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Identification of some useful scented rice mutants for grain yield and quality traits

Swapan K Tripathy, Dibya R Mishra, Rajesh Ranjan, D N Bastia and S R Das
College of Agriculture, OUAT, Bhubaneswar-3

ABSTRACT

Fifteen advanced generation mutant lines derived from recurrent mutagenesis (EMS, NG and their combinations) of PB 1, Pusa Sugandha 2 and a popular local scented rice variety Ketakijoha were assessed for seed yield and sixteen physical and cooking quality traits. ORM 250-3 and 228-3 had more longer kernel (9.12mm) than even world's largest kernel (9.04mm.)genotype PS-4 (Pusa-1121) and the former was also more slender while, the later was breadth-wise equal to PS 4. Induction of mutation in Ketakijoha led to recovery of a very slender kernel(1.55mm) mutant ORM 242-2 which even excelled in kernel L/B ratio over its grain dimension. ORM 920-3(a PB-1 mutant) and ORM 227-2(a Pusa Sugandha-2 mutant) with high yield potential and quality features serve as valuable genetic materials their use in further basmati rice breeding programme.

Key words: *scented rice mutants, grain yield, physical and cooking quality traits*

Self-sufficiency in rice production and enhanced purchasing power have resulted changed life style and awareness among consumers to improve and diversify diets including quality of rice consumed. Therefore, quality consideration assumes due importance to promote growth and sustenance of rice exports in the highly competitive international trade. Indian basmati-the soft cooking aromatic rice is acclaimed as the best quality rice in the world market due to its unique features e.g., pleasant and subtle aroma, delicate taste, extra long super fine grain, extreme elongation upon cooking (more than double the original length), intermediate amylose content and high head rice recovery. The crosses so far made involving Pusa Basmati-1, Taraori Basmati, Basmati 370 have not rendered any remarkable breakthrough in genetic enhancement for productivity. Besides, very often the delicate genetic background conforming to the basmati standard is disturbed in the segregating population derived from recombination breeding. However, induction of mutation in the popular high yielding basmati rice variety or a popular local scented landrace fulfilling the quality features can be a feasible proposition. In the present investigation, the authors report selection of a few high yielding basmati quality mutants derived through recurrent mutagenesis in scented rice.

Fifteen selected advanced generation mutant cultures out of a total 75 fixed mutant lines(M_8 generation)(Mishra 2009) derived through recurrent mutagenesis with EMS(0.2, 0.4 and 0.6%), NG(0.01, 0.015 and 0.02% and a combination of 0.4% EMS and 0.015% NG (following a pre-soaking period of 10.5hsin distilled water), their parents (Pusa Basmati-1, Pusa Sugandha -2 and a land race Ketakijoha local) and two standard check varieties(Geetanjali and Pusa Sugandha-4). The mutant cultures under present investigation were initially sorted out based on high yield vis-à-vis acceptable physical grain features. The experiment was laid out in randomized block design with three replications. Freshly harvested grains of the test genotypes were assessed for grain yield and 16 quality parameters to judge their relative merit as compared to the parents and check varieties used. The quality tests e.g., gel consistency(GC) was based on the method described by Cagampang *et al.* (1973), and alkali spreading value(ASV) and Gelatinization temperature(GT) scores ranging from 1-7 were assessed as per Little *et al.* (1958). Gelling or gelatinization temperature is the measure of cooking ease and is indexed by an inverse measure of alkali spreading value. Varieties with gel consistency >60mm, between 40-60mm, and < 40mm were considered soft, medium and hard gel genotypes, respectively. In the present investigation, the cooking qualities e.g., cooked kernel length, cooked kernel length/breadth ratio, elongation ratio upon cooking were calculated as per Verghese (1950) and volume expansion ratio (VER) were determined as per method of Juliano and Perez(1984). Presence or absence of aroma was scored (0-3 scale) during alkali digestion of milled kernels soaked in 1.7% KOH for 23hrs. at 30^oC. Assessment of all these quality features were repeated thrice to minimize experimental error.

The increase in kernel length along with a significant decrease in kernel breadth would be a desirable feature towards isolation of improved basmati type mutants. In the present investigation, the shift in means in kernel dimension of mutant lines as compared to their parents (Table 1) might have resulted from induced polygenic mutations with unequal effects. A PB-1 mutant ORM 250-3 and a PS-2 mutant ORM 228-3 were identified to possess even more than 12.0 mm. and 9.0 mm. for grain and kernel length respectively. ORM 250-3 had more slender and longer kernel than even world's largest kernel genotype PS-4 (Pusa-1121). Whereas, ORM 228-3 had also longer kernel than PS-4 But breadth-wise both had same dimension.

