



ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating 2017: 5.03
TPI 2017; 6(11): 350-357
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www.thepharmajournal.com
Received: 20-09-2017
Accepted: 21-10-2017

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Mean performance analysis for yield and quality related traits in non-basmati aromatic rice (*Oryza sativa* L.)

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Abstract

In view to invigorate hybrid rice breeding three CMS lines viz., IR-58025A, CRMS 31A and CRMS 32A and ten rice breeding line/ landraces viz., IET-21842 (R 1536-136-1-77-1), Tulsimongra, Bisni, Gopalbhog, Badshahbhog, Govindphool, Tenduphool, Kumbhdev, Bhatamasuri and Chhinguchi. Altogether 30 crosses were made in LxT mating fashion and evaluated along with one standard hybrid check US 314 (mid early duration) in Randomized Completely Block Design (RCBD) design with 3 replication. Observations were recorded for 29 yield components and quality related traits from five randomly selected plants. Among hybrids, based on mean performance, CRMS 32A X Tenduphool and CRMS 31A X Tenduphool were identified higher yielder. Maximum genetic diversity among parents taken in the study were reported between all lines and testers Chhinguchhi, Kumbhdev and Bhatamahsuri.

Keywords: Testors, lines, mean performance, aromatic rice

Introduction

Rice (*Oryza sativa* L.), is the most important staple food crop in the world and feed over half of the global population. It is growing over an area of 159.4 million ha (half of the arable land used for agriculture (Cantrell and Hettel, 2004) [3] with the production of 696.3 million tonnes (Ezuka and Kaku, 2000, FAO, 2015) [4]. Among the rice growing countries in the world, India has the largest area under rice cultivation and ranks second in production next to China. Rice contributes 43% of total food grain production and 46% of the total cereal production of the country.

Aromatic rice occupies a prime position in Indian culture not only because of their high quality but also of its auspicious nature. India had an immense wealth of aromatic rice; many have been lost during the last four decades as an aftermath of the green revolution where main emphasis was given on yield rather than quality.

Besides the much sought after basmati types which get high price in international markets, the country also abounds with hundreds of indigenous short grain aromatic cultivars and landraces grown in pockets of different states. Almost every state has its own collection of aromatic rice that performs well in native areas. These aromatic rice lines also possess exemplary quality traits like aroma, fluffiness and taste. However, the improvement of these rice varieties very much neglected as they lack export value per se.

Keeping in view the above facts and considering the potential of aromatic rice, the investigation has been carried out to observe the mean performance of the genotypes and its segregants at different location and to select the suitable genotype (both parents and its respective hybrids) that show best performance and good productivity.

Materials and Methods

The material comprised of 13 rice genotypes (three CMS, used as tester; and 10 breeding line/landraces as line) namely IR 58025A, CRMS31A, CRMS 32A, IET 21842, Tulsimongra, Bisni, Gopalbhog, Badshahbhog, Govindphool, Tenduphool, Bhatamahsuri, Kumbhdev and Chhinguchhi were crossed in Line x Tester fashion during Rabi 2015. During Kharif 2015 season, Altogether 43 entries (30 crosses and 13 parents) along with one standard hybrid check of the same duration, US 314 were grown in a randomised block design with three replications at the Research and Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Chhattisgarh and Research Farm of National Rice Research Institute (NRI), Cuttack, Odisha (India). Single seedling hill⁻¹ was transplanted at a spacing of 20 cm x 15 cm. The F₁'s and parents were planted in a two row plot of 2 meter length. Data were collected from

5 randomly selected competitive plants, leaving border row of each genotype (Dhaliwal and Sharma, 1990). Observations were recorded on 28 characters *viz.*, days to 50% flowering (DFF), plant height (PH), panicle length (PL), number of panicles plant⁻¹ (PN), grain number panicle⁻¹ (GP), pollen fertility (PF), spikelets fertility (SF), 1000-grain weight (TW), grain yield plant⁻¹ (GY), biological yield plant⁻¹ (BY), harvest index (HI), hulling % (HUL), milling% (ML), head rice recovery (HRR), paddy length (PDL), paddy breadth (PDB),

paddy L/B ratio (PDLB), brown rice length (BRL), brown rice breadth (BRB), brown rice L/B ratio (BRLB), kernel length (KL), kernel breadth (KB), kernel L/B ratio (LBR), kernel length after cooking (KLAC), kernel breadth after cooking (KBAC), cooked rice L/B ratio (KLBAC), elongation ratio (ER) and alkali spreading value (ASV). Combining ability analysis was carried out by the method suggested by Kempthorne (1957).

