

*Full Length Research Paper*

# Collection and agro-morphological characterization of aromatic short grain rice in eastern India

H. N. Subudhi\*, S. Samantaray, D. Swain and O. N. Singh

Central Rice Research Institute, Cuttack, 753006, Orissa, India.

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Exploration and collection of aromatic short grain rice were undertaken in tribal dominated districts of Orissa viz., Dhenkanal, Anugul, Sambalpur, Deogarh, Nuapada, Kalahandi, Phulbani and Cuttack. A total of 55 germplasm accessions were collected with detailed passport information. Analysis of variance for 16 quantitative morpho-agronomic characters showed very significant results. The qualitative characters were recorded as per International Rice Research Institute-International Board for Plant Genetic Resources (IRRI-IBPGR) descriptors and frequency distribution was also presented. The range, mean and coefficient of variation for different quantitative characters were mentioned. The study revealed that the leaf length varied from 30.7 cm (Kanika) to 73.6 cm (Basuabhog). The culm height varied from 90.5 cm (Thakurbhog) to 184.4 cm (Jabaphool). Culm number is also high and ranged from 8.9 (Dhusara) to 20.0 (Vasumati). The panicle length varied from 22.2 cm (Banspatri) to 32.06 cm (Kalajeera) with mean length, 27.3 cm. High F-values were observed in leaf length ( $F = 155.56$ ), plant height ( $F = 159.24$ ), flag leaf length ( $F = 120.73$ ), days to 50% flowering ( $F = 669.77$ ). The good yielders are Chhotbasmati, Pimpudibas, Lajkuri, Jaigundi, Kanika, Bishnubhog. These landraces can be popularized among the farmers and can be used as donor in varietal development programme.

**Key words:** Exploration, collection, characterization, frequency distribution, aromatic short grain rice, Orissa.

## INTRODUCTION

Rice occupies a pivotal role in Indian agriculture and it is the staple food for more than 70% Indians. It is grown in all states and in all ecologies ranging from high mountains to lowlands and saline coastal areas. Due to enhanced rice production, the country made a mark in international trade by becoming fourth exporter of rice in the world. India is very rich in rice genetic resources in general and aromatic rice particular. Aromatic rice constitute small and special group of rice and highly priced due to their quality. Usually in India, aromatic rice is popularly known as basmati rice which is usually grown in north western Indian states like Punjab, Haryana, Himachal Pradesh, Jammu and Kashmir and parts of Uttar Pradesh (Nene, 1998). The production is about 1.2 million tons with average 1.5 t/ha. Sobha and Krishnaiah

(2001) studied the current status of long grained and short grained rice in India. Due to high demand of basmati rice in international market, about two-third of basmati produced in the country is exported to different countries and it is increasing every year (Siddiq, 1990). This has resulted in the shortage of basmati rice for our internal consumption. The areas for basmati production are limited due to geographical indicator. The aroma in basmati rice will not retain when grown in eastern India due to warm climate, which is the rice bowl of the country. Besides basmati rice, hundreds of aromatic short grained rice are grown in specialized pockets in the states like Bihar, Orissa, Madhya Pradesh, West Bengal, Chhattisgarh, Uttar Pradesh etc. (Singh et al., 2000). These are short and medium grained and having good scent and aroma retain for longer time. The quality traits are better than basmati. There is also high demand of this rice in national as well as international markets. It is estimated that India has over 70,000 germplasm accessions including wild form. These landraces are the

\*Corresponding author. E-mail: dr\_hatanath\_subudhi@yahoo.co.in. Tel: 09438328309.

reservoir of many useful genes (Siddiq, 1992). But the large-scale spread of high yielding varieties has replaced the traditional varieties leading to narrow genetic base, loss and shrinkage in the areas of local varieties (Hore, 2005; Rana et al., 2009). Jepore tract of Orissa is the putative secondary centre of origin of cultivated rice and having greatest variability (Richharia, 1979). In addition to these, Chhattisgarh is having greatest diversity of rice including aromatic rice (Bisne and Sarawgi, 2008). More than 100 of traditional landraces of aromatic rice with pleasant aroma are grown in different parts of the state and their diversity and quality traits were studied (Das, 2009; Das et al., 2003). So, it is high time to collect and evaluate the valuable germplasm to find some useful gene and their conservation before further extinction. Realizing this, Singh and Nagar (1996) studied the improvement of indigenous scented rice. But the farmers are not growing these varieties because of low yield and lack of marketing facility. Now, realizing the demand in the market, to improve the economy of farmers, efforts are being started to collect, characterize and evaluate the aromatic short grain rice in the state of Orissa for documentation and to find suitable donors for different traits which are prerequisite for varietal development. Singh et al. (2010) and Nayak et al. (2001) studied the variability and correlation in scented rice of Orissa, respectively. Mallick et al. (1994) studied the agromorphological characters in aromatic short grain rice of Orissa. The promising cultivars will be popularized among the farmers to uplift the economy of rice farmers of eastern India.

