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Conservation and characterization of indigenous rice germplasm adapted to temperate/cooler environments of Kashmir valley

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ABSTRACT

Adoption of modem agricultural technology vis-a-vis, the introduction of new high yielding exotic varieties has largely endangered the rice genetic diversity that got adapted to the temperate environments of Kashmir since their first domestication. This germplasm resource is diverse in morphology, grain characteristics, quality parameters, maturity period and response to biotic/ abiotic stresses. Sixty six indigenous rice cultivars adapted to agro-climatic conditions of Kashmir were collected, evaluated under different micro-and macro-environments and characterized for morphological, maturity, yield, yield component traits, and quality parameters. Most of these cultivars got grouped into cold-tolerant Indica rice, with a few under Japonica rice. Most of the cultivars possessed genes for quality rice, better recovery of milled rice and higher head rice recovery, but, by and large, were poor yielders despite vigorous growth, usually medium in tillering and with lesser grains panicle^{-1}. Presence of high G x E interaction revealed that minor genes and modifying factors have played a significant role during adaptation to a particular macro-environment. Genotypic coefficient of variation was high for grain yield plot^{-1}, moderate for tillers plant^{-1}, grains panicle^{-1}, 1000-grain weight, amylose content and gelatinization temperature and low for maturity traits, plant height, head rice recovery, milled rice recovery and amylose content. The grains of all these cultivars are bold and sticky on cooking. Significant variation in grain colour (blackish brown and creamy white) and aroma exists revealing constellation of elite allelic resources in this set of germplasm.

Key words: *Indigenous rice germplasm, cold stress, phenotypic variability, quality parameters*

Rapid growth in human population envisaged increase in vertical productivity of cereal grains, particularly rice and wheat. This led to development of high yielding varieties of rice at the cost of replacement of long adapted heterogeneous cultivars. The increase in genetic uniformity led to genetic erosion of most precious gene complexes present in the long adapted region specific cultivars. The valley basin and higher altitudes of Kashmir are known for the cultivation of bold seeded quality *Indica/Japonica* rices. With the advent of high yielding and uniform varieties, these long adapted cultivars have been pushed to smaller pockets. During this transition many valuable cultivars have been lost. The present investigation was aimed at conservation and characterization of this indigenous rice germplasm bio-diversity.

MATERIALS AND METHODS

Sixty six long adapted indigenous rice cultivars, along with standard checks, were evaluated for maturity, yield and quality traits at three random geographical environments in the Kashmir valley. Two of the locations represented valley basin rice area (1650 m to 1850 m amsl) and one high altitude cold environment (2250 m amsl). Each experimental plot comprised of two rows of four meter length. The rows were spaced 20 cm apart with plant to plant distance of 15 cm. Experiment was laid in RBD with three replications. Ten competitive plants were randomly selected for recording the observations for all the characters except for maturity traits, where whole experimental plot was considered. Mean/ median values were used to compute the analysis of variance. Diagnostic plant characteristics (as per the standard method suggested by IRRI) were recorded, besides recording the other observations viz. plant height, tillers m^{-2}, maturity traits (flowering and maturity), panicle characteristics (length, number of grains and seed weight), grain yield and quality traits (hulling, milling, head rice recovery, L/B ratio, kernel elongation on cooking, amylose content, gelatinization temperature and aroma). Analysis of variance for all the quantitative characters was performed for individual environments and on the data pooled over the environments to estimate the magnitude of G x E interaction and get a reliable estimate of the genotypic and phenotypic variance and other related parameters.

