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Evaluation of CMS lines for different allogamic traits that influence out crossing in Rice (*Oryza sativa* L.)

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Abstract. 24 CMS lines of rice derived from wild abortive male sterility source were evaluated for various agronomical and floral traits. Out of 24 CMS lines IR68897A, IR68628A, IR68886A, IR68896A, IR68280A, APMS6A, DRR6A were completely pollen sterile. For all other CMS lines spikelet fertility ranged from 0.1%-3.6%. The CMS lines IR69617A, IR68275A, IR68893A, IR58025A, IR68628A, IR68902A, DRR6A, PUSA6A, IR68897A, IR62829A, IR68280A, IR68896A, IR75603A and IR68886A were exhibited more than 70 % panicle exertion. Stigma exertion of more than 30 % was observed in the CMS lines IR75601A, IR62829A, IR68897A, IR69617A, IR64608A, IR68899A, IR58025A, IR68886A, IR68280A, IR68275A, IR68893A, IR64607A and DRR6A. Natural out crossing ranged from 14.8% - 51% and 14 CMS lines had more than 35 % out-crossing. CMS lines IR58025A, IR62829A, IR68897A, IR68886A, IR68896A, IR69617A (Basmati type), and IR75601A were found promising CMS lines for good phenotypic acceptability characters viz., pollen sterility, panicle exertion, stigma exertion, natural out-crossing and medium duration which offer better scope for utilizing these CMS lines for the development of high yielding rice hybrids.
Key words: rice, CMS lines, pollen sterility, hybrids, agronomic and floral traits.

Introduction. Rice (*Oryza sativa* L.) is the most important food crop of India with world ranking first in area and second to China in production. At the current growth of population rice requirement increases dramatically; hence, it is challenging task to ensuring food and nutritional security to the country. Therefore, enhancing productivity of rice through novel genetic approaches like hybrid rice was felt necessary. Commercial exploitation of hybrid vigor is one of the most important applications of genetics in agriculture. It has not only contributed to food security, but has also benefited the environment (Duvick 1999). Among the various crop species in which hybrid varieties are used commercially, rice ranks very high. Rice hybrids were first commercialized in the late 1970s in China. Since rice is a self-pollinated crop, hybrid seed production must be based on male sterility systems. These may be cytoplasmic (CMS), thermo-sensitive genetic (TGMS) or photo-sensitive genetic (PGMS). Currently, the most popular male sterility system for commercial exploitation of hybrid rice technology is the CMS, popularly known as the three-line system. This utilizes three different lines, namely a cytoplasmic male sterile line (A line), a maintainer (B line), and a restorer (R line). Hybrid rice based on cytoplasmic male sterility (CMS) increases grain yield by more than 20% relative to improved inbred rice varieties (Yuan et al 1994).

Successful development of hybrid rice depends on improvement of parental lines i.e., A, B and R. The search of alternate sources of CMS in hybrid rice breeding is a priority because more than 90% of the hybrids released throughout the world are based wild abortive cytoplasm (WA). To minimize the potential damage from rice diseases caused by a unique CMS line and narrow genetic background, other CMS resources have been exploited and used in the breeding of new hybrids. But it is not easy to obtain new elite lines from the inbred breeding programme on a continual basis.

Therefore, in order to improve the efficiency of hybrid rice breeding, it is essential to augment it with a parental line improvement. The previous observations indicated that the flowering habit of CMS lines was related to the degree of male sterility. Although CMS lines of the WA type usually have a lower out crossing rate but higher male sterility. To enhance the efficiency of hybrid seed production, it is necessary to increase the yield of hybrid seed by improving the out crossing capacity of CMS lines (Yang et al 2006; Cheng et al 2007). Hence an attempt was made to evaluate different CMS lines and their maintainer for adaptability, stability of pollen and spikelet fertility and agronomic characteristics for developing better rice hybrids.

Material and Methods. 24 CMS lines derived from wild abortive (WA) male sterility source of rice were evaluated for various morphological, floral and agronomical traits at Crop Research Station, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad during 2004. All CMS lines were transplanted in rows of 30 plants spaced at 20 x 20 cm from each side. The CMS line and its maintainer line were transplanted in the ratio of 2:6. Standard agronomic and plant protection measures were followed to raise the crop. Observations were recorded for days to 50% flowering, plant height (cm), panicle number per plant, panicle length (cm), pollen sterility (%), panicle exertion (%), stigma exertion (%) and natural out-crossing. About 15 spikelets from the freshly emerged panicles of 10-12 plants were collected and examined under microscope with 1% Iodine Potassium Iodide (IKI) solution for pollen sterility assessment. Five panicles per plant were evaluated for natural seed setting percent. For this, 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 percent. The general reference for data collection was standard evaluation system for rice (Anonymous 1996; Virmani et al 1997).

Results and Discussion. The data for different agro-morphological and floral traits were presented in Table 1. Out of 24 CMS lines IR68897A, IR68628A, IR68886A, IR68896A, IR68280A, APMS6A, DRR6A were completely pollen sterile. For all other CMS lines spikelet fertility ranged from 0.1%-3.6%. The CMS lines with complete pollen sterility had reduced anthers and non functional pollens hence, no seed set in bagged panicles. High pollen sterility (99.00%-99.9%) was also observed in CMS lines by Hossain & Li (2002), Pradhan & Jachuck (1993) and Kumar et al (1996).

