

IDENTIFICATION OF RESTORERS AND MAINTAINERS IN RICE (*ORYZA SATIVA* L.)

S.K. Korram¹, D.K. Sharma² and R.R. Kanwer³

Abstract: Three cytoplasmic Genetic male sterile (CMS) Lines of rice having wild abortive (WA) cytoplasmic male sterility source were crossed with 36 entries to assess their maintainers and restorers obtained from 40 crosses.

The 40 hybrids were subjected to pollen and spikelet fertility analysis. Among the 40 hybrids 3 were expressed as restorer, 4 were partial restorer for CMS line CRMS 31A, 9 male line regarded as restorer and 19 male line regarded as partial restorer for the CMS line CRMS 32A. The 2 male line were restorer for CMS line DRR 3A. The only one parent R1130-100-1-88-1 was observed as maintainer for CMS line DRR 3A. Two partial maintainers viz., RF- 59 and IR 73459-120-2-2-3 were observed for CMS line CRMS 32A.

Keywords: CMS lines, Restorers, Maintainers, Rice

INTRODUCTION

The heterosis breeding programme using cytoplasmic male sterility (CMS) system, identification of maintainers and restorers is fundamental. Restorers for different cytoplasmic sterile sources will increase the cytoplasmic diversification, which in turn can prevent genetic vulnerability due to the use of single CMS source (Pradhan *et al.*, 1992).

The establishment of testcross nursery to identify restorers and maintainers is the first step in three line heterosis breeding.

Mc William *et al.*, (1995) found higher frequency of restorers (21%) than that of the maintainers (11%) from the evaluation of the 6000 testcrosses in India.

The CMS lines introduced from China are unstable to use as such in developing hybrid rice in India. Therefore it is imperative to identify restorers and maintainers, among the lines developed through conventional breeding procedures. Pollen & spikelet fertility or both have been used as an index to fix the restoration ability of the lines (Sutaryo, 1989). The present study was undertaken to find out the identify restorers & maintainers in rice (*Oryza sativa* L.).

MATERIAL AND METHOD

Three CMS lines viz., CRMS 31A, CRMS 32A, DRR 3A and 36 male genotype viz., R975, IR71606-1-1-4-2-3-1-2, IR1470-351-137-1-1, IR77958-7-4-3, SWARNA,

NSICRC112, RF-59, IR 71604-4-1-4-7-10-2-1-3, Ratna, R1033-103-1-1, PSBRC 88, R1513-806-420-1-1, MADHURI-11, NDR 8015, RF-6, R12501, R975-897-1-1, R 1262-1667-1-1, R 1182-167-2-1-57-7, Samund Chini, R 1055, PNR 590-12-10, Mahamaya, R 1249-1499-2-834-1, B 6144F-MR-6-0-0*, SWARNA, Sambha Mashasuri, RF-59, OR 1898-2-34, IR 72969-143-5-3-6-2, IR 68830-NDR-1-1, R 1216-6, R 1473-521-249-1-1, OR 1920-7, IR 73459-120-2-2-3, IR 75299-94-1-2-2, R 1130-100-1-88-1, SWARNA and Sambha Mahasuri were raised in three different dates during kharif 2006 at the

research Farm, department of plant breeding and Genetics, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.).

Crossing was done by adopting clipping method. In the CGMS lines individual plants with complete pollen sterility was identified by observing the pollen grains under the microscope using one percent Iodine Potassium Iodide stain.

For this purpose 15-20 spikelets from the just emerged panicles of 3 randomly selected plants were collected in a vial containing 70% ethanol. Anthers from at least 6 spikelets were taken out with the help of forceps and placed on a glass slide with a drop of 1% Iodine Potassium Iodide (IKI) stain. The anthers were gently crushed by using a needle to release the pollen grains. After removing the debris a cover slip was placed and the slide was observed under the microscope (Virmani *et al.* 1997).

The spikelets were clipped off one third from the top without damaging the stigma, between 7.00 and 9.30 a.m. after clipping, the panicles were covered with butter paper covers. At the time of anthesis, panicles with fully opened spikelets, were collected from the male parents and the pollen grains were dusted over the clipped panicles between 10:30 and 11:30 a.m. crosses were effected between female and male parent genotypes and a total of 40 cross combinations were obtained. After 25 days the matured panicles were harvested. The F₁ generations of all the crosses were raised during kharif 2007 in a test cross nursery. Each entry was planted with spacing of (15 X 20) cm. with two replications. Identification of restorers and maintainers was carried out by observing pollen and spikelet fertility under bagged condition. For spikelet fertility, 5 panicles of each test cross were covered with butter paper bags to avoid foreign pollen contamination and mature panicles were evaluated. The criteria for classifying the parental lines as restorers and maintainers were used as proposed by Virmani *et al.* (1997). Restorer were identified as > 70 percent pollen / spikelet fertility, partial restorer 21 – 69 percent, maintainer < 10 percent and partial

¹ P.G. Scholar, Deptt. of Genetics and Plant Breeding, College of Agriculture, IGKV, Raipur (C.G.).