Table 1: Parental description of *indica* rice cultivar, its pedigree and features

Genotype	Pedigree	Special features	Recommend-ation for cultivation
IET-21842 (R 1536-136-1-77-1)	Breeding line	Short grains, aroma	Chhattisgarh
Tulsimongra	Landrace	Short grains, aroma	Chhattisgarh
Bisni	Landrace	Short grains, aroma	Chhattisgarh
Gopalbhog	Landrace	Short grains, aroma	Chhattisgarh
Badshabhog	Landrace	Short grains, aroma	Chhattisgarh
Govindphool	Landrace	Short grains, aroma	Chhattisgarh
Tenduphool	Landrace	Short grains, aroma	Chhattisgarh
Kumbhdev	Landrace	Short grains, aroma	Chhattisgarh
Bhatamasuri	Landrace	Short grains, aroma	Chhattisgarh
Chhinguchi	Landrace	Short grains, aroma	Chhattisgarh
IR58025A	IR48483A/ PUSA 167-120-3-2	CMS	IGKV, Raipur
CRMS31A	V20A/Manipuri	CMS	NRRI, Cuttack, Odisha
CRMS32A	Kalinga-I/Mirai	CMS	NRRI, Cuttack, Odisha

Results and Discussion

Results on *per se* performance of the parents and F1 hybrids are presented in Table 1 for yield, yield components and quality traits.

1. Days to 50% flowering

Days to 50% flowering was ranged from 94 (IR58025A) to 111 days (Govindphool) in parents and from 89 (IR58025A X Kumbhdev) to 111 days (CRMS31A X Chhinguchhi) in F1 hybrids with an overall average of 102.22 days for parents and F1 hybrids.

2. Plant height (cm)

Plant height ranged from 79.5 (IET-21842) to 145.3 cm (Bisni) for parents, while in F1 hybrids it ranged from 82.5 (CRMS31A X BISNI) to 129.2 cm (CRMS32A X Tulsimongra) with an average of 104.65 cm.

3. Number of effective tillers per plant

This character ranged from 4.9 (Govindphool) to 12.6 (CRMS32A X Bhatamasuri) for parental lines and from 5.7 (CRMS32A X Bhatamasuri) to 9.1 (CRMS32A X Bisni) in F1 hybrids. Mean values for ear bearing tillers per plant was recorded 6.76 for both hybrids and 8.5 in parents.

4. Panicle length (cm)

Panicle length ranged from 19.6 (Bhatamasuri) to 27.0 cm (Badshabhog) in parents and from 22.0 (IR58025A x Tenduphool) to 30.2 cm (IR58025A X Bisni) in F1 hybrids. Further mean panicle length was recorded 22.5 and 24.90 cm for both parents and F1 hybrids, respectively.

5. Pollen fertility (%)

Pollen fertility ranged from 54.71 (Kumbhdev) to 91.2 per cent (Chhinguchi) in parents and from 25.83 (IR58025A X Tulsimongra) to 112.55 per cent (CRMS31A X Tulsimongra) in F1 hybrids with an overall mean of 76.11 per cent in parents and 52.51 in F1 hybrids.

6. Number of grains per panicle

Number of grains per panicle ranged from 107.90 (Bhatamahsuri) to 207.52 (Govindphool) in parents and from 159.40 (IR58025A X BISNI) to 242.74 (IR58025A X Tulsimongra) in F1 hybrids. The average number of grains per panicle was observed to be 155.97 for parents and 199.44 in F1 hybrids.

7. Spikelet fertility (%)

Spikelet fertility ranged from 64.56 (Badshabhog) to 88.60 per cent (Tulsimongra) in parents and from 5.28 (CRMS31A X Bisni) to 80.25 per cent (IR58025A X IET-21842) in F1 hybrids with an overall mean of 66.23 per cent in parents and 41.61 in F1 hybrids

8. Test or 1000 grain weight (g)

1000 grain weight ranged from 11.92 (IET 21842) to 35.89g (Bisni) in parents and from 13.34 (CRMS31A X Bisni) to 25.75 g (IR58025A X Govindphool) in F1 hybrids with an overall mean of 14.82 g in parents and 19.89 in F1 hybrids.

9. Grain yield per plant (g)

Most of the hybrids recorded low mean values for grain yield per plant than the parents studied. Grain yield per plant ranged from 5.76 (Chhinguchi) to 19.05 (CRMS32A) in parents and from 1.00 (CRMS31A X Tulsimongra) to 12 g (IR58025A X IET-21842) in F1 hybrids with an overall mean of 12.08 g in parents and 3.57 in F1 hybrids.

10. Biological yield/plant (g)

Biological yield/plant ranged from 39.0 g (Govindphool) to 140.0 g (Chhindguchi) in parents and from 69.00 g (IR58025A X Bhatamasuri) to 191.0 g (CRMS31A X Tulsimongra) in F1 hybrids with an overall mean of 77.46 g in parents and 115.31 in F1 hybrids.

11. Harvest index (%)

In terms of harvest index, the range was observed from 1.4 (Govindphool) to 36.0 (Bahtamahsuri) and from 2.1

(CRMS31A X Tulsimongra) to 6.5 (CRMS32A X Chindguchi) per cent with an overall mean of 17.33 for parents and 17.26 in F1 hybrids.

