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NEW CMS SOURCES WITH STABLE MALE STERILITY AND BETTER OUTCROSSING TRAIT IN RICE (*O. SATIVA* L.)

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ABSTRACT

Six CMS lines possessing different cyto-sterility sources from *O. rufipogon* and *O. nivara* were evaluated for pollen and spikelet sterility characters in advanced back cross generations (BC_5-BC_8). All CMS lines showed 100 per cent spikelet sterility but the pollen stainability varied depending on the CMS source. The lines viz., RPMS 1-1, 1-2, 1-3, 1-4 and RPMS 2 possessing cyto-sterility source from *O. rufipogon* and *O. nivara* respectively were found to have gametophytic type of male sterility and RPMS 4 possessing *O. nivara* source was found to exhibit sporophytic male sterility system. The maintenance of complete male sterility with restorers of WA system indicate the diversified nature of new male sterility sources. The field evaluation of these new CMS lines along with CMS lines belonging to wild abortive (WA), *O. perennis* (IR 64A) and MS 577A sources, carried out during *kharif* 1994 and *rabi* 1994-95 seasons demonstrated that in addition to stable male sterility the new CMS lines possessed very good panicle and stigma exsertion rate and high rate of outcrossing which will go a long way in maximising the seed yield in hybrid rice seed production plots. The efforts are on to identify effective restorers for the new CMS sources. Reduction in the cost of hybrid seed and the nuclear and cytoplasmic diversification of hybrids will help in large scale adoption and sustenance of hybrid rice technology in India respectively, in the years ahead.

Key Words : Cytoplasmic diversification of male sterility, hybrid rice, inter-specific crosses, pollen sterility

The cytoplasmic genetic male sterility (CMS) system is controlled by the interaction of cytoplasmic and nuclear genes. Presence of homozygous recessive nuclear gene(s) for fertility restoration in association with sterility inducing genetic factor(s) in cytoplasm makes a genotype male sterile. Most of the commercial hybrids of *indica* rice are based on wild abortive (WA) source of genetic male sterility that was developed from a wild rice (*Oryza sativa f. spontanea*). Previous experience in other crops like corn and pearl millet indicate that over dependence on a single cytosterility source may to lead to genetic vulnerability of hybrids to sudden outbreak of disease and insect pests. Some of the drawbacks of the WA system are poor panicle exsertion

and undesirable flowering behaviour leading to low seed yield in seed production plots, which underscores the need for cytoplasmic diversification of male sterility source.

Among the various approaches to develop new CMS sources, inter sub specific crosses have been used by many researchers [1-2]. On the other hand, majority of the new CMS sources are the result of inter specific crosses involving cultivated and wild species of rice [3-7]. Even though, may new CMS sources were developed in the past, none of them became popular except the WA source because of one or the other short comings. In this paper, we report the pollen stainability and spikelet sterility characteristics of three new CMS sources [5] in the advanced backcross generations (BC5 to BC8) and their desirable out crossing traits which will be of immense value in commercial hybrid rice seed production.

MATERIAL AND METHODS

The material consisted of four advanced back cross generations (BC_5-BC_8) of CMS lines viz., RPMS 1-1, 1-2, 1-3 and 1-4 having *O. rufipogon* CMS source and RPMS-2 and RPMS-4 possessing *O. nivara* source [5]. Pollen stainability of 40-50 plants from each entry in advanced back cross generations, was determined by staining pollen grains in 1.5% potassium iodide- iodine (IKI) solution. Based on iodine and starch reaction pollen grains were classified into typical abortive (TA), Round sterile (RS) and partially stained sterile (PSS) types. The microscopic count of the pollen types was expressed in percentage. A few panicles of each plant were bagged and mean spikelet sterility was recorded at harvest. Apart from this, the new CMS lines viz., RPMS 1-1A, RPMS 1-4A and RPMS 2A were grown in replicated trials along with other CMS lines viz., IR 58025A, IR 62829A belonging to WA, *O. perennis* (IR 64A) and Mangala A having MS 577 A (*O. perennis*) source during *kharif* 1994 and *rabi* 1994-95 seasons at Directorate of Rice Research Farm, Hyderabad. The observations on panicle exsertion, stigma exsertion and percent seed set on sterile plants were recorded on five randomly selected competitive plants in each replication and data were subjected to statistical analysis.

