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Vageeshvari
Department of Genetics and Plant Breeding, IGKV, Raipur, Chhattisgarh, India

Prabha R Chaudhari
Department of Genetics and Plant Breeding, IGKV, Raipur, Chhattisgarh, India

Vivek Kumar Sandilya
Department of Genetics and Plant Breeding, IGKV, Raipur, Chhattisgarh, India

Priyanka
Department of Genetics and Plant Breeding, IGKV, Raipur, Chhattisgarh, India

Deepak Gauraha
Department of Genetics and Plant Breeding, IGKV, Raipur, Chhattisgarh, India

Sunil Verma
Department of Genetics and Plant Breeding, IGKV, Raipur, Chhattisgarh, India

Corresponding Author:
Vageeshvari
Department of Genetics and Plant Breeding, IGKV, Raipur, Chhattisgarh, India

Studies on genetic variability for quality traits in rice germplasm (*Oryza sativa* L.)

Vageeshvari, Prabha R Chaudhari, Vivek Kumar Sandilya, Priyanka, Deepak Gauraha and Sunil Verma

Abstract
The present investigation is carried out to study the genetic parameters for grain appearance quality, milling and eating quality characters in forty five rice germplasm accessions. Analysis of variance revealed significant differences for all the traits under study. Genotypic and phenotypic coefficient of variation their higher magnitude were registered towards quality characters gel consistency and head rice recovery (%) suggesting that the gene pool sufficient variability was found thus indicated ample scope for genetic enhancement for choice for these characters. High heritability including higher genetic advance as mean percentage for quality character *viz*., head rice recovery percent, gel consistency, elongation ratio, cooked rice width, milling %, endosperm content of amylose, hulling %, paddy L/B ratio, brown rice length width ratio, brown rice length, brown rice width, kernel L/B ratio, kernel length, paddy length and paddy width the expression traits recommended prevalence of the additive gene action. These kinds of characteristics can be enhanced by mass selection and another hybridization methodology dependent on the selection of progeny.

Keywords: Rice, germplasm, genetic variability, heritability, genetic advance

Introduction
Rice (*Oryza sativa* L.) (2n=24) is the important cereal crop, known as "Global Grain" due to its use as the primary staple food for more than 60 percent of the global population. In Chhattisgarh, over 20,000 rice cultivars have been and is commonly known as Rice Bowl of India. It is the predominant dietary energy source and is considered important for consumer in Asian countries. The Rice germplasm provide with ample of genetic diversity and a treasury of valuable genes. It is a rich pool of important genes that plant breeders can exploit for crop improvement (Yadav *et al*., 2011) [10].

The basic breeding strategy is to develop rice varieties with high yield and better quality. Quality traits refer to size, shape, symmetry and overall appearance, decorticated grain shape and decorticated L / B ratio and hence the genetic improvement of rice for yield and quality traits should be a high priority theme of research in next two decades. IGKV maintains 23,250 rice accessions being evaluated for yield, quality traits and tolerance to biotic and abiotic stresses. The land races maintained in IGKV have certain genetic integrity.

Coloured rice shows stronger antioxidants and free radical scavenging activities compared to brown rice. Property of this coloured rice originates from the seed capsule. Purple and black rice were superior compared to red pigmented rice, as the former retained higher amounts of phytochemicals and antioxidant capacities in the cooked rice and hence this rice could be used in food product preparation (Sangeeta *et al.* 2012) [8]. Rice bran and husk also appears as a rich source of antioxidant compounds. Therefore, rice is a good candidate for natural sources of antioxidants, and may hold the potential for the development of rice based functional foods, drugs, food preservative, pharmaceuticals and cosmetic products.

Hence selection of higher yields and greatly increased milling, cooking, eating and processing qualities are therefore extremely important for meeting customer demand and industry requirements (Nirmaladevi *et al*., 2015) [4].

Therefore, improvement of grain quality features of rice becomes the important objective next to yield enhancement and has become big issue to satisfy customer interest and industry demand in rice breeding programmes. Therefore, the present experiment was conducted to assess nature and magnitude of variability grain appearance, milling and eating traits in indigenous rice landraces of Chhattisgarh, India.