12. Hulling %

In terms of hulling percentage, the range was observed from 51.4 (Bisni) to 82.32 per cent (Bhatamasuri) and from 56.55 (IR58025A X Bhatamasuri) to 77.49 (CRMS31A X IET-21842) per cent with an overall mean of 77.21 per cent for parents and 69.18 in F1 hybrids

13. Milling %

In terms of milling percentage, the range was observed from 37.35 (Bhatamasuri) to 78.28 per cent (Govindphool) and from 30.45 (CRMS31A X Govindphool) to 67.40 (CRMS 32A X Tenduphool) per cent with an overall mean of 60.71 per cent for parents and 50.61 in F1 hybrids.

14. Head rice recovery (%)

In terms of head rice recovery, the range was observed from 36.00 (Bahtamasuri) to 62.2 per cent (Govindphool) and from 29.7 (CRMS31A X Badshabhog) to 57.20 (CRMS 31A X Tenduphool) per cent with an overall mean of 53.72 per cent for parents and 45.63 in F1 hybrids.

15. Paddy length (mm)

In terms of paddy length, the range was observed from 4.15 (IET 21842) to 9.99 mm (Kumbhdev) and from 5.21 (CRMS32A X Bisni) to 10.31mm (IR58025A X Badshabhog) with an overall mean of 6.58 mm for parents and 6.55 mm in F1 hybrids.

16. Paddy breadth (mm)

In terms of paddy breadth, the range was observed from 1.66 (Tulsimongra) to 2.63 mm (Tenduphool) and from 1.69 mm (CRMS31A X Bisni) to 2.46 mm (IR58025A X IET-21842) with an overall mean of 2.02 mm for parents and 2.00 mm in F1 hybrids.

17. Paddy L/B ratio

The paddy L/B ratio ranged from 2.24 (Bisni) to 4.44 (Kumbhdev) for parents and from 2.13 (IR58025A X IET-21842) to 5.06 (IR58025A X Badshabhog) with an overall mean of 3.29 for parents and 3.31 in F1 hybrids.

18. Brown rice length (mm)

In terms of brown rice length, the range was observed from 2.51 (Tulsimongra) to 8.35 mm (Kumbhdev) and from 3.57 (CRMS32A X Bisni) to 8.67 mm (IR58025A X Badshabhog) with an overall mean of 4.94 mm for parents and 4.9 mm in F1 hybrids.

19. Brown rice breadth (mm)

In terms of brown rice breadth, the range was observed from 1.23 (Tulsimongra) to 2.20 mm (Tenduphool) and from 1.27 (CRMS31A X Bisni) to 2.04mm (IR58025A X IET-21842) with an overall mean of 1.60mm for parents and 1.57 mm in F1 hybrids.

20. Brown rice L/B ratio

The brown rice L/B ratio ranged from 1.84 (Bisni) to 4.57 (Kumbhdev) for parents and from 1.76 (IR58025A X IET-21842) to 5.37 (IR58025A X Badshabhog) with an overall mean of 3.13 for parents and 3.16 in F1 hybrids.

21. Kernel length (mm)

Kernel length ranged from 2.84 (Bisni) to 5.25 mm (Kumbhdev) for parents and from 2.13 (CRMS32A X Tulsimongra) to 4.91 mm (CRMS31A X Badshabhog) for F1 hybrids with an overall mean of 3.16 mm for parents and 2.98 mm for F1 hybrids.

22. Kernel breadth (mm)

The range for kernel breadth observed from 1.48 (Tulsimongra) to 2.45 mm (Tenduphool) for parents and from 1.52 (CRMS31A X Bisni) to 2.29 mm (IR58025A X IET-21842) for F1 hybrids with an overall mean of 1.86 mm for parents and 1.83 mm for F1 hybrids.

23. Kernel L/B ratio

The kernel L/B ratio ranged from 1.17 (Tenduphool) to 2.76 (Kumbhdev) for parents and from 1.09 (IR58025A X IET-21842) to 3.36 (IR58025A X Badshabhog) with an overall mean of 2.05 for parents and 2.07 for F1 hybrids.

24. Kernel length after cooking (mm)

KLAC ranged from 2.98 (Tulsimongra) to 10.76 mm (Kumbhdev) for parents and from 4.19 (IR58025A X IET-21842) to 10.69 mm (CRMS 32A X Tenduphool) for F1 hybrids with an overall mean of 6.28 mm for parents and for 6.15 mm F1 hybrids.

25. Kernel breadth after cooking (mm)

The range for KBAC observed from 2.10 (Tulsimongra) to 3.80 mm (Govindphool) for parents and from 2.16 (CRMS31A X Bisni) to 3.51 mm (IR58025A X IET-21842) for F1 hybrids with an overall mean of 2.75 mm for parents and 2.70mm for F1 hybrids.

26. After cooking Kernel L/B ratio

The After cooking kernel L/B ratio ranged from 1.32 (IET-21842) to 3.59 (CRMS 31A) for parents and from 1.19 (IR58025A X IET-21842) to 3.86 (IR58025A X Badshabhog) with an overall mean of 2.33 for parents and 2.31 for F1 hybrids.