² Senior Scientist, Deptt. of Genetics and Plant Breeding, College of Agriculture, IGKV, Raipur (C.G.).

³ Technical Assistant, R.M.D. College of Ag. & Res. Station, Ambikapur, (C.G.).

maintainer 10 – 20 percent.

RESULT AND DISCUSSION

From 40 testcross hybrids, 14 Restorers, 23 partial restorer, 1 maintainer (R1130 – 100 – 1 – 88 – 1) and two partial maintainer were obtained. The frequency of restorers was 35%, partial restorers (57.5%) , maintainer 2.5% and partial maintainer were 5% respectively. The classification of restorers and maintainers are given in table 1 and 2 on the basis of pollen and spikelet fertility percentage. In some cases the same genotype behaved as a restorer for one CMS line and as maintainer for the other CMS line. Male genotype swarna is restorer for CRMS 31A and partial restorer for CRMS 32A. Sambha Mahasuri and swarna is restorer for DRR 3A and partial restorer for the CRMS 32A (CMS) line. The male genotype RF – 59 was partial maintainer for CRMS 32A and partial restorer for CRMS 31A.

The variation 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 kind of the differential reaction of

the same genotype in restoring the fertility of different CMS lines of same cytoplasmic source was reported by Gannamani (2001), Sao (2002), Hariprasanna et al. (2005) and Murugan and Ganesan (2006). This could be due to differential nuclear cytoplasmic interactions between the male genotype and CMS lines.

Based on the study of pollen fertility and spikelet fertility percentages only one parent (R 1130 – 100 – 1 – 88 – 1) was observed as maintainer for CMS line DRR 3A as its pollen fertility and spikelet fertility percentages were in the order 9.91 and 3.85 percents respectively. The partial maintainers, (RF – 59 and IR 73459 – 120 – 2 – 2 – 3) were observed for the CMS line CRMS 32A, whose pollen fertility and spikelet fertility percentage was in the order 29.02%, 17.07%, 28.19% and 15.98% . The various studies in this aspect were previously carried out by Sharma and Mani (1989), Mandal et al. (1990), Prasad et al. (1992), Rosamma et al. (2005) and Jayaramaiah et al. (2007).

The maintainers (IR 1130 – 100 – 1 – 88 – 1) can be used in the back cross programme to develop new CMS line.

Table 1 – Rice (*Oryza sativa L.*) genotypes identified as restorers and maintainers based on pollen and spikelet fertility of various cross combination.

Crosses	Pollen fertility (%)	Spikelet fertility (%)	*Inference
CRMS 31AX R975	70.14	61.31	PR
CRMS 31AX IR71606-1-1-4-2-3-1-2	70.22	64.21	PR
CRMS 31A X R1470-351-137-1-1	89.17	86.44	R
CRMS 31A X IR 77958-7-4-3	72.78	64.96	PR
CRMS 31A X SWARNA	81.88	71.65	R
CRMS 31A X NSICRC 112	87.18	82.99	R
CRMS 31A X RF-59	71.46	58.92	PR
CRMS 32A X IR 71604-4-1-4-7-10-2-1-3	74.12	67.46	PR
CRMS 32A X RATNA	73.17	70.73	R
CRMS 32A X R1033-103-1-1	70.68	67.98	PR
CRMS 32A X PSBRC 88	45.05	37.02	PR
CRMS 32A X R1533-806-420-1-1	68.06	57.5	PR
CRMS 32A X MADHURI-11	87.13	79.49	R
CRMS 32A X NDR 8015	65.04	57.38	PR
CRMS 32A X RF-155	90.65	87.2	R
CRMS 32A X RF- 6	61.37	52.54	PR
CRMS 32A X R1250	80.56	58.04	PR
CRMS 32A X R 975 -897-1-1	67.61	45.12	PR
CRMS 32A X R 1262 -1667-1-1	79.07	77.56	R
CRMS 32A X R1182-167-2-1-57-7	62.88	49.6	PR
CRMS 32A X SAMUND CHINI	86.93	83.86	R