## MATERIALS AND METHODS

The seeds of 55 aromatic rice accessions and one check variety were shown in the nursery bed. Twenty-five (25) days old seedlings were transplanted in the field during wet seasons (June to December) 2009 and 2010. The design used was randomized block design with two replications. The spacing was 15 × 20 cm. Each plot was 3.0 m<sup>2</sup>. The fertilizer dose of N:P:K was 60:30:30. Vasumati (long slender released variety) is used as local check. Both qualitative and quantitative characters were recorded according to International Rice Research Institute-International Board for Plant Genetic Resources (IRRI-IBPGR) descriptors in randomly selected 10 plants in each replication at different stages of crop growth (Anonymous, 1980). The data were statistically analyzed. The quantitative characters like leaf length (cm), leaf width (cm), ligule length (cm), plant height (cm), culm number, panicle length (cm), flag leaf length (cm), flag leaf width (cm), 1000 grain weight (g), panicle weight (g), grains/panicle, sterility percentage, grain length (mm), grain breadth (mm), days to 50% flowering, single plant yield (g) etc. were recorded during this experiment to find out better cultivars for the farmers and donors for varietal development. The qualitative characters are shown in Table 4 with their frequency distribution.

### Exploration and collection

Due to spread of high yielding varieties, local cultivars in general and aromatic short grain rice landraces in particular are becoming

extinct. So, exploration and collection programme was undertaken under the auspices of Central Rice Research Institute, Cuttack in the tribal districts like Dhenkanal, Anugul, Sambalpur, Deogarh, Nuapada, Kalahandi, Phulbani and Cuttack to document the information about aromatic short grain rice (Figure 1). The seed samples were collected from the farmers' fields/farm yards/threshing floor with all passport information and local uses about the paddy variety from the farmers. Total 55 rice landraces were collected during the collection mission. The detail list is shown in Table 1. These landraces were collected from rainfed areas of tribal dominated districts of Orissa. The tribal communities are now growing the valuable germplasm for their own consumption for special occasions and also maintaining these every year. They are also cultivating these cultivars by applying farmyard manure only and no inorganic fertilizer. The cultivars like Dubraj are cultivated in different tribal districts of western Orissa. But Kalajeera is grown in all districts of Orissa. Although these are grown as same name, there is much variability among the landraces.

## RESULTS AND DISCUSSION

### Morpho-agronomic characterization

#### Qualitative characters

The qualitative characters like blade pubescence, blade colour, auricle colour, auricle shape, leaf angle, culm angle, culm strength, panicle type, flag leaf angle, panicle exertion, apiculus colour, stigma colour, lemma palea colour, awning etc. were recorded according to IRRI-IBPGR descriptors. Both qualitative and quantitative characters were recorded in different growth stages. It was observed that there is no much variation in qualitative characters. In all the cultivars, blade is pubescent and blade colour is green. The ligule shape is cleft and culm strength is weak. In most of the landraces, the flag leaf is droopy and panicle exertion is fully exerted. The landraces viz., Dubraj, Vasumati and Sunka basmati are having awn. Dubraj is very popular in western Orissa. Kalajeera is a very popular landraces and cultivated in all the districts and having black lemma and palea, better cooking quality and retain aroma for longer period. In most cases, the apiculus colour is black. Kalikati is highly scented landraces with brown lemma palea colour. Jabaphool is highly scented and popular landraces in western Orissa and having high market price. The landraces like Najkuri, Basuabhog, Ramchandra bhog, Surguja, Kalkati, Maharaji, Bindli, Imp.Raskadam and Lalchandani are having brown lemma palea colour.