Out crossing in rice depends upon the capacity of stigma to receive alien pollen (i.e., stigma respectability), and it is a function of the time interval from flowering to pollen emission, size and exertion of stigma from the flower as conditioned by the style plus stigma length (Virmani 1994). These results indicate that improvement in floral traits of female and male parents has to done separately to increase out crossing potential in rice in relation to hybrid rice breeding. Out crossing percent was varied from 14.8% - 51%. Xu & Li (1988) reported out crossing rates ranging from 14.6-53.1% in various experiments conducted at Changsha, Hunan, China. Maximum out crossing were observed for the 14 sterile CMS lines *viz.,* DRR6A, APMS6A, IR58025A, IR73323A, IR75594A, IR68628A, IR62829A, IR68897A, IR68886A, IR68893A, IR75603A, IR75601A, PUSA6A and IR69617A. Similar findings were also observed by Li et al (1993), Wang et al (1993) and Yuan et al (1994).

Male sterility in crops often results in poor flowering habit. In rice, the flowering time of WA-CMS lines is usually later than that of the male parent (conventional rice) with other poor flowering habits such as enclosed panicle in sheath (panicle exertion), unbloomed spikelets, spikelets blooming diversely, and decreased stigma viability (Wang & Gao 1998). Therefore, to enhance out crossing improvement in these characters necessary. The present data revealed that panicle exertion was varied from 14.5% to 30.0% and more than 70% panicle exertion were observed for the CMS lines IR69617A, IR68275A, IR68893A, IR58025A, IR68628A, IR68902A, DRR6A, PUSA6A, IR68897A, IR62829A, IR68280A, IR68896A, IR75603A and IR68886A. These findings were in agreement with Ramesha et al (1998).

Selection for floral traits that increased cross pollination such as stigma length and the proportion of extruded stigma improved hybrid rice seed production (Virmani et al 1973). Stigma exertion was ranged from 11.2% to 37.54%. Stigma exertion of more than 30 % was observed in the CMS lines IR75601A, IR62829A, IR68897A, IR69617A, IR64608A, IR68899A, IR58025A, IR68886A, IR68280A, IR68275A, IR68893A, IR64607A and DRR6A.

In any crop genotypes with early maturing habits are generally wanted. The CMS line IR69617A, IR68893, IR68897A and IR68899A were very early in flowering. On account of morphological traits; highest tillering was observed in IR68893A followed by IR68897A, while lowest tillers recorded IR5603A followed by IR5594A and Pusa-6A. Panicle length ranged from 14.5 to 30.00 cm. Dwarfism is a desirable trait in rice. The data revealed that dwarf to semi dwarf plant height was observed in all CMS lines. Similar findings were also reported by Wang et al (1993) and Pradhan & Jachuck (1993) for agronomic and floral traits of rice CMS lines.

From the present study it is concluded that CMS lines IR58025A, IR62829A, IR68897A, IR68886A, IR68896A, IR69617A (Basmati type), and IR75601A were found promising CMS lines for good phenotypic acceptability characters viz., pollen sterility, panicle exertion, stigma exertion, natural out-crossing and medium duration which offer better scope for utilizing these CMS lines for the development of high yielding rice hybrids.

Table 1

Evaluation of different rice CMS lines for pollen sterility, morphology and other floral traits

S.No.	CMS Lines	Days to 50% flowering	Plant height (cm)	No. of tillers	Panicle length (cm)	Pollen sterility (%)	Panicle exertion (%)	Stigma exertion (%)	Natural outcrossing (%)	Spikelet fertility (%)
1	PUSA6A	106	84.21	11.0	20.07	98.00	76.50	11.20	35.24	1.6
2	APMS6A	98	74.60	11.5	20.60	100.00	68.20	17.30	40.00	0.0
3	DRR6A	92	74.40	12.8	14.50	100.00	77.00	37.54	51.00	0.0
4	IR73323A	100	66.82	14.2	17.60	98.25	63.70	17.50	38.00	2.2
5	IR75594A	100	68.30	9.4	21.10	96.50	67.00	19.10	38.00	3.1
6	IR75601A	98	67.23	14.6	20.30	99.25	56.90	36.40	35.40	0.6
7	IR75603A	103	64.60	9.2	22.00	98.00	71.40	18.80	35.70	1.0
8	IR58025A	89	92.10	15.4	27.20	99.72	80.15	32.30	39.48	0.1
9	IR62829A	91	81.52	14.2	23.90	99.81	72.50	34.60	36.79	0.2
10	IR64607A	82	89.10	14.7	27.00	99.53	61.81	30.00	28.14	0.7
11	IR64608A	82	85.17	15.9	27.20	92.67	59.18	32.50	19.42	3.6
12	IR67683A	93	92.28	22.3	25.80	99.26	66.67	28.00	14.80	0.2
13	IR73318A	102	72.70	12.4	21.30	94.78	64.24	18.22	19.21	3.2
14	IR73328A	104	69.12	11.6	15.20	98.30	61.80	19.10	18.00	2.4
15	IR68275A	90	91.86	12.7	23.30	97.45	86.83	31.40	16.90	2.1
16	IR68897A	78	98.70	18.6	29.00	100.00	75.81	33.56	36.15	0.0
17	IR68899A	78	92.00	12.5	23.40	97.72	66.04	32.50	22.40	2.3
18	IR68902A	90	102.30	17.3	28.20	98.76	78.66	25.40	27.50	1.7
19	IR68886A	87	100.20	22.5	23.50	100.00	70.12	32.21	36.00	0.0
20	IR68628A	90	95.40	19.8	27.00	100.00	79.55	26.18	37.16	0.0
21	IR68896A	80	95.60	16.0	24.30	100.00	71.72	27.30	31.15	0.0
22	IR68893A	77	100.20	19.0	30.00	97.65	81.48	30.70	35.80	1.8
23	IR68280A	98	94.00	20.3	28.00	100.00	71.76	31.80	27.40	0.0
24	IR69617A	72	77.20	19.8	23.60	99.70	87.87	33.50	35.20	0.1

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