27. Elongation Ratio

The range for kernel breadth observed from 1.18 (IR 58025A) to 1.55 mm (CRMS 31A) for parents and from 1.17 (IR58025A X IET-21842) to 1.37 mm (IR58025A X Govindphool) for F1 hybrids with an overall mean of 1.27 mm for parents and 1.25 mm for F1 hybrids.

28. Alkali spreading value

The range for ASV observed from 2.17 mm (IR 58025A) to 7.17 mm (Bhatamasuri) for parents and from 1.17 mm (CRMS32A X IET-21842) to 6.67 mm (IR58025A X Tulsimongra) for F1 hybrids with an overall mean of 4.00 mm for parents and 4.29 mm for F1 hybrids.

29. Aroma

The parents and F1 hybrids grains exhibited aroma range of strong scent (SS), mild scent (MS) and non scent (NS) (Table – 4).

Table 2: Mean performance for 28 yield and quality traits of 13 parents

S. No	Character/ Genotypes	Days to 50% flowering (Days)	Plant height (cm)	Number of effective tillers per plant (no.)	Panicle length (cm)	Number of grains per panicle (no.)	Spikelet fertility (%)	Pollen Fertility %	Test or 1000-seed weight (g)	Grain yield per plant (g)
1	IR58025A	94.00	93.1	11.8	21.3	173.01	65	70	16.20	17.20
2	CRMS31A	98.33	85	11.6	20.2	202.40	68	71	16.40	18.1
3	CRMS32A	99.00	81.9	12.6	21.6	152.52	69	72	16.05	19.05
4	IET-21842 (R 1536-136-1-77-1)	109.33	79.5	8.8	20.3	107.90	74.27	85.87	13.00	13.54
5	Tulsimongra	98.33	142.2	7.5	26.4	110.58	88.06	86.01	11.92	8.8
6	Bisni	105.00	145.3	5.1	26.1	109.67	69.34	74.54	12.57	20.5
7	Gopalbhog	109.67	126.8	8.00	21.8	154.95	40.06	63.13	35.89	7.6
8	Badshabhog	109.67	108.8	8.8	23.9	124.92	64.56	75.06	15.56	9.85
9	Govindphool	111.33	135.2	4.9	27.0	207.52	70.33	80.78	13.83	12.2
10	Tenduphool	106.33	118.1	6.9	21.3	195.81	81.47	83.35	25.87	6.75
11	Kumbhdev	99.33	128.3	6.4	24.5	152.52	53.56	54.71	21.11	5.59
12	Bhatamasuri	102.33	92.9	5.6	22.2	107.90	71.93	81.88	17.29	12.2
13	Chhindguchi	110.33	104.6	6.3	19.6	110.58	85.10	91.2	20.10	5.76
	Mean	103.13	106.41	8.575	22.5	155.97	69.28	76.11	14.82	9.25
	C.V.	3.90	2.94	1.68	3.8	6.48	3.37	3.76	3.01	5.35
	F ratio	19.11	15.98	17.49	18.2	14.61	4.59	14.61	6.23	20.53
	S.E.	0.53	0.57	0.21	0.20	2.18	1.49	0.003	0.23	0.29
	C.D. 5%	1.56	1.68	0.62	0.58	6.38	4.37	0.90	0.70	0.86
	Range Highest	111.33	145.3	12.6	27.0	207.5	85.10	91.2	35.89	20.5
	Range Lowest	94.00	79.5	4.9	19.6	107.9	64.56	54.71	11.92	1.15
S. No	Character/ Genotypes	Biological Yield/P (g)	Harvest Index%	Hulling %	Milling%	Head Rice Recovery (%)	Paddy length (mm)	Paddy breadth (mm)	Paddy L/B ratio	Brown Rice length (mm)
1	IR58025A	79.5	21.1	81.4	71.8	57.5	7	1.8	3.89	5.36
2	IR58025B	92.0	19.7	81.3	76.1	59.2	7.1	1.91	3.72	5.46
3	CRMS31A	92.0	17.0	74.75	64.0	55.00	7.01	1.82	3.85	5.37
4	CRMS31B	92.0	19.2	79.25	68.0	60.5	7.32	1.86	3.94	5.68
5	CRMS32A	92.5	18.4	75.25	64.0	55.00	7.1	1.8	3.95	5.46
6	CRMS32B	98.0	18.8	77.0	67.0	60.00	7.24	1.89	3.83	5.6
7	IET-21842 (R 1536-136-1-77-1)	52.5	30.9	66.21	52.1	50.2	5.04	2.25	2.24	3.4
8	Tulsimongra	77.5	18.5	69.7	52.27	47.2	4.15	1.66	2.50	2.51
9	Bisni	63.0	3.4	82.55	40.86	36.2	4.82	2.15	2.24	3.18
10	Gopalbhog	50.0	6.9	66.0	48.6	46.2	7.38	2.23	3.31	5.74
11	Badshabhog	100.5	3.4	80.19	52.0	47.6	5.43	2.33	2.33	3.79
12	Govindphool	39.0	1.4	82.32	78.28	62.6	8.52	2.01	4.24	6.88
13	Tenduphool	70.0	17.2	80.08	59.0	56.8	6.01	2.63	2.28	4.37
14	Kumbhdev	60.0	1.7	81.785	62.15	54.8	9.99	2.25	4.44	8.35
15	Bhatamasuri	41.0	36.0	51.4	37.35	36.00	5.48	1.83	3.00	3.84
16	Chhindguchi	140.0	13.7	79.25	67.9	57.8	5.75	2.05	2.81	4.11
	Mean	77.46	15.4	77.21	60.71	53.72	6.58	2.029	3.29	4.94
	C.V.	12.41	1.66	1.35	4.89	6.30	3.20	1.49	1.96	8.41
	F ratio	19.47	8.33	14.14	4.47	9.07	19.11	15.98	17.49	14.61

