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CHARACTERIZATION AND EVALUATION OF *ORYZA NIVARA* AND *ORYZA RUFIPOGON*

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ABSTRACT
Field experiment was conducted during wet season 2009-10 at Agricultural Research Farm, Banaras Hindu University, Varanasi Uttar Pradesh to evaluate and characterize thirty five wild rice accessions for fourteen quantitative and twelve qualitative traits. Analysis of variance revealed sufficient variability for all the quantitative traits. The magnitude of phenotypic coefficient of variation was higher to corresponding genotypic coefficient of variation. High heritability coupled with high genetic advance as per cent of mean was found in the trait fertile spikelet per panicle, total number of grains per panicle and grain yield per plant. The qualitative traits variation were found to be high for leaf blade colour, flag leaf angle, panicle exertion, stigma colour and apiculus colour; basal leaf sheath colour, leaf blade pubescence, panicle type, sterile lemma, awning and threshability showed moderate whereas low variability was recorded in leaf senescence. The accessions NKSWR-48, NKSWR-64 and NKSWR-75 are found to be most promising for panicle length, fertile spikelet per panicle, spikelet fertility percentage, test weight and grain yield per plant. The result suggested that these accessions are valuable resource and can be utilized for yield and yield traits.

INTRODUCTION

The genus *Oryza* consists 22 wild species and two cultivated species *O. sativa* and *O. glaberrima*, belonging to the family Poaceae. The wild species are widely distributed in the pantropics and subtropic. Wild rices are valuable repository of useful allelic variation for crop improvement and constitute an excellent reservoir of variability for several traits resistance to biotic and abiotic stresses, quality and productivity traits (Tanksley and Mc-Couch, 1997). In India there are four valid wild species of *Oryza*. These are *O. nivara* Sharma *et* Shastry, *O. rufipogon* Griff., *O. officinalis* Wall. Ex Watt and *O. granulate* Nees et Arn. Ex Watt. *O. nivara* and *O. rufipogon* are widely distributed over Eastern Indian and used as donors for major diseases, pests, environmental stress (Hore, 2005 and Patra *et al.*, 2008). However, the switch over to high yielding varieties with the spread of modern agriculture, posed a great threat to these securities of the age-old practice of growing traditional varieties and land races which may have immense potential for different important traits (Sharma *et al.*, 1987 and Patra, 2000). In recent years, a considerable amount of information about the genetic structure within and among natural populations of *O. rufipogon* and *O. nivara* has been obtained (Zhou *et al.*, 2008), but *O. rufipogon* and *O. nivara* germplasm present in eastern IGP is not well characterized. In order to prevent further gene erosion, collection and conservation of such invaluable genetic recourses of rice is essential. Thus, evaluation, characterization and preservation of the entire existing wild rice and land races are essential to varietal improvement. Therefore, the present investigation was planned to collect, characterize and assess the extent of variability in a set of thirty five wild rice accessions to aid in introgression and manipulation of the required traits in cultivated rice (*Oryza sativa* L.).

MATERIALS AND METHODS

Plant material and experimental design

Panicles of thirty five wild rice germplasm accessions were collected from natural habitat of Indo-Gangetic region of Eastern India during *Kharif 2008-09* and their seeds were multiplied in wet season 2009-10. The details of the source of rice accessions are presented in Table 1. These accessions were evaluated in randomized block design with three replications during *Kharif 2011* and *2012*. Twenty five days old single seedlings were transplanted in small separate plot 20 cm apart between row and 15 cm within row. The recommended packages of practices were followed to raise a healthy crop.

Data collections

The data on fourteen quantitative traits were recorded from ten well grown plant of each accession in each replication viz. days to 50% flowering, days to maturity, leaf length, leaf width, plant height, panicle length, number of effective tillers per plant, fertile spikelets per panicle, total number of grains

Table 1: List of thirty five wild rice accessions, their collection site and species level