Materials and Methods

The experimental material used during the present investigation consisted of forty five indigenous rice germplasm along with six checks namely IR 64, Swarna, MTU 1010, Zinc rice -2, Chaptimathyala and Madhuraj Dhan-55 were grown in randomized complete block design with two replications at the Research cum Instructional Farm, Department of Genetics and Plant Breeding, College of Agriculture, IGKV, Raipur, Chhattisgarh during *Kharif* 2019**.** Crop was raised following recommended package of practices. Observations were recorded on five randomly tagged plants of each genotype per replication. Data were recorded on grain appearance, milling and eating traits which includes paddy length (mm), paddy width (mm), paddy L/B ratio, paddy husk colour, brown rice length (mm), brown rice width (mm), brown rice L/B ratio, decorticated grain color, decorticated grain shape, kernel length (mm), kernel width (mm), kernel L/B ratio, cooked rice length (mm), cooked rice width (mm), cooked rice L/B ratio, elongation ratio, hulling percentage (%),milling percentage (%),head rice recovery, gel consistency test and endosperm content of amylose.

Results and Discussion

The mean sum of squares values for grain appearance, milling and eating traits are listed in table 1. Due to treatment the mean sum of squares were highly remarkable (1% and 5% level of significance) for all traits studied signifying the survival of huge quantity of genetic variability between the genotypes might be due to diverse resource of materials with ecological influence affecting the phenotypes.

Table 1: Analysis of variance for different quality characters

S. No.	Source of variation	Mean sum of square		
		Replication	Treatment	Error
		(df=1)	(df=44)	(df=44)
1	Paddy length (cm)	0.034	1.69**	0.024
2	Paddy width (cm)	0.003	0.24**	0.005
3	Paddy L/B ratio	0.009	0.32**	0.007
4	Brown rice length (mm)	0.107	0.68**	0.053
5	Brown rice width (mm)	0.087	0.11**	0.004
6	Brown rice L/B ratio	0.037	0.28**	0.015
7	Kernel length (mm)	0.015	0.67**	0.006
8	Kernel width (mm)	0.002	0.06**	0.005
9	Kernel L/B ratio	0.019	0.26**	0.011
10	Cooked rice length (mm)	0.009	0.71**	0.014
11	Cooked rice width (mm)	0.007	0.22**	0.020
12	Cooked rice L/B ratio	0.017	0.16**	0.015
13	Elongation ratio	0.000	0.11**	0.003
14	Hulling %	11.435	204.79**	14.367
15	Milling %	0.557	186.99**	13.068
16	Head rice recovery %	3.099	132.44**	8.122
17	Gel consistency (mm)	0.544	395.11**	30.340
18	Endosperm content of amylose	0.964	40.94**	4.538

* Significant at 5% and ** significant at 1% probability level

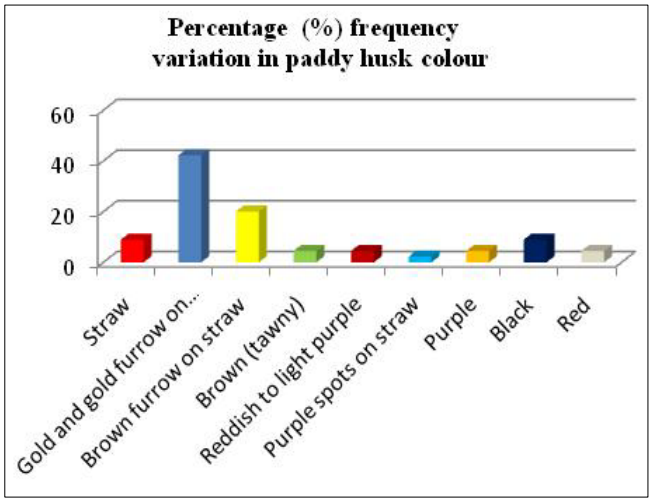
Frequency distribution and percentage value of grain appearance, milling and eating quality characters are present in table 2. According to grain appearance qualily paddy husk colour was categories in nine groups in all forty five lines. Straw colour was recorded in hunder, gold and gold furrow in Sathaka, brown furrow on straw in Korma, brown (tawny) in Kalimuch, reddish to light purple in Mehardhan, purple spots on straw in Barhasal, purple in Kujjii, black in Kalajeera and red in Gathuwan. Consequently, brown rice colour was categorized in four groups; white colour was observed in Aalcha, light brown in Sathi, light red in Karanga and red in R-RKM-1. Similarly, according to kernel colour in fourty five genotypes were divided in three group *viz*., white in Khutbuti, light brown in Sathi and red in Nagpuri gurmatiya. Red/brown rice is a great source of iron or manganese as well as rich in antioxidant and it helps for preventing for skin and heart diseases. White rice is a good source of energy, carbohydrates, calcium, iron, thiamin, pantothenic acid, folate and vitamin E.

