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Short Communication

Evaluation of rice genotypes for fertility restoration against WA and *Oryza perennis* cytoplasm based cytoplasmic male sterility

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Abstract

Five cytoplasmic male sterile (CMS) lines with Wild Abortive (WA) CMS source and one CMS line having *Oryza perennis* cytoplasm were crossed with 20 rice genotypes to assess their restorer/maintainer behaviour. All the 20 F_1s with IR 66707A line having *O. perennis* cytoplasm produced only sterile hybrids. Most of the genotypes expressed differential fertility reactions when crossed with CMS lines having WA cytoplasm. The genotypes, IR 10198-66-2R, IR 65515-47-2-1-19, TNAU 94241 and TNAU 841434 were identified as effective restorers while ADT 43, ASD 19, CB 97083 and CO (R) 47 produced completely sterile hybrids with CMS lines carrying WA cytoplasm. Ten best heterotic combinations were identified based on economic traits.

Key words: CMS line, maintainer, restorer, WA cytoplasm, *O. perennis*

Rice is the most important cereal food crop of India. Rice production in India has increased during the last 62 years by nearly 5 times from 20.58 million tonnes in 1950 to nearly 103.41 million tonnes during 2011-12 from 30.81 million ha and 44.41 million ha, respectively [1]. Plateauing of rice yields, coupled with restrictions on area expansion and the need to increase paddy yields by at least 3 million tonnes each year to maintain self-sufficiency in rice production are the major challenges for Indian rice breeders. Hybrid rice technology may be one of the approaches for breaking the yield plateau [2]. For the CMS-WA system hundreds of effective stable restorer lines have been identified among cultivated rice cultivars and elite breeding lines. Identification of maintainers and restorers from rice cultivars and elite breeding lines is desirable to breed new promising hybrids. Hence, the present investigation was formulated with the objective to evaluate 20 rice genotypes for their fertility restoration/maintenance behaviour with Cytoplasmic Male Sterile (CMS) lines of Wild Abortive (WA) and *Oryza perennis* based cytoplasm.

Five CMS lines *viz*., IR 58025A, IR 68888A, IR 69616A, IR 70364A and IR 70370A with WA cytoplasm source and one CMS line (IR 66707A) having *O. perennis* cytoplasm were crossed with 20 high yielding genotypes namely, ADT 43, ASD 18, ASD 19, C 20, C 37, CB 95066, CB 97083, CO (R) 47, IR 50, IR 64, IR 10198-66-2R, IR 40750-82-2, IR 65515-47-2-1-19, MRST 9, Paiyur 1, TNAU 80030, TNAU 94241, TNAU 94301, TNAU 841434 and Improved White Ponni in line x tester fashion at Paddy Breeding Station, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.

The seedlings of 120 cross combinations were transplanted 20 x 20 cm spacing using single seedling per hill along with their respective parents in Randomised Block Design in two replications. Standard agronomic and plant protection measures were adopted. For pollen fertility, studies were carried out in three randomly selected plants using 1 per cent potassium iodine iodide (KII) in 3 randomly selected microscopic fields. Well filled, dark blue stained and

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round pollen grains were recorded as fertile. Spikelet fertility was determined by dividing the total number of seeds by the total number of spikelets [3]. The criteria for classifying the parental lines as maintainers and restorers were used as given in Table 1 proposed by Virmani *et al*. [4]. The spikelet fertility of the 120 hybrids studied ranged from 0 to 96.10 per cent. Among this, 20 hybrids developed by crossing CMS line IR 66707A (*O. perennis* cytoplasm) with all the 20 rice genotypes were not fertile and showed complete sterility. Ganesan *et al*. [5] also reported similar results but in a different set of genotypes.

On the basis of pollen and spikelet fertility status of the hybrids, IR 10198-66-2R, IR 65515-47-2-1-19, TNAU 94241 and TNAU 841434 were identified as effective restorers for all the CMS lines with WA cytoplasm (Table 2). The cultivar C 20 restores the fertility of IR 58025A and IR 70364A, whereas CB 95066 restores the fertility of IR 68888A, IR 70364A and IR 70370A. The identified restorers are high yielding with good cooking quality traits. The effective restorer cultivars are mainly distributed in the tropics where Indica rice was exclusively grown [6] and the restorer frequency is very low in local germplasm [7]. The origin and pedigree of test lines are important characters to be considered in evaluating the rice genotypes for restoring and maintaining WA cytoplasm [8].

The genotypes ADT 43, ASD 19, CB 97083 and CO (R) 47 were identified as maintainers (Table 3), as F_1 of these pollen parents showed 0% spikelet fertility and 0.5 to 1% pollen fertility. Presence of excess sterility genes act as inhibitors of pollen fertility restoration in F_1 generation [9]. Pedigree studies indicated that ADT 43 and CO (R) 47 are having IR 50 as one of the parent in common. The morphological characters of these main tainers are suitable for the development of CMS lines and can be converted into new CMS lines for the development of local rice hybrids. Ten best heterotic combinations identified from the test crosses on the basis of filled grains per panicle, spikelet fertility and acceptable maturity days are presented in (Table 4). Yield performance on larger area and cooking quality characteristics need to be determined before their release for commercial cultivation. In conclusion, among 20 rice genotypes utilized in this study the frequency of restorers was slightly higher than (35%) than that of maintainers (30%). The identified restorers and maintainers are locally adopted with high yield and good grain quality traits; hence these genotypes can be utilized in hybrid rice breeding programme. New CMS lines can be developed utilizing maintainer lines in conversion programme. Restorer lines identified can be utilized to develop heterotic rice hybrids. Besides, new restorers can be developed through cross breeding, which can enlarge the genetic base of restorer lines by pyramiding complementary traits from various sources.

