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Research Note

Study for restoration ability in cytoplasmic male sterile system in Indian mustard [*Brassica juncea* (L.) Czern & Coss.]

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Abstract
Two cms lines of Moricandia viz., CMSNDRE-4 and CMS Mori were crossed with 30 genotypes to identify restorers and maintainers. Effective restorers for two CMS lines *i.e.*, CMSNDRE-4 and CMS Mori could not be identified through *Moricandia* CMS system. However, common partial restorers were found in the parents, NPJ-147, NPJ-112, PRE-2007-06, NPJ-135, Divya-33, DRMREJ-2010-01, NPJ-148, DRMREJ-2010-02, Divya-22, R.H-919, RRN-693 and Kranti for both CMS lines. Effects of CMS lines on seed yield and its components traits indicated that seed yield in F_1's were higher than the parents. The overall performance of F_1's over both the standard variety *viz.*, Kranti (SV_1) and Maya (SV_2) in seed yield showed yield depression as a result of negative cytoplasm interaction.

Key words: *Brassica juncea*, Cytoplamic male sterilty, *Moricandia*, Maintainers, Restorers.

Exploitatable level of standard heterosis depends on an effective male sterility and fertility system which is the most important prerequisites for the development of commercially viable hybrids. Restoration ability in CMS line is an important factor for the exploitation of hybrid in the breeding programme. Banga and Banga (1997) have developed lyratus based CMS line in *B. napus*. Alloplasmic *B. juncea* and *B. napus* have been obtained based on *B. oxyrrhina*, *Trachystoma balli*, *Moricandia arvensis*, *Diplotaxis siifolia* and *Sinapis alba* cytoplasm (Rao *et al.,* 1996; Prakash *et al*. 2001). In order to deploy CMS systems in the development of commercial *brassica* hybrids, it is essential to sort-out effective restorer lines. Fertility restorers have been identified in the *Trachystoma* and *Moricandia* based CMS lines of *B. juncea* (Prakash and Kirti, 1997). As a results of these investigations functional 3 line system have become available in *B. juncea* and *B. napus* for the first time. Lack of restorers has hampered the exploitation of several other CMS systems for producing commercial hybrid seed (Singh and Verma, 1997). The major difficulty in finding restorer in natural accessions is the multilocus control of incompatibility between the mitochondrial and nuclear genome (Downey and Chopra, 1996). Among different CMS systems, *Moricandia* CMS system has been reported as very effective system which is evolved though somatic hybrid between *M. arvensis* and *B. juncea*. This cms system is available in *B. juncea* with small non-dehiscent anthers and excellent nectarines. Restorers are available and female fertility is about 95 per cent for this cms system. Heterosis has been extensively explored and utilized for boosting various quality traits in *Brassica* because of an effective and economic pollination control system for production of F_1 hybrid seeds on a large scale. In the present study, restoration ability and level of standard heterosis were estimated for the hybrids developed using L x T cross experiment.

Two cytoplasmic male sterile lines *i.e.* CMSMori and CMSNDRE-4 were available were crossed with 30 diverse genotypes to identify their hybrids at Research Farm of genetics and Plant Breeding of N.D. University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) during *Rabi* 2011-12. To assess the pollen viability, a few matured buds and their pollens were collected from the five selected plants during anthesis period. These pollen grains were placed on clean slide and one or two drops of aceto-carmine were poured on the pollen. Then a coverslip was put on the pollens and lightly pressed to removed air bubbles as well as excess solution of aceto-carmine. The stained and non stained pollen were counted under the microscope to know their fertility and sterility, respectively. The percentages of pollen fertility of

F_1's were used as an index of fertility restoring ability of different pollen parents. Pollen fertility per cent of F_1's in the crosses involving two CMS lines are given in Table 1. Observations were recorded for days to 50 per cent flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, length of main raceme (cm), number of siliquae on main raceme, number of seeds per siliqua, 1000-seed weight (g), biological yield (g), harvest Index (%), oil content (%) and seed yield per plant (g).

