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Research Note

Identification of Restorers and Maintainers for Development of Rice Hybrids using WA and Kalinga sources of CMS lines

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Abstract
Three cytoplasmic male sterile (CMS) lines of rice having wild abortive (WA) and Kalinga cytoplasmic male sterility source were crossed with seven testers to identify their restorer/maintainer nature. Total of 21 hybrids were subjected to pollen and spikelet fertility analysis along with their parents. Most of the genotypes expressed differential fertility reactions when crossed with CMS lines were identifies as potential restorers. None of the genotypes identified as potential maintainer based on pollen and spikelet fertility. Among these, Bagdidhan was identified as restorer for all three cms lines. Potential restorers identified in the present investigation could be used to develop good, high yielding and promising rice hybrids.

Keywords
Rice, CMS lines, restorers, maintainers

Heterosis breeding in rice is valuable only when promising restorers are identified for different sources of cytoplasmic-genic male sterile (CMS) lines (Pradhan *et al*., 1992). The use of cytoplasmic genetic male sterility system in developing hybrids in crops is possible only when effective restorers are identified (Sharma *et al*., 2012). A number of cytosterile maintainers and restorer lines in rice have been developed to diversify the genetic and cytoplasmic base of commercial F_1 rice hybrids. The CMS lines developed outside the country are being used as such in developing rice hybrids in India as well as in the state. Therefore, it is essential to identify locally adapted maintainers and restorers among the lines developed using conventional breeding procedures, which could be converted into CMS lines for wide adaptability (Jayasudha and Sharma, 2010). Exotic CMS line IR 58025A and IR79156A has been widely used in 3 line breeding system and therefore, incorporation of indigenous CMS lines viz., CRMS32A and CRMS31A have also enormous value to develop locally adopted rice hybrid. Pollen (or) spikelet fertility or both has been used as an index to fix restoration ability of the genotypes (Sutaryo, 1989). The percentage of fertile pollens is the most reliable criterion for evaluating pollen fertility (Veeresha *et al.*, 2013). Considering the importance of heterosis breeding the present investigation was undertaken with the objective to identify different restorers and maintainers for three CMS lines from the local and high yielding rice (*Oryza sativa* L.) genotypes.

The experimental material comprised of three CMS lines from two different CMS sources *viz.*, IR58025A and IR79456A (Wild Abortive) and CRMS 32A (Kalinga) and seven genetically diverse testers- Kanakgopala, Bagdidhan, RIL-62 (Danteshwari-Dagaddeshi), Inger-2-114 (WANXIAN-7777), Karmamahsuri, TOX981-11-2-3 and Suraksha. A set of 21 hybrids were generated in Line x Tester fashion (Kempthrone, 1957) for the purpose and evaluated along with their corresponding parents in Randomized Complete Block Design with two replications at research cum instructional farm, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Viswavidyalaya, Raipur, Chhattisgarh during *kharif* 2013. Twenty one days old seedlings of 21 hybrids and 10 parents were transplanted in the field. A standard spacing of 20 x 20 cm was adopted for planting and 10 plants were maintained in a single row. Single seedling per hill was transplanted. Recommended package of practices were adopted.

Pollen studies were carried out at flowering time to assess fertility / sterility status of F_1 plants. For this purpose, 15-20 spikelet's from the just emerged panicles of five randomly selected plants were collected in a vial containing 70% ethanol. All the anthers from at least three to four spikelets were taken out with the help of forceps and placed on a glass slide with a drop of distill water. The anthers were gently crushed by using a needle to release the pollen grains. Then the pollen grains were stained with one percent iodine potassium iodide (I-KI) solution. After removing the debris, a cover slip was placed and the slide was observed under the microscope and estimated the pollen fertility (%).

For spikelet fertility/sterility, five panicles of each testcross were covered with butter paper bags to avoid foreign pollen contamination and were

harvested at maturity. After that taking count of well filled and chaffy spikelets of each panicle and estimated the spikelet fertility (%).

Classification of parental lines as restorers and maintainers is done on the basis of method proposed by Virmani *et al.* (1997). According to this method the genotypes that could produce 0-1 per cent pollen fertility and 0.0-0.1 per cent spikelet fertility were classified as maintainers, 1.1-50 per cent pollen fertility and 0.1-50 per cent spikelet fertility were classified as partial maintainers, 50.1-80 per cent pollen fertility and 50.1-75 per cent spikelet fertility were classified as partial restorers and >80 per cent pollen fertility and >75 per cent spikelet fertility were classified as potential restorers.