RESULTS AND DISCUSSION

The CMS lines viz., RPMS 1-1, 1-2, 1-3 and 1-4 belonging to *O. rufipogon* CMS source possess very high proportion (71-85%) of round sterile pollen grains and about 15-29 percent of typical abortive pollen grains. Among the CMS sources possessing *O. nivara* cytoplasm, RPMS 2 showed high proportion (73-82%) of round

sterile and low proportion (14.0-24.9%) of typical abortive pollen grains. However RPMS 4 showed high proportion (74.5-84.6%) of typical abortive and low proportion (15.4-25.5%) of round sterile pollen grains (Table 1).

Table 1. Pollen stainability and spikelet sterility characteristics of new CMS sources

CMS line	Recurrent parent	Pollen stainability (%) pooled over 4 backcross generations (BC5 to BC8)			Spikelet sterility (%)
		Type of pollen grain			
		TAS	RS	PSS	
RPMS1-1*	IR 66	19.26(15.4-29.2)	78.29(74.8-83.6)	2.45(1.0-3.2)	100
RPMS1-2*	V20B	21.77(14.7-25.8)	78.23(74.2-85.3)	0.00	100
RPMS1-3*	IR 70	24.46(21.4-28.3)	75.54(71.7-78.6)	0.00	100
RPMS1-4*	PMS 2B	26.54(18.8-29.6)	73.46(70.4-81.2)	0.00	100
RPMS2**	IR 66	20.40(14.0-24.9)	76.94(73.6-81.6)	2.66(1.5-3.6)	100
RPMS4**	IR 66	79.45(74.5-84.6)	20.55(15.4-25.5)	0.00	100

* and ** indicate CMS sources from *O. rufipogon* and *O. nivara* respectively.
TAS = Typical abortive sterile; RS = Round sterile; PS = Partilly stained sterile.
Figures in the parenthesis indicate range

Although RPMS 1-1 and RPMS 2 showed a few (1-3%) partially stained pollen grains, all the CMS lines were found to possess stable and 100 percent male sterility in all back cross generations. Based on pollen stainability, pollen shape and other characteristics, RPMS 1-1, 1-2, 1-3 and 1-4 of *O. rufipogon* source and RPMS 2 of *O. nivara* source were found to possess gametophytic type of male sterility. The CMS line RPMS 4, possessing *O. nivara* source was found to have sporophytic type of male sterility. The changed pollen stainability characteristics and the ability of the recurrent parents viz., IR 66 and IR 70 which are otherwise restorers of WA system, to maintain male sterility in the cytoplasmic background of *O. rufipogon* and *O. nivara* clearly indicate that these sources are quite different from that of WA source [5].

The CMS lines belonging to different CMS sources showed significant differences among themselves for panicle exsertion, stigma exsertion and out crossing ability (Table 2). The simple correlations worked out based on pooled data clearly indicate

highly significant positive association (r = 0.98) between stigma exsertion and out crossing ability and moderately significant correlation (r = 0.69) between out crossing ability and panicle exsertion and thereby emphasising the importance of these traits in commercial hybrid rice seed production.

Table 2. Pooled ANOVA for out crossing traits of different CMS sources in rice

		Mean squares		
Source	d.f.	P.E.	S.E.	O.C.
CMS source	6	393.4**	1190.5**	751.7**
Replication	2	1.35	8.38	2.41
Error	12	2.16	3.14	2.35

** = Significance at 1% level; P.E. = Panicle exsertion; S.E. = stigma exsertion; O.C. = Outcrossing ability

One of the major drawbacks of the CMS lines belonging to WA and *O. perennis* (IR 64A) sources is poor panicle exsertion which necessitates the use of high quantity of GA3 in commercial hybrid rice seed production plots. However the new CMS lines from diversified sources have very good panicle exsertion as compared to all other CMS sources (Fig. 1). Similarly all the CMS lines derived from *O. rufipogon* and *O. nivara* sources exhibited very good stigma exsertion in relation to other CMS lines (Fig. 2). The two years data (*kharif* 1994 and *rabi* 1994-95) on evaluation of CMS lines belonging to different cyto-sterility sources clearly indicate that the sterility inducing cytoplasm of the new CMS sources viz., *O. rufipogon* and *O. nivara* has favourable effects on panicle exsertion and stigma exsertion in the nuclear background of all the recurrent parents as compared to that of other CMS sources like WA and IR 64 A. Further, all the CMS lines belonging to the new CMS sources viz., *O. rufipogon* and *O. nivara* exhibited very good and highly significant out crossing ability under natural conditions as compared to that of all other CMS lines. (Fig. 3).

