

Evaluation of CMS lines for out crossing potential in rice

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ABSTRACT

A total of 74 CMS lines and their maintainers were evaluated for morphological and floral characters influencing out crossing rate. Out of 74 CMS lines, forty two CMS lines were completely pollen sterile for all other CMS lines. Spikelet fertility ranged from 0.51 to 4.55. The CMS lines viz., COMS 13, COMS 15, IR 68281, IR 69626, DRR 7, RTN 6, RTN 13 and PMS 17 were found to be promising for the characters pollen sterility, glume angle, panicle exertion, stigma exertion, natural out crossing. These CMS lines offer scope of utilizing them for the development of three line hybrid with high yield in rice.

Key words: rice, CMS lines, morphological, floral traits, out crossing rate

Rice is strictly self pollinated crop and natural out crossing rate is extremely low. Hybrid rice giving a yield advantage of about 20-30 % over high yielding homozygous varieties (Yuan, 2002) is a better choice for increasing grain yield. Higher yield in hybrid seed production depends on out crossing rate of CMS lines and out crossing rate is influenced by various morphological and floral traits. The three line breeding method is most commonly used in China and elsewhere for commercial application of heterosis. Successful development of hybrid rice depends on improvement of parental lines A, B and R. The search for alternate sources of CMS in hybrid rice breeding is a priority as more than 90 percent of the hybrids released throughout the world are based on a single sterile cytoplasm wild abortive (WA). Hence, the present study was initiated to evaluate different rice CMS lines and their maintainer lines for pollen sterility, spikelet fertility, glume angle, agronomic characters and natural out crossing percentage for developing three line hybrids in rice.

MATERIALS AND METHODS

Seventy four CMS lines and their maintainer lines were raised at Paddy Breeding Station, Tamil Nadu Agricultural University, Coimbatore during wet season of 2007. Three pairs of each CMS and their maintainer lines were planted side by side in single row plots having

twelve hills per row with a spacing of 20x20 cm. During the crop growth, recommended package of practices were followed. Observations were recorded for stigma exertion, pollen sterility, spikelet fertility, glume angle, anthesis time, panicle exertion, tip and awn colour and natural seed setting. About 10-15 spikelets from the freshly emerged panicles of all the 12 plants were collected and examined under microscope with 1% Iodine Potassium Iodide (I-KI) solution for pollen sterility assessment. Five panicles per plant were evaluated for natural seed setting percentage. Panicles emerging from the sheath were bagged with butter paper bags prior to anthesis to prevent cross-pollination. Bagged panicles were harvested to assess seed setting percentage.

RESULT AND DISCUSSION

Analysis of variance showed significant differences among the lines for all the characters (Table 1). Taller pollen parent and clear panicle exertion would facilitate better pollen dispersal resulting in higher seed set. The mean, range, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), CD %, CV %, heritability (broad sense), GA as percentage of mean for six floral traits was worked out and presented in table 3. Angle of floret opening for all the lines varied from 15 to 30°. In the present study maximum angle was observed in COMS 15 A, IR 68892 A and PMS

Table 1. Analysis of variance for various traits of CMS lines of rice.

Sl. Characters no	Mean sum of square		
	Replication DF=1	Genotype DF=73	Error DF=73
1 Days to 50 % flowering	5.297	98.069**	6.188
2 Panicle exertion %	8.463	53.129**	2.654
3 Stigma exertion%	41.573	92.497**	1.695
4 Pollen sterility %	1.088	0.786*	0.205
5 Glume angle (°)	21.19	31.74**	0.53
6 Out crossing %	1.613	130.678*	23.173

17A (Table 2). Singh and Rang (1999) observed a range of 35 to 48^o. The minimum days to 50% flowering were 86.50, for DMS 3A and Zhenshan 97A and the maximum was observed for KJT CMS 6A (113.50 days).

Hundred percent pollen and spikelet fertility is a highly desirable character. The CMS lines having sterility of less than 100 % are not suitable for hybrid rice production. The result showed that (Table 2) out of 74 CMS lines evaluated, forty two CMS lines namely,

Table 2. Evaluation of seventy four rice CMS lines for pollen sterility and other floral traits