RESULTS AND DISCUSSION

For estimation of diagnostic characteristics a general scale with index value of 0-9 was adopted for most of the traits as per the SES scale of IRRI. Desirable parents for a particular trait were identified if the score was 3 or less on the scale. Such varieties or cultivars having majority of the traits with a score of 3 or less are known to express full biological potential even under different levels of biotic and abiotic stresses. These cultivars are good to be used as parents for hybridization to broaden their genetic base or incorporate elite allelic resources present in these indigenous cultivars into high yielding exotic varieties to recover segregants with better quality and higher yield. Twenty six morphological traits were considered for diagnostic characterization of these varieties. Majority of the cultivars were of *Indica* group. Leaf length varied from 30.5 to 44.6 cm while the width ranged from 0.9 to 1.3 cm. Most of the cultivars have pubescent leaf blade and a few glabrous one. Leaf blade was green in majority of the cultivars but a few had purple coloration. Awning revealed great variability from short and partly awning to long and fully awned cultivars. Majority of the cultivars expressed vigorous growth, medium tillering ability, late and slow senescence, good panicle exsertion and moderate to difficult threshability. An overall salient characteristics of this germplasm resource is given in the Table 1. Analysis of variance revealed significant difference in the environments (locations) and G x E interaction for all the traits except 1000-grain weight. All the characters revealed significant difference in individual environments and in pooled analysis, revealing presence of substantial genetic variability. Perusal of the Table 2 revealed that mean plant height ranged from 72.8 to 127.3 cm, tillers $plant^{-1}$ ranged from 8.24 to 13.4, panicle length varied from 19.2 to 23.0 cm, grains $panicle^{-1}$ from 69.5 to 118.1, 1000-grain weight from 13.8 to 29.6 g, days to 50 per cent flowering from 82 to 105, days to maturity from 124 to 139 days, harvest index from 23.6 to 40.9, grain, yield $plant^{-1}$ from 7.2 to 16.1 g and grain yield $plot^{-1}$ (of 2.4 m^2) from 263.3 to 701.1 g. Per cent hulling ranged from 72.5 to 80.4; milling from 63.3 to 75; head rice recovery from 47.6 to 69.4; L/B ratio from 1.59 to 2.41; kernel elongation on cooking from

Table1. Indigenous rice germplasm adapted to cooler/ temperate environments of Kashmir valley and their characteristic features.

1	Begum [a,c]	34	Poot Brear [c,e,f]
2	Mushk Budgi [k]	35	Poot Brear [c,g,h]
3	Zagir [c,j]	36	Mehwan (Green) [c,e,f]
4	Qadir Baig [a,b]	37	Mehwan (Purple) [c,d]
5	Balakoun [d]	38	Umberzul [c,i]
6	Tilla Zag [l,k]	39	Watezag [d,,g]
7	Mughal [a]	40	Rehman Bhatti [b,f]
8	Gulla Zag [e,k]	41	Madew [c,f,e]
9	Kamad [a,k]	42	Safeed Khuch [f,j,i]
10	Batu-Baber [I,j]	43	Zaged [c,f,h]
11	Prunchwall [d,f]	44	Noor Meeri [b,c,e]
12	Larbeoul [a,i]	45	Zagir Purple [d,k]
13	Safed Brez [c,k]	46	Barrat [b,f]
14	Katwara [f,k]	47	Resham [d,e]
15	Siga Safeed [e,h]	48	Gulla Bara [a,b]
16	Shahie [d,g,i]	49	Tral Zagir [c,d]
17	Mushkandi-I [e,k]	50	Mazzatte-I [d,e]
18	Mushkandi-II [b,f]	51	Mazzatte-II [a,d,f]
19	Aziz Beoul [f,k]	52	Prenei Zaged [a,j,k]
20	Brez [a,d]	53	Safeed Budgi [a,k]
21	Rama Hall [b,e]	54	Guru Kanue [a,c,f]
22	Niver [f,i]	55	Khuch [d,f,g]
23	Tumla Hall [d,f]	56	Kala Brear [c,d,f]
24	Baber [a,k]	57	Kala Brear-I [a,c,d]
25	Prenei Baber [a,b]	58	Zag Baber [a,f,g]
26	Nun Beoul [e,h,f]	59	Bala Anzul [bc,e]
27	Qadir Ganaie [c,k]	60	Niver Zag [a,h]
28	Meer Zag [a,g,e]	61	Chine Bara [b,d,e]
29	Shalla Kew-I [g,j,k]	62	Tumal Zag [c,j,k]
30	Shalla Kew-II [a,c]	63	Luaul Anzul [b,h,j]
31	Kawa Kuder [a,f,j]	64	K-116 [b,d,i]
32	Guru [d,g,h]	65	Siga [a,b,e]
33	Kawa Krear [c,k]	66	Black Rice [I,j,k]

Legends: a) Early maturing b) Tall c) Profuse tillering d) Long panicle e) Higher biomass f) Bold seeded g) Good hulling (%) h) Good milling (%) i) High L/B ratio j) High Head Rice Recovery k) Aromatic