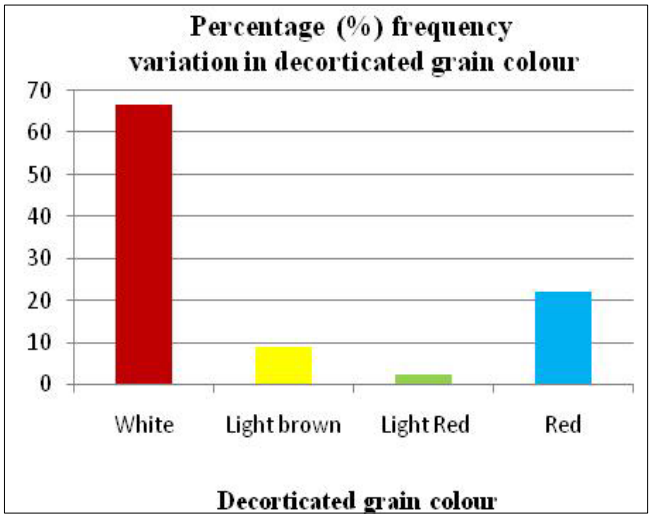
Table 2: Frequency distribution and percentage value of quality characters

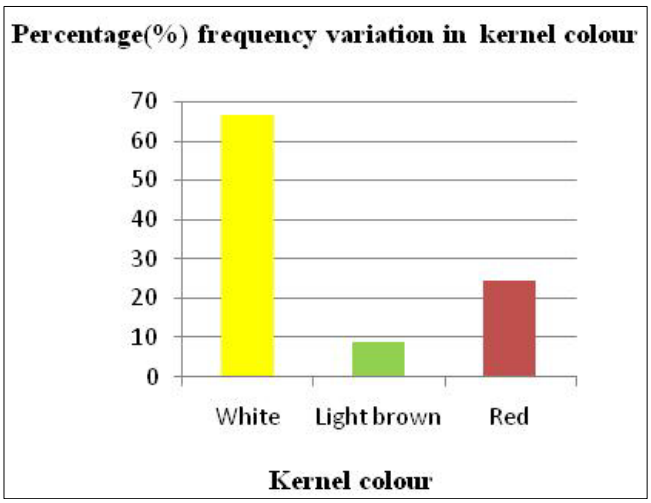
S. No.	Traits	Category	Number	Frequency %
1	Paddy length	Very short	2	4.44
		Short	27	60
		Medium	16	100
2	Paddy width	Very narrow	1	2.22
		Narrow	9	20
		Medium	23	51.11
		Broad	11	24.44
		Very broad	1	2.22
3	Brown rice length	Very Short	9	20