S.E.		4.5	0.74	0.12	0.05	0.03	0.08	0.02	0.033	0.06	
C.D. 5%		13.38	2.18	0.40	0.12	0.22	0.12	0.04	0.09	0.012	
Range Highest		140.0	36.0	82.55	78.28	60.2	9.99	2.63	4.44	8.35	
Range Lowest		39.0	1.4	51.4	37.35	36.0	4.15	1.66	2.24	2.51	
S. No	Character/ Genotypes	Brown Rice breadth (mm)	Brown Rice L/B ration	Kernel length (mm)	Kernel breadth (mm)	Kernel L/B ratio	KL after cooking (mm)	KB after cooking (mm)	Kernel L/B ratio	Elongation ratio	Alkali spreading value
1	IR58025A	1.38	3.89	3.59	1.63	2.63	6.31	2.35	2.68	1.18	2.0
2	IR58025B	1.49	3.67	3.42	1.74	2.42	7.19	2.54	2.83	1.32	2.0
3	CRMS31A	1.4	3.84	3.55	1.65	2.58	6.67	2.39	2.79	1.24	2.0
4	CRMS31B	1.44	3.95	3.65	1.69	2.62	8.81	2.46	3.59	1.55	4.0
5	CRMS32A	1.38	3.97	3.65	1.63	2.67	7.19	2.35	3.06	1.32	5.0
6	CRMS32B	1.47	3.82	3.54	1.72	2.52	7.12	2.51	2.84	1.27	2.0
7	IET-21842 (R 1536-136-1-771)	1.83	1.86	2.87	2.08	1.19	4.14	3.14	1.32	1.22	5.0
8	Tulsimongra	1.24	2.02	2.00	1.48	1.52	2.99	2.11	1.42	1.20	4.0
9	Bisni	1.73	1.84	2.84	1.98	1.21	4.31	2.96	1.45	1.36	5.0
10	Gopalbhog	1.81	3.18	3.02	2.06	1.96	7.19	3.10	2.32	1.25	2.0
11	Badshabhog	1.91	1.98	2.98	2.16	1.25	4.52	3.28	1.38	1.19	3.0
12	Govindphool	1.59	4.34	4.01	1.84	2.76	8.27	2.72	3.04	1.20	3.0
13	Tenduphool	2.21	1.98	2.97	2.46	1.17	5.52	3.80	1.45	1.26	4.0
14	Kumbhdev	1.83	4.57	5.25	2.08	2.76	10.77	3.14	3.43	1.29	5.0
15	Bhatamasuri	1.41	2.73	2.60	1.66	1.88	4.69	2.40	1.95	1.22	7.0
16	Chhindguchi	1.63	2.52	2.44	1.88	1.65	4.96	2.79	1.78	1.21	6.0
Mean		1.6	3.13	3.16	1.86	2.05	6.29	2.75	2.33	1.27	4.00
C.V.		1.35	3.32	5.35	11.48	3.73	8.72	2.49	1.22	4.96	6.30
F ratio		6.23	20.53	18.29	12.44	4.59	19.47	8.33	14.14	4.47	9.07
S.E.		0.02	0.02	0.04	0.13	0.057	0.012	0.01	0.007	0.054	0.013
C.D. 5%		0.07	0.012	0.24	0.39	0.025	0.08	0.011	0.04	0.02	0.025
Range Highest		2.205	4.57	5.25	2.457	2.76	10.76	3.802	3.59	1.55	7.0
Range Lowest		1.235	1.84	2.84	1.487	1.17	2.985	2.105	1.32	1.18	2.0