#### Quantitative characters

The analysis of variance showed that the variation of each character is very significant having maximum variability (Table 2). The range, mean value, coefficient of variation and standard deviation of different quantitative characters are shown in Table 3. The frequency distributions of quantitative characters are shown in

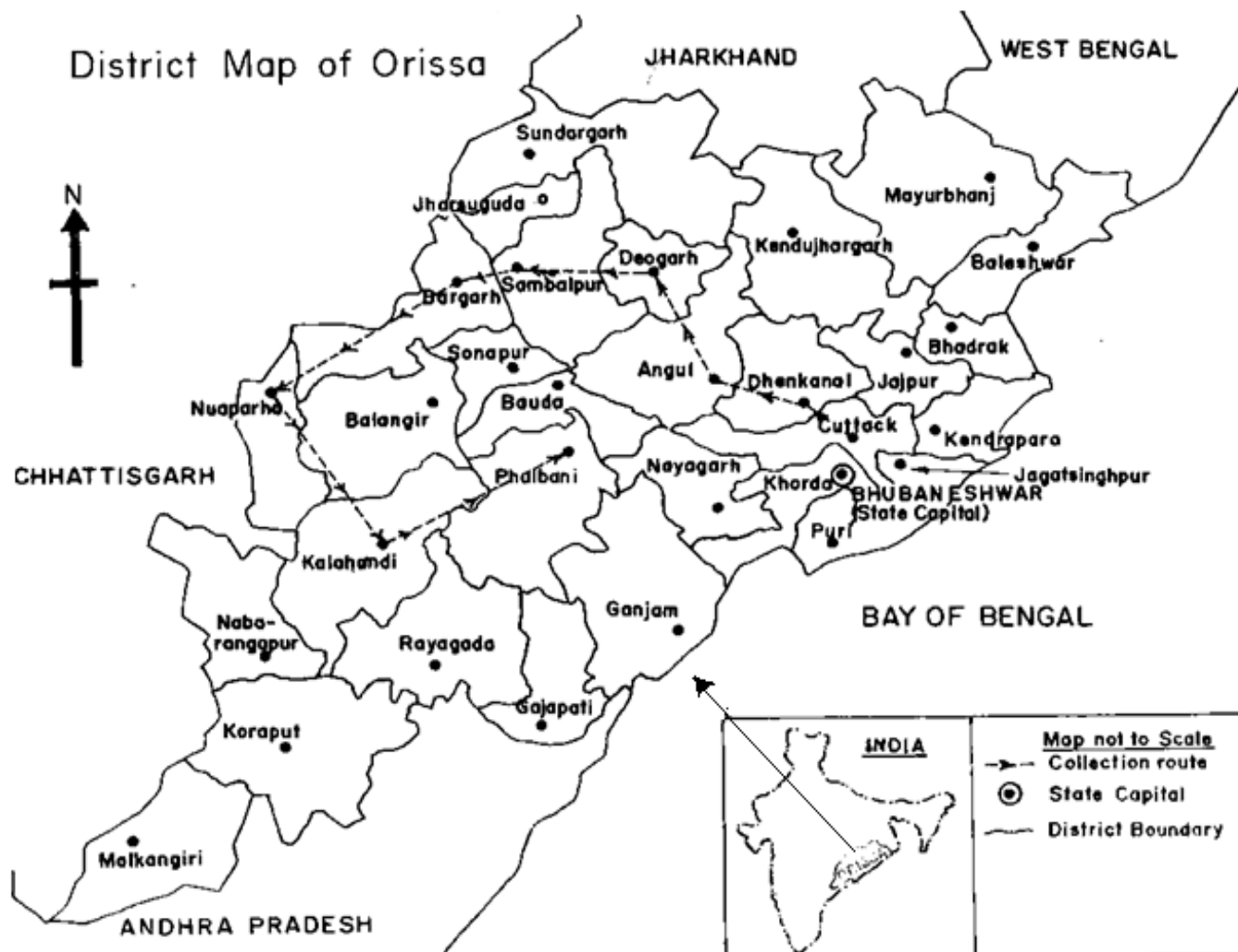


Figure 1. Map of Orissa showing the route of exploration programme.

Table 1. List of aromatic short grain rice land races collected from different districts of Orissa.