Table 1. Classification of test lines into restorers and maintainers

Pollen fertility (%)	Category	Spikelet fertility (%)
0-1	Maintainer (M)	0
1.1-50	Partial maintainer (PM)	0.1-50
50.1-80	Partial restorer (PR)	50.1-75
>80	Restorer (R)	>75

Table 2. Effective restorers for the CMS lines with WA cytoplasm

S.No.	CMS line	Effective restorers	Pollen fertility (%)	Spikelet fertility (%)
1.	IR 58025A	C 20	85.70	90.40
		IR 10198-66-2R	88.40	83.70
		IR 65515-47-2-1-19	84.90	89.70
		TNAU 94241	90.30	95.60
		TNAU 94301	85.70	89.50
		TNAU 841434	84.30	88.30
2.	IR 68888A	CB 95066	85.70	83.40
		IR 10198-66-2R	86.60	83.70
		IR 65515-47-2-1-19	88.10	80.10
		TNAU 94241	92.50	81.50
		TNAU 94301	89.10	86.50
		TNAU 841434	84.90	82.50
3.	IR 69616A	IR 10198-66-2R	88.20	87.30
		IR 65515-47-2-1-19	85.40	82.30
		TNAU 94241	85.10	89.40
		TNAU 841434	92.60	96.10
4.	IR 70364 A	C 20	85.90	80.00
		CB 95066	88.80	87.80
		IR 10198-66-2R	87.50	82.30
		IR 65515-47-2-1-19	85.20	85.30
		TNAU 94241	85.60	80.50
		TNAU 94301	91.40	82.00
		TNAU 841434	86.30	81.00
5.	IR 70370 A	CB 95066	90.90	80.60
		IR 10198-66-2R	85.40	82.50
		IR 65515-47-2-1-19	84.60	80.10
		TNAU 94241	86.10	92.47
		TNAU 841434	75.40	81.60

Table 3. Fertility restoration/sterility maintenance in rice hybrids

S.No.	Genotypes	WA based CMS (A) lines				
		IR 58025A	IR 68888A	IR 69616A	IR 70364 A	IR 70370 A
1	ADT 43	M	M	M	M	M
2	ASD 18	PR	PM	PM	PM	M
3	ASD 19	M	M	M	M	M
4	C 20	R	PR	PM	R	PM
5	C 37	PR	PR	PR	PR	PR
6	CB 95066	PR	R	PR	R	R
7	CB 97083	M	M	M	M	M
8	CO (R) 47	M	M	M	M	M
9	IR 50	PR	PR	PR	PM	PM
10	IR 64	PR	PR	PM	M	M
11	IR 65515-47-2-1-19	R	R	R	R	R
12	IR 10198-66-2R	R	R	R	R	R
13	IR 40750-82-2	PM	PR	PR	PR	PM
14	MRST 9	PM	PM	PM	PM	M
15	Paiyur 1	PR	M	M	PM	PM
16	TNAU 80030	M	PM	PM	PR	PR
17	TNAU 94241	R	R	R	R	R
18	TNAU 94301	R	R	PM	R	PR
19	TNAU 841434	R	R	R	R	R
20	Improved White Ponni	PM	PM	PM	PM	PM

M = maintainer; PR = partial restorer; PM = partial maintainer and R = restorer

Table 4. Morphological attributes of best heterotic rice hybrids identified from the test crosses

S.No.	Parentage	Maturity (Days)	Plant height (cm)	Productive tillers/ plant (no.)	Filled grains/ panicle (no.)	Spikelet fertility (%)
1	IR 58025 A/ C 20	125	80.30	12.30	157.65	90.40
2	IR 58025A/ IR 65515-47-2-1-19	122	84.18	13.15	136.30	89.70
3	IR 58025A/ TNAU 94241	130	82.00	13.20	127.35	95.60
4	IR 58025A/ TNAU 94301	136	88.30	12.15	146.00	89.50
5	IR58025A/ TNAU 841434	120	93.00	11.70	155.20	88.30
6	IR 68888A/ TNAU 94301	120	85.15	14.50	127.30	86.50
7	IR 69616A/ TNAU 94241	127	84.20	11.60	145.75	89.40
8	IR 69616A/ TNAU 841434	122	96.00	11.00	206.15	96.10
9	IR 70364 A / CB 95066	120	86.35	12.70	122.00	87.80
10	IR 70370 A / TNAU 94241	125	78.10	12.65	112.20	92.47
	SEd		1.406	0.569	3.621	1.634
	CD (0.05)		2.954	1.195	7.607	3.434
	CD (0.01)		4.047	1.637	10.424	4.705

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