S.N.	Accession number	Collection site (Village, Block, District, Country)	Species/Subspcies
1.	NKSWR-1	Bhainsa, Sewapuri, Varanasi, India	*O. nivara*
2.	NKSWR-2	Nakahara, City Block, Mirzapur, India	*O. nivara*
3.	NKSWR-4	Tikara, City Block, Mirzapur, India	*O. rufipogon*
4.	NKSWR-9	Malua, Patehara, Mirzapur, India	*O. nivara*
5.	NKSWR-12	Patewar, Madihan, Mirzapur, India	*O. rufipogon*
6.	NKSWR-16	Dhurkar, Kalwari, Mirzapur, India	*O. nivara*
7.	NKSWR-25	Godhana, Niyamatbad, Chandauli, India	*O. nivara*
8.	NKSWR-26	Mahoharpur,, Niyamatbad, Chandauli, India	*O. nivara*
9.	NKSWR-32	Lokmanpur, Saidraja, Chandauli, India	*O. rufipogon*
10.	NKSWR-34	Amada, Barahani, Chandauli, India	*O. rufipogon*
11.	NKSWR-35	Baruin, Jamania, Ghazipur, India	*O. nivara*
12.	NKSWR-36	Kasera Pokhara, Jamania, Ghazipur, India	*O. nivara*
13.	NKSWR-37	Dildarnagar, Bhadaura, Ghazipur, India	*O. nivara*
14.	NKSWR-41	Bara, Bhadaura, Ghazipur, India	*O. nivara*
15.	NKSWR-42	Charitraban, Naibazar, Buxar, India	*O. rufipogon*
16.	NKSWR-46	Chilkaha, Chilkahar, Ballia, India	*O. rufipogon*
17.	NKSWR-48	Nakahara, Garwar, Ballia, India	*O. rufipogon*
18.	NKSWR-49	Hishampur, Bemra Bari, Ballia, India	*O. rufipogon*
19.	NKSWR-51	Near Suraha Tal, Suraha Tal, Ballia, India	*O. rufipogon*
20.	NKSWR-53	Inside Surah Tal, Suraha Tal, Ballia, India	*O. rufipogon*
21.	NKSWR-54	Deorara, Bansdih, Ballia, India	*O. rufipogon*
22.	NKSWR-55	Maniyar, Maniyar, Ballia, India	*O. rufipogon*
23.	NKSWR-57	Shisotar, Nawanagar, Ballia, India	*O. rufipogon*
24.	NKSWR-64	Maturi, FatehpurManda, Ballia, India	*O. rufipogon*
25.	NKSWR-65	Maturi, FatehpurManda, Ballia, India	*O. rufipogon*
26.	NKSWR-70	Rajapur, Mohammadabad Gohna, Mau, India	*O. rufipogon*
27.	NKSWR-73	Naretha, Jahanaganj, Azamgarh, India	*O. nivara*
28.	NKSWR-75	Mehnagar, Mehnagar, Azamgarh, India	*O. nivara*
29.	NKSWR-82	Shishwara, Martinganj, Azamgarh, India	*O. rufipogon*
30.	NKSWR-84	Kotila, Rani kiSarai, Azamgarh, India	*O. nivara*
31.	NKSWR-85	Kotila, Rani kiSarai, Azamgarh, India	*O. nivara*
32.	NKSWR-86	Shahpur, Jahanaganj, Azamgarh, India	*O. rufipogon*
33.	NKSWR-97	Lahangpur, Jalalpur, Jaunpur, India	*O. nivara*
34.	NKSWR-98	Trilochan Mahadev, Jalalpur, Jaunpur, India	*O. rufipogon*
35.	NKSWR-99	Binda Morh, Pindra Bajar, Varanasi, India	*O. nivara*

Table 2: Analysis of variance of fourteen quantitative traits in thirty five wild rice accessions

Quantitative characters	Replecation	Treatment	Error
Degree of freedom	2	34	68
Days to 50 % flowering	0.15	109.02**	2.03
Days to maturity	1.55	130.15**	2.00
Leaf length	15.40	121.14**	13.78
Leaf width	0.006	0.126**	0.005
Plant height	6.47	943.11**	25.67
Panicle length	1.13	17.87**	3.66
Number of effective tillers per plant	1.39	77.56**	4.93
Fertile spikelets per panicle	108.52	4511.04**	44.032
Total number of grains per panicle	185.70	5885.81**	116.10
Spikelet fertility	10.08	505.96**	6.17
Test weight	0.16	45.20**	0.39
Kernel length	0.0002	0.432**	0.010
Kernel breadth	0.00002	0.325**	0.0028
Grain yield per plant	1.22	124.09**	2.72

** and * Significant at 1 and 5 per cent level, respectively

per panicle, spikelet fertility, test weight, kernel length, kernel breadth and grain yield per plant; and twelve qualitative traits viz. basal leaf sheath colour, leaf blade colour, leaf blade pubescence, flag leaf angle, panicle exsertion, panicle type, stigma colour, sterile lemma, awning, apiculus colour, leaf senescence and threshability were recorded as per IRRI-IBPGR descriptors based on 50% population. The panicles of accessions showing shattering characteristics were observed every day and filled grains were plucked one by one 1-2 days before shattering and stored.