S/N	Collector No.	Name of cultivars	Name of district	State	Country	Altitude (fts)	Latitudes (N)	Longitude (E)
1	HS-1	Basmati-1	Dhenkanal	Orissa	India	75	21°9 <sup>1</sup>	86°2 <sup>1</sup>
2	HS-2	Kanika	Dhenkanal	Orissa	India	86	21°1	86°1 <sup>1</sup>
3	HS-6	Kalajeera-1	Dhenkanal	Orissa	India	90	21°9	85°95 <sup>1</sup>
4	HS-11	Najkuri,	Dhenkanal	Orissa	India	89	21°2	85°60 <sup>1</sup>
5	HS-19	Desi basamati,	Dhenkanal	Orissa	India	121	21°8 <sup>1</sup>	85°84 <sup>1</sup>
6	HS-21	Basmati-2	Dhenkanal	Orissa	India	242	21°7 <sup>1</sup>	85°82 <sup>1</sup>
7	HS-30	Pimpudibas	Dhenkanal	Orissa	India	246	21° 9 <sup>1</sup>	85°90 <sup>1</sup>
8	HS-32	Laxmibilas	Dhenkanal	Orissa	India	241	21°5 <sup>1</sup>	85°2 <sup>1</sup>
9	HS-35	Krushnabhog	Dhenkanal	Orissa	India	145	20°85 <sup>1</sup>	85°75 <sup>1</sup>
10	HS-36	Sunka basmati	Dhenkanal	Orissa	India	201	21°5 <sup>1</sup>	85°74 <sup>1</sup>
11	HS-37	Chotabasmati	Dhenkanal	Orissa	India	222	20°80 <sup>1</sup>	85°82 <sup>1</sup>
12	HS-43	Dhalajeera	Anugul	Orissa	India	564	20°85 <sup>1</sup>	85°23 <sup>1</sup>
13	HS-47	Basmati-3	Anugul	Orissa	India	622	20°75 <sup>1</sup>	85°22 <sup>1</sup>
14	HS-50	Kalajeera-2	Anugul	Orissa	India	589	20°52 <sup>1</sup>	85°20 <sup>1</sup>
15	HS-52	Nanu	Anugul	Orissa	India	560	20°45 <sup>1</sup>	85°17 <sup>1</sup>
16	HS-53	Basuabhog	Anugul	Orissa	India	595	20°93 <sup>1</sup>	85°15 <sup>1</sup>

Table 1. Contd.