In general, L/B ratio of kernel decreased due to more reduction in length compared to breadth after hulling as also reported by Bordoloi and Talukdar (1999). Besides, the considerable difference between L/B ratio of grain and kernel in most of the mutants could be ascribed either to the relative amount of air space between hull and kernel or hull thickness which directly influenced grain density in rice. Grain density reflects the degree of compactness of starch grains in the kernel and complete development of kernel, leaving no space between the kernel and hull (Bong and Singh, 1996). The L/B ratio of kernel and grain were reported to be equal in an advanced mutant line of PB-1 (ORM 239-1) indicating proportionate decrease in length and breadth after hulling (Mishra 2009). Whereas, ORM 242-2 excelled in kernel L/B ratio over that of grain suggesting more of iso-diametric reduction in breadth compared to length of kernel. The mutants e.g., ORM 250-3 and ORM 228-3 exhibited marginal reduction in L/B ratio after hulling. These above three mutants had exceptionally high L/B ratio for both grain and kernel.

Long and very slender kernel types are preferred by the consumers and therefore, such kernel types fetch high premium price in the market. These types can be identified easily based on kernel length and L/B ratio. Kernel length more than 7.0 mm. and L/B ratio >3.5 fulfill the minimum standard for basmati types. Therefore, such criteria of selection along with significantly higher grain yield than their respective parents were considered to sort out valuable mutants out of 75 advanced fixed mutant lines(Mishra 2009) for further quality analysis along with their parents and a few standard checks(Table 1). These includes ten PB-1 mutants (ORM 920-3, ORM 920-5, ORM 920-6, ORM 250-5, ORM 250-7, ORM 254-5-3-3, ORM 256-8-15, ORM 257-5-3-1, ORM 256-8-6 and ORM 256-7-2), one PS-2 mutant (ORM 227-2) and one Ketakijoha mutant (ORM 240-1). Besides, mutants e.g., ORM 250-3, ORM 228-3 and ORM 242-2 derived from PB-1, PS-2 and Ketakijoha respectively, were also selected for further quality analysis owing to their erstwhile mentioned exceptionally high kernel length and L/B ratio.

The selected test genotypes were further analyzed for hulling percentage, cooking qualities e.g., kernel length, breadth and L/B ratio of kernel after cooking, elongation ratio, volume expansion ratio, alkali spreading value, gelatinization temperature, gel consistency and also aroma to select superior quality types. The test genotypes varied widely for the above quality traits (Table-1). Subtle aroma, hulling percentage, kernel length, kernel L/B ratio, elongation ratio, volume expansion ratio and gel consistency are the important selection criteria for selection of genotypes to fulfill the minimum standard of basmati types. PB-1 exhibited moderately high grain length (11.00 mm), very high G.L/B ratio (5.38), high kernel length and K.L/B ratio, very high hulling percentage (82.93%), acceptable aroma and cooking qualities with moderately low grain yield (20.50g). Maximum grain length was exhibited by PS-4 (World's longest grain genotype) followed by ORM 228-3 and ORM 250-3, but ORM 250-3 and ORM 228-3(a PS 2 mutant) recorded highest kernel length (9.12mm) even more than PS-4. Among these two mutants ORM 250-3 had also shown very high K.L/B ratio but had poor productivity and unsuitable for table rice purpose owing to its poor cooking qualities in terms of ASV (score 6.0), GT (score 2.0) and GC (72 mm). Whereas, the mutant ORM 228-3 with

