Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5550

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (4):** 1333-1336 (2017)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Identification of Best Restorers and Maintainers in Rice Genotypes Suitable for Aerobic Cultivation with a CMS line (*Oryza sativa* L.)

P. Madhukar[1*], CH. Surender Raju[2], P. Senguttuvel[3] and S. Narender Reddy[4]

[1]Department of Genetics and Plant Breeding, College of Agriculture, PJTSAU, Hyd-30

[2]Rice Research Station, Agriculture Research Institute, PJTSAU, Rajendranagar, Hyd

[3]Crop Improvement Section, ICAR-Indian Institute of Rice Research, Rajendranagar, Hyd-30

[4]Department of Crop Physiology, College of Agriculture, PJTSAU, Rajendranagar, Hyd-30

*Corresponding Author E-mail: madhu0743@gmail.com

Received: 2.08.2017 | Revised: 10.08.2017 | Accepted: 12.08.2017

ABSTRACT

Hybrid rice systems are based on three line cytoplasmic male sterility (CMS) which has been an efficient tool in commercialization of hybrid rice technology. Therefore, identification of potential restorers in rice is the basic step in development of rice hybrids. In present study, 50 drought tolerant lines were crossed to one cytoplasmic male sterile line i.e. CMS59A F_1s were analyzed for pollen fertility (1% I-KI solution) and spikelet fertility. Based on the fertility restoration in F_1s, 15 genotypes were restorers, 25 partial restorers and 10 partial maintainers were obtained. Among the 50 lines, SVHR-3005, NH12-103R, KMP-128, RNR-21280, KMP-175, SV-315-081R, MTU-1075 and MTU-1001 are considered as promising restorers.

Key words: *Hybrid rice, Restorers, Maintainers, Pollen Sterility, Spikelet Fertility.*

INTRODUCTION

In India rice is the most important staple food crop of more than two third of the population. The slogan 'Rice is life' is the most appropriate for india, as this crop plays a livelihood for millions of rural households. The human population is increasing alarmingly year after year and to fulfil the hungry stomach, demand for rice is increasing in developing and developed countries. To meet the increasing demand for rice, several measures have to be envisaged. On the other hand, there is reduction in the availability of land, labour and water every year. Therefore, rapid increase in production and productivity of rice is the need of hour as per the growing population. So, different strategies are to be worked out in order to bridge the gap between demand and supply. One such strategy would be the improvement of high yielding genotypes through hybridization. Hybrid rice is the best practically feasible and readily acceptable options available to increase the production.

Cite this article: Madhukar, P., Raju, CH. S., Senguttuvel, P. and Reddy, S.N., Identification of Best Restorers and Maintainers in Rice Genotypes Suitable for Aerobic Cultivation with a CMS line (*Oryza sativa* L.), *Int. J. Pure App. Biosci.* **5(4):** 1333-1336 (2017). doi: http://dx.doi.org/10.18782/2320-7051.5550

For the development of viable, adoptable rice hybrids through utilization of cytoplasmic genetic male sterility, the processes of identification of maintainers and restorers involving local elite lines has become inevitable. In order to sustain rice cultivation and to increase the productivity in the country we need to use this technology successfully and exploit the heterosis through development and use of genetically divergent parental lines[5] from time to time. Successful development of rice hybrids by utilizing the cytoplasmic genetic male sterility and fertility restoration system mainly depends on the availability of stable male sterile lines. The choice of suitable parents with favourable alleles, which on crossing could produce heterotic hybrids, is very important.

MATERIAL AND METHODS

The 50 hybrids (50 testers with one CMS59A) developed during *Kharif* 2015 were transplanted with a spacing of 20 x 15 cm during *rabi*, 2015-16 at Rice Research Centre, Rajendranagar, Hyderabad to study the restorer / maintainer reaction. The following criteria for classifying the pollen parents were used as proposed by Virmani[6].

Procedure for phenotypic analysis

At days to 50% flowering, the 5-8 spikelet's were randomly collected from indehiscence anthers of a panicle to study the spikelet fertility percentage and to prevent out crossing two panicles per plant were bagged with butter paper bag and pinned the bag to leaf sheath.

