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Genetic variability studies for yield and quality parameters in aromatic breeding lines of rice (*Oryza sativa* L.)

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Abstract
An experiment was conducted to estimate the genetic variability parameters for yield and quality traits in 67 aromatic breeding line of rice. Analysis of variance showed presence of considerable variability among the aromatic lines. All the genotypes showed highly significant differences for the yield and contributing traits and quality traits. Coefficient of variation ranges from 2.39% for cooking length to 21.06% for alkali spreading value. Highest GCV value was found for gel consistency (34.88%) and high PCV value was found for cooking width (71.99%), indicating high variability for these traits. High heritability with moderate /low genetic advance as a% of mean was found for harvest index, panicle length, kernel width and day to 50% flowering are governed by non additive gene action and these characters can be used heterosis breeding programs. Higher estimates of heritability coupled with high genetic advance was found for gel consistency followed by amylose content, filled spikelet per plant, test weight, flag leaf length, plant height, grain yield per plant, kernel length, grain length and spikelet fertility %. These character are governed by additive gene action and selection will be beneficial is the present materials for these traits. High heritability with moderate /low genetic advance as a% of mean as found for harvest index, panicle length, kernel width and day to 50% flowering and governed by non additive gene action.

Keywords: rice variability, heritability, genetic advance, amylase content.

Introduction
Rice is the largest cereal crop in the world that provides more calories to millions of humans**.** Rice contributes about 45% of India's cereal production and is the main staple food for more than 60% of the country's population. Rice is a tropical plant it thrives in a hot and humid climate and is mostly grown in rain fed condition, covering both the highlands and the lowlands. Rice is cooked by boiling or eaten alone in a wide range of soups, side dishes and many other cuisines. Rice belongs to genus *Oryza* and cultivated species are *Oryza sativa* and *Oryza glaberrima* and 22 wild species but almost all rice cultivated worldwide belongs to *Oryza sativa* L. (Annual species), whereas the other species is a perennial one, i.e. *Oryza glaberrima*. The Asian cultivated rice (*Oryza sativa* L.) originated in south -East Asia.
Rice is grown in different countries like China, India, Thailand, Japan etc. China is major grower of rice, after that India is the second largest producer country. Rice is cultivated all over countries except Antarctica. In India, rice is mainly grown in all the states. "Rice is life" was the famous theme of the international rice year 2004, which denote its overwhelming importance as a food and trade item. The demand for food in most parts of world will be double by the year 2025 and nearly triple by 2050. India covers more than 30% of total cultivated area and contributes more than 40% of total food production. In India rice production for 2015-2016 amounts to 104.41 million tonnes, 2400 kg /hectare of productivity covering an area of 434.99 lakh hectares. The area decreased to 431.94 lakh hectares in 2016-17 with an increase in 110.15 million tons of production and 2550 kg /hectare of productivity (Annual Report 2017–18) [1]. India has 42.95 million ha acreage with 111.01 million tonnes of production (Anonymous, 2018a). Chhattisgarh is known as "Indian rice bowl". The rice has vast biodiversity in Chhattisgarh. The biodiversity serves as a source and gives range to wide variability. Chhattisgarh produces 6.91 million tons in 3.79 million ha of area (Anonymous, 2018b) [2].
Prior focus was laid on high yield and resistance to insects /diseases during varietal production. But now in all rice growing countries, quality is the major breeding objective in the breeding programme. So the breeders are focus in quality characters. Sobha *et al.* (2008) [11] studied the quality characters of 78 released varieties for India. Rice varieties having good

cooking, good appearance, good milling and eating parameters, can be considered a superior grain quality rice variety which directly increases the total economic value of rice. "Grain yield improvement is the prime objective of plant breeders for several decades but demand for good quality rice is also increased in current decade as living standard of people are being gradually improved (Rathi *et al*., 2010) [8]. In Chhattisgarh state, more than 23,250 rice germplasm were conserved which has great diversity for specific quality features *viz*., good cooking quality, aroma, grain type and shape, kernel color etc. Short grain aromatic rice of Chhattisgarh is most popular because they are of superior grain quality. Aromatic rice considered as an important part among the sub- group of rice having best quality with much higher price than high quality non-aromatic rice in international market. It is known for its nut like aroma and taste caused by the chemical compound 2-acetyl-1-pyrroline. Generally in India, the aromatic rice Basmati known as "Queen of Fragrance" is famous for its fragrance and delicate flavour. It is a variety of long grain, slender shape, medium texture and less chalkiness (Kamath *et al*., 2008) [5]. Apart from basmati rice, many cultivars of aromatic short medium grained rice is grown in specific area in the states such as Bihar, Orissa, Madhya Pradesh, West Bengal, Chhattisgarh, Uttar Pradesh etc. The aromatic quality of scented rice is a key factor that increases the value of rice on the international market (Nayak *et al*., 2006). The success of any varietal improvement programme depends on how much genetic variation there is in the programme. The existence of variability is most significant in any breeding programme for effective selection. Looking to the need of aromatic quality rice, the present study was performed.

