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IDENTIFICATION OF SUPERIOR HYBRIDS AMONG THE CROSSES BETWEEN VARIOUS RICE GENOTYPES

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ABSTRACT

Three cytoplasmic male sterile (CMS) lines of rice i.e. IR58025A, IR68897A and Pusa 6A were crossed with seven pollen parents (Sarjoo-52, Jaya, Sasyashree, Swetha, HUR 5-2, PR-106 and BPT 5204) into line x tester design. In addition to the yield traits, mean performance for grain quality characters were recorded in parents and all the 21 hybrids. Based on their yield performance and grain quality features, only two hybrid combinations, IR68897A X Jaya and IR68897A X BPT 5204 were identified to be superior as compared to their parents and the check variety. Both these hybrids can be recommended for the commercial cultivation.

Key words: Grain quality, hybrid, rice, yield performance

INTRODUCTION

Rice is a staple food for more than half of world's population. The hybrid rice due to its high heterotic potential is widely cultivated in almost all the rice growing countries of world. The main concern regarding the prospects of large scale adoption of hybrid rice is the acceptability of quality of hybrid rice grain among consumers. Consumer acceptance is the ultimate factor that determines the price of the product and its marketability, which ultimately affects the gross revenues of those involved in production and marketing. Yield is the most noticeable characteristic while the crop is in field, but when the product reaches the market, quality becomes the key factor for its selling ability.

Rice is primarily consumed as a whole grain. The harvested grains from commercial F_1 rice hybrids represent the F_2 seed generation, which shows segregation for some grain characteristics. Therefore, a concern is being expressed about consumer preferences because of the possible effect of this segregation on grain quality. Moreover, there are regional preferences for different quality parameters of rice. Best quality type of one region may not be liked at all by another region. Juliano and Villareal (1991), while studying the grain quality characteristics of popular world rice varieties observed that a wide variation in quality preferences existed between countries and between regions within large countries.

Rice is used almost exclusively as a food item. Acceptance of hybrids by consumers is primarily determined by cooking and eating quality characteristics. Thus, higher yield potential of rice hybrids by itself would not make hybrid rice technology acceptable unless quality features are taken into consideration. But, the higher magnitude of heterosis for both the yield and quality traits in a single hybrid combination can rarely be accomplished (Roy *et al.*, 2009). Studies on genetic variability and combining ability have revealed the rare existence of any excellent cross combination for all the quality characters (Chandirakala *et al.*, 2012). Therefore, the major challenge in rice hybrid breeding is to ensure that the heterotic rice hybrids possess grain quality that is at least comparable, if not superior, to that of inbred check varieties grown by farmers. Therefore, the present study was conducted to evaluate some parent and hybrid rice for better quality and yield potential.

MATERIALS AND METHODS

Seven genotypes of rice i.e., Sarjoo-52, Jaya, Sasyashree, Swetha, HUR 5-2, PR-106 and BPT 5204 were crossed with three WA cyto-sterile lines (IR58025A, Pusa6A and IR68897A) in wet season of 2011, at Agricultural Research Farm, BHU, Varansi (India) [25° 18’ N latitude, 83° 03’ E longitude and 128.93 m masl]. All the 10 genotypes were seeded in nursery at 3 dates, 10 days apart and transplanted in crossing blocks at 21 days after sowing. The first transplanting was done during last week of June, 2011 and crosses were made in Line x Tester design. The 21 F_1 hybrids obtained along with their parents and check variety were transplanted during first fortnight of July, 2012 in a randomized block design with three replications to evaluate the mean performance of parents and hybrids for yield and grain quality characteristics. Jaya was selected as check variety and due to the male sterile nature of three CMS or female lines, their corresponding maintainer lines were used for studying yield and quality traits. For both the years, 21 day old single seedlings per hill were transplanted in 5 m rows at plant spacing of 20 cm x 15 cm. The recommended package of practices was followed for raising good crop.