17	HS-56	Ramachandrabhog,	Anugul	Orissa	India	598	20°861	85°231
18	HS-58	Gagandholi	Anugul	Orissa	India	601	20°95 <sup>1</sup>	85°22 <sup>1</sup>
19	HS-63	Kapurkanti,	Deogarh	Orissa	India	612	210301	84°43 <sup>1</sup>
20	HS-71	Basanadhan	Deogarh	Orissa	India	666	21°41 <sup>1</sup>	84°44 <sup>1</sup>
21	HS-72	Surguja	Deogarh	Orissa	India	612	21°25 <sup>1</sup>	84°42 <sup>1</sup>
22	HS-73	Utkalballav	Deogarh	Orissa	India	711	21°31 <sup>1</sup>	84°40 <sup>1</sup>
23	HS-75	Sakarchini,	Deogarh	Orissa	India	725	21°52 <sup>1</sup>	84°43 <sup>1</sup>
24	HS-76	Anu	Deogarh	Orissa	India	752	21°23 <sup>1</sup>	84°43 <sup>1</sup>
25	HS-78	Dubraj,	Deogarh	Orissa	India	689	21°31 <sup>1</sup>	84°41 <sup>1</sup>
26	HS-79	Bansapatri,	Sambalpur	Orissa	India	134	21°171	84°23 <sup>1</sup>
27	HS-80	Kalajeera-3	Sambalpur	Orissa	India	231	21°25 <sup>1</sup>	84°22 <sup>1</sup>
28	HS-81	Jaigundi,	Sambalpur	Orissa	India	211	21°15 <sup>1</sup>	84°21 <sup>1</sup>
29	HS-83	Jubraj	Sambalpur	Orissa	India	189	21°24 <sup>1</sup>	84°23 <sup>1</sup>
30	HS-85	Sorisophool	Bargarh	Orissa	India	171	21°20 <sup>1</sup>	84°23 <sup>1</sup>
31	HS-87	Bansapatri,	Bargarh	Orissa	India	215	21°22 <sup>1</sup>	84°25 <sup>1</sup>
32	HS-90	Bishnubhog,	Bargarh	Orissa	India	201	21°231	84°23 <sup>1</sup>
33	HS-91	Jaiphool	Bargarh	Orissa	India	245	21°25 <sup>1</sup>	84°24 <sup>1</sup>
34	HS-92	Kalajeera-4	Bargarh	Orissa	India	301	21°20 <sup>1</sup>	84°25 <sup>1</sup>
35	HS-98	Jabaphool	Bargarh	Orissa	India	289	21°28 <sup>1</sup>	84°23 <sup>1</sup>
36	HS-102	Nadiakora,	Nuapada	Orissa	India	1200	20°49 <sup>1</sup>	83°57 <sup>1</sup>
37	HS-104	Dubraj	Nuapada	Orissa	India	1272	20°56 <sup>1</sup>	83°57 <sup>1</sup>
38	HS-105	Kalkati,	Nuapada	Orissa	India	1205	20°55 <sup>1</sup>	83°58 <sup>1</sup>
39	HS-107	Basmati-4	Kalahandi	Orissa	India	1330	19°11 <sup>1</sup>	83°10 <sup>1</sup>
40	HS-109	Kalkati,	Kalahandi	Orissa	India	1335	19°25 <sup>1</sup>	83°12 <sup>1</sup>
41	HS-110	Tulsibas,	Kalahandi	Orissa	India	1412	19°24 <sup>1</sup>	83°23 <sup>1</sup>
42	HS-111	Kalajeera-5	Kalahandi	Orissa	India	1425	19°11 <sup>1</sup>	83°10 <sup>1</sup>
43	HS115	Sankarjeera,	Kalahandi	Orissa	India	1435	19°11 <sup>1</sup>	83°10 <sup>1</sup>
44	HS-119	Thakurbhog	Kalahandi	Orissa	India	1436	19°12 <sup>1</sup>	83°15 <sup>1</sup>
45	HS-120	Mohanbhog	Kalahandi	Orissa	India	1415	19°12 <sup>1</sup>	83°15 <sup>1</sup>
46	HS 121	Kalajeera-6	Kalahandi	Orissa	India	1403	19°14 <sup>1</sup>	83°15 <sup>1</sup>
47	HS-122	Maharaji	Kalahandi	Orissa	India	1412	19°13 <sup>1</sup>	83°10 <sup>1</sup>
48	HS-127	Mugjai	Phulbani	Orissa	India	1600	20°36 <sup>1</sup>	83°34 <sup>1</sup>
49	HS-140	Siresa	Phulbani	Orissa	India	1625	20°36 <sup>1</sup>	83°34 <sup>1</sup>
50	HS142	Bindli	Cuttack	Orissa	India	33	20°281	85°54 <sup>1</sup>
51	HS144	Lalchandani	Cuttack	Orissa	India	33	20°281	85°54 <sup>1</sup>
52	HS145	IMP.Raskadam	Cuttack	Orissa	India	33	20°29 <sup>1</sup>	85°55 <sup>1</sup>
53	HS148	Govindbhog	Cuttack	Orissa	India	12	20°16 <sup>1</sup>	86°10 <sup>1</sup>
54	HS149	Dhusara	Cuttack	Orissa	India	15	20°16 <sup>1</sup>	86°10 <sup>1</sup>
55	HS150	Atte	Cuttack	Orissa	India	33	20°16 <sup>1</sup>	86°10 <sup>1</sup>
56	Check	Vasumati(check)	CRRI,Cuttack	Orissa	India			

Figure 2. The leaf length varied from 30.7 cm (Kanika) to 73.6 cm (Basuabhog) with mean of 54.5 cm. The leaf width varied from 0.56 cm (Kanika) to 1.83 cm (Govindbhog) with mean of 1.1 cm. The culm height varied from 90.5 cm (Thakurbhog) to 184.4 cm (Jabaphool) indicating wide variability. All the landraces are tall except check. In all the cases, culm number is also high and ranged from 8.9 (Dhusara) to 20.0 (Vasumati). The panicle length varied from 22.2 cm (Bansapatri) to 32.06 cm (Kalajeera) with mean of 27.3

cm. Flag leaf is very important for preparation of food. Flag leaf length varied from 23.2 cm (Sankarjeera) to 66.0 cm (Siresa), which indicate wide variability. The 1000 grain weight is the key character for high yield and it varied from 9.5 g (Basmati) to 23.5 g (Maharaji). The panicle weight varied from 1.5 g (Dhalajeera) to 4.06 g (Jaigundi). Grains/panicle varied from 54 (Thakurbhog) to 206.6 (Anu) with mean of 131.65 showing very wide variability. All the landraces are having medium slender/short slender grain. The days to 50% flowering