Material and Methods

Sixty seven aromatic rice accessions along with five checks namely Dubraj, Badshah bhog, Chhattisgarh Sugandhit Bhog, Chhattisgarh Devbhog, Indira Sugandhit Dhan. During *kharif* (wet season) 2019, all the 67 aromatic rice accessions were raised following essential package and practices. Subsequently, aroma test through leaves were done in which 67 aromatic genotypes and 2 testers were selected in which one non-aromatic search was carried out for the analysis. The experiment was carried out at Research cum Instructional Farm, Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidalaya, Raipur, (C.G.), India and the quality work carried out of quality lab, Dept. of Genetics and Plant Breeding. The statistical analysis was performed using OPSTAT and XLSTAT softwares.

Results and Discussion

The analysis of variance showed high level of variability present in the genetic material. The range for days to 50% flowering varies from 71 to 127 with mean of 108.88 days. Maximum No. days to 50% flowering was noted for Atmashital (127) and minimum for R2281-308-1-185-1 (71.00). The range for plant height varies from 91.04 cm to 184.26 cm with mean performance 132.62 cm. Maximum plant height was noted for Tulsimajri (184.26 cm) and minimum for R1919-537-1-160-1 (91.04 cm). Grain length varies from 5.11 mm to 10.49 mm with mean performance 6.94 mm. Maximum grain length noted in Tedesi (10.49) mm and minimum for Atma Shital (5.11) mm. The range for grain width varies from 2.1 to 4.5 with mean performance 3.44 mm. Maximum grain width noted in CG Devbhog (4.5) mm and minimum for Kubrimohor (2.1) mm. Grain yield per plant varies from 10 g to 35.60 g Maximum grain yield per plant (g) found in R1665-2151-1-412-1(35.60 g) and minimum in Javaphool (10 g).

Among the quality parameters, the range for kernel L:B ratio varies from 1.72 to 4.0 with mean performance 2.79. Maximum value for kernel L:B ratio noted in Jatashankar (4) and Minimum value observed in Bhainsa poonchi (1.72). Amylose content range from 12 to 49. The volume expansion ranged from 68 to 57. The range for cooking length varied from 5.6 mm to 11.30 mm whereas, cooking breadth varies from 2.5 mm to 4.8 mm with mean performance 4.5. Maximum value cooking breadth noted in (4.8 mm) and Minimum value observed is (2.5 mm).

Classification of coefficient of variation as low (less than 10%), moderate (10-20%) and high (more than 20%) is done as suggested by Sivasubramaniam and Madhavamenon (1973) [10]. The maximum coefficient of variation was found for ASV value (21.06%), L:B ratio (13.06%) and moderate coefficient of variation was found in hulling% (10.57%) followed by total tiller per plant (10.78%), grain yield per plant (12.64%), L/B ratio (13.04%) and the minimum coefficient of variation was observed for cooking length (2.39%) followed by panicle length (3.80%), cooking width (4.08%), grain length (4.16%), grain width (9.64%) considered as low coefficient of variation (Table 1).

All the traits under study except milling% (56.18%), grain width (51.77%), ASV value (47.5%), hulling% (45.2%), total tiller per plant (35.98%), effective tillers per plant (30.39%), cooking width (13.96%), volume expansion (11.09%) showed the high estimates of heritability (i.e. > 60% as suggested by Johnson. 1995 [4] in broad sense (Choudhary and Motiramani, 2003) [3]. The values of heritability for all the 27 traits ranged from (11.09%) for volume expansion to cooking length (96.7%). The traits showing high heritability exhibited following values of heritability. The traits showing high heritability are cooking length (96.7%), gel consistency (96.57%), amylase content (94.5%), kernel length (93.9%), spikelet per plant (93.48%), spikelet fertility% (93.48%), grain length (92.83%), filled spikelet per plant (92.67%), test weight (92.61%), plant height (92.21%), (91.99%), head rice recovery (88.2%), panicle length (87.31%), grain yield per plant (81.86%), harvesting index (81.24%), L/B ratio (80.53%), day of 50% flowering (70.29%), day to maturity (69.85%), kernel width (68.5%). The trait showing moderate heritability for Milling% (56.18%), grain width (51.77%, ASV value (47.5%), hulling% (45.2%). The trait showing low heritability for total tiller per plant (35.98%), effective tillers per plant (30.39%), cooking width (13.96%), and volume expansion (11.09%).