Statistical analysis

Ten randomly selected plants in each accession in each replication were tagged for recording observation. The mean

Table 3: Range, mean, standard error of mean and coefficient of variation of fourteen quantitative traits

Quantitative characters	Range		Mean	SEm (±)	Variability (%)		Heritability (%)	Genetic advance as % of mean
	Min.	Max.			PCV	GCV		
Days to 50 % flowering	91.00	120.66	113.41	0.82	5.41	5.26	94.60	10.55
Days to maturity	128.66	157.00	147.95	0.81	4.52	4.41	95.50	8.89
Leaf length (cm)	52.61	78.90	63.35	2.14	11.11	9.44	72.20	16.52
Leaf width (cm)	1.04	1.80	1.37	0.04	15.55	14.62	88.40	28.31
Plant height (cm)	128.72	210.82	155.26	2.92	11.72	11.26	92.30	22.28
Panicle length (cm)	17.72	28.50	23.09	1.10	12.54	9.42	56.40	14.57
Number of effective tillers per plant	3.50	10.15	7.19	1.28	24.35	22.19	83.10	41.67
Fertile spikelets per panicle	19.12	231.90	69.65	3.83	56.21	55.39	97.10	112.46
Total number of grains per panicle	54.61	267.29	107.32	6.22	42.07	40.86	94.30	81.74
Spikelet fertility (%)	23.44	86.77	63.52	1.43	20.69	20.31	96.40	41.10
Test weight (g)	14.10	33.50	23.53	0.36	16.63	16.41	97.40	33.38
Kernel length (mm)	5.01	7.01	6.05	0.06	6.42	6.19	93.20	12.31
Kernel breadth (mm)	1.12	2.62	2.04	0.04	16.28	16.07	97.46	32.68
Grain yield per plant (g)	7.89	36.98	23.04	0.95	28.51	27.60	93.70	55.03

Table 4: Promising wild rice accessions for different yield characteristics

Traits	Value	Name of accessions
Grain yield per plant (g)	> 25.0	NKSWR-16, NKSWR-34, NKSWR-35, NKSWR-37, NKSWR-48, NKSWR-49, NKSWR-51, NKSWR-64, NKSWR-73, NKSWR-75, NKSWR-84, NKSWR-98
Spikelet fertility (%)	> 75.0	NKSWR-1, NKSWR-35, NKSWR-48, NKSWR-49, NKSWR-64, NKSWR-70, NKSWR-86
Number effective of tillers per plant	> 8.0	NKSWR-4, NKSWR-12, NKSWR-25, NKSWR-26, NKSWR-34, NKSWR-35, NKSWR-36, NKSWR-41, NKSWR-46, NKSWR-49, NKSWR-99
Panicle length (cm)	> 25.0	NKSWR-37, NKSWR-48, NKSWR-53, NKSWR-64, NKSWR-75, NKSWR-86, NKSWR-98
Fertile spikelets per panicle	> 75.0	NKSWR-37, NKSWR-48, NKSWR-51, NKSWR-53, NKSWR-64, NKSWR-75
Test weight (g)	> 25.0	NKSWR-16, NKSWR-48, NKSWR-51, NKSWR-57, NKSWR-64, NKSWR-70, NKSWR-75, NKSWR-98

value of both year data were pooled over and used for statistical analysis. The data was analyzed for variability as per procedure given by Panse and Sukhatme (1985), genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) by Burton and De-Vane (1953), and heritability and genetic advance by Johnson *et al*. (1955).