**Table 2.** Analysis of variance for 16 different morpho-agronomic characters.

Character	Sum of squares	Mean squares	F-value
Leaf length	11103.52	201.882**	87.92
Leaf width	7.83	0.142**	155.86
Ligule length	43.72	0.795**	87.84
Plant height	57200.16	1040.002**	159.24
Culm number	744.30	13.532**	4.91
Panicle length	780.12	14.184**	9.57
Flag leaf length	11648.64	211.793**	120.73
Flag leaf width	3.674	0.0668**	86.18
1000grain weight	1307.96	23.781**	72.81
Panicle weight	20.91	0.380**	48.0
Grains/panicle	120348.13	2188.147**	38.9
Sterility %	8620.18	156.73*	12.60
Grain length	114.38	2.079**	44.25
Grain breadth	7.51	0.1364**	17.3
DFF	20069.11	364.892**	669.77
Single plant yield	963.69	17.52*	8.42

\* and \*\*, Significant at 5 and 1% level, respectively.

**Table 3.** Range, mean, coefficient of variation (CV) and standard deviation (SD) for 16 different morpho-agronomic characters.

Character	Range	Mean $\pm$ SE	CV (%)	SD
Leaf length (cm)	30.7 - 73.6	54.5 $\pm$ 1.07	2.78	10.06
Leaf width (cm)	0.56 - 1.83	1.1 $\pm$ 0.02	2.72	0.26
Ligule length (cm)	1.0 - 3.15	2.11 $\pm$ 0.06	4.4	0.63
Plant height (cm)	90.5 - 184.4	148.6 $\pm$ 1.8	1.72	22.77
Culm number	8.9 - 20.0	13.2 $\pm$ 1.2	13.1	2.86
Panicle length (cm)	22.15 - 32.06	27.3 $\pm$ 0.86	4.4	2.78
Flag leaf length (cm)	23.2 - 61.7	37.9 $\pm$ 0.93	3.4	10.28
Flag leaf width (cm)	0.9 - 1.76	1.3 $\pm$ 0.02	2.1	0.18
1000grain weight (g)	9.5 - 23.5	14.6 $\pm$ 0.4	3.9	3.4
Panicle weight (g)	1.5 - 4.06	2.17 $\pm$ 0.06	4.0	0.43
Grains/panicle	54 - 20.6.6	131.6 $\pm$ 5.2	5.6	33.35
Sterility percentage	4.65 - 32.7	15.98 $\pm$ 3.52	22.05	2.49
Grain length (mm)	5.6 - 10.3	6.7 $\pm$ 0.15	3.2	1.02
Grain breadth (mm)	1.75 - 3.06	2.3 $\pm$ 0.6	3.8	0.26
DFF (days)	71 - 131.5	118.9 $\pm$ 0.52	0.6	13.45
Single plant yield (g)	5.0 - 17.5	10.12 $\pm$ 1.44	14.24	1.01

varied from 71 (Atte) to 131.5 (Krushnabhog). Most of the landraces are late duration. It is observed that Kalajeera is grown in all the districts of Orissa and is very popular among the farmers. The landrace Dubraj is also very popular in western Orissa and Chhattisgarh having good scent and quality. High coefficient of variation is observed in sterility percentage (22.05), followed by single plant yield (14.24). The donors for different characters are shown in Table 4.

### Frequency distribution

The frequency distribution of qualitative characters is shown in Table 5. Frequency distribution for blade pubescence is intermediate (85.7%), pubescent (14.3%) and glabrous (0.0%). Blade color is green in 78.5% followed by pale green (19.6%). Basal leaf sheath colour is green in 78.5% followed by light purple (14.2%). Leaf angle is very important for photosynthesis but droopy

