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Identification of maintainers and restorers for CMS lines of rice

■ SAMRATH BEDI AND DEEPAK SHARMA[1]

AUTHORS' INFO

Associated Co-author :

[1]Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, RAIPUR (C.G.) INDIA
Email: deepakigkv@gmail.com

Author for correspondence:
SAMRATH BEDI
Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, RAIPUR (C.G.) INDIA
Email: esha0402@gmail.com

ABSTRACT : The availability of stable cytoplasmic male sterility and fertility restoring system is vital for commercial exploitation of heterosis in rice. The biological material used in the present study comprised of three CMS lines *viz.,* CRMS 31A, IR 58025A and IR79156A and five testers *viz.,* NPT 453-2, NDR 8054 (IR 77768-25-NDR-B-108-14), CR 2330-3-3-2-1-1, NPT 76-8 and PR-115. Parents NPT 76-8 and CR 2330-3-3-2-1-1 were identified as potential restores, whereas NPT 453-2, NPT 76-8, PR-115 and NDR 8054 (IR 77768-25-NDR-B-108-14) were identified as potential maintainers.

Key Words : CMS lines, Restorers, Maintainers, Rice

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Rice is one of the foremost cereal crops feeding over more than half of world's population. It is grown in more than a hundred countries with a total harvested area of about 156 million hectare, producing more than 680 million tonnes grain annually. About 90 per cent of the rice in the world is grown in Asia. Rice provides 27 per cent of dietary energy supply and 20 per cent of dietary protein intake in the developing world (Anonymous, 2010). To meet the demand of increasing population and to maintain self-sufficiency, the present production 100 million tonnes needs to be increased up to 120 million tonnes by the year 2020. This increase in production has to be achieved in the backdrop of declining and deteriorating resources such as land, water and other inputs and without adversely affecting the environment (Viraktamath, *et al.,* 2010). In order to increase production and productivity in this ecosystem, hybrid rice technology is the proven technology in china and a more practical one to raise production. In order to evolve hybrids that are superior in yield potential to the existing ones and adaptable in newer areas, one essential component of the requisite methodology is to identify newer potential restorer and maintainer lines from local material through systematic generation of new crosses and their proper evaluation. There upon converting them through recurrent backcrossing into new parents of commercial hybrids.

RESEARCH PROCEDURE

The present study entitled was conducted at the Research cum Instutional Farm and Laboratories of the Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *Rabi* season 2010-2011 and *Kharif* 2011. Raipur is situated in central part of Chhattisgarh and lies at latitude, longitude of 21°4' N, 81°35' E, respectively and 290.20 meters above mean sea level. The biological material used in the present study comprised of three CMS lines *viz.,* CRMS 31A, IR 58025A and IR79156A and five testers *viz.,* NPT 453-2, NDR 8054 (IR 77768-25-NDR-B-108-14), CR 2330-3-3-2-1-1, NPT 76-8 and PR-115. The crosses were attempted during *Rabi* 2010-11 with line x tester mating design. The evaluation of 15 F1's along with their parents and two checks were done at *Kharif* 2011 with two replications. The distance between row to row and plant to plant was 20 cm and 15 cm, respectively. A standard agronomic package practices was adopted. Transplanting of the material was done manually keeping single seedling per hill of 21 days old seedling. Five plants of each line from each replication was randomly selected for observations for the fifteen characters *viz.,* days to 50 per cent flowering, plant height (cm), number of productive tillers per plant, flag leaf length, flag leaf width, leaf area index, number of filled spikelets per panicle, number of sterile spikelets per panicle, spikelet fertility percentage, pollen fertility percentage, 1000 grain weight, grain yield per plant, harvest index, chlorophyll content.

Identification of restorers and maintainers are the integral part of every hybrid rice breeding programme. It induces the identification of sterility system and its maintenance and registration for commercial exploitation. Maintainers and restorers are identified on the basis of pollen fertility and spikelet fertility.

Pollen fertility recorded as microscopic pollen grain count. The florets were first preserved in 70 per cent alcohol. Later on, the pollen fertility counts were taken by using Iodine Potassium Iodide solution as stain. The stained pollen grains were counted as fertile unstained pollen grains were counted as unfertile and partial stained were counted as partial fertile. The total counts of fertile pollen grain were observed in relation to the total pollen grains in the five microscopic fields. The mean of five microscopic fields was then calculated. These mean values for fertile pollens and total pollens were used for calculating the pollen fertility percentage :

$$\text{Pollen fertility (\%)} = \frac{\text{No. of stained pollen grains}}{\text{Total no. of pollen grains}} \times 100$$

The panicle was threshed and sterile and fertile spikelets were counted. Spikelets fertility percentage was calculated as:

$$\text{Spikelet fertility (\%)} = \frac{\text{Number of fertile spikelets}}{\text{Total number of spikelets}} \times 100$$

As per the pollen fertility and spikelet fertility percentage in the hybrids, the testers that could produce 0-1 per cent pollen fertility and 0-0.1 per cent spikelet fertility classified as maintainers, 1.1-50 per cent pollen fertility and 0.1-75 per cent spikelet fertility classified as partial maintainers, 50.1-80 per cent pollen fertility and 50.1-75 per cent spikelet fertility classified as partial restorers and >80 per cent pollen fertility and >75 per cent spikelet fertility classified as potential restorers as per the classification is given by (Virmani *et al.,* 1997).