RESULTS AND DISCUSSION

Quantitative traits

Result clearly showed that the variation of each character is highly significant, suggested the large amount of variability exist among the characters and accessions (Table 2). The range, mean value, standard error and coefficient of variation of different quantitative traits are presented in Table 3 and frequency distributions of different quantitative characters are shown in figure 1. The days to 50 per cent flowering varied from 91.00 to 120.66 with mean of 113.41 and days to maturity from 128.66 to 157.00 with mean of 147.95. The almost 88.57 per cent accessions had more than 110 days to 50 per cent flowering and 140 days for maturity. The results of present investigation for days to 50 per cent flowering and maturity are conformity with the findings of Rana *et al*. (2009) and Kumar *et al*. (2013). Leaf length varied from 52.61 to 78.90 cm with mean of 63.35 cm and leaf width varied from 1.04 to 1.80 cm with mean of 1.37 cm. Leaf length and width showed moderate variability. Evenly distributed narrow and short leaves can reduced mutual shading and increase efficient utilization of light. Panicle length varied from 17.72 to 28.50 cm with mean of 23.09 cm and 68.57 per cent accessions had intermediate type. Patra and Dhua (2003) reported similar findings for leaf length, leaf width and plant height. High variability was found in plant height which ranged from 128.72 to 210.82 cm with mean of 155.26 cm. Number of effective tillers per plant varied from 3.50 to 10.15 with mean of 7.19, and 65.71 % accessions had more than 6 tillers per plant. Fertile spikelets per panicle varied from 19.12 to 231.90 with mean of 69.65, total number of grains per panicle varied from 54.61 to 267.29 with mean of 107.32 and spikelet fertility varied from 23.44 to 86.77 % with mean of 63.52 %. These are the most variable characters, and being an important yield contributing traits offers scope for improvement in *indica* rice through hybridization breeding programme. These results were conformity with the finding of Das and Ghosh (2010). Test weight is the key characters for high yield and it varied from 14.10 to 33.50 g with mean of 23.53 g, and showed presence of high variability. High variability in this trait was earlier reported by Sharma *et al*. (2004); Subudhi *et al*. (2012) and Singh *et al*. (2013). Kernel length varied from 5.01 to 7.01 mm with mean of 6.05 mm and kernel breadth from 1.12 to 2.62 mm with mean of 2.04 mm. Grain yield per plant varied from 7.89 to 36.98 g with mean of 23.04 g showed high variability in grain yield per plant.

The highest estimate of PCV and GCV were observed for fertile spikelet per panicle (56.21 and 55.39) followed by total grains per panicle (42.07 and 40.86) and grain yield per plant (28.51 and 27.60) indicating their importance in selection for improving the yield. Moderate value of PCV and GCV were

Table 5: Frequency distribution of morphological characters in thirty five wild rice accessions

Character	Description	Score	No of accession	% Frequency (n/N X100)
Basal leaf sheath colour	Green	1	22	62.86
	Purple lines	2	02	05.71
	Light purple	3	06	17.14
	Purple	4	05	14.29
Leaf blade colour	Light green	1	04	11.43
	Green	2	12	34.28
	Dark green	3	11	31.43
	Purple tips	4	07	20.00
	Purple margins	5	01	02.86
	Purple blotch	6	00	00.00
	Purple	7	00	00.00
Leaf blade pubescence	Glabrous	1	24	68.57
	Intermediate	2	10	28.57
	Pubescent	3	01	02.86
Flag leaf angle	Erect	1	16	45.72
	Intermediate	2	07	20.00
	Horizontal	5	09	25.71
	Descending	7	03	08.57
Panicle exsertion	Well exserted	1	15	42.86
	Moderately well exserted	3	06	17.14
	Just exserted	5	03	08.57
	Partly exserted	7	11	31.43
	Enclosed	9	00	00.00
Panicle type	Absent	1	01	02.86
	Compact	3	05	14.29
	Intermediate	5	17	48.57
	Open	9	12	34.28
Stigma colour	White	1	11	31.43
	Light green	2	00	00.00
	Yellow	3	00	00.00
	Light purple	4	00	00.00
	Purple	5	13	37.14
	Dark purple	9	11	31.43
Sterile lemma	Straw	1	27	77.15
	Gold	2	02	05.71
	Red	3	02	05.71
	Purple	4	04	11.43
Awning	Absent	0	02	05.71
	Short and partly awned	1	03	08.57
	Short and fully awned	5	02	05.71
	Long and partly awned	7	05	14.30
	Long and fully awned	9	23	65.71
Apiculus colour	White	1	12	34.28
	Straw	2	00	00.00
	Brown	3	00	00.00
	Red	4	14	40.00
	Red apex	5	01	02.86
	Purple	6	08	22.86
	Purple apex	7	00	00.00
Leaf senescence	Late and slow	1	02	05.71
	Intermediate	5	02	05.71
	Early and fast	9	31	88.58
Threshability	Easy	1	21	60.00
	Intermediate	2	11	31.43
	Difficult	3	03	08.57