Table 3: Mean performance for 28 morpho-physico chemical traits of 30 F₁ hybrids

S. No	Character/ F ₁ hybrids	Days to 50% flowering(Days)	Plant Height (cm)	No. of eff. Tillers/plant	Panicle Length (cm)	No. of grains /panicle	Sipkelet Fertility (%)	Pollen Fertility %	Test Weigh (g)	Grain yield /plant (g)	Biological Yield/P (g)	Harvest Index%	Hulling %	Milling%	Head Rice Recovery (%)
1	IR58025A X IET-21842	110.00	89.6	5.9	25.0	233.64	80.25	95.12	17.95	12.0	85.00	54.5	74.77	65.03	56.20
2	CRMS31A X IET-21842	106.67	91.6	6	25.2	233.07	54.97	41.57	16.55	3.99	105.00	17.4	77.49	64.05	56.60
3	CRMS32A X IET-21842	106.67	96.8	7	27.2	234.10	42.56	39.16	23.33	1.67	147.5	3.8	74.44	36.30	35.80
4	IR58025A X Tulsimongra	96.00	124.8	7.3	27.9	242.74	23.92	25.83	15.99	1.67	122.5	6.1	73.88	44.39	41.20
5	CRMS31A X Tulsimongra	98.33	120.8	6.4	26.5	198.08	24.15	112.55	16.67	1.00	191.5	2.1	61.92	33.75	31.60
6	CRMS32A X Tulsimongra	101.67	129.2	8.6	29.6	208.62	31.09	33.94	23.38	1.41	147.5	4.4	74.83	41.87	39.70
7	IR58025A X BISNI	102.67	117.1	6.1	30.2	159.40	8.17	43.43	14.30	1.96	107.5	9.5	60.20	37.30	37.12
8	CRMS31A X BISNI	100.33	82.5	6.1	22.5	217.22	5.28	69.20	13.34	2.61	89.00	6.4	64.21	59.37	51.60
9	CRMS32A X BISNI	104.33	122.9	9.1	29.5	181.92	5.88	44.08	18.59	2.47	124.00	10.3	67.46	51.58	49.40
10	IR58025A X Gopalbhog	110.67	107.1	6.7	24.6	163.35	42.92	34.57	19.66	3.00	82.5	15.0	66.89	58.28	50.20
11	CRMS31A X Gopalbhog	105.67	105.4	7.1	22.5	173.24	38.85	32.11	20.07	2.79	110.00	11.2	69.69	52.28	49.50
12	CRMS32A X Gopalbhog	101.67	108.2	8.1	22.6	171.59	66.25	51.41	15.90	3.00	132.5	11.4	66.35	53.37	48.25
13	IR58025A X Badshabhog	102.67	105.2	7.3	28.0	187.59	39.70	48.50	18.18	2.00	127.5	7.3	64.50	40.88	40.02
14	CRMS31A X Badshabhog	106.67	105	5.9	24.7	170.50	34.78	45.10	17.79	1.31	147.5	3.7	73.61	31.90	29.70
15	CRMS32A X Badshabhog	107.67	119.2	6.9	24.8	205.73	42.16	49.17	18.66	1.29	130.00	5.7	75.06	60.49	52.75
16	IR58025A X Govindphool	98.33	112.2	6.5	25.6	185.92	47.37	47.68	25.75	2.01	142.5	8.2	71.08	52.96	49.20
17	CRMS31A X Govindphool	95.00	110.3	7.3	26.7	186.60	21.20	35.10	25.25	1.48	165	3.8	66.18	30.45	30.00
18	CRMS32A X Govindphool	96.67	109.1	6.2	27.3	187.38	20.23	35.72	17.53	1.60	96.5	6.8	62.91	45.06	41.02
19	IR58025A X Tenduphool	99.67	83.5	6.4	22.0	185.04	80.0	87.04	24.96	8.79	69.00	16.9	70.76	52.77	44.60
20	CRMS 31A X Tenduphool	93.00	83.5	6.46	22.8	194.00	75.0	82.30	24.96	7.87	78.00	17.3	72.25	65.50	57.20
21	CRMS 32A X Tenduphool	95.33	83.5	6.4	22.5	227.06	56.0	79.37	24.96	6.95	80.5	15.9	75.60	67.40	54.60
22	IR58025A X Kumbhdev	89.67	123.9	8.8	25.2	224.56	30.88	38.04	19.61	2.90	137.5	2.7	74.10	44.82	41.20
23	CRMS31A X Kumbhdev	92.67	105.1	6.1	25.1	187.00	54.36	56.27	16.79	3.91	135	14.2	62.83	55.81	49.60
24	CRMS32A X Kumbhdev	95.33	86.4	6.3	22.4	200.08	72.59	57.24	17.30	3.44	72.5	23.3	64.31	51.72	48.02
25	IR58025A X Bhatamasuri	104.67	121.6	5.8	23.5	207.17	57.46	70.0	14.71	5.00	69.5	34.7	56.55	51.01	49.00
26	CRMS31A X Bhatamasuri	106.33	92.1	5.8	23.5	219.76	37.48	66.24	18.44	2.90	79.00	17.6	64.88	50.68	43.80
27	CRMS32A X Bhatamasuri	108.67	93	5.7	24.6	173.24	27.43	33.07	25.07	1.91	135.00	6.8	71.41	46.82	36.80
28	IR58025A X Chhindguchi	111.00	102.8	7.5	22.4	171.59	36.70	42.00	21.85	4.90	119.5	64.0	66.90	52.20	49.40
29	CRMS31A X Chhindguchi	108.33	102.33	6.66	21.23	187.59	46.56	47.35	24.93	5.99	111.25	52.0	73.60	54.80	50.06
30	CRMS32A X Chhindguchi	110.33	104.9	6.4	22.1	170.50	43.35	52.33	24.60	5.43	119.00	65.0	76.75	65.50	54.80
	Mean	102.22	104.65	6.76	24.90	199.44	49.93	52.33	19.89	3.09	115.31	14.0	69.18	50.61	45.63
	C.V.	1.57	1.59	1.47	3.63	15.56	7.23	5.52	1.84	6.31	7.25	1.51	0.27	4.89	6.30
	S.E.m	1.80	1.85	1.68	3.63	0.73	0.57	9.06	2.07	0.42	1.56	0.84	0.14	0.05	0.13
	C.D. at 5%	1.97	2.74	0.08	0.40	12.05	3.28	1.10	0.60	0.32	4.41	1.7	2.22	0.15	0.36
	Range Highest	111	129.2	9.1	30.2	242.74	80.25	112.55	25.75	12.0	191.5	0.65	77.49	67.40	57.20
	Range Lowest	89.66	82.5	5.7	22.0	159.40	5.28	25.83	13.34	1.00	69.00	0.02	56.55	30.45	29.70
S.	Character/ F ₁ hybrids	Paddy length	Paddy	Paddy	Brown	brown rice	Brown	Kernel	Kernel	Kernel	KLAC	KBAC	Kernel	Elongation	Alkali