8.77 to 11.87 mm; amylose content from 13.5 to 26.6 per cent and gelatinization temperature from 3.43 to 6.0. Coefficient of variation (both phenotypic and genotypic) was high for grain yield plot^{-1}, moderate for tillers plant^{-1}, grains panicle^{-1}, 1000 grain weight, grain yield plant^{-1}, amylose content and gelatinization temperature, while for other traits these parameters were low (Table 2). Katoch *et al.* (1993) and Sawant & Patil (1995) reported high GCV for plant height, whereas Ganesan and Subramanian (1994) reported moderate GCV for this trait. High GCV for tillers plant^{-1} (Ganesan and Subramanian, 1994) and for panicle length (Lokaprakash *et al.*, 1992) has been reported. Similarly, several research workers have reported high GCV for yield and yield component traits. Heritability estimates were high (>60%) for plant height, grains panicle^{-1}, 1000-grain weight, days to flowering and maturity, grain yield plant^{-1} and plot, and all the quality parameters (Table 2). It was moderate (30 to 60%) for harvest index and low (30%) for tillers plant $^{-1}$ and panicle length. Expected genetic gain (per cent of mean) was high for most of the yield and yield component traits and amylose content. It was moderate for most of the quality parameters and low for plant height and maturity traits. High magnitude of genetic variability, heritability and genetic gain has been reported in this crop. High heritability for tillers/plant (Sarvanan and Senthil, 1994) and grain yield plant^{-1} (Sawant and Patil, 1995; Choudhury and Das 1998) have been reported. High expected genetic gain for tillers plant^{-1} and yield components have been reported by Selvarani and Rangaswamy (1997). High GCV together with high heritability results in higher genetic gain from selection. Lower expected genetic gain results from low genetic variability rather than from moderate to low heritability (Singh *et al*, 1984). High genetic advance and high heritability results from additive gene action and vice versa indicates influence of dominance and or epitasis. In the present materials, grain yield, panicle length and grains panicle^{-1} revealed both high heritability and expected genetic gain, revealing influence of additive gene effects and improvement in these traits through selection is possible. Milling recovery is influenced by environmental factor (Tomar and Nanda, 1985), besides kernel shape and size. Head rice recovery need to be given more emphasis than milled rice yield to increase the value addition of brown rice. The indigenous germplasm resources are being maintained at Rice Research Station, Khudwani and also seed is deposited at NBPGR (ICAR), New Delhi for long term storage.

Table 2. Magnitudes of variability and estimates of coefficient of variation, heritability and expected genetic gain for different morphological, quality and yield and yield contributing traits in the indigenous rice germplasm

Trait	Range	Mean*	Coefficient of variation		Heritability (broad sense)	Expected genetic gain (% of mean)
			Phenotypic	Genotypic		
Plant height (cm)	72.80 - 127.30	114.04	7.17	5.65	0.62	9.16
Tillers plant^{-1}	8.24 - 13.40	10.69	19.37	11.06	0.32	13.00
Panicle length (cm)	19.20 - 23.00	21.06	7.49	3.42	0.20	3.22
Grains panicle^{-1}	69.50 - 118.09	88.12	14.70	12.66	0.74	22.45
1000-grain weight (g)	13.80 - 29.60	21.72	16.16	14.43	0.79	26.00
Days to 50% flowering	82.00 - 105.00	92.00	5.05	4.56	0.81	8.40
Days to maturity	124.00 - 139.00	132.00	2.39	1.80	0.56	2.79
Harvest index (%)	23.60 - 40.90	31.78	17.70	3.79	0.46	11.10
Grain yield plant^{-1} (g)	7.20 - 16.10	11.92	22.84	16.19	0.54	25.83
Grain yield plot^{-1} (g)**	263.33 -701.10	482.12	33.34	28.40	0.64	40.80
Hulling (%)	72.49 - 80.40	77.15	3.19	1.23	0.15	0.97
Milling (%)	63.30 - 74.98	69.39	2.65	2.34	0.78	4.28
Head Rice Recovery	47.60 - 69.42	55.45	7.63	6.27	0.67	10.62
Kernel L:B ratio	1.59 - 2.41	1.91	5.70	5.49	0.92	10.72
Kernel elongation on cooking (mm)	8.77 - 11.87	10.27	8.15	6.32	0.60	10.12

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