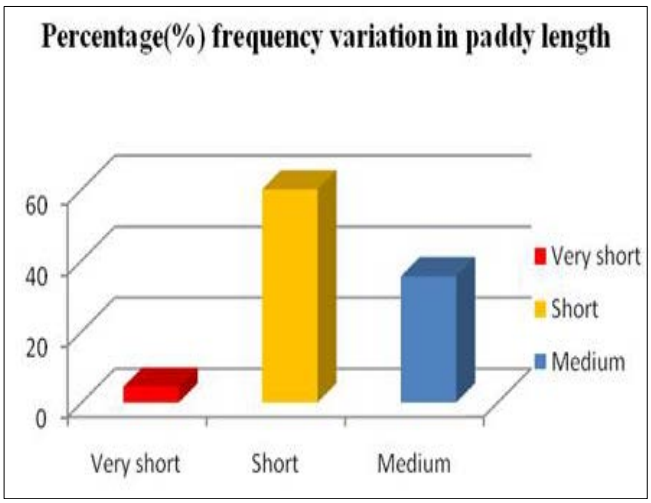
		Short	36	80
4	Brown rice width	Narrow	3	6.66
		Medium	26	57.77
		Broad	16	35.55
5	Decorticated grain shape	“Short bold	7	15.55
		Medium slender	24	51.11
		Long slender	12	26.66
		Long bold	2	4.44
6	Paddy husk colour	Straw	4	8.88
		Gold and gold furrow on straw background	19	42.22
		Brown furrow on straw	9	20
		Brown (tawny)	2	4.44
		Reddish to light purple	2	4.44
		Purple spots on straw	1	2.22
		Purple	2	4.44
		Black	4	8.88
		Red”	2	4.44
7	Decorticated grain colour	White	30	66.66
		Light brown	4	8.88
		Light Red	1	2.22
		Red	10	22.22
8	Kernel colour	White	30	66.66
		Light brown	4	8.88
		Red	11	24.44
9	Endosperm: presence of Amylose	Present	45	100
10	Endosperm content of amylase	Low	15	28.88
		Medium	18	48.88
		High	11	17.77
		Very High	1	4.44
11	Gel consistency	“Hard gel consistency	39	86.66
		Medium gel consistency	3	6.66
		Soft gel consistency”	3	6.66