No		(mm)	breadth (mm)	L/B ratio	rice length (mm)	breadth (mm)	rice L/B ratio	length (mm)	breadth (mm)	L/B ratio	(mm)	(mm)	L/B ratio	ratio	spreading value
1	IR58025A X IET-21842	5.24	2.46	2.13	3.6	2.04	1.76	2.44	2.29	1.09	4.19	3.51	1.19	1.17	2.0
2	CRMS31A X IET-21842	5.61	1.99	2.82	3.97	1.57	2.53	2.78	1.82	1.68	4.85	2.68	1.81	1.22	2.0
3	CRMS32A X IET-21842	7.52	1.86	4.05	5.88	1.44	4.09	2.45	1.69	2.71	7.32	2.46	2.98	1.25	1.0
4	IR58025A X Tulsimongra	6.13	1.88	3.26	4.49	1.46	3.08	3.77	1.71	2.07	5.67	2.49	2.28	1.26	7.0
5	CRMS31A X Tulsimongra	5.50	2.21	2.49	3.86	1.79	2.16	2.91	2.04	1.38	4.82	3.07	1.57	1.25	5.0
6	CRMS32A X Tulsimongra	5.89	2.27	2.59	4.25	1.85	2.3	2.13	2.10	1.44	5.05	3.17	1.59	1.19	4.0
7	IR58025A X BISNI	6.06	2.16	2.81	4.42	1.74	2.54	2.25	1.99	1.62	5.38	2.98	1.80	1.22	4.0
8	CRMS31A X BISNI	6.44	1.69	3.81	4.8	1.27	3.79	2.46	1.52	2.64	6.12	2.16	2.83	1.28	4.0
9	CRMS32A X BISNI	5.21	2.12	2.46	3.57	1.7	2.1	3.48	1.95	1.37	4.35	2.91	1.49	1.22	4.0
10	IR58025A X Gopalbhog	5.62	1.75	3.21	3.98	1.33	3.00	2.08	1.58	2.10	4.94	2.26	2.18	1.24	5.0
11	CRMS31A X Gopalbhog	6.89	1.87	3.69	5.25	1.45	3.63	2.83	1.70	2.42	6.76	2.47	2.73	1.29	6.0
12	CRMS32A X Gopalbhog	6.41	1.99	3.22	4.77	1.57	3.04	3.38	1.82	1.99	5.86	2.68	2.18	1.23	6.0
13	IR58025A X Badshabhog	10.31	2.04	5.06	8.67	1.62	5.37	2.89	1.87	3.36	10.69	2.77	3.86	1.23	6.0
14	CRMS31A X Badshabhog	7.63	2.13	3.58	5.99	1.71	3.51	4.91	1.96	2.20	7.79	2.93	2.66	1.30	6.0
15	CRMS32A X Badshabhog	5.90	2.17	2.72	4.26	1.75	2.44	3.30	2.00	1.55	5.65	3.00	1.88	1.33	4.0
16	IR58025A X Govindphool	7.51	1.86	4.04	5.87	1.44	4.09	2.37	1.69	2.70	8.02	2.46	3.27	1.37	3.0
17	CRMS31A X Govindphool	7.14	1.97	3.63	5.5	1.55	3.55	3.77	1.80	2.31	7.09	2.65	2.68	1.29	3.0
18	CRMS32A X Govindphool	5.47	2.05	2.67	3.83	1.63	2.35	3.33	1.88	1.55	4.92	2.79	1.76	1.29	4.0
19	IR58025A X Tenduphool	5.81	1.78	3.27	4.17	1.36	3.07	2.29	1.61	2.12	5.07	2.32	2.19	1.22	4.0
20	CRMS 31A X Tenduphool	6.21	1.86	3.34	4.57	1.44	3.18	2.89	1.69	2.14	5.53	2.46	2.25	1.21	4.0
21	CRMS 32A X Tenduphool	9.74	2.05	4.75	8.1	1.63	4.98	2.99	1.88	3.12	10.06	2.79	3.61	1.24	4.0
22	IR58025A X Kumbhdev	5.88	2.05	2.87	4.24	1.63	2.6	4.58	1.88	1.70	5.46	2.79	1.96	1.29	5.0
23	CRMS31A X Kumbhdev	6.70	1.90	3.53	5.06	1.48	3.42	2.51	1.73	2.27	6.74	2.53	2.67	1.33	6.0
24	CRMS32A X Kumbhdev	6.96	1.84	3.78	5.32	1.42	3.75	3.21	1.67	2.51	7.10	2.42	2.93	1.33	5.0
25	IR58025A X Bhatamasuri	5.75	2.05	2.81	4.11	1.63	2.52	3.48	1.88	1.65	5.03	2.79	1.80	1.22	6.0
26	CRMS31A X Bhatamasuri	6.57	2.11	3.11	4.93	1.69	2.92	2.44	1.94	1.86	6.06	2.89	2.09	1.23	5.0
27	CRMS32A X Bhatamasuri	6.71	1.86	3.61	5.07	1.44	3.53	2.79	1.69	2.36	6.10	2.46	2.48	1.20	5.0
28	IR58025A X Chhindguchi	5.85	2.01	2.91	4.21	1.59	2.65	3.29	1.84	1.74	5.00	2.72	1.84	1.19	2.0
29	CRMS31A X Chhindguchi	6.96	2.10	3.32	5.32	1.68	3.17	2.55	1.93	2.01	6.41	2.88	2.23	1.21	2.0
30	CRMS32A X Chhindguchi	7.00	1.91	3.67	5.36	1.49	3.6	3.01	1.74	2.37	6.56	2.54	2.58	1.22	2.0
	Mean	6.55	2.0	3.31	4.9	1.57	3.16	2.98	1.83	2.07	6.15	2.70	2.31	1.25	4.29
	C.V.	3.20	1.12	1.59	3.41	1.084	3.32	2.35	10.13	3.73	8.72	2.49	3.91	4.89	6.30
	S.E.m	0.34	0.021	0.027	0.02	0.019	0.011	0.014	0.121	0.47	0.03	0.012	0.07	0.05	0.13
	C.D. at 5%	5.06	0.06	0.07	1.08	0.96	0.024	0.02	0.34	0.012	0.04	1.84	0.89	0.51	0.031
	Range Lowest	5.21	1.69	2.13	3.57	1.27	1.76	2.13	1.52	1.09	4.19	2.16	1.19	1.17	1.0
	Range Highest	10.31	2.46	5.06	8.67	2.04	5.37	4.91	2.29	3.36	10.69	3.51	3.86	1.37	7.0