High estimates for genetic advance as a percent of mean was observed for Gel consistency (69.52%), amylose content (57.21%), filled spikelet per plant (51.34%), grain yield per plant (50.04%), spikelet per plant (44.27%), test weight (43.56%), flag leaf length (37.39%), plant height (34.65%), kernel length (32.67%), grain length (29.69%), spikelet fertility% (28.58%), ASV value (28.52%), L/B ratio (27.74%), cooking length (26.30%) and milling% (24.43%). Moderate genetic advance as a mean% for harvesting index (19.28%), panicle length (19.18%), kernel length (18.48%), head rice recovery (17.21%), hulling% (13.33%), day of 50% flowering (12.38%), grain width (12.04%) and day to maturity (11.44%). Higher estimates of heritability coupled with high genetic advance as a was found for gel consistency followed by amylose content, filled spikelet per plant, test weight, flag leaf length, plant height, grain yield per plant,

kernel length, grain length and spikelet fertility%.this character are governed additive gene action and selection will be profitable. High heritability with moderate /low genetic advance as a% of mean was found for harvesting index, panicle length, kernel width and day of 50% flowering are governed non additive gene action and these characters can be used heterosis breeding. Similar findings were also reported by Lingaiah *et al*. (2015) [6], Srujana *et al*. (2017) [12] and Sahu *et al*. (2017) [9]. Findings of the present investigation highlighted the importance of genetic variability parameters for deciding the breeding procedures to be utilized in crop improvement of high quality rice.

Table 1: Variability parameters for yield and quality related traits

S.N.	Character	Mean	Range		Coefficient of variance			H^2 %	Genetic advance	Genetic advance as % of mean
			Min	Max	GCV	PCV	CV %			
1	PH	132.63	91.04	184.2	17.52	18.25	5.09	92.21	45.97	34.66
2	PL	26.20	20.16	34.06	9.97	10.67	3.8	87.31	5.03	19.19
3	FLL	52.16	30.1	71.9	18.93	19.73	5.58	91.99	19.51	37.39
4	TTPP	7.86	6	9.8	8.08	13.48	10.78	35.98	0.79	9.99
5	ETPP	6.83	4.6	8.7	6.84	12.40	11.49	30.39	0.53	7.77
6	SPP	156.25	80.6	282	22.18	22.89	5.64	93.49	69.19	44.28
7	FSPP	121.47	59.4	216	25.89	26.90	7.28	92.67	62.37	51.35
8	SP %	77.89	45.09	94.58	14.35	14.84	5.2	93.49	22.26	28.58
9	DYFF	108.89	71	127	7.17	8.55	4.66	70.29	13.49	12.39
10	DTM	138.31	95	156	6.65	7.96	11.49	69.85	15.83	11.45
11	TW	24.57	9.45	33.12	21.98	22.83	6.18	92.62	10.71	43.57
12	GYPP	35.60	35	10	26.85	29.67	12.64	81.86	8.91	50.04
13	GL	8.78	10	35	14.96	15.52	4.16	92.83	2.60	29.69
14	GW	3.44	2.1	4.5	8.12	11.29	7.84	51.77	0.41	12.04
15	KL	7.92	6	10.5	16.3	16.8	9.17	93.9	2.5	32.67
16	KW	3.04	1.8	3.9	10.83	13.08	9.96	68.5	0.5	18.48
17	L:B ratio	2.79	1.72	4	15	16.72	13.04	80.53	0.7	27.74
18	H%	70.40	39.81	93.77	9.62	14.29	10.57	45.2	9.4	13.33
19	M%	60.46	40.45	95	15.82	21.1	13.97	56.18	14.7	24.43
20	ASV	4.18	2	7	20.07	29.09	21.06	47.5	1.17	28.52
21	GC	59.75	30	100	34.88	34.76	6.44	96.57	41.33	69.52
22	VE	62.40	57	68	2.882	8.6	8.16	11.09	1.2	1.98
23	AC	0.77	0.12	0.49	28.55	29.3	6.8	94.5	0.15	57.21
24	CL	8.44	5.6	11.3	12.98	13.2	2.39	96.7	2.18	26.30
25	CW	4.50	2.5	4.8	8.5	71.99	4.08	13.96	0.08	2.07
26	HI	57.65	29.02	50.87	10.38	11.5	4.99	81.25	7.2	19.28
27	HRR	56.93	30.81	64.2	8.892	9.46	4.37	88.2	9.75	17.21

PH = Plant height, PL= Panicle length, FLL= Flag leaf length, TTPP= Total tiller per plant, ETTP= effective tiller per plant, SSP= spikelet per plant, FSPP= Filled spikelet per plant, SF% = Spikelet fertility %, DYFF= Day to 50 % flowering, DTM= Day to maturity, TW = test weight, GYPP= Grain yield per plant, GL= grain length, GW= Grain width, KL = Kernel length, KW= Kernel width, L/B ratio = Length breadth ratio, H% = hulling %, M%= milling %, ASV= Alkali spreading value, GC= Gel consistency, VE= Volume expansion, AC= Amylose content, KL= Kernel length, KW= Kernel width, HI =harvest index, HRR= head rice recovery(%).

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