Pollen fertility percentage:

Pollen fertility study was done using anthers collected from spikelets at 1 to 2 days before anthesis. The anthers from each spikelets were smeared in a drop of 1% Iodine-potassium iodide (I-KI) solution[6] on a glass slide and fertile and sterile pollens were counted in the three randomly selected microscopic fields. Stained, well filled and round pollen grains were counted as fertile, while unstained, shrivelled and empty pollen grains were considered as sterile. Pollen fertility was calculated and expressed in percentage as given below:

$$\textbf{Pollen fertility (\%)} = \frac{\text{Number of stained pollen grains}}{\text{Total number of pollen grains}} \times 100$$

Spikelet fertility

The panicles that emerged from the primary tiller were bagged before anthesis to avoid out crossing and the number of filled grains and chaffs in the panicle were counted at the time of maturity. The ratio of filled grains to the total number of spikelets was expressed as spikelet fertility percentage as given below:

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

Methodology for pollen fertility studies

Category	Pollen fertility (%)	Spikelet fertility (%)
Maintainers	0-1	0
Partial maintainers	1.1-50	0.1-50
Partial restorers	50.1-80	50.1-75
Restorers	>80	>75

RESULTS AND DISCUSSION

A total of 50 crosses developed from one CMS line with WA source CMS59A in normal *kharif*, 2015 and 50 male lines were evaluated for fertility restorer reaction during *Rabi 2015-16*. The performance exhibited by the hybrids in test cross nursery for fertility restoration is presented in Table 1.

Spikelet fertility: A high range of spikelet fertility was recorded among the hybrids *i.e.*, from 30.35 to 90.77 per cent which indicated that restorability varies depending on male parent. Among the 50 crosses studied, 15 crosses exhibited high spikelet fertility (>75%), 25 crosses exhibited partial fertility (50 to 75 %), whereas, 10 crosses resulted from partial maintainers (1 to 50 %). No crosses had complete sterility (0 %). Also reported[3] that fertility restoration reaction of the genotypes varies with genetic background of CMS lines.

Pollen fertility: Pollen fertility is one of the important traits in three line heterosis breeding especially at test cross nursery stage which is a first step. Higher temperatures reduce the pollen fertility which in turn affects the spikelet fertility[4]. Pollen fertility is a genetically controlled trait and is less influenced by environment. However spikelet fertility is influenced by environmental factors like nutrition, abiotic stress like drought, salinity and extreme temperature[1]. CMS lines derived from the WA cytoplasm were found to be most stable in terms of pollen sterility[2]. Highest pollen fertility was observed in genotypes, SV-315-081R (91.5%), RNR-21280 (89.5%), MTU-1001 (88.4%) and KMP-128 (86.3%).

Table: 1: Fertility restoration study for identification of restorers and maintainers among the 50 lines test crossed with CMS-59A

S.No	Crosses	Days to 50% Flowering	Pollen fertility (%)	Unfilled grains/ panicle	Filled grains/ panicle	Spikelet fertility (%)	Fertility reaction
1	CMS 59A X SVHR-3005	94.00	80.90	20.25	199.23	90.77	R
2	CMS 59A X NH12-103R	92.00	82.60	19.12	148.69	88.61	R
3	CMS 59A X KMP-128	86.00	86.30	22.00	166.66	88.34	R
4	CMS 59A X MTU-1001	94.00	88.40	21.53	150.66	87.50	R
5	CMS 59A X KMP-175	93.00	83.90	24.66	168.66	87.24	R
6	CMS 59A X SU-315-081R	82.00	91.50	20.86	147.00	87.57	R
7	CMS 59A X RNR-21280	87.00	89.50	20.66	162.66	88.73	R
8	CMS 59A X MTU-1075	83.00	84.90	20.46	141.53	87.37	R
9	CMS 59A X CSR-27	82.00	80.70	30.28	145.92	82.81	R
10	CMS 59A X RNR-17445	88.00	83.90	34.64	166.07	82.74	R
11	CMS 59A X RP4978-60-3-2-2	98.00	82.50	39.33	180.66	82.12	R
12	CMS 59A X RTN605-111-1-2	97.00	87.90	32.00	141.33	81.54	R
13	CMS 59A X AAGP9772	93.00	84.00	36.66	123.33	77.09	R
14	CMS 59A X RNR-20824	93.00	83.70	52.53	170.00	76.39	R
15	CMS 59A X RNR20747	79.00	85.20	32.33	97.33	75.07	R
16	CMS 59A X IET-24342	100.00	79.60	57.30	168.70	74.65	PR
17	CMS 59A XRNR- 20743	108.00	82.00	52.50	146.00	73.55	PR
18	CMS 59A X RNR-21271	106.00	71.90	54.40	144.00	72.58	PR
19	CMS 59A X SKAU-389	94.00	76.40	55.00	131.25	70.47	PR
20	CMS 59A X IET-24356	86.00	83.40	54.80	133.80	70.94	PR
21	CMS 59A X RNR-21042	91.00	68.20	73.33	175.00	70.47	PR
22	CMS 59A X RNR-21268	105.00	61.80	80.40	183.50	69.53	PR
23	CMS 59A X IET-24151	99.00	56.30	66.56	149.37	69.18	PR
24	CMS 59A X RNR-20719	92.00	73.50	35.13	79.86	69.45	PR
25	CMS 59A X NP-9807	87.00	55.00	54.40	117.33	68.32	PR
26	CMS 59A X RNR-19405	91.00	64.80	58.26	110.00	65.38	PR
27	CMS 59A X RNR-21304	98.00	59.40	75.80	141.20	65.07	PR
28	CMS 59A X IIRON-57	101.00	50.20	68.78	121.65	63.88	PR
29	CMS 59A X RNR-21252	96.00	65.30	69.92	120.78	63.34	PR
30	CMS 59A X RNR-21225	95.00	74.30	73.00	100.00	57.80	PR
31	CMS 59A X Bhadrakhali	86.00	59.60	61.73	73.93	54.50	PR
32	CMS 59A X L2-182	99.00	52.00	76.00	86.66	53.28	PR
33	CMS 59A X RNR-20710	86.00	55.60	53.43	60.12	52.95	PR
34	CMS 59A X GSR-22	104.00	59.60	95.26	99.44	51.07	PR
35	CMS 59A X IER-24342	84.00	53.60	107.33	108.33	50.23	PR
36	CMS 59A X GSR-2	100.00	52.60	107.33	108.33	50.23	PR
37	CMS 59A X ABU-10-82R	99.00	48.60	85.00	85.66	50.19	PR
38	CMS 59A X RNR-19411	92.00	56.90	99.53	99.66	50.03	PR

