

Evaluation of promising cytoplasmic male sterile lines of rice for agronomical and floral traits

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ABSTRACT

Thirty cytoplasmic male sterile (CMS) lines of rice, received from various sources, were evaluated for agronomical traits viz., days to 50 % flowering, plant height, productive tillers plant⁻¹, panicle length, panicle exertion (%), total spikelets panicle⁻¹ and their floral traits viz. stigma exertion (%), pollen sterility (%), spikelet sterility (%), outcrossing (%) and phenotypic acceptability with standard check CMS line IR-58025A. Eleven CMS lines viz., IR-68888A, IR-62829A, IR-68892A, IR-68893A, IR-69628A, IR-68886A, IR-68885A, PMS-5A, PMS-10A, COMS-9A, CRMS-32A were of early duration and rest lines were of medium duration (91-102 days to flowering). The CMS lines exhibited the maximum plant height in IR-68886A (106.33cm), days to 50 % flowering in IR-70372A (101 days), productive tillers per plant in IR-69628A (9.33), panicle length in IR-70372A (33.25 cm), panicle exertion in IR-70369A (90 %), spikelets per panicle in IR-68892A (192), stigma exertion in IR-68888A (61 %), pollen and spikelet sterility in RTN-15A (100 %, 99 %) and maximum outcrossing in IR-68902A (40 %). Out of 29 CMS lines RTN-9A, RTN-12A, IR-70369A, IR-68886A, IR-70959A, IR-70372A, IR-69626A, IR-68897A, IR-68902A, and IR-62275A were promising for most of the agronomical and floral traits under the investigation and could be used in the heterosis rice breeding programme. Among the CMS lines, 3 lines categorized as very good; 14 good and 12 average based on their over all performance.

Key words: rice, cytoplasmic male sterile line, agronomical, floral trait

Availability of stable cytoplasmic male sterility and fertility restoration system is vital for commercial exploitation of heterosis in any crop. The discovery of the 'wild abortive' (WA) male sterility, inducing cytoplasm from *Oryza sativa f. spontanea* and subsequent development of three line hybrids, made a breakthrough in exploitation of heterosis in rice (Lin and Yuan, 1980). The WA cytoplasm has been found to be the most stable and hence about 95 % of the rice hybrids worlds over are based on this single source of cyto sterility (Virmani and Wan, 1986). This is an apprehension that the increased genetic homogeneity may cause disease and pest problems in the crop in future. Among the various approaches to develop new CMS sources, inter-subspecific crosses have been used by many researchers (Lin and Yuan, 1980; Virmani and Wan, 1986). Even though, many CMS sources were developed in the past, none of these became usable, except the WA source, because of some shortcomings. In the present investigation, efforts have been made to study morphological and floral traits of CMS lines by

using various CMS lines for development of new rice hybrid combinations.

MATERIALS AND METHODS

The experimental material consisted of 30 cytoplasmic male sterile lines of rice from various research centers like IR-58025A, IR-68888A, IR-62829A, IR-62280A, IR-68892A, IR-68893A, IR-70362A, IR-70959A, IR-70372A, IR-70369A, IR-69626A, IR-69628A, IR-68897A, IR-69616A, IR-68902A, IR-62275A, IR-67684A, IR-68886A, IR-68885A from IRRI, Philippines; PMS-14A, PMS-11A, PMS-5A, PMS-10A from Kapurthala; COMS-9A, COMS-11A from Coimbatore; CRMS-32A, CRMS-22A from Cuttack; RTN-9A, RTN-15A, RTN12A from ARS, Shirgaon, Ratnagiri.

Twenty-nine CMS lines along with check IR-58025A line were evaluated for their morphological and floral traits. The experiment was laid out in randomized block design with three replications during

wet season at Regional Agricultural Research Station, Karjat, Maharashtra. The seedlings of 26 days old were transplanted at 30 x 20 cm spacing in 4 m² plot. The observations were recorded on five randomly selected plants from the middle row in each plot for six agronomical traits *viz.*, days to 50 % flowering, plant height, number of productive tillers plant⁻¹, panicle length, panicle exertion, total spikelets / panicle and five floral traits *viz.* stigma exertion, pollen sterility, spikelet sterility, outcrossing and phenotypic

acceptability.

RESULTS AND DISCUSSION

Eleven CMS lines *viz.*, IR-68888A, IR-68886A, IR-68885A, IR-62829A, IR-68892A, IR-68893A, IR-69628A, PMS-5A, PMS-10A, COMS-9A and CRMS-32A, were of early in duration (75 to 89 days to 50 % flowering) and other eighteen lines were of medium duration (91-101 days) Table 1. CRMS-22A was the