**According to DUS descriptive Shobha *et al.* (2006) [9]









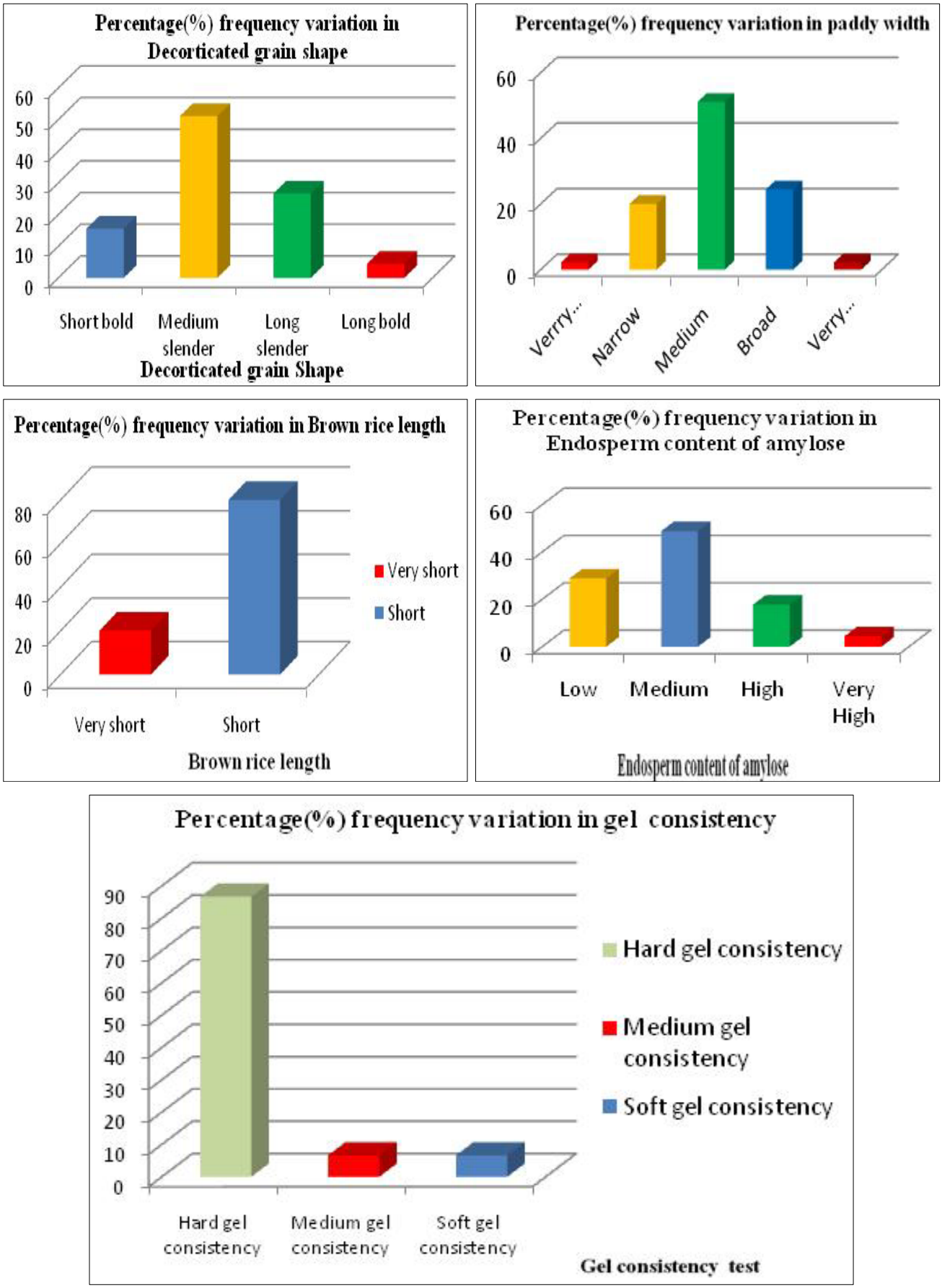


Fig 1: Percentage (%) frequency variation in grain appearance quality, milling and eating quality

