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RESEARCH ARTICLE :

Identification of best restorers and maintainers in rice genotypes through test cross nursery

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SUMMARY : 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, 39 lines were crossed to one cytoplasmic male sterile line *i.e.* IR-79156A, F_1s were analyzed for pollen fertility (1% I-KI solution) and spikelet fertility. Based on the fertility restoration in F_1s, 32 genotypes were restorers and 7 partial restorers were obtained. Among the 39 lines, AR-7-75, TCP-650, AR-19-18, TCP-657, AR-19-42, TCP-661, AR-9-21, TCP-585, AR-7-65 and TCP-643are considered as promising restorers.

KEY WORDS :
Hybrid rice,
Restorers,
Maintainers,
Pollen sterility,
Spikelet fertility

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BACKGROUND AND OBJECTIVES

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. 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

(Viraktamath *et al.*,2006) 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.

RESOURCES AND METHODS

The 39 hybrids (39 testers with one IR79156A) developed during *Kharif* 2014-15were transplanted with a spacing of 20 x 15 cm during *Rabi*, 2014-15at IIRR, Rajendranagar, Hyderabad to study the restorer / maintainer reaction. The following criteria for classifying the pollen parents were used as proposed by (Virmani *et al.*, 1997).

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 (Virmani *et al.*, 1997) 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:

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

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:

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

Table A : 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

OBSERVATIONS AND ANALYSIS

A total of 39 crosses developed from one CMS linewith WA source IR79156A in normal *Kharif*, 2014 and 39 male lines were evaluated for fertility restorer reaction during *Rabi* 2014-15. 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 63.5 to 92.4 per cent which indicated that restorability varies depending on male parent. Among the 39 test crosses studied, 32 genotypes exhibited high spikelet fertility (>75%), seven genotypes found to be partial fertile (50 to 75 %) (Table 1). Das *et al*. (2013); Ali *et al*. (2014); Kumar *et al*. (2015); Parimala *et al*. (2016) and Ramesh *et al*. (2016) also reported 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 (Tsutomu *et al.*, 1997). 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 (Babu *et al.*, 2010). CMS lines derived from the WA cytoplasm were found to be most stable in terms of pollen sterility (Brar *et al.*,1998). Highest pollen fertility was observed in genotypes, TCP-657 (92.8%), AR-6-75 (94.2%), RPHR-255 (90.0%) and AJAY (90.0%).

Conclusion:

Among the 32 restorers, 10 best lines with more than 85 per cent fertility restorability (AR-7-75, TCP-

Table 1 : Effective restorers identified among the 42 lines test crossed with IR-79156A

Sr. No.	Crosses	Pollen fertility (%)	Unfilled grains / panicle	Filled grains / panicle	Total grains/ panicle	Spikelet fertility (%)	Fertility reaction
1.	IR-79156A x AR-7-75	89.5	19.7	239.4	259.1	92.4	R
2.	IR-79156A x TCP-650	85.0	19.5	235.4	254.9	92.3	R
3.	IR-79156A x AR-19-18	82.6	19.8	221.5	241.3	91.8	R
4.	IR-79156A x TCP-657	92.8	23.5	258.3	281.8	91.7	R
5.	IR-79156A x AR-19-42	86.0	18.6	183.3	201.9	90.8	R
6.	IR-79156A x TCP-661	84.3	19.1	184.7	203.8	90.6	R
7.	IR-79156A x AR-9-21	80.7	22.5	209.0	231.5	90.3	R
8.	IR-79156A x TCP-585	87.5	19.7	175.6	195.3	89.9	R
9.	IR-79156A x AR-6-75	94.2	21.0	189.7	210.7	90.0	R
10.	IR-79156A x TCP-643	86.1	23.3	195.4	218.7	89.3	R
11.	IR-79156A x NH-12-114	82.5	18.0	142.3	160.3	88.8	R
12.	IR-79156A x NH-12-103	86.3	28.6	216.4	245.0	88.3	R
13.	IR-79156A x BK-49-43	88.4	31.2	219.2	250.4	87.5	R
14.	IR-79156A x RPHR-255	90.0	28.6	198.4	227.0	87.4	R
15.	IR-79156A x GQ-70	80.9	29.5	201.6	231.1	87.2	R
16.	IR-79156A x RPHR-518	91.5	36.5	245.7	282.2	87.1	R
17.	IR-79156A x GQ-86	84.9	36.1	238.4	274.5	86.8	R
18.	IR-79156A x AJAY	90.5	29.7	184.8	214.5	86.2	R
19.	IR-79156A x RPHR-124	83.7	32.6	198.5	231.1	85.9	R
20.	IR-79156A x IB2-517	86.0	35.6	208.2	243.8	85.4	R
21.	IR-79156A x SG-26-120	87.9	36.7	215.0	251.7	85.4	R
22.	IR-79156A x SG-17-118-3	93.5	36.5	204.9	241.4	84.9	R
23.	IR-79156A x NRL-3158	86.7	42.5	254.9	297.4	85.7	R
24.	IR-79156A x SG-27-72	90.0	26.7	136.4	163.1	83.6	R
25.	IR-79156A x SG-22-289-3	92.5	23.7	118.0	141.7	83.3	R
26.	IR-79156A x TCP-432	83.9	34.6	166.0	200.7	82.7	R
27.	IR-79156A x TCP-3005	82.5	39.3	180.6	219.9	82.1	R
28.	IR-79156A x SG-27-31	87.9	32.0	141.3	173.3	81.5	R
29.	IR-79156A x SG-27-105	87.9	32.0	141.3	173.3	81.5	R
30.	IR-79156A x SG-27-175	84.0	36.6	123.3	159.9	77.0	R
31.	IR-79156A x TCP-3005	83.7	52.5	170.0	222.5	76.3	R
32.	IR-79156A x RPHR-517	81.2	48.5	152.2	200.7	75.8	R
33.	IR-79156A x GQ-25	82.0	62.8	175.9	238.7	73.7	PR
34.	IR-79156A x 363-5	62.5	64.5	179.8	244.3	73.6	PR
35.	IR-79156A x SG-27-177	68.2	53.4	145.0	198.4	73.1	PR
36.	IR-79156A x TCP-10274	83.4	29.7	78.7	108.4	72.6	PR
37.	IR-79156A x GQ-54	50.0	53.7	132.7	186.4	71.2	PR
38.	IR-79156A x NDR-3026	56.3	110.6	224.6	335.2	67.0	PR
39.	IR-79156A x L2-182	56.0	115.2	200.5	315.7	63.5	PR

R=Restorer, PR=Partial restorer

650, AR-19-18, TCP-657, AR-19-42, TCP-661, AR-9-21, TCP-585, AR-7-65, and TCP-643) were selected. In addition to spikelet fertility the characters like pollen fertility (%) and number of filled grains per panicle were taken into consideration while selection of restorers.

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