The restorers and maintainers identified in the present investigation are presented in the Table 1. The studies on pollen and spikelet fertility percentages indicated that none of the hybrids possessed complete pollen and spikelet sterility. So, none of the hybrids could be identified as maintainer, of course partial maintainers were identified. Kanakgopala have been identified as partial maintainers for the CMS line IR58025A. The parent Inger 2-114 have been identified as partial maintainers for the line IR79156A. The genotypes Kanakgopala and Inger 2-114 have been identified as partial maintainers in relation to line CRMS 32A. The lines identified as partial maintainers can be further multiplied and back crossed with their respective F1's to look for completely sterile back cross progenies so that these can be developed as new CMS lines. Similar work plan was reported by Singh and Singh (2000) and Durai and Nadarajan (2007).

The parents Bagdidhan and Suraksha can be considered as potential restorers for the CMS line IR58025A. Parents Bagdidhan and RIL-62 were identified as potential restorers for the CMS line IR79156A. Whereas the parents, Bagdidhan, RIL-62, Karmamahsuri and TOX-981-11-2-3 can be considered as potential restorers for CMS line CRMS32A. Bagdidhan has been considered as potential restorer for all the three CMS lines. It is a red rice landrace of Chhattisgarh state and is a very long duration variety with poor yield. Hence Bagdidhan can be used as potential restorer to develop high yielding, red rice hybrids.

Hybrid CRMS32A/ TOX-981-11-2-3 showed highest pollen fertility (86.00%) and spikelet fertility (76.46%) followed by crosses CRMS32A/Karmamahsuri (82.08% and 77.63%), IR58025A/Bagdidhan (82.83% and 76.31%), IR79156A/RIL-62 (82.00% and 76.90%), CRMS32A/Bagdidhan (81.55% and 76.10%), CRMS32A/ RIL-62 (81.05% and 76.09%), IR58025A/ Suraksha (80.46% and 76.18%) and IR79156A/Bagdidhan (80.97% and 75.29%). Therefore these crosses can be effectively utilized as good restorer lines to develop high yielding rice hybrids.

In some cases, the same genotype behaved as a restorer for one CMS line and as partial maintainer or partial restorer for the other CMS line. Similar type of results was reported by Bisne and Motiramani (2005). The variations in behaviour of fertility restoration indicate that either the fertility-restoring genes are different or that their penetrance and expressivity varied with the genotypes of the parents or the modifiers of female background. This could be due to differential nuclear cytoplasmic interactions between the testers and CMS lines. This kind of the differential reaction of the same genotype in restoring the fertility of different CMS lines of same cytoplasmic source was reported by Hariprasanna *et al.* (2005), Murugan and Ganesan (2006) and Jayasudha and Sharma (2010).

The investigation concludes five genotypes were identified as potential restorers, among which only one genotypes viz., Bagdidhan was identified as potential restorers for all three CMS lines (IR58025A, IR79156A and CRMS 32A). Potential restorers identified in the present study can be further used for developing good, high yielding and hopeful rice hybrids.

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Table 1. Identified Restorers and Maintainers (Based on pollen and spikelet fertility)

S. No.	Crosses	Pollen Fertility		Spikelet Fertility		Based on both
		%	Class	%	Class	
1	IR58025A/Kanakgopala	07.96	PM	18.86	PM	PM
2	IR58025A/ Bagdidhan	82.83	R	76.31	R	R
3	IR58025A/ RIL-62	64.25	PR	53.11	PR	PR
4	IR58025A/Inger 2-114	72.66	PR	59.75	PR	PR
5	IR58025A/Karmamahsuri	77.22	PR	57.00	PR	PR
6	IR58025A/ TOX-981-11-2-3	66.75	PR	55.93	PR	PR
7	IR58025A/ Suraksha	80.46	R	76.18	R	R
8	IR79156A/ Kanakgopala	52.00	PR	47.02	PM	PR/PM
9	IR79156A/ Bagdidhan	80.97	R	75.29	R	R
10	IR79156A/ RIL-62	82.00	R	76.90	R	R
11	IR79156A/ Inger 2-114	17.00	PM	50.00	PM	PM
12	IR79156A/ Karmamahsuri	74.00	PR	64.70	PR	PR
13	IR79156A/ TOX-981-11-2-3	70.20	PR	64.02	PR	PR
14	IR79156A / Suraksha	76.80	PR	50.22	PR	PR
15	CRMS32A/ Kanakgopala	18.00	PM	10.50	PM	PM
16	CRMS32A/ Bagdidhan	81.55	R	76.10	R	R
17	CRMS32A/ RIL-62	81.05	R	76.09	R	R
18	CRMS32A/ Inger 2-114	15.00	PM	20.79	PM	PM
19	CRMS32A/ Karmamahsuri	82.08	R	77.63	R	R
20	CRMS32A/ TOX-981-11-2-3	86.00	R	76.46	R	R
21	CRMS32A/ Suraksha	68.00	PR	68.52	PR	PR

R- Restorers PR- Partial Restorers PM- Partial Maintainers M- Maintainers