1)-6-4-1	24	PPK1954	Rajendra Suhasini (C_3)
27	PPK1927	(Pusa 6A/CSIDSMEP305)-6-1-9	55	PPK1955	Sahbhagi Dhan (C_4)
28	PPK1928	(Pusa 6A/SBR-Sel-CN 1648-8-1-11)-2-7-5	56	PPK1956	Sabour Deep (C_5)

Table 2: ANOVA in Alpha Lattice design for 13 agro-morphological traits

S. No.	Name of the Trait		MSS (Genotypes)	MSS (Replication)	MSS (Blocks)	MSS (Error)
	Name in full	Name in short				
1	Days to 50% Flowering	DFF	100.98**	2.86	27.05**	3.12
2	Plant Height (cm)	PHT	346.76**	19.39	414.21**	22.06
3	Panicle length (cm)	PANLEN	10.18**	0.87	14.22*	4.86
4	Flag leaf: Width (mm)	FLW	0.15**	0.15	6.35	0.04
5	Flag leaf: Length (cm)	FLL	40.09**	20.61*	15.92*	5.05
6	Panicle Exertion Rate (PER) (%)	PER	36.83**	0.45	1.64	3.26
7	Number of effective tillers/ hill	ETILL	9.13*	4.83	6.35	5.79
8	Spikelet Fertility (%)	SFP	72.70**	210.03**	48.26**	8.44
9	1000-grain weight (g)	TW	18.89**	1.14	46.83**	0.82
10	Grain (decorticated) length (mm)	GDL	1.08**	0.11	0.52**	0.068
11	Grain (decorticated) width (mm)	GDW	0.11**	0.01	0.14**	0.01
12	Grain (decorticated) length/width ratio	GLBR	0.59**	0.01	0.11*	0.00
13	Yield /plot (kg/ha)	GYPKG	0.37**	0.59**	0.16**	0.03

Table 3: Range, Mean, CD (5%) and CV (%) for different traits among half-sibs

Trait	Lowest value	Highest value	Lowest check	Highest check	Mean	CD (5%)	CV (%)
Days to 50% flowering (days)	82.66(PPK1956)	112.66(PPK1952)	82.66(S. Deep)	112.66(Swarna)	93.45	2.85	1.88
Plant Height (cm)	83.66(PPK1911)	137.93(PPK1933)	86.00(R. Sweta)	99.53(S. Dhan)	105.29	7.71	4.52
Panicle length (cm)	19.87(PPK1953)	30.06(PPK1922)	19.87(R. Sweta)	27.60(S. Deep)	25.05	3.58	8.84
Flag leaf width (cm)	0.96(PPK1902)	1.86(PPK1950)	0.97Swarna	1.46R. Suwasini	1.30	0.34	16.09
Flag leaf length (cm)	26.82(PPK1931)	45.90(PPK1909)	30.74(R. Sweta)	44.18(S. Deep)	37.50	3.60	5.94
Panicle exertion rate (%)	86.33(PPK1943)	100.00	100.00	100.00	98.66	2.90	1.81
Effective tillers per plant	7.71(PPK1956)	14.53(PPK1948)	7.71(S Deep)	11.27(Swarna)	10.32	3.90	23.34
Spikelet fertility (%)	74.95(PPK1933)	96.38(PPK1949)	92.20(R. Suwasini)	94.31(Swarna)	88.53	4.66	3.25
1000 grain weight (g)	14.54(PPK1944)	26.13(PPK1904)	15.39(R. Sweta)	22.68(S. Deep)	21.23	1.47	4.28
Grain decorticated length (mm)	5.13(PPK1952)	7.89(PPK1907)	5.13(Swarna)	7.86(R. Suwasini)	6.84	0.42	3.79
Grain decorticated breadth (mm)	1.60(PPK1949)	2.45(PPK1903)	1.72(R. Sweta)	2.19(Swarna)	1.97	0.11	3.49
Grain length/breadth ratio	2.33(PPK1952)	4.32(PPK1901)	2.33(Swarna)	4.13(R. Suwasini)	3.50	0.27	4.91
Grain yield (kg/plot)	1.08(PPK1936)	2.49(PPK1930)	1.09(S. Dhan)	1.91(Swarna)	1.78	0.28	9.75

Table 4: Estimation of genetic parameters for the half-sibs under study

Trait	ECV	GCV	PCV	h² (%)(Broad Sense)	Genetic Advance as % of Mean
Days to 50% flowering(days)	1.88	6.097	6.38	91.20	11.99
Plant Height (cm)	4.52	10.08	11.05	83.20	18.95
Panicle length (cm)	8.84	5.45	10.38	47.60	5.90
Flag leaf width (cm)	16.09	14.53	21.69	44.90	20.07
Flag leaf length (cm)	5.94	9.13	10.90	70.20	15.77
Panicle exertion rate (%)	1.81	3.36	3.82	77.30	6.08
Effective tillers per plant	23.34	10.10	25.43	15.80	8.26
Spikelet fertility (%)	3.25	5.28	6.20	72.50	9.26
1000 grain weight (g)	4.28	12.24	12.97	89.10	23.79
Grain decorticated length (mm)	3.79	8.51	9.32	83.40	16.02
Grain decorticated breadth(mm)	3.49	9.78	10.39	88.70	18.98
Grain length/breadth ratio	4.91	12.28	13.23	86.20	23.49
Grain yield (kg/plot)	9.75	19.17	21.51	79.40	35.20

height, flag leaf width, effective tillers per plant, 1000 grain weight, grain length-breadth ratio and grain yield per plot showed moderate to high genotypic coefficient of Variance as well as phenotypic Coefficient of Variance (PCV). The Environmental Coefficient Variance (ECV) was found to be low for most of the traits, indicating lesser effect of environment of the traits under consideration (Table 4). Broad sense heritability (h^2) and genetic advance as percentage of mean were calculated for all traits. High broad sense heritability coupled with moderate to high Genetic Advance was observed for days to 50% flowering, plant height, flag leaf length, 1000-grain weight, grain decorticated length, grain decorticated width, grain length-breadth ratio and grain yield per plot. Table 4 comprises of the genetic parameters, Genetic Coefficient of Variance (GCV), Phenotypic Coefficient of Variance (PCV), Environmental Coefficient of variance (ECV), h^2 (broad sense) and Genetic Advance as % of mean for the genotypes for the traits under consideration. These findings are supported by the findings of Abebe *et al.,* 2017; Sumanth *et al.,* 2017 and Rashid *et al.,* 2017. High heritability coupled with moderate to high genetic advance was observed for 1000-grain weight, grain length-breadth ratio, grain length, grain width, plant height and Grain yield per plot. Sumanth *et al.,* 2017 and Abebe *et al.,* 2017 observed high genetic advance for grain yield and plant height, panicles per plant and number of fertile spikelet. Good genetic advance for days to 50% flowering was supported by the findings of Manjunatha, 2018.

CONCLUSION

Half-sibs used in the study showed significant genetic variation for different agronomically important traits. Conclusively, 1000-grain weight, grain length-breadth ratio, grain length, grain width, plant height and grain yield per plot could be efficiently used for selection of the genetically diverse and superior genotypes for further utilization in the hybrid development program.

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