Observations were recorded on five randomly selected plants from each replicate for sixteen traits *viz.*, days to 50% flowering, days to maturity, plant height, panicle plant^{-1}, seeds panicle^{-1}, panicle length, 100-seed weight, yield plant^{-1}, grain length, grain width, brown rice length, brown rice width, brown rice length: width ratio, kernel length, kernel width and kernel length: width ratio. Grain dimension analysis was done with the help of electronic grain analyzer. Grain type classification was done as per the standard evaluation system (SES) for rice (IRRI, 1996). The alkali spread value and gelatinization temperature of milled rice kernels in 1.7% KOH solution for a period of 23 hr were rated as per SES for rice (IRRI, 1996). Amylose content was determined by spectrophotometry method (Juliano, 1971). Statistical analysis of data was carried out by using computer program Statistical Analysis System (SAS, 1997).

RESULTS AND DISCUSSION

The mean performance of parents, hybrids and commercial checks for yield and quality characters, summarized in Tables 1 and 2, revealed that among the 21 hybrids, crosses IR68897A/Jaya and IR68897A/BPT 5204 showed superior per se performance over its parents and the check variety (Jaya). The yield and yield traits *i.e.*, days to 50% flowering (DTF), days to maturity, plant height, panicles plant^{-1}, seeds panicle^{-1}, panicle length, 100-seed weight and yield plant^{-1} of both these hybrid combinations were better than their parents and the commercial check. By early sowing of two restorer lines *viz.*, Jaya (DTF, 94 days) and BPT 5204 (DTF, 114 days), their flowering can be made easily to synchronize with the flowering of female line, IR68897A (DTF, 87 days). Both the

Table 1: Mean performance of parents for yield and quality characters during 2011-2012

Parents	Yield and qualitative characters															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Testers																
IR58025B	99.0	129.0	96.1	13.5	184.6	25.7	2.31	33.5	9.08	1.81	6.21	1.70	3.66	6.13	1.65	3.7
Pusa6B	109.5	138.0	91.4	12.8	117.0	21.1	2.62	30.1	9.46	2.10	6.62	1.68	3.94	6.55	1.61	4.1
IR68897B	86.5	117.0	92.5	15.2	137.8	26.4	2.67	35.2	8.18	2.41	6.20	2.04	3.04	6.08	1.97	3.1
$CD_{0.05}$	2.1	2.5	1.1	1.2	9.5	2.0	0.05	2.3	0.19	0.25	0.21	0.11	0.26	0.10	0.08	0.3
Lines																
Sarjoo-52	89.0	118.5	106.5	8.9	117.7	24.0	3.23	28.2	8.99	2.68	5.55	2.35	2.36	5.43	2.26	2.4
Jaya	93.5	123.5	106.1	8.0	136.6	23.2	3.33	30.8	9.16	2.90	5.93	2.39	2.48	5.84	2.32	2.5
Sasyashree	105.5	135.5	100.2	8.5	112.1	26.4	3.26	25.1	9.18	2.44	6.34	2.32	2.74	6.23	2.20	2.8
Swetha	110.0	138.5	118.0	7.3	153.5	23.4	2.79	23.5	8.28	2.98	5.38	2.37	2.27	5.23	2.28	2.3
HUR 5-2	98.5	129.3	75.9	10.4	151.7	21.6	1.92	24.3	8.07	2.06	5.15	1.65	3.13	5.06	1.56	3.2
PR-106	92.5	123.0	118.6	10.2	115.3	25.9	2.92	28.2	10.18	2.10	6.20	1.87	3.32	6.10	1.78	3.4
BPT 5204	113.5	144.0	97.3	10.4	146.5	19.4	2.18	24.4	8.12	2.40	6.59	2.19	3.01	6.52	2.14	3.0
$CD_{0.05}$	1.7	1.8	2.0	1.2	8.4	1.7	0.04	2.7	0.15	0.17	0.16	0.14	0.22	0.17	0.12	0.2

[1 = Days to 50% flowering; 2 = Days to maturity; 3 = Plant height (cm); 4 = Panicles plant^{-1}; 5 = Seeds panicle^{-1}; 6 = Panicle length (cm); 7 = 100 seed weight (g); 8 = Yield plant^{-1} (g); 9 = Grain length (mm); 10 = Grain width (mm); 11 = Brown rice length (mm); 12 = Brown rice width (mm); 13 = Brown rice length: width ratio; 14 = Kernel length (mm); 15 = Kernel width (mm); and 16 = Kernel length: width ratio]

Table 2: Mean performance of hybrids for yield and quality characters during 2012-2013