CRMS 32A X R1055	57.24	49.23	PR
CRMS 32A X PNR 590-12-10	39.68	29.35	PR
CRMS 32A X MAHAMAYA	68.44	63.82	PR
CRMS 32A X R1249-1499-2-834-1	35.24	24.73	PR
CRMS 32A X B6144F-MR-6-0-0*	40.46	28.79	PR
CRMS 32A X SWARANA	71.66	61.44	PR
CRMS 32A X SAMBHA MAHASURI	56.89	45.41	PR
CRMS 32A X RF - 59	29.02	17.07	PM
CRMS 32A X OR 1898-2-34	86.33	78.6	R
CRMS 32A X IR 72969-143-5-3-6-2	35.29	28.67	PR
CRMS 32A X IR 68830-NDR-1-1	76.93	70.71	R
CRMS 32A X R1216-6	78.87	73.96	R
CRMS 32A X R1473-521-249-1-1	89.76	86.01	R
CRMS 32A X OR 1920-7	61.31	55.19	PR
CRMS 32A X IR 73459-120-2-2-3	28.19	15.98	PM
CRMS 32A X IR 75299-94-1-2-2	47.31	37.99	PR
DRR 3A X 1130 - 100-1-88-1	9.91	3.85	M
DRR 3A X SWARNA	76.65	71.75	R
DRR 3A X SAMBHA MAHASURI	87.18	76.31	R

PM = Parital Maintainer, M = Maintainer, PR = Partial Restorer, R = Restorer

Table 2: Identification of Restorers, Partial Restorer, Maintainers, Partial Maintainer for three CMS lines

CMS lines	Restorers	Partial Restorer	Maintainers	Partial Maintainers
CRMS 31A	R1470-351-137-1-1, NSICRC 112, SWARNA, NSICRC 112	R975, IR71606-1-1-4-2-3-1-2, IR 77958-7-4-3, RF-59,	&	&
CRMS 32A	RATNA, MADHURI-11, RF-155, R 1262 - 1667-1-1, SAMUND CHINI, OR 1898-2-34, IR 68830-NDR-1-1, R1216-6, R1473-521-249-1-1	IR 71604-4-1-4-7-10-2-1-3, R1033-103-1-1, PSBRC 88, R1533-806-420-1-1, NDR 8015, RF- 6, R1250, R 975 -897-1-1, R1182-167-2-1-57-7, R1055, PNR 590-12-10, MAHAMAYA, R1249-1499-2-834-1, B6144F-MR-6-0-0*, SWARANA, Sambha Mahasuri, IR 72969-143-5-3-6-2, OR 1920-7, IR 75299-94-1-2-2	&	RF - 59 and IR 73459-120-2-2-3
DRR 3A	Swarna and Sambha Mahasuri	&	R1130 - 100-1-88-1	&

REFERENCES

- Gannamani, N.** (2001). Study of heterosis and combining ability by utilizing cytoplasmic genetic male sterility and fertility restoration system in rice. M.Sc. (Ag.) thesis, Indra Gandhi Agricultural University, Raipur, India.
- Hariprasanna, K., Zaman, F.U. and Singh, A.K.** (2005). Identification of versatile fertility restorer genotypes for diverse CMS lines of rice. *Oryza*, **42** : 20 – 26.
- Jayaramaiah, K., Zaman, F.U. and Singh, S.K.** (2007). Identification of versatile fertility restorer genotypes for different CMS lines of rice (*Oryza sativa L.*) *Oryza*, **41**(1) : 2 – 6.
- Mandal, R.K., Saran, S. and Sahai, V.N.** (1990). Fertility restoration in a male sterile line in rice. *Oryza*, **27**: 319-321.
- Mcwilliam, J.R., H. Ikehashi and Sinha S.K.** (1995). Progress in hybrid rice in India. *Intl. Rice Comm. Newsletter*, **44** : 80 – 86.
- Murugan, S. and Ganesan, J.** (2006). Pollen and spikelet fertility analysis in rice crosses involving WA cytoosteriles. *Int. J. agric. Sci.*, **2** : 315 – 316.
- Pradhan, S.B., Ratho, S.N. and Jachuck, P.J.** (1992). Restorers and maintainers for five CMS lines. *Int. Rice Res. Newsl.*, **17** (5): 8.
- Prasad, M.N., Thiyagarajan, K., Jayamani, P. and Rangasamy, M.** (1992). Isolation of maintainers and restorers for CMS lines in Rice. *Int. Rice Res. Notes*, **18**:10.
- Rosamma, C.A. and Vijayakumar, N.K.** (2005). Maintainers and restorers for CMS lines of rice. *Journal of Tropical Agriculture*. **43**(1/2): 75-77.
- Sao, A.** (2002). Studies on combining ability and heterosis in F₁ rice hybrids using cytoplasmic male sterile lines. M.Sc. (Ag.) thesis, Indira Gandhi Agricultural University, Raipur, India.
- Sharma, J.P. and Mani, S.C.** (1989). A medium duration high yielding scented hybrid rice. *Int. Rice. Res. News.*, **14**:7.
- Sutaryo, B.** (1989). Evaluation of some F₁ rice hybrids developed using MB 365 A as CMS line. *Int. Rice. Res. Newsl.*, **14** : 7 – 8.
- Virmani, S. S., Viraktamath, B. C., Casal, C. L., Toledo, R. S., Lopez, M. T. and Manalo, J. O.** (1997). Hybrid rice breeding manual. International rice Research Institute, Philippines.