Table 1. Evaluation of rice CMS lines for their agronomical and floral traits

CMS line	Days to 50 % flowering	Plant height (cm)	No. of tillers plant ⁻¹	Panicle length (cm)	Panicle exertion (%)	No. of spikelets panicle ⁻¹	Stigma exertion (%)	Pollen sterility (%)	Spikelet sterility (%)	Outcrossing (%)	Phenotypic acceptability
IR-68888A	85	69.66	7.33	23.36	78.00	177.0	61.0*	96.00	95.70	22.0	A
IR-62829A	81	65.7	7.0	20.66	74.60	144.2	50.0	96.00	94.00	27.0*	B
IR-62280A	96*	85.00	6.66	2.26	77.00	177.7	25.0	92.00	92.00	25.0*	B
IR-68892A	82	67.00	9.20	26.00*	85.20	192.0	29.0	93.33	92.00	22.0	B
IR-68893A	85	71.02	8.33	26.00*	80.00	193.0	33.3	97.00	96.00	20.0	B
IR-70362A	100*	86.00	7.00	30.47*	75.50	188.3	43.0	88.00	86.00	22.5	C
IR-70959A	98*	87.02*	6.66	25.6*	78.50	168.3	45.0	89.66	88.33	22.0	C
IR-70372A	101*	90.66*	8.00	33.25*	76.80	177.3	26.0	90.00	89.20	18.0	C
IR-70369A	97*	93.00*	7.00	26.86*	90.00	183.0	51.2	87.00	85.40	25.0*	C
IR-69626A	90*	89.53*	8.00	25.73*	78.25	170.0	37.8	93.00	90.00	12.0	C
IR-69628A	88	83.00	9.33	24.90	76.00	185.0	44.5	98.20	97.00	16.0	B
IR-68897A	92*	75.00	7.00	25.00	85.02	156.0	54.8*	96.70	95.40	31.0*	B
IR-69616A	91*	84.20	8.33	26.30*	84.60	164.3	24.0	92.80	91.30	16.0	C
IR-68902A	94*	85.58	7.66	27.00*	79.52	169.0	36.2	90.10	88.00	40.0*	C
IR-62275A	96*	90.01*	6.00	28.66*	86.70	183.0	41.0	96.40	96.40	17.0	B
IR-67684A	96*	85.00	8.00	25.53*	81.08	182.0	50.0	96.20	96.90	20.0	B
IR-68886A	82	106.30*	11.00*	24.00	76.00	182.0	41.6	93.40	92.00	38.0*	C
IR-68885A	84	73.00	7.00	22.13	78.00	184.0	48.0	80.30	77.00	30.0*	C
PMS-5A	89	75.00	8.00	20.00	77.00	111.0	43.00	98.0	96.0	16.0	B
PMS-10A	83	84.50	8.00	25.00	81.20	185.0	48.00	96.0	94.0	17.0	B
PMS-11A	92*	89.00*	5.00	23.25	81.00	185.0	35.20	88.0	87.0	15.0	C
PMS-14A	95*	91.00*	6.33	22.00	80.00	146.0	53.00	96.0	95.2	22.0	B
COMS-9A	85	68.80	6.33	22.00	74.00	118.0	36.00	99.0	98.0	18.0	B
COMS-11A	90*	85.00	5.00	21.55	84.00	122.0	42.00	86.0	85.0	22.0	C
CRMS-22A	75	67.00	8.33	25.35	75.00	187.0	40.00	98.0	96.0	9.0	B
CRMS-32A	87	71.00	8.33	27.00*	90.00	179.0	34.20	68.0	66.0	22.0	C
RTN-9A	94*	88.00*	6.33	23.20	82.40	165.0	58.85*	98.0	96.0	37.0*	A
RTN-12A	95*	74.33	7.00	18.00	77.00	160.0	48.00	96.0	94.0	37.0*	A
RTN-15A	100*	75.00	6.33	26.00*	81.00	169.0	47.00	100.0*	99.0	21.0	B
IR-58025A	87	83.00	9.00	23.00	85.50	175.0	51.00	100.0*	96.0	20.0	A
(CD=P0.05)	2.83	3.13	1.99	2.37	4.74	31.46	3.15	3.48	4.27	4.73	

* - Significantly superior to the check IR-58025A at 5 % level.

earliest in days to 50 % flowering (75 days); while IR-70372A was late (101 days). The CMS lines varied in days to 50 % flowering at different locations (Bharaj *et al.*, 1989 and Pradhan and Jachuck, 1993). The lines *viz.*, IR-62280A, IR-70362A, IR-70959A, IR-70372A, IR-70369A, IR-69626A, IR-68897A, IR-69616A, IR-68902A, IR-62275A, IR-67684A, PMS-14A, PMS-11A, COMS-11A, RTN-9A, RTN-15A and RTN-12A recorded, significantly more days to fifty percent flowering over IR-58025A (check). These observations indicate that there is a scope to develop suitable hybrid combinations by utilizing the CMS lines under the studies for different agro ecological situations.

The maximum plant height was observed in IR-68886 (106.33 cm) followed by IR-70369A (93.0 cm) and PMS-14A (91.00 cm). The shortest plant height was observed in CRMS-22A (67.0 cm). A good CMS line should have a short stature as compare to its restorer and maintainer lines for an effective transfer of pollen grains (Azzini and Rutger, 1982). The CMS lines *viz.*, IR-70959A, IR-70372A, IR-70369A, IR-69626A, IR-62275A, IR-68886A, PMS-14A, PMS-11A, RTN-9A showed significantly superior plant height than the check IR-58025A (83.0 cm). It indicated that there was wide variability in plant height among the CMS lines.