Hybrids	1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
IR58025A/Sarjoo- 52	95	128	87.3	8.3	152	25.8	2.25	18.3	8.8	2.67	6.68	1.79	3.72	6.52	1.75	3.73
IR58025A/Jaya	95	126	90.2	8.7	139	23.2	2.39	24.8	8.3	3.06	6.38	2.76	2.31	6.28	2.64	2.38
IR58025A/Sasyashree	94	126	87.4	11.7	202	23.8	2.01	26.0	8.7	3.07	6.66	1.79	3.72	6.51	1.69	3.86
IR58025A/Swetha	99	129	113.2	10.8	193	25.7	2.46	27.3	9.0	2.85	7.09	2.14	3.31	7.01	1.86	3.76
IR58025A/HUR 5-2	81	112	79.3	10.3	128	21.9	1.81	22.8	9.8	2.10	6.28	1.74	3.62	6.14	1.65	3.73
IR58025A/PR-106	97	126	109.7	8.3	231	24.5	2.02	29.7	9.3	2.90	6.43	2.17	2.97	6.29	2.02	3.13
IR58025A/BPT 5204	86	117	93.1	6.8	171	27.4	1.9	24.1	8.8	2.07	6.50	1.59	4.10	6.29	1.51	4.19
Pusa6A/Sarjoo-52	96	127	90.5	9.8	132	25.7	2.35	16.8	10.1	2.86	6.87	1.84	3.74	6.70	1.72	3.92
Pusa6A/Jaya	86	115	95.8	8.2	150	20.2	2.75	25.6	9.6	3.13	6.99	2.21	3.17	6.84	2.13	3.22
Pusa6A/Sasyashree	95	127	103.7	9.0	171	26.6	2.51	22.6	10.1	2.86	6.59	2.16	3.06	6.41	2.06	3.14
Pusa6A/Swetha	93	122	112.0	9.1	228	24.3	2.07	28.1	8.3	2.94	6.24	2.06	3.04	6.13	1.87	3.28
Pusa6A/HUR 5-2	85	117	81.2	11.7	159	22.6	1.67	19.5	8.8	2.66	6.10	1.76	3.47	5.79	1.63	3.57
Pusa6A/PR-106	105	135	127.2	11.2	157	27.4	2.35	24.4	11.8	2.91	7.33	1.72	4.26	6.60	1.60	4.13
Pusa6A/BPT 5204	93	127	97.4	11.7	150	17.5	2.72	25.5	8.4	2.39	6.51	2.15	3.04	6.43	2.00	3.23
IR68897A/Sarjoo-52	85	117	103.0	12.1	246	22.3	1.84	22.2	8.2	2.76	6.22	1.66	3.75	6.05	1.59	3.82
IR68897A/Jaya	93	124	97.2	8.8	195	25.6	2.59	42.4	9.3	2.85	6.84	2.17	3.15	6.46	1.75	3.70
IR68897A/Sasyashree	105	135	95.2	10.3	163	21.5	2.40	20.5	9.1	3.06	6.74	2.37	2.87	6.52	1.86	3.50
IR68897A/Swetha	94	124	95.1	10.1	219	26.3	2.14	29.3	9.8	2.31	7.23	1.67	4.33	5.21	1.55	3.36
IR68897A/HUR 5-2	88	118	77.2	16.9	125	16.7	1.79	23.7	7.4	2.55	5.74	1.85	3.11	5.65	1.74	3.25
IR68897A/PR-106	90	121	102.3	11.1	123	22.8	2.17	19.2	10.2	2.81	6.88	1.78	3.86	6.63	1.64	4.04
IR68897A/BPT 5204	105	135	88.3	14.1	173	23.8	1.86	35.1	8.3	2.30	6.24	1.92	3.25	5.99	1.83	3.28
Average	93	124	96.5	10.4	172	23.6	2.19	25.1	9.1	2.72	6.60	1.97	3.42	6.31	1.81	3.53
$CD_{0.05}$	1.6	2.3	1.6	1.1	7.4	1.5	0.03	2.3	0.1	0.14	0.13	0.10	0.12	0.13	0.07	0.18