Sl. no	Entries	Days to 50% flowering	Anthesis time	Glume angle %	Panicle exertion %	Stigma exertion	Pollen sterility	Tip colour	Awning	Stigma colour	Spikelet fertility	Out crossing
1	COMS 8	88.50	10.45	25.00	79.86	33.69(T.S)	99.98	Green	-	White	0.00	27.00
2	COMS 9	93.50	10.30	25.00	86.71	31.08(T.S)	99.75	Purple	-	Purple	0.51	19.00
3	COMS 11	97.00	10.45	20.00	81.12	26.51(T.S)	99.43	Green	-	White	0.89	21.50
4	COMS 12	95.50	10.30	25.00	81.39	35.98(T.S)	99.39	Purple	-	Purple	0.78	19.50
5	COMS 13	99.50	10.30	25.00	87.63	41.85(O.S)	100.00	Green	Small	White	0.00	46.50
6	COMS 14	95.00	10.30	20.00	74.67	38.89(O.S)	99.59	Green	-	White	0.68	35.00
7	COMS 15	99.00	11.00	30.00	81.25	41.95(O.S)	100.00	Green	-	White	0.00	40.00
8	COMS 16	96.00	10.40	20.00	75.41	36.96(O.S)	99.99	Green	-	White	0.00	30.50
9	COMS 18	99.50	10.45	25.00	77.36	30.19(T.S)	98.89	Green	-	White	0.74	33.00
10	COMS 19	98.00	10.45	20.00	81.61	37.09(O.S)	99.95	Green	-	White	0.00	27.00
11	IR 66707	95.50	10.45	25.00	71.79	34.09(T.S)	99.93	Green	small	White	0.00	21.00
12	IR 68229	88.50	10.30	25.00	79.08	42.19(T.S)	98.54	Green	Small	White	0.93	19.00
13	IR 68275	99.50	10.45	20.00	81.28	31.15(O.S)	100.00	Green	-	White	0.00	22.50
14	IR 68280	102.00	11.00	20.00	80.95	31.48(O.S)	98.81	Green	small	White	1.47	31.00
15	IR 68281	107.5	10.45	25.00	89.68	41.09(T.S)	99.94	Purple	-	Purple	0.00	44.00
16	IR 68285	109.00	11.00	20.00	79.90	41.20(T.S)	99.06	Yellow	-	White	0.94	29.50
17	IR 68890	102.50	11.15	25.00	83.75	35.20(O.S)	98.28	Purple	-	Purple	1.52	22.00
18	IR 68892	105.50	10.45	30.00	81.38	37.89(T.S)	99.19	Green	-	White	0.68	19.00
19	IR 68899	107.50	10.45	20.00	74.25	36.44(O.S)	99.94	Green	Medium	White	0.00	19.50
20	IR 68902	104.00	10.30	20.00	76.12	37.50(T.S)	99.94	Green	Medium	White	0.00	26.50
21	IR 69628	106.50	10.30	15.00	79.76	24.84(O.S)	99.17	Green	-	White	0.93	29.50
22	IR 70362	104.00	10.30	20.00	72.16	36.84(O.S)	99.93	Green	Medium	White	0.00	27.50
23	IR 69626	102.50	11.00	25.00	83.97	41.87(T.S)	99.92	Green	Medium	White	0.00	39.80
24	DRR 2	109.00	11.00	20.00	79.86	39.09(O.S)	99.04	Purple	-	Purple	0.00	29.50
25	IR 75596	107.50	11.00	25.00	77.09	41.40(O.S)	99.97	Green	-	White	0.00	18.50
26	IR 68885	99.00	11.00	20.00	71.46	40.87(O.S)	99.92	Green	-	White	0.00	22.00
27	IR 80155	109.00	11.00	25.00	77.03	34.29(T.S)	99.24	Green	Small	White	0.92	18.50
28	IR 70369	96.50	10.00	20.00	78.26	41.38(O.S)	98.89	Green	Medium	White	1.74	15.00
29	IR 70959	99.00	10.30	15.00	74.25	41.97(O.S)	99.93	Purple	-	Purple	0.00	33.00
30	IR 71321	107.50	10.15	20.00	88.48	47.06(T.S)	98.64	Green	Small	White	0.76	27.50
31	IR 73320	102.50	9.30	20.00	74.06	48.65(T.S)	99.28	Green	-	White	0.94	14.00
32	IR 73321	103.50	10.00	20.00	69.64	38.81(O.S)	98.51	Green	Medium	White	1.02	34.50
33	IR 73328	109.00	10.00	20.00	75.25	26.82(O.S)	98.53	Green	-	White	1.04	19.50
34	IR 79156	102.50	10.00	25.00	79.75	37.50(O.S)	99.95	Green	Medium	White	0.51	25.50
35	IR 80151	99.00	10.00	25.00	76.96	40.37(O.S)	99.98	Green	-	White	0.00	19.00

Table 2 contd....