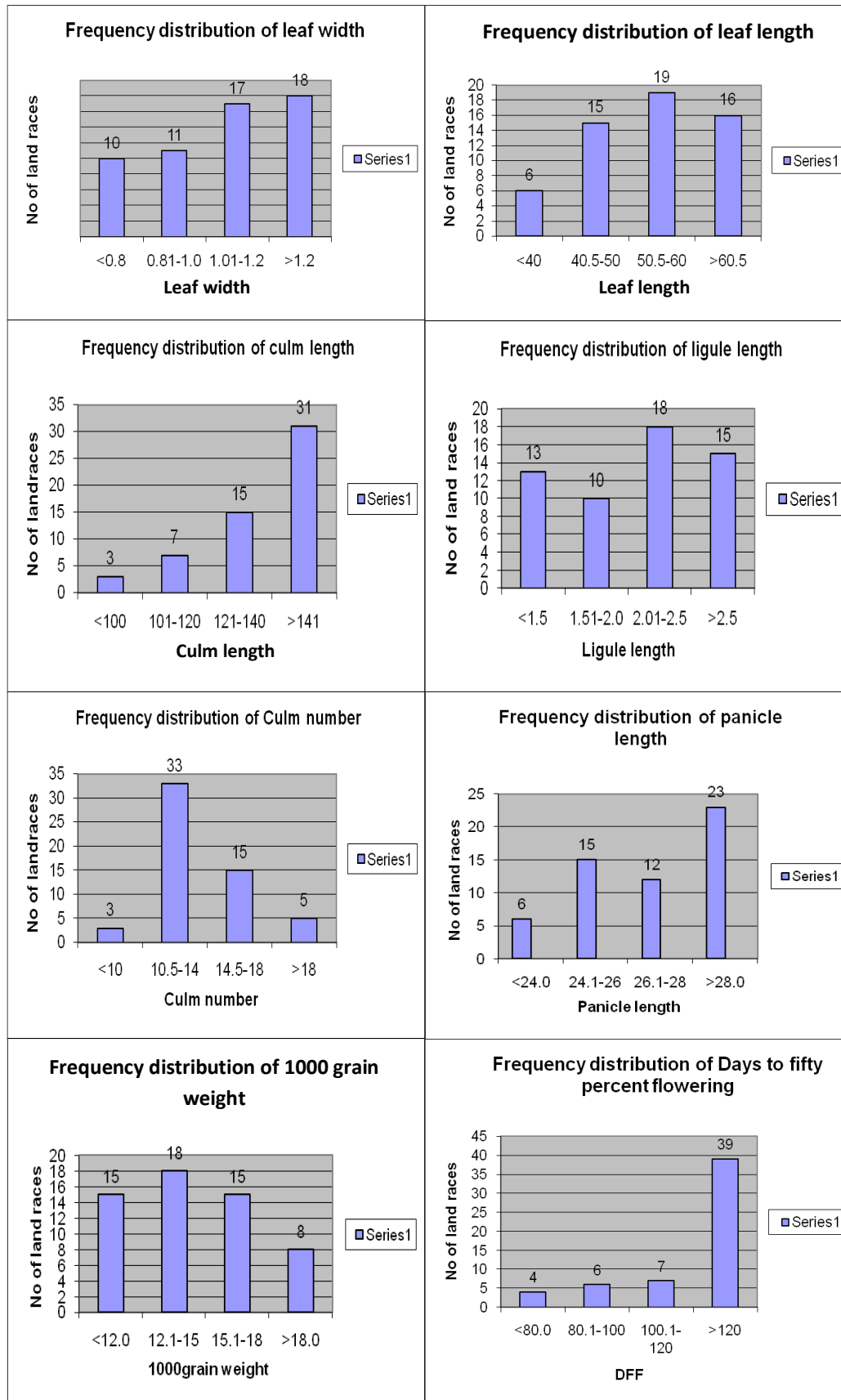


Figure 2. Frequency distribution for different quantitative characters.