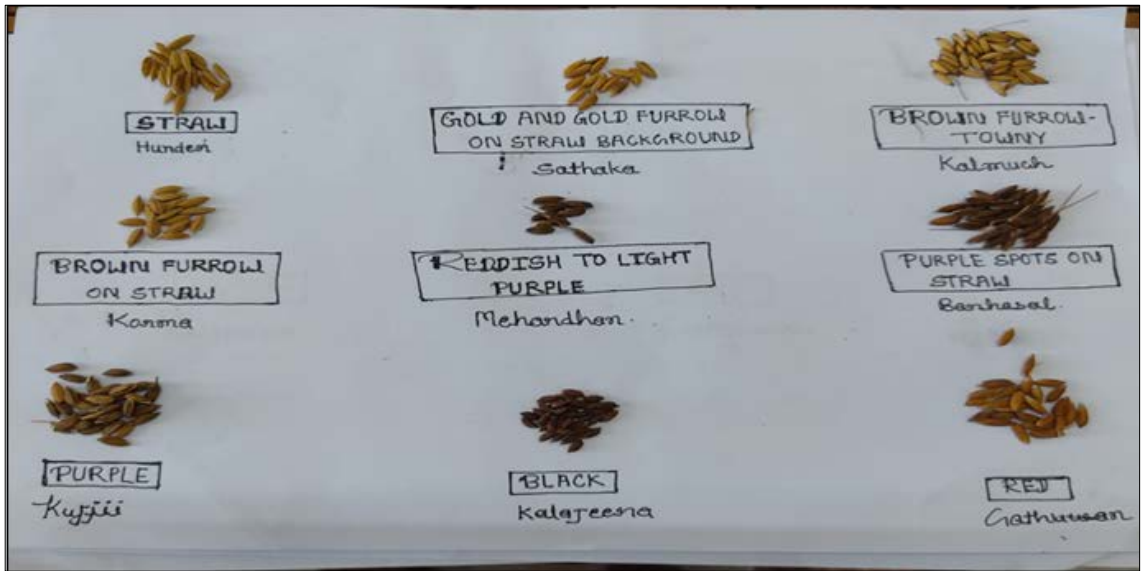


Fig 2: Variation in Paddy husk colour

Fig 3: Variation in decorticated grain colour

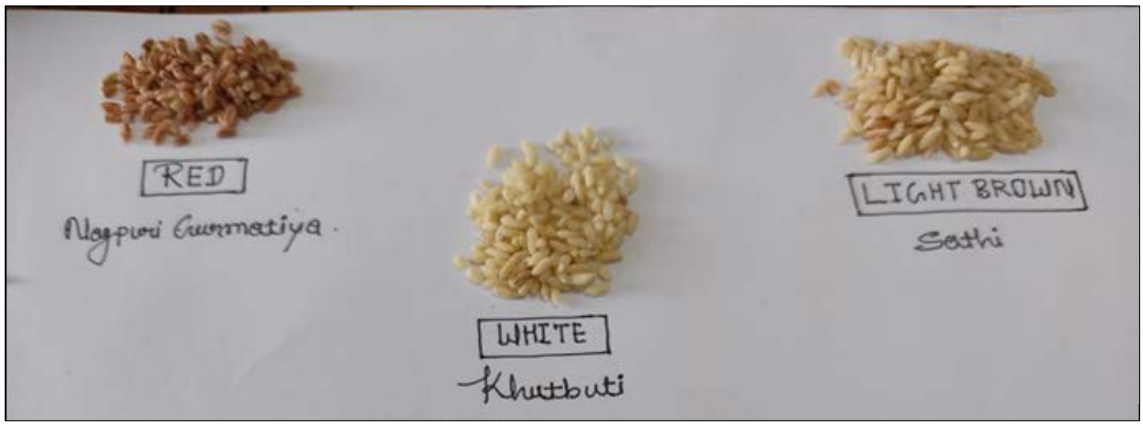


Fig 4: Variation in kernel colour

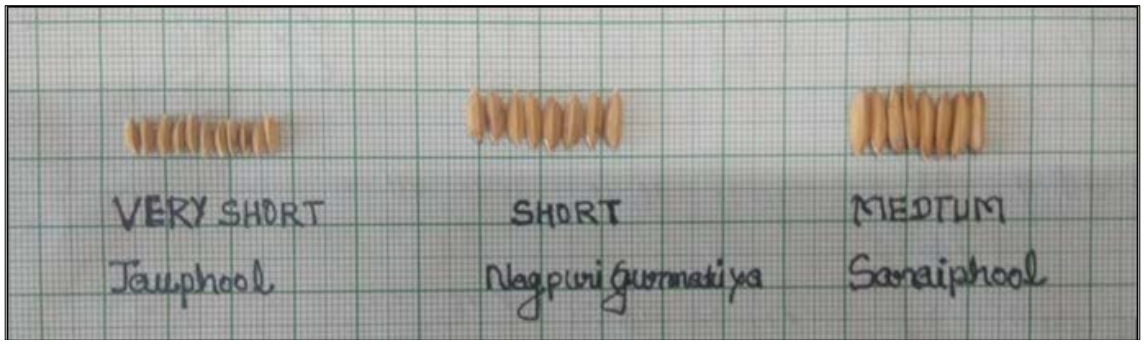


Fig 5: Variation in paddy length

Fig 6: Variation in paddy width

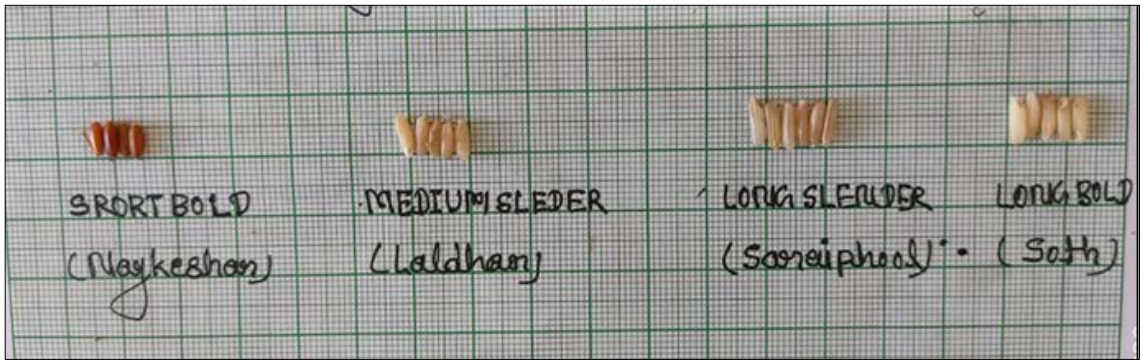


Fig 7: Variation in decorticated grain shape

According to grain shape forty five accessions were categorized based on grain length and grain L/B ratio. Nagkeshar, Korma and Kalajeera were registered as short bold, Karanga, Lal banko and Gathuwan were noted as medium slender rice and long slender grain shape was observed in R-RKM-1, Saraiphool and Danwar. Similarly, long bold shape was observed in Soth and Sathi. Long slender and long bold grains are more preferable for consumption and poha making respectively.