observed in total number of tillers per plant (24.35 and 22.19), spikelet fertility (20.69 and 20.31), test weight (16.63 and 16.41) and kernel breadth (16.28 and 16.07), and lowest in days to maturity (4.52 and 4.41) followed by days to 50% flowering (5.41 and 5.26). These finding are similar to those Dhanwani *et al.* (2013) for high PCV and GCV in biological yield, grain yield per plant, filled grains per panicle and unfilled grains per panicle; Gangashetty *et al.* (2013) for plant height, number of tillers per plant, number of productive tillers per plant, panicle weight, grain length, test weight and grain yield per plant; Singh *et al.* (2014) for low PCV and GCV in days to maturity, panicle length, spikelet fertility percentage and kernel breadth. The estimate of heritability was high for kernel breadth (97.46%), test weight (97.40%) and fertile spikelet per panicle (97.10%). It indicated that variation observed in these traits is primarily due to genetic causes and not only by environmental

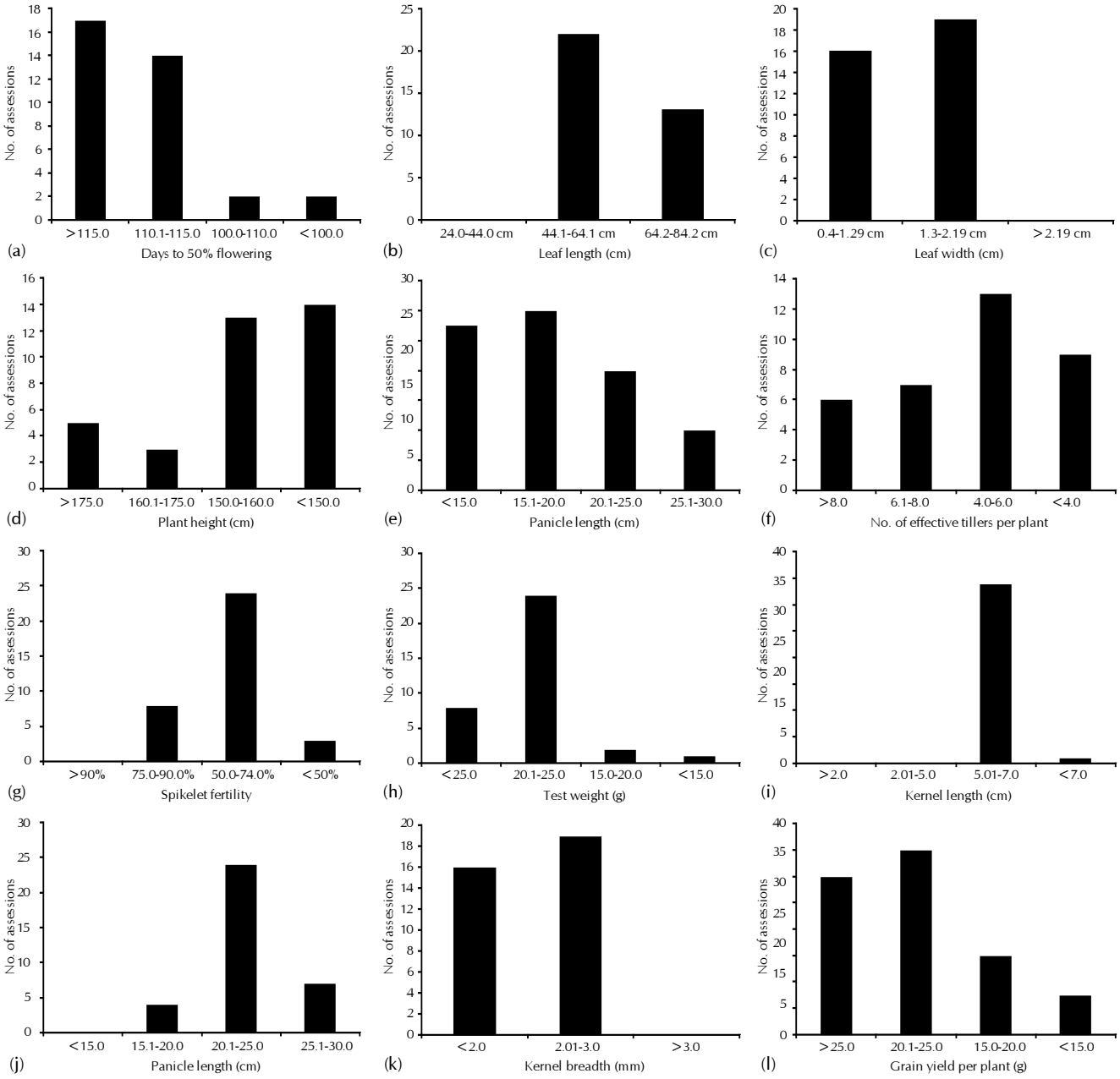

Figure 1: Frequency distributions of different quantitative characters

effects. High heritability does not always indicate high genetic gain. The heritability coupled with high genetic advance as per cent of mean under the control of additive gene action would be effective for selecting superior germplasm. High heritability coupled with high genetic advance as per cent of mean were observed for fertile spikelet per panicle (97.10% and 112.46), total number of grains per panicle (94.30% and 81.74) and grain yield per plant (93.70% and 55.03) which indicates the preponderance of additive gene action and such characters could be improved through selection. These results are conformity with the earlier reports of Ghosh and Sharma (2012) for grain yield per plant, pollen fertility, sterile spikelet per panicle, fertile spikelet per panicle, spikelet fertility and test weight; Singh *et al.* (2013) for plant height, number of spike lets per panicle, flag leaf length, grain yield per plant, days to 50 per cent flowering and flag leaf width. Whereas high heritability coupled with low genetic advance as per cent mean were observed in days to maturity (95.50% and 8.89), days to 50% flowering (94.60% and 10.55) and kernel length (93.20% and 12.31) which indicates non additive type of gene action and that genotype x environment interaction plays a significant role in the expression of the traits. These results are inconformity with the findings of Rahaman *et al.