The maximum productive tillers plant⁻¹, observed in IR-68886 (11.0), was significantly superior to the check IR-58025A (9.00). The productive tillers per plant in IR-68882A (9.2), IR-69628A (9.33) was at par with the check IR-58025A (9.0). The panicle length ranged from 18.0 (RTN-12A) to 33.23 (IR-70372) cm. The CMS lines *viz.*, IR-70372, IR-70362, IR-62275, IR-68892A, IR-68893A, IR-70959A, IR-70369A, IR-69626A, IR-69616A, IR-68902A, IR-67684A, IR-62275A, CRMS-32A and RTN-15A recorded significantly higher panicle length over IR-58025A (23.00 cm). The panicle length reported from 18.5 to 22.5 cm in the different rice CMS lines (Rangaswami *et al.*, 1987).

Panicle exertion is an important feature in CMS lines for getting proper seed production. The panicle exertion ranged from 74.00 (COMS-9A) to 90.00 (IR-70369) per cent. Seventeen CMS lines recorded significantly inferior panicle exertion to IR-58025A while the others were at par. The panicle exertion directly influences natural outcrossing and ultimately

seed setting (Ramesha *et al.*, 1999).

The spikelets per panicle were the highest in IR-68893A (193.0). PMS-5A (111) and COMS-9A recorded significantly lower spikelets panicle⁻¹ over the check IR-58025A. All other CMS lines were at par with IR-58025A for spikelets panicle⁻¹. The high productive tillers plant⁻¹ and spikelets panicle⁻¹ in different CMS lines have been reported by Mishra and Pandey, 1993.

Besides, the above agronomic traits, suitable floral characteristics are very important in CMS lines for an efficient seed setting. The floral characteristics, like stigma exertion was maximum in CMS line IR-68888A (61 %) followed by IR-688897A (54.8 %) and RTN-9A (58.85 %) which were significantly superior IR-58025A (check). Nineteen CMS lines showed significantly inferior stigma exertion over the check IR-58025A (51.0 %). Male sterile spikelets with better stigma exertion had significantly higher seed setting than that of spikelets without exerted stigma (Kato and Namani, 1978). Quite good range of stigma exertion (0.2 to 87.8 %) observed in cultivated indica rice (Virmani and Athwal, 1973). In the present investigation significant variation in stigma exertion confirms the above finding.

Pollen sterility was cent percent in the lines RTN-15A and IR-58025A. Fourteen CMS lines *viz.*, IR-68888, IR-68893, IR-69628, IR-62829, IR-68897, IR-62275, IR-67684, PMS-14A, PMS-5A, PMS-10A, COMS-9A, CRMS-22A, RTN-9A and RTN-12A showed more than 95 % pollen sterility and these were categorized under highly sterile CMS lines. The CMS lines should have complete pollen sterility to avoid self-fertilization during seed multiplication (Virmani and Wan, 1981). Spikelet sterility was maximum in RTN-15A (99 %). Twelve CMS lines showed above 95 % spikelet sterility. Among these lines, IR-69628A, IR-62275A, IR-67684A, COMS-9A, RTN-15A recorded more spikelet sterility than the check IR-58025A. Spikelet sterility showed significant reduction in eleven CMS lines as compare to IR-58025A.

The outcrossing rate was the highest in IR-68902 (40%), followed by IR-68886A (38 %), RTN-12A (37.00 %), RTN-9A (37.33 %), IR-68897A (31 %), IR-68885A (30 %), IR-70369 (25 %), IR-62829A (27 %) and IR-62280A (25%), which were significantly higher than IR-58025A. A wide range of natural

outcrossing (0-44 %) was reported in male sterile lines of rice (Azzini and Rutger, 1982, Stansel and Craigmiles, 1966 and Athwal and Virmani, 1972). The new CMS lines were found to have very high outcrossing ability (38.52 %) as compared to the other CMS sources (Ramesha *et.al.*, 1996). IR-69626A showed significantly less outcrossing over IR-58025A. All other CMS lines were at par with IR-58025A. However, IR-68888A, IR-68892A, IR-70362A, IR-70959A, PMS-14A, COMS-11A, CRMS-32A and RTN-15A recorded higher outcrossing than the IR-58025A (check) in the present investigation.

Out of 29 CMS lines, 10 CMS lines *viz.*, RTN-9A, RTN-12A, IR-70369A, IR-68886A, IR-70959A, IR-70372A, IR-69626A, IR-68897A, IR-68902A and IR-62275A were found promising for most of the agronomical and floral traits under investigation. Among the CMS lines, three lines were categorized very good, 14 good and 12 average based on their agronomic and floral characteristics. These CMS lines could be used for the development of new hybrid combinations effectively.

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