Table: 1. Continue…….

S.No	Crosses	Days to 50% Flowering	Pollen fertility (%)	Unfilled grains/ panicle	Filled grains/ panicle	Spikelet fertility (%)	Fertility reaction
39	CMS 59A X R 1641-914-1-400-1	99.00	53.60	90.45	90.50	50.01	PR
40	CMS 59A X RNR-19397	95.00	50.50	103.60	103.66	50.01	PR
41	CMS 59A X L-493	95.00	56.20	119.33	110.00	47.97	PM
42	CMS 59A X Surekha	86.00	38.60	81.60	74.06	47.58	PM
43	CMS 59A X CRR484-2-1-1-1-1	93.00	23.40	92.66	81.33	46.74	PM
44	CMS 59A X Vandana	86.00	64.80	95.56	77.18	44.68	PM
45	CMS 59A X RNR-20595	91.00	25.50	95.56	77.18	44.68	PM
46	CMS 59A X NDR3308	95.00	35.30	100.02	79.68	44.34	PM
47	CMS 59A X RNR-20110	94.00	42.50	102.69	55.76	35.19	PM
48	CMS 59A X SG-26-120	98.00	37.50	96.50	47.90	33.17	PM
49	CMS 59A X HKR10-34	96.00	35.60	181.30	78.60	30.24	PM
50	CMS 59A X RNR-21245	92.00	38.50	132.13	57.58	30.35	PM

R – Restorer,**PR**-Partial Restorer, **PM**-Partial Maintainer, **M**-Maintainer

CONCLUSION

Among the 50 genotypes studied, 8 best lines with more than 85 per cent pollen and spikelet fertility restorability (SVHR-3005, NH12-103R, KMP-128, MTU-1001, KMP-175, SU-315-081R, RNR-21280 and MTU-1075) were selected for further study.

REFERENCES

1. Babu, N.N., Shivakumar, N and Hittalmani, S. Pollen fertility Vs spikelet fertility in F_2 of a CMS based hybrid in rice under aerobic condition. *Electronic J.Plant Breed.*, **1 (2):** 789-793 (2010).
2. Brar, D.S., Zhu, Y.G., Ahmed, M.I. Jachuk, P.J and Virmani, S.S. Diversifying the CMS system to improve the sustainability of hybrid rice technology. Proceedings of the 3rd International Symposium on Hybrid Rice, November 14-16, 1996, Hyderabad, india, pp129-146 (1998).
3. Pankaj Kumar, Vinay Kumar Sharma and Bishun Deo Prasad. Characterization of maintainer and restorer lines for wild abortive cytoplasmic male sterility in indica rice (*Oryza sativa* L.) using pollen fertility and microsatellite (SSR) markers. *Australian Journal of Crop Science.* **9(5):** 384-393 (2015).
4. Tsutomu, M., Kenji, O and Takeshi, H. High temperature induced spikelet fertility of Japonica rice at flowering in relation to air temperature, humidity and wind velocity conditions. *Jap. J. Crop Sci.*, **66(1):** 449-455 (1997).
5. Viraktamath, B.C., Ilyas Ahmed, M and Ramesha, M.S. Current status and future prospects of hybrid rice in India. *Journal of Rice Research*. **1(1):** 52-60 (2006).
6. Virmani, S.S, Viraktamath, B.C., Casal, C.L., Toledo, R.S., Lopez, M.T and Manalo,J.O. Hybrid rice breeding manual. International Rice Research Institute, Phillipines,ISBN: 9789712201035, Page:151 (1997).