**Table 4.** Promising landraces for different yield characters.

Character	Value	Name of landraces
Grain yield per plant	> 13.0 g	Basanadhan, Chhotbasmati, Pimpudibas, Najkuri, Basmati-3, Jaigundi, Kanika and Bishnubhog
Fertility percentage	> 94.0 %	Basanti-1, Basmati-2, Basanadhan, Dubraj, Kalajeera-3, Jubraj, Basmati-4, Tulsibas and Kalajeera-5
Tiller number per plant	> 15	Desibasmati, Basmati-1, Basumati-3, Kalajeera 2, Basuabhog, Kapurkanti, Surguja, Baspatri, Kalajeera-3, Basmati-4, kalajeera-6 and vasumati
Panicle length	> 30.0 cm	Kalajeera-1, Pimpudibas, Basmati-1, Nanu, Utkalballav, Anu, Kalajeera-3, Jaiphool and Kalajeera-4
Panicle weight	> 2.5 g	Kalajeera-3, Jaigundi, Jubraj, Kalkati, Maharaji and Mugjai
Number of grains/panicle	> 170	Kalkati, Pimpudibas, Basanadhan, Sakarchini, Kalajeera-3 and Anu
1000 grain weight.	> 20.0 g	Gagandholi, Sorishphool, Kalajeera-4, Maharaji, Bindli and Atte

**Table 5.** Percentage value and frequency distribution of morphological characters of aromatic short grain rice of Orissa.

Character	Quality	No. of genotypes	Frequency (%)
Blade pubescence	1 Glabrous	0	0.0
	2 Intermediate	48	85.7
	3 Pubescent	8	14.2
Blade colour	1 Pale green	11	19.6
	2 Green	44	78.5
	3 Dark green	1	2.0
Basal leaf sheath colour	1 Green	44	78.5
	2 Purpleline	4	7.0
	3 Light purple	8	14.2
	4 Purple	0	0.0
Leaf angle	1 Erect	3	5.3
	2 Intermediate	8	14.2
	3 Horizontal	10	17.0
	4 Droopy	35	62.0
Ligule colour	1 White	51	92.0
	2 Purpleline	5	8.0
	3 Purple	0	0.0
Ligule shape	1 Acute	0	0.0
	2 Cleft	56	100
	3 Truncate	0	0.0
Collar colour	1 Light green	18	32.0
	2 Green	38	68.0
	3 Purple	0	0.0

Table 5. contd.

Auricle colour	1 Light green	22	40.0
	2 Green	34	60.0
	3 Purple	0	0.0
Culm angle	1 Erect	9	16.0
	2 Intermediate	37	66.0
	3 Open	7	12.0
	4 Spreading	3	6.0
Internode colour	1 Green	7	12.0
	2 Light green	45	80.0
	3 Light gold	4	8.0
	4 Purple	0	0.0
Culm strength	1 Strong	2	4.0
	2 Medium strong	5	9.0
	3 Intermediate	14	25.0
	7 Weak	35	62.0
	9 Very weak	0	0.0
Flag leaf angle	1 Erect	5	9.0
	3 Intermediate	21	38.0
	5 Hori	25	44.0
	7 Droopy	5	9.0
Panicle type	1 Com	0	0.0
	5 Intermediate	5	9.0
	7 Open	51	91.0
Secondary branching	1 Absent	2	4.0
	9 Present	54	96.0
Panicle exertion	1 Well exerted	44	78.0
	3 Medium well exerted	10	18.0
	5 Just exerted	02	4.0
	7 Partially enclosed	0	0.0
Panicle axis	1 Straight	51	91.0
	2 Drooping	5	9.0
Awn	1 Absent	50	89.0
	9 Present	6	11.0
Apiculus colour	1 White	26	46.0
	2 Straw	18	32.0
	3 Brown	4	7.0
	4 Red	5	8.0
	5 Purple	3	7.0
Stigma colour	1 White	44	78.0
	2 Light green	3	5.0
	3 Yellow	6	12.0
	4 Light purple	3	5.0
	5 Purple	0	0.0



Table 5. contd.

	Gold	36	64.0
Lemma palea colour	Brown spot	6	10.7
	Brown furrow	8	14
	Black	6	10.7

type are found in 62% followed by horizontal (17%). Erect culm angle prevent lodging but in this study, intermediate culm angle is found in 66% followed by erect (16%). Culm strength is weak (62%). Flag leaf angle is horizontal (44%) and intermediate (38%). Panicle exertion is well exerted (78%). Awns are absent in 89%. Apiculus colour is white (46%) and straw (32%). Stigma colour is white (78%). Lemma palea colour is black in Kalajeera (10.7%), brown furrow (14%), brown spot (10.7%) and gold (64%). High F-values are observed in leaf length ( $F = 155.56$ ), plant height ( $F = 159.24$ ), flag leaf length ( $F = 120.73$ ), days to 50% flowering ( $F = 669.77$ ) indicating very wide variability among them. These characters help in grouping of the germplasms, which will help in varietal development programme.

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