Higher magnitude of PCV was observed for quality character gel consistency (39.06%), head rice recovery % (22.02%), endosperm content of amylose (21.51%). While, moderate estimates of PCV was recorded for milling % (17.55%), elongation ratio (16.86%), hulling percent (15.30%), brown rice L/B ratio (14.10%), L/B ratio of paddy (14.15%), kernel L/B ratio (13.13%), paddy width (12.51%), cooked rice width (11.58%), paddy length (11.32%), cooked rice L/B ratio (10.70%), brown rice width (10.37%) and lower estimates of PCV was observed for kernel length (9.99%), kernel width (8.97%), brown rice length (8.78%) and cooked rice length (7.27%). quality characters, genotypic coefficient of variation ranging from 7.12% cooked rice length to 36.16% of gel consistency.

For quality characters higher estimates of genotypic coefficient of variation were recorded in gel consistency (36.16%) and head rice recovery percent (20.70%). Traits having moderate values of Genotypic coefficient of variation were reported in amylose content (19.24%), elongation ratio (16.39%), milling percent (16.36%), hulling percent (14.26%), paddy L/B ratio (13.84%), brown rice L/B ratio (13.66%), kernel L/B ratio (12.58%), paddy width (12.25%), paddy length (11.16%), cooked rice width (10.61%) and brown rice width (10.02%).

Grain quality traits estimated lower value of genotypic coefficient of variation were reported in kernel length (9.90%), cooked rice L/B ratio (9.74%), brown rice length (8.71%), kernel width(8.34%) and cooked rice length (7.12%).

On the other hand, quality traits exhibited lower estimates of PCV and GCV kernel length (PCV 9.99% and GCV 9.90%), kernel width (PCV 8.97% and GCV 8.34%), brown rice length (PCV 8.78% and GCV 8.71) and cooked rice length (PCV 7.27% and GCV 7.27%). This represented the narrow capacity for further genetic enhancement through selection. These results are in similar with the previous reports of Laxmi and Chaudhari (2019) [3] for spikelet fertility (%), Babu *et al*., (2012) [1] for panicle length, kernel length and kernel width and Rathi *el al*., (2010) [6] cooked rice length.

High heritability was registered for all attributes *viz*., brown rice length (98.45%), kernel length (98.25%), paddy length (97.24%), cooked rice length (96.09%), paddy width (96.01%), paddy L/B ratio (95.80%), elongation ratio (94.53%), brown rice width (93.27%), kernel L/B ratio (91.83%), brown rice L/B ratio (89.98%), head rice recovery percent (88.44%), milling % (86.94%), hulling % (86.89%), kernel width (86.51%), gel consistency (85.74%), cooked rice width (83.95%), cooked rice L/B ratio (82.81%) and amylose content (80.04%). Therefore, it showed that certain traits under analysis are less affected by environment in their performance. These reports are in similar with earlier analysis of Sahu *et al*., (2018) [7], Ekka *et al*., (2015) [2] and Babu *et al*., (2012) [1].

High heritability together with high genetic advance as mean percentage for quality traits were recorded for head rice recovery, gel consistency, elongation ratio, cooked rice width, milling %, endosperm content of amylose, hulling %, paddy length width ratio, brown rice length width ratio, brown rice length, brown rice width, kernel length width ratio, kernel length, paddy length and paddy width the expression traits suggesting preponderance of additive gene action. These kinds of characteristics can be improved by mass selection and other breeding methodologies based on the testing of

progeny. These results are in similar with earlier report of Nithya *et al*., (2020) [5] and Laxmi and Chaudhari (2019) [3].