Table 4: Status (score) of aroma in parents and hybrids * Non-scented (0), Mild scented (1), Strong scented (2).

Genotypes	Aroma	Genotypes	Aroma
Parents			
IR58025A	1	IET-21842 (R 1536-136-1-77-1)	1
CRMS31A	0	Tulsi mongra	1
CRMS32A	0	Bisni	2
		Gopalbhog	2
		Badshabhog	2
		Govindphool	2
		Tenduphool	1
		Kumbhdev	1
		Bhatamasuri	1
		Chhindguchi	2
Hybrids			
IR58025A X IET-21842	1	IR58025A X Govindphool	2
CRMS31A X IET-21842	1	CRMS31A X Govindphool	2
CRMS32A X IET-21842	1	CRMS32A X Govindphool	2
IR58025A X Tulsi mongra	1	IR58025A X Tenduphool	2
CRMS31A X Tulsi mongra	1	CRMS 31A X Tenduphool	1
CRMS32A X Tulsi mongra	1	CRMS 32A X Tenduphool	1
IR58025A X BISNI	2	IR58025A X Kumbhdev	1
CRMS31A X BISNI	2	CRMS31A X Kumbhdev	1
CRMS32A X BISNI	2	CRMS32A X Kumbhdev	1
IR58025A X Gopalbhog	2	IR58025A X Bhatamasuri	1
CRMS31A X Gopalbhog	2	CRMS31A X Bhatamasuri	1
CRMS32A X Gopalbhog	2	CRMS32A X Bhatamasuri	1
IR58025A X Badshabhog	2	IR58025A X Chhindguchi	2
CRMS31A X Badshabhog	2	CRMS31A X Chhindguchi	2
CRMS32A X Badshabhog	2	CRMS32A X Chhindguchi	2

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