Table-1. Mean grain yield and quality traits of twenty selected rice genotypes

Genotypes	Pedigree	Grain			Kernel			Hull. (%)	Cooked rice			E.R	V.E.R	A.S.V score (1-7)	G.T Score (1-7)	G.C (mm)	Aroma score (0-3)	Grain yield / plant (g)
		L (mm)	B (mm)	L/B ratio	L (mm)	B (mm)	L/B ratio		L (mm)	B (mm)	L/B ratio							
ORM920-3	Mutant of PB-1	10.91	2.18	5.01	8.32	2.00	4.16	81.15	10.91	4.91	2.22	1.50	3.88	3	5	72	1	36.61
ORM920-5	-do-	10.90	2.21	4.94	7.92	1.84	4.30	73.87	12.16	4.16	2.92	1.53	3.60	5	3	74	0	24.86
ORM920-6	-do-	10.74	2.69	3.99	7.84	2.20	3.56	74.92	9.25	4.08	2.26	1.17	3.26	6	2	75	1	27.98
ORM250-5	-do-	11.01	2.12	5.20	8.17	1.93	4.24	79.64	10.83	3.94	3.00	1.32	5.00	5	3	69	1	37.38
ORM250-7	-do-	9.55	2.27	4.20	8.28	2.12	3.90	79.62	11.58	3.58	3.23	1.39	3.40	4	4	58	0	25.20
ORM254-5-3-3	-do-	10.03	2.22	4.51	7.27	2.03	3.59	78.85	9.91	3.75	2.64	1.38	3.66	5	3	64	2	30.88
ORM240-1	Mutant of Ketakijoha	11.20	2.25	4.98	7.84	1.73	4.54	77.85	10.00	4.41	2.26	1.27	3.76	3	5	71	2	24.79
ORM256-8-15	Mutant of PB-1	10.20	2.26	4.50	7.72	1.90	4.05	80.98	10.25	3.91	2.62	1.32	3.62	3	5	49	1	29.14
ORM242-2	Mutant of Ketakijoha	11.50	2.40	4.80	8.32	1.55	5.36	82.02	13.00	3.65	3.29	1.56	3.53	4	4	53	3	9.41
ORM257-5-3-1	Mutant of PB-1	11.10	2.41	4.60	7.54	2.11	3.56	73.16	11.66	3.86	3.02	1.54	4.88	4	4	71	1	32.75
ORM250-3	-do-	12.08	2.15	5.61	9.12	1.72	5.29	79.10	12.20	4.30	2.83	1.33	3.50	6	2	72	1	15.17
ORM256-8-6	-do-	10.31	2.32	4.45	7.92	2.04	3.88	81.53	11.08	4.33	2.55	1.39	3.15	4	4	52	1	26.28
ORM228-3	Mutant of PS-2	12.42	2.65	4.68	9.12	1.99	4.58	82.03	13.72	4.32	3.17	1.50	3.52	3	5	58	2	18.24
ORM227-2	-do-	9.73	2.11	4.60	7.22	2.06	3.50	83.85	11.58	3.83	3.02	1.60	3.20	4	4	70	1	34.28
ORM256-7-2	Mutant of PB-1	10.44	2.22	4.71	7.43	1.72	4.32	78.67	10.83	4.16	2.60	1.45	4.66	5	3	67	1	32.14
Pusa basmati-1	Parent	11.00	2.04	5.38	8.47	1.72	4.91	82.93	11.33	4.00	2.83	1.33	3.55	3	5	54	2	20.50
Pusa sugandha-2	Parent	10.82	2.26	4.78	7.57	2.03	3.73	78.65	12.16	3.66	3.32	1.60	3.40	4	4	48	3	18.13
Ketakijoha	parent	8.31	2.20	3.78	6.04	1.93	3.13	78.47	9.16	4.25	2.15	1.51	4.35	4	4	56	2	17.60
Geetanjali	Standard check	11.00	2.21	4.97	8.22	1.88	4.38	82.57	10.66	3.91	2.72	1.29	3.55	3	5	45	3	19.75
Pusa sugandha-4	Standard check	13.01	2.35	5.52	9.04	1.99	4.53	76.98	12.08	4.19	2.88	1.33	3.77	5	3	60	1	9.41
$CD_{0.05\%}$	0.09	0.04	0.42	0.07	0.19	0.05	5.03	0.08	0.21	0.07	0.02	0.07	-	-	-	-	6.58	
$CD_{0.01\%}$	0.12	0.05	0.55	0.10	0.26	0.07	7.11	0.11	0.29	0.08	0.03	0.09	-	-	-	-	8.65	

Figures within the parenthesis indicates serial number of the test genotypes.
E.R-Kernel elongation ratio,V.E.R-Volume expansion ratio, A.S.V- Alkali spreading value, G.T-Gelatinization temperature,G.C-Gel consistency

appreciably high K.L/B ratio, had very high hulling percentage (82.03%), maximum kernel length after cooking (13.72 mm), better cooking qualities and harbor moderately high aroma (score 2.0). However, productivity of this mutant is poor (18g per plant). On similar consideration, a Ketakijoha mutant ORM 242-2 was found to harbor very high level of aroma and was qualitatively superior for all quality features to fulfill basmati standard, but again its yield level is extremely low. ORM 250-5 had maximum volume expansion ratio (5.0) but very low elongation ratio (1.32) which is undesirable. This may be attributed to more of iso-diametric increase of kernel then its length after cooking but typical basmati types are characterized by high kernel elongation without much increase in breadth after cooking. In this context, ORM 227-2 had high elongation ratio, low volume expansion ratio along with high grain yield, high hulling percentage and comparatively good cooking qualities. High elongation ratio (>1.5) and very high volume expansion ratio (4.88) along with comparatively favourable cooking qualities (intermediate ASV and GT value) and high grain yield (32.75g) in case of ORM 257-5-3-1 may be also considered desirable, but the mutant had poor kernel recovery after hulling (73.16%) among the test genotypes. However, among the mutants under study, ORM 920-3 with intermediate height (Mishra 2009) and high grain yield (36.61g) along with acceptable quality features e.g., high kernel length, very high L/B ratio of grain and kernel, high hulling percentage (81.15%), acceptable elongation ratio (1.50), very high volume expansion ratio (3.88), intermediate ASV and GT value and subtle aroma may be considered promising.

Thus, ORM 920-3(a PB 1 mutant) and ORM 227-2(a PS 2 mutant) with high yield potential and quality features serve as valuable genetic materials for multilocation testing and their use in further basmati rice breeding programme.

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