Table 3: Estimation of variability parameters for grain appearance quality, milling and eating quality traits

S. No.	Characters	Mean	Range		CV%	PCV (%)	GCV (%)	$h^2_{(bs)}$	GA as % of mean
			Min	Max					
1	Paddy length (mm)	8.18	5.6	10.15	1.88	11.32	11.16	97.24	22.68
2	Paddy width (mm)	2.85	1.7	3.45	2.50	12.51	12.25	96.01	24.73
3	Paddy L/B ratio	2.90	2.31	4.38	2.90	14.15	13.84	95.80	27.91
4	Brown rice length (mm)	6.49	6.5	7.9	1.09	8.78	8.71	98.45	17.81
5	Brown rice width (mm)	2.40	1.6	2.8	2.69	10.37	10.02	93.27	19.92
6	Brown rice L/B ratio	2.69	1.95	3.7	4.56	14.40	13.66	89.98	26.70
7	Kernel length (mm)	5.83	4.3	7.15	1.32	9.99	9.90	98.25	20.22
8	Kernel width (mm)	2.09	1.5	2.45	3.29	8.97	8.34	86.51	15.98
9	Kernel L/B ratio	2.80	2.15	3.91	3.75	13.13	12.58	91.83	24.84
10	Cooked rice length (mm)	8.30	6.5	9.75	1.44	7.27	7.12	96.09	14.38
11	Cooked rice width (mm)	3.04	2.3	3.85	4.64	11.58	10.61	83.95	20.03
12	Cooked rice L/B ratio	2.76	2.13	3.51	4.44	10.70	9.74	82.81	18.26
13	Elongation ratio	1.43	1.14	2.8	3.94	16.86	16.39	94.53	32.82
14	Hulling %	68.42	40.12	84.15	5.54	15.30	14.26	86.89	27.39
15	Milling %	57.00	31.15	68.62	6.34	17.55	16.36	86.94	31.42
16	Head rice recovery %	38.08	22.84	54.78	7.48	22.02	20.70	88.44	40.11
17	Gel consistency (mm)	37.34	18	88.5	14.75	39.06	36.16	85.74	68.98
18	Endosperm content of amylose	22.17	10.87	31.06	9.61	21.51	19.24	80.04	35.47

Note- CV % = coefficient of variance in percent, PCV % = Phenotypic coefficient of variation, GCV % = Genotypic coefficient of variation, h^2 % = Heritability in broad sense, GA % = Genetic advance in percent value.

Grain appearance quality the entry Saraiphool expressed best performance for paddy length, brown rice length and kernel length followed by R-RKM-1 and Lal banko. Similarily for milling quality best genotypes are Korma followed by MTU1010 and Parwatkala. According to eating and cooking quality best lines are Soth followed by Hunder, Parwatkala and Sathaka.

Conclusion

According to grain shape forty five accessions were categorized based on grain length and grain L/B ratio. Nagkeshar, Korma and Kalajeera were registered as short bold, Karanga, Lal banko and Gathuwan were noted as medium slender rice and long slender grain shape was observed in R-RKM-1, Saraiphool and Danwar. Similarly, long bold shape was observed in Soth and Sathi. Long slender and long bold grains are more preferable for consumption and poha making respectively.

The appearance quality of rice is essential to the customer that in turn makes it important to the producer and the miller. Consequently, brown rice colour was categorized in four groups; white colour was observed in Aalcha, light brown in Sathi, light red in Karanga and red in R-RKM-1. Black rice contains fibre, iron, and also rich in antioxidants. Kernel length followed by R-RKM-1 and Lal banko. Similarily for milling quality best genotypes are Korma followed by MTU1010 and Parwatkala. According to eating and cooking quality best lines are Soth followed by Hunder, Parwatkala and Sathaka.

Genotypic and phenotypic coefficient of variation their higher magnitude were registered towards quality characters gel consistency and head rice recovery (%) suggesting that the gene pool sufficient variability was found thus indicated ample scope for genetic enhancement for choice for these characters. High heritability including higher genetic advance as mean percentage for quality character *viz*., head rice recovery percent, gel consistency, elongation ratio, cooked rice width, milling %, endosperm content of amylose, hulling %, paddy L/B ratio, brown rice length width ratio, brown rice length, brown rice width, kernel L/B ratio, kernel length, paddy length and paddy width the expression traits recommended prevalence of the additive gene action. These rice varieties are of valuable genetic resources for the development of new and improved rice varieties with superior nutritional and medicinal values. Further studies aimed at confirming the anticancerous and antioxidative properties of medicinal rice cultivars are in progress.

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