Sl. no	Entries	Days to 50% flowering	Anthesis time	Glume angle %	Panicle exertion %	Stigma exertion	Pollen sterility	Tip colour	Awning	Stigma colour	Spikelet fertility	Out crossing
36	IR 80154	101.00	10.15	20.00	79.48	36.92(O.S)	99.13	Green	Small	White	0.74	19.00
37	IR 80156	99.00	10.30	25.00	78.03	41.35(T.S)	98.91	Green	-	White	1.47	24.50
38	IR 80555	98.50	10.00	20.00	69.23	39.86(T.S)	99.98	Green	Small	White	0.00	27.00
39	IR 80559	98.50	9.30	25.00	78.09	32.64(T.S)	99.15	yellow	Small	White	1.00	28.00
40	IR 80186	101.50	10.00	15.00	74.29	35.45(T.S)	100.00	Green	Medium	White	0.00	30.50
41	DRR 3	96.00	10.00	15.00	83.33	38.42(T.S)	99.93	Green	-	White	0.97	29.00
42	DRR 4	88.50	10.15	15.00	77.01	22.92(O.S)	98.79	Purple	-	Purple	1.23	54.50
43	DRR 5	88.80	10.15	20.00	80.77	34.00(O.S)	99.92	Green	-	White	0.00	21.00
44	DRR 6	92.00	9.45	20.00	79.24	22.95(O.S)	99.28	Purple	-	Purple	0.91	36.50
45	DRR 7	90.00	9.30	25.00	88.81	41.36(T.S)	99.93	Purple	-	Purple	0.00	42.00
46	DRR 8	95.00	10.00	20.00	80.26	38.51(T.S)	100.00	Purple	-	Purple	0.00	29.00
47	DRR 10	99.50	10.30	15.00	70.78	38.89(T.S)	99.64	Green	-	White	0.56	31.00
48	DRR 12	102.50	9.45	20.00	79.10	46.79(O.S)	97.64	Green	-	White	2.17	24.50
49	RTN 1	96.50	10.00	20.00	80.53	26.09(T.S)	96.30	Green	-	White	4.55	35.00
50	RTN 2	90.00	9.30	20.00	74.68	37.50(T.S)	99.81	Green	-	White	0.85	42.00
51	RTN 3	96.50	10.30	25.00	81.92	35.00(T.S)	98.15	Green	-	White	2.22	39.00
52	RTN 4	112.50	11.00	20.00	70.11	25.68(T.S)	99.92	Green	Small	White	0.00	26.50
53	RTN 5	105.50	10.30	15.00	73.34	27.94(O.S)	99.90	Green	-	White	0.00	29.00
54	RTN 6	96.50	10.30	30.00	82.14	42.11(T.S)	99.97	Green	-	White	0.00	40.50
55	RTN 11	112.50	10.30	30.00	67.66	28.57(O.S)	99.25	Green	small	White	0.53	26.75
56	RTN 12	99.00	10.30	25.00	81.84	27.07(T.S)	99.73	Green	-	White	0.00	21.00
57	RTN 13	111.00	11.00	25.00	81.25	41.59(T.S)	100.00	Green	Small	White	0.00	41.00
58	RTN 17	114.50	11.00	20.00	79.36	20.69(T.S)	99.74	Green	Small	White	0.00	29.75
59	RTN 18	92.50	11.00	25.00	71.17	36.56(O.S)	99.92	Green	Medium	White	0.00	27.00
60	PMS 3	102.50	11.00	25.00	71.74	29.58(T.S)	100.00	Green	-	White	0.00	30.25
61	PMS 10	106.50	11.00	20.00	74.78	34.68(O.S)	99.19	Green	-	White	0.76	25.50
62	PMS 17	104.00	11.15	30.00	82.84	45.04(T.S)	99.95	Green	-	White	0.00	41.50
63	CRMS 45	97.50	11.00	25.00	70.14	20.00(T.S)	99.11	Green	-	White	0.78	33.13
64	KJT 2	112.50	11.00	20.00	70.13	32.08(O.S)	98.63	Green	-	White	1.85	24.00
65	KJT 5	109.00	10.30	25.00	70.44	36.26 T.S)	100.00	Green	Small	White	0.00	23.15
66	KJT 6	113.50	9.45	20.00	69.75	29.21(O.S)	99.60	Green	-	White	0.00	23.50
67	APMS 5	99.50	10.00	20.00	79.64	31.76(O.S)	99.52	Green	Medium	White	0.00	27.00
68	APMS 6	100.50	10.30	20.00	89.21	42.12(T.S)	99.60	Green	-	White	0.00	33.75
69	DMS 3	86.50	10.00	15.00	79.69	35.54(O.S)	99.73	Green	-	White	0.00	27.75
70	DMS 4	87.50	11.00	15.00	76.26	32.31(O.S)	99.61	Green	Small	White	1.59	19.25
71	V 20	96.00	9.45	20.00	77.76	28.33(O.S)	99.26	Purple	-	Purple	0.56	17.75
72	Zhen shan97	86.50	9.30	20.00	76.75	10.08(O.S)	98.86	Purple	-	Purple	1.02	19.75
73	CMS 29	94.00	10.00	20.00	89.90	35.65(T.S)	99.74	Green	Small	White	0.00	21.50
74	CMS 39	107.50	9.30	20.00	81.95	41.56(T.S)	100.00	Green	-	White	0.00	24.00