*[1 = Days to 50% flowering; 2 = Days to maturity; 3 = Plant height (cm); 4 = Panicles plant^{-1}; 5 = Seeds panicle^{-1}; 6 = Panicle length (cm); 7 = 100 seed weight (g); 8 = Yield plant^{-1} (g); 9 = Grain length (mm); 10 = Grain width (mm); 11 = Brown rice length (mm); 12 = Brown rice width (mm); 13 = Brown rice length: width ratio; 14 = Kernel length (mm); 15 = Kernel width (mm); 16 = Kernel length: width ratio]

Table 3: Grain quality characteristics* of parents and two superior hybrids obtained

Parents/hybrids	Grain type	KLBC (mm)	KLAC (mm)	ER	ASV	GT (^{0}C)	AC (%)
Parents							
IR58025B	Long slender	6.13	8.63	1.40	7	65-69	25.04
Pusa6B	Long slender	6.55	8.81	1.29	7	65-69	22.62
IR68897B	Long slender	6.08	9.05	1.48	7	65-69	23.94
Sarjoo-52	Short bold	5.43	8.63	1.59	7	65-69	25.04
Jaya	Short bold	5.84	8.45	1.45	7	65-69	22.97
Sasyashree	Long bold	6.23	8.11	1.29	5	70-74	21.82
Swetha	Short bold	5.23	7.08	1.34	5	70-74	21.9
HUR 5-2	Short slender	5.06	6.6	1.32	4	70-74	19.25
PR-106	Long slender	6.10	8.18	1.34	4	70-74	21.38
BPT 5204	Long bold	6.52	7.15	1.11	4	70-74	20.86
Hybrids							
IR68897A X Jaya	Long slender	6.46	9.91	1.53	6	65-69	24.5
IR68897A X BPT 5204	Medium slender	5.99	9.39	1.56	7	65-69	22.8

*KLBC = Kernal length before cooking; KLAC = Kernal length after cooking; ER = Elongation ratio; ASV = Alkali spread value; GT = Gelatinization temperature (^{o}C); AC = Amylose content (%)

restorer lines, Jaya and BPT 5204, were taller than IR68897A by 14 and 5 cm, respectively, and therefore, the pollination in both the cases can be easily accomplished for the production of commercial F_1 seed.

The grain quality features *viz.*, grain length, grain width, brown rice length, brown rice width, brown rice length/width, kernel length, kernel width and kernel length/width, all indicated that both these F_1s possessed acceptable grain dimensions (Table 2). Moreover, the other quality traits like grain type, amylose content (AC), kernel length after cooking (KLAC), amylase content (AC), elongation ratio (ER), alkali spread value (ASV), gelatinization temperature (GT) and kernel length before cooking (KLBC) also indicated good volume expansion and better cooking quality characteristics (Table 3). The grains of IR68897A/Jaya were long and slender whereas IR68897A/BPT 5204 had medium and slender grains. Long grains with slenderness are generally preferred by consumers over bold grains (Reddy *et al.*, 2012). Both the superior hybrids recorded higher elongation ratio (1.53 and 1.56) than their parents. IR68897A, Jaya and BPT 5204 exhibited elongation ratio of 1.47, 1.45 and 1.11, respectively, indicating that the length expansion after cooking was more in hybrids than their parents. Both the hybrids showed high alkali digestion values with low gelatinization temperature. Rice with low gelatinization temperature often cooks to a softer texture and is, therefore, preferable. Amylose content influences the cooking and eating characteristics of rice. Rice with high amylose content tends to cook firm and dry, whereas rice with a intermediate amylose content tends to be softer and stickier; and rice with a low amylose content is generally quite soft and sticky. The cross IR68897A/Jaya showed 24.5% and IR68897A/BPT 5204 recorded 22.8% amylose content. Both the hybrids showed intermediate amylose content which is usually preferable. Therefore, it can be concluded that both the hybrids combine good grain quality as well as better yield potential and hence can be recommended for the commercial cultivation. Similar results were also observed by some earlier workers. Khush *et al.* (1988) studied grain quality of several rice hybrids compared with that of the respective parental lines possessing diverse grain quality characteristics. They concluded that the genetic heterozygosity of hybrids did not impair grain quality in terms of physical and chemical characteristics as long as one of the parents was not glutinous rice or poor in grain quality. Moreover, the development of high quality

CMS or EGMS lines with improved outcrossing capacity has enhanced the grain quality of newly born hybrids (Yang *et al*., 2006). Therefore, proper choice of parents is essential to breed the hybrids with high yield and better quality.

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