Besides the advantage of cytoplasmic diversification and stable male sterility, the new CMS lines possess many useful traits which are of prime importance in large scale hybrid rice seed production. Efforts to identify good restorers for these CMS sources are in progress. Development of promising hybrid combinations involving these new CMS lines can pave the way for maximising the hybrid seed yield without the use of GA3, a costly input in hybrid rice seed production. Reduction in the cost of hybrid seed and the nuclear and cytoplasmic diversification of hybrids will help in large scale adoption and sustenance of hybrid rice technology in India, in the years ahead.

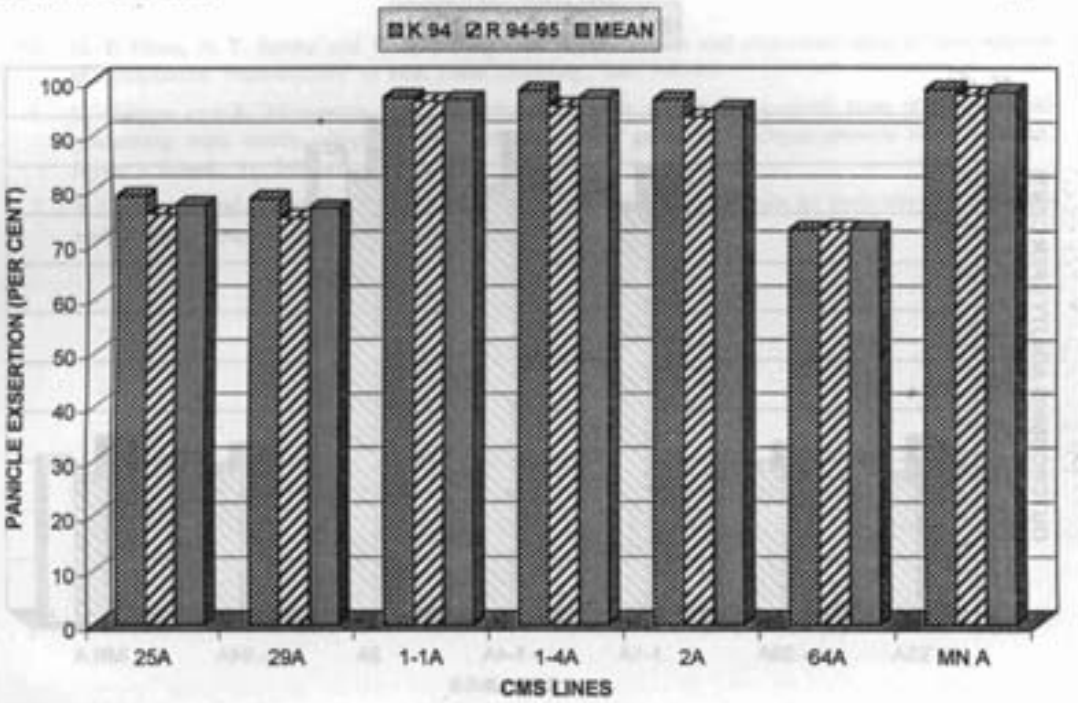

Fig. 1. Panicle exsertion in different CMS lines

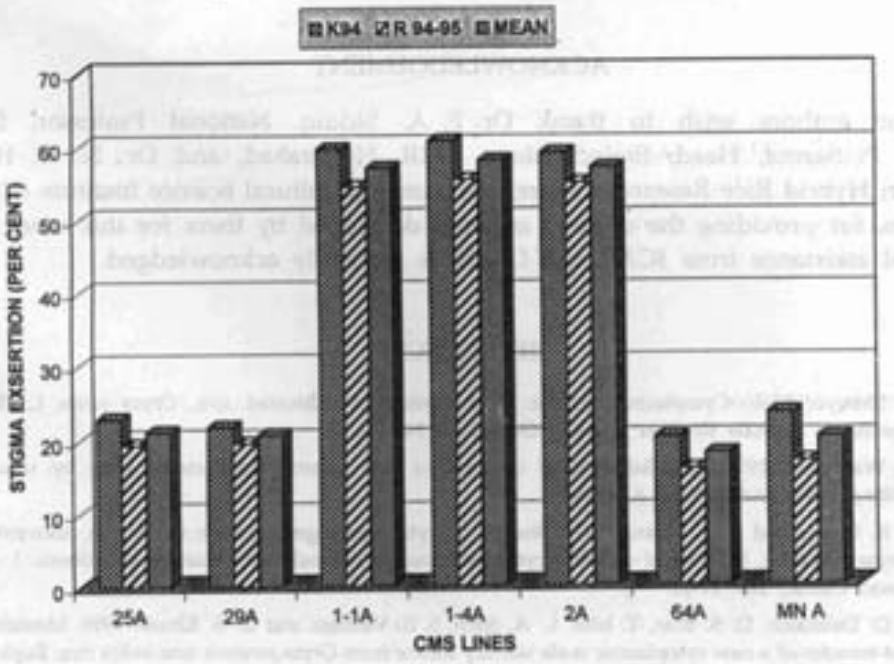

Fig. 2. Stigma exsertion in different CMS lines

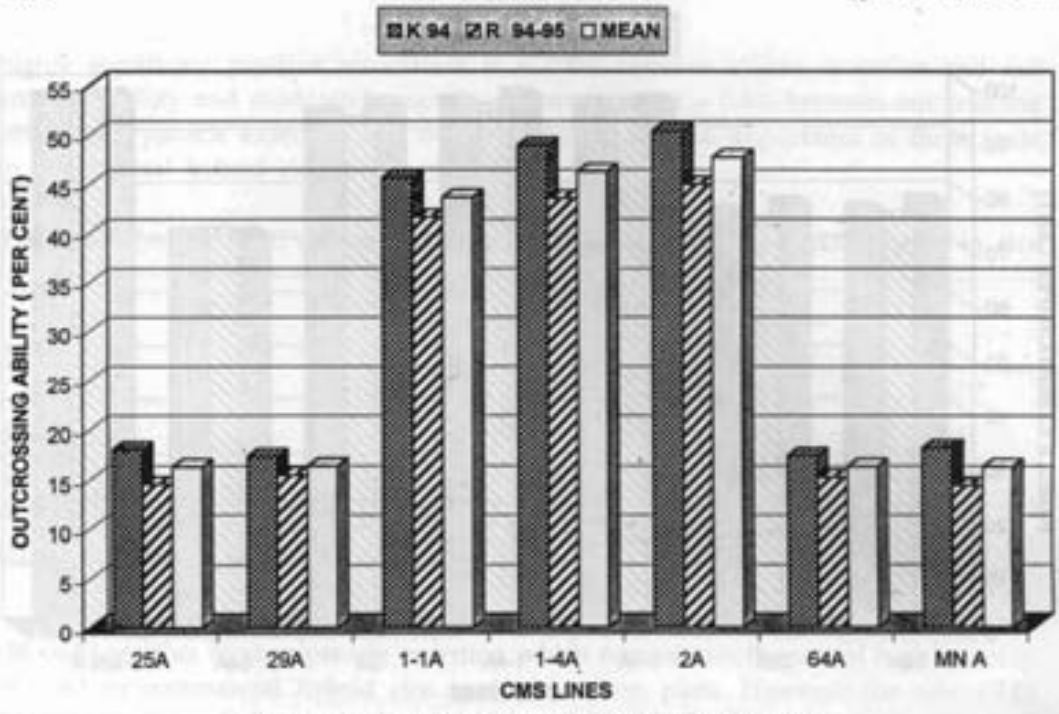

Fig. 3. Out crossing ability of different CMS lines

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