* (2012) for days to 50 per cent flowering, panicle exertion rate and harvest index. The promising wild rice accessions for different yield characteristics are given in table 4. The accessions NKSWR-48, NKSWR-64 and NKSWR75 are found to be most promising for panicle length, fertile spikelet per panicle, spikelet fertility

percentage, test weight and grain yield per plant.

Qualitative traits

The frequency distributions of qualitative characters are presented in table 5. Colour of outer surface of leaf sheath had moderate variability while high variability was found in leaf blade colour. The 34.28 per cent accessions had green followed by dark green (31.43 %) coloured leaf blade. Flag leaf angle is very important for photosynthesis; most of the accessions had erect (45.72 %) and horizontal (25.71 %) flag leaf angle. High variability was found in panicle exertion. Most of the accessions had well exerted (42.86 %) and partly exserted (31.43 %) panicle. In panicle type variability, 48.57 % of accessions recorded intermediate followed by open type (34.28 %). The above results of present investigation are conformity with the findings of Das and Ghosh (2010) and Subudhi et al. (2012). Frequency of glabrous type leaf blade pubescence was high (68.57 %) in the accessions collected. Rice plant with pubescence leaf blade irritates workers skin during harvesting and threshing, thus glabrousness is fairly desirable. High variability was found stigma colour with maximum accessions had purple (37.14 %), dark purple (31.43 %) and white (31.43 %) coloured. Sterile lemma had moderate variability with maximum of accessions (77.15 %) having straw colour. Awn is a filiform exertion of the keel of the lemma. Farmers prefer awnless grain because awns are objectionable in threshing and milling. In present collection 80.01 per cent accessions had long awn which is fairly desirable. Similar results were also reported by Rana *et al.* (2009) for awning in rice germplasms of Western Himalayan region of India. High variability was found in apiculus colour with a maximum of red (40.00 %) followed by white (34.28 %) colour. However low variability was found in leaf senescence. Threshability had moderate variability. The 60.00 per cent accessions having easy threshability followed by intermediate type (31.43 %) threshability.

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