TS – Two side exertion OS- One side exertion

COMS 8, COMS 13, COMS 15, COMS 16, COMS 19, IR 66707, IR 68275, IR 68281, IR 68899, IR 68902, IR 70362, IR 69626, , IR 75596, IR 68885, IR 70959, IR 79156, IR 80151, IR 80555, IR 80156, DRR 3, DRR 5, DRR 7, DRR 8, DRR 10, RTN 2, RTN 4, RTN 5, RTN 6, RTN 12, RTN 13, RTN 17, RTN 18, PMS 3, PMS 17, KJT CMS 5, KJT CMS 6, APMS 5, APMS 6, DMS 3, DMS 4, CMS 29, CMS 39 had complete pollen sterility. High pollen sterility in CMS lines have also been observed by Kumar *et al*, 1996: Kalaiyarasi *et al*,

2001: Hossain and Li 2002 and Jayaramaiah *et al.*, 2007. Virmani *et al* (1980) attributed better seed set in Zhenshan 97 due to better panicle exertion. Among the 74 CMS lines, twenty six CMS line *viz.*, COMS 9, COMS 11, COMS 12, COMS 13, COMS 15, COMS 19, IR 68275, IR 68280, IR 68281, IR 68890, IR 68892, IR 69626, IR 71321, DRR 3, DRR 5, DRR 7, DRR 8, RTN 1, RTN 3, RTN 6, RTN 12, RTN 13, PMS 17, APMS 6, CMS 29, CMS 39 exhibited more than 80% of panicle exertion. High percentage of stigma

Table 3. Estimates of variability and genetic parameters of 74 rice germplasm for floral traits

Sl. No	Characters	Mean	Range	S.E difference	S.E of mean	CD %	CV %	GCV %	PCV %	Heritability %	GA %	GA % of mean
1	Days to 50 % flowering	100.28	86.50-113.50	2.49	1.75	3.48	2.48**	6.76	6.98	93.69	13.52	13.48
2	Panicle exertion %	78.04	67.66-89.90	1.63	1.14	2.28	0.46	6.43	6.60	95.00	10.09	12.93
3	Stigma exertion%	34.66	10.57-49.55	1.30	0.91	1.82	3.76**	19.44	19.62	98.17	13.75	39.68
4	Pollen sterility %	99.36	96.30-100.00	0.45	0.32	0.63	0.46	0.54	0.63	73.95	0.95	0.96
5	Glume angle	22.07	15-30	0.73	-	1.45	3.30**	-	-	-	-	-
6	Out crossing %	27.86	14.00-54.50	4.81	3.38	6.74	17.28**	26.32	29.02	0.823	13.69	49.18

exsertion is an important character which directly affects the out crossing rate of A lines. The stigma exsertion of above 40 % was recorded for the twenty CMS lines *viz.*, COMS 13, COMS 15, IR 68229, IR 68281, IR 68285, IR 69626, IR 68885, IR 75596, IR 70369, IR 70959, IR 71321, IR 73320, IR 75596, IR 80151, IR 80156, DRR 7, DRR 12, RTN 6, RTN 13, PMS 17 and APMS 6A.

In the present study the traits like days to 50% flowering, panicle exsertion and stigma exsertion recorded higher heritability estimates in broad sense exceeding 95%. The genetic advance as percent of mean was found to be high for stigma exsertion percentage and out crossing percentage. Such high heritability coupled with high genetic advance was reported for sigma exsertion (Kamalagar, 2000). On the contrary high heritability and high genetic advance was reported by Seetharamaiah *et al* (2001) for panicle exsertion %. Phenotypic coefficient variation (PCV) was higher than genotypic coefficient of variation genotypic coefficient of variation (GCV) for all the characters studied. Higher magnitude of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) (more than 20%) was recorded only for out crossing percentage. Low genotypic coefficient of variation (GCV) estimates were noticed in the present study for days to 50% flowering, panicle exsertion %, pollen sterility %. Similar findings of low genotypic coefficient of variation (GCV)% were reported earlier for Shivani and Sree Rama Reddy, 2000 and Seetharamaiah *et al* (2001) for panicle exsertion %.

The CMS lines *viz.*, COMS 13, COMS 15, IR 68281, IR 69626, DRR 7, RTN 6, RTN 13 and PMS 17

were found promising for the characters *viz.*, pollen sterility, panicle exsertion, stigma exsertion, glume angle, out crossing percentage and medium duration which offer scope for development of three line high yielding rice hybrids with good grain quality.

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