RESEARCH ANALYSIS AND REASONING

Identification of restorer and maintainer are the

Table 1 : Mean performance of hybrids for pollen and spikelet fertility

Characters	Pollen fertility	Spikelet fertility
25A*NPT 453-2	67.04	64.25
25A* NDR 8054 (IR 77768-25-NDR-B-108-14)	76.51	75.17
25A* CR 2330-3-3-2-1-1	73.85	70.68
25A*NPT 76-8	82.62	79.77
25A*PR-115	52.28	49.06
56A*NPT 453-2	9.39	7.36
56A* NDR 8054 (IR 77768-25-NDR-B-108-14)	50.51	41.30
56A* CR 2330-3-3-2-1-1	73.70	72.69
56A*NPT 76-8	87.60	84.25
56A*PR-115	6.64	6.49
31A*NPT 453-2	67.04	64.22
31A* NDR 8054 (IR 77768-25-NDR-B-108-14)	10.72	9.47
31A* CR 2330-3-3-2-1-1	53.01	73.65
31A*NPT 76-8	76.90	76.09
31A*PR-115	0.04	0.86

Table 2 : Identification of maintainers and restorers

CMS lines	Potential maintainers (0- 10 %)	Potential restorers (70-100 %)	Partial restorers (21-69 %)
IR-58025A		NPT 76-8, NDR 8054 (IR 77768-25-NDR-B-108-14), CR 2330-3-3-2-1-1	NPT 453-2,PR 115, NDR 8054 (IR 77768-25-NDR-B-108-14)
IR-79156A	NPT 453-2, PR-115	CR 2330-3-3-2-1-1, NPT 76-8	NDR 8054 (IR 77768-25-NDR-B-108-14)
CRMS-31A	PR-115, NDR 8054 (IR 77768-25-NDR-B-108-14)	NPT 76-8	NPT 453-2, CR 2330-3-3-2-1-1

prerequisite for three line breeding systems. The identification of new restorers and maintainers were essential for production of potentially high yielding and widely adopted hybrid rice by using diverse source of cytosterile lines from different origin. The maintainer lines which may be converted into CMS lines in future should have desirable characters like medium plant height, longer stigma and style, and higher stigma angle. The studies on pollen fertility and spikelet fertility percentage indicated that the hybrids *viz.*, CRMS 31A / PR-115 (0.04 and 0.86), IR 79156A / PR-115 (6.49-6.64), IR 79156A / NPT 453-2 (7.36-9.39), CRMS 31A / NDR 8054 (IR 77768-25-NDR-B-108-14) (9.47-10.72) exhibited lowest pollen and spikelet fertility (0-10%.) The pollen parents PR-115 and NDR 8054 (IR 77768-25-NDR-B-108-14) for line CRMS 31A and PR-115 and NPT 453-2 for line IR 79156A identified as maintainers with lowest pollen and spikelet fertility. These potential maintainers can be utilized for the development of new CMS line as recurrent parent in backcross programme. Similar findings have also been reported by Kumer *et al.* (1998), Gannamani (2001), Ram *et al.* (2006), Akhter *et al.* (2008), Ingale *et al.* (2008), Jayashudha and Sharma (2010) and Waghmode and Ingale (2011) (Table 1 and 2).

The practical use of cytoplasmic male sterility in developing hybrid varieties in grain crops is possible only when effective restorer lines are identified and or developed on practical and commercial scale. The CMS and restorer lines should possess high combining ability, morphological and floral characters suitable for high out crossing in seed production plots. The maintainers which may be converted into a CMS line in future should have desirable characters like medium plant height, more number of panicles and spikelets, longer stigma and style, and higher stigma angle. Similarly, a restorer should have medium-tall plant height, more number of panicles and spikelets, bigger anther and longer filament length (Virmani and Edwards, 1983). The frequency of usable CMS lines is very low since such lines should have good combining ability, higher out crossing potential, good grain quality and resistance to major pests and diseases besides being stable in male sterility. The frequency of potential restorers were higher as compared to maintainers for the line IR 58025A followed by IR 79156A and CRMS 31A based on pollen fertility per cent and spikelets fertility per cent. The hybrid showed pollen and spikelets fertility per cent between 20 to 69 per cent termed as partial restorers were NPT 453-2 (67.04-64.25), PR-115 (52.28-49.06) in combination with IR 58025A, CR 2330-3-3-2-1-1 (50.51-41.30) in combination with IR 79156A and pollen parents NPT 453-2 (67.04-64.22) and CR 2330-3-3-2-1-1 (53.01-73.65), respectively.

The potential restorers were identified on the basis of spikelet fertility and pollen fertility percentage. The parent NPT 76-8 (82.68-79.77), NDR 8054 (IR 77768-25-NDR-B-108-14) (76.51-75.17) and CR 2330-3-3-2-1-1 (73.85-70.68) in combination with IR 58025 A behaved as potential restorers. Pollen parent NPT 76-8 (87.60-84.25) and CR 2330-3-3-2-1-1 (73.70-72.69) in combination with line IR 79156A showed potential restorer. The parents NPT 76-8 (76.9-76.09) in combination with CRMS 31A showed high pollen and spikelet fertility (Table 1 and 2). The present findings are in accordance with the findings of Casal and Virmani (1998), Gannamani (2001); Sharma *et al.* (2004) Bisne and Motiramani (2005), Hariprasanna *et al.* (2005), Ram *et al.* (2006), Satyanarayana *et al.* (2006), Wang *et al.* (2009), Hossain *et al.* (2010), Jayashudha and Sharma (2010) and Waghmode *et al.* (2011).

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