The results of mean data of pollen fertility percentage showed that pollen fertility of F_1's ranged from 0.00 to 19.27 per cent and due to very low pollen fertility percentage, none of the good restorer were identified for these two CMS lines. However, for CMSNDRE-4, 12 parents NPJ-147, NPJ-112, PRE-2007-06, NPJ-135, Divya-33, DRMREJ-2010-01, NPJ-148, DRMREJ-2010-02, Divya-22, R.H-919, RRN-693 and Kranti were identified as partial restorers, while NDRE-7, EJ-17, IC-355399, NDRE-22, RH-0704 and EJ-22 as partial maintainers and NDRE-1, PRE-2009-09, NDRE-08-04, JD-06, DRMRIJ-258, NML-100, DRMR-904, HYT-33, NPJ-149, RGN-73 and Maya were identified as effective maintainers. Genotypes viz., PRE 2009-9, NDRE-22, DRMRIJ-258 and HYT-33 were found as effective maintainers for CMSMori and PRE-2007-06, NPJ-147, NPJ-112, NPJ-135, RRN-693, Divya-33, NPJ-148, Divya-22, DRMREJ-2010-02, DRMREJ-2010-01, Maya, RH-919, NDRE-7 and RH-0704 were found as partial restorers, while rest were found as partial maintainers for this CMS system. These results suggest that more genotypes need to be studied for judicious classification of testers into maintainers, partial restorers or restorers. Pollen parent *viz.*, NPJ-147, PRE-2007-06, NPJ-112 and Divya-33 with higher pollen fertility percentage in hybrid combinations appear promising for further studies. The present observations are in agreement with earlier report of Angadi and Anand (1988) and Sodhi et *al.*, (1994).

The performance of F_1's was higher than their CMS parent's *viz.*, CMSNDRE-4 and CMSMori (Table 2 and Table 3). The yield performance of F_1's over standard varieties *viz.*, Kranti (SV_1) and Maya (SV_2) for seed yield showed yield depression as a result of negative nuclear-cytoplasmic interaction. Banga and Amandeep (1996) revealed a general depression in various seed storage product such as protein, oil and carbohydrates. The present investigation also revealed a general depression in various yield and yield contributing traits and storage products such as oil.

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Table 1. Pollen fertility percentage of 60 F_1's in Indian mustard

S. No.	Crosses	Mean	S. No	Crosses	Mean
1	CMSNDRE-4 x Kranti	11.82	31	CMSMori x Kranti	9.73
2	CMSNDRE-4 x IC-355399	9.71	32	CMSMori x IC-355399	6.31
3	CMSNDRE-4 x DRMREJ-2010-02	14.43	33	CMSMori x DRMREJ-2010-02	15.72
4	CMSNDRE-4 x NDRE-1	4.26	34	CMSMori x NDRE-1	7.42
5	CMSNDRE-4 x PRE-2009-9	0.00	35	CMSMori x PRE-2009-9	0.00
6	CMSNDRE-4 x NDRE-7	10.00	36	CMSMori x NDRE-7	11.26
7	CMSNDRE-4 x NPJ-148	15.57	37	CMSMori x NPJ-148	17.63
8	CMSNDRE-4 x RRN-693	12.13	38	CMSMori x RRN-693	18.52
9	CMSNDRE-4 x NPJ-147	19.27	39	CMSMori x NPJ-147	20.27
10	CMSNDRE-4 x NDRE-08-04	0.00	40	CMSMori x NDRE-08-04	4.27
11	CMSNDRE-4 x RH-919	12.47	41	CMSMori x RH-919	12.11
12	CMSNDRE-4 x EJ-17	9.99	42	CMSMori x EJ-17	7.72
13	CMSNDRE-4 x NPJ-112	18.72	43	CMSMori x NPJ-112	19.19
14	CMSNDRE-4 x DRMREJ-2010-01	16.13	44	CMSMori x DRMREJ-2010-01	15.13
15	CMSNDRE-4 x NDRE-22	8.85	45	CMSMori x NDRE-22	0.00
16	CMSNDRE-4 x JD-06	0.00	46	CMSMori x JD-06	3.12
17	CMSNDRE-4 x DRMRIJ-258	0.00	47	CMSMori x DRMRIJ-258	0.00
18	CMSNDRE-4 x PRE-2007-06	18.24	48	CMSMori x PRE-2007-06	20.71
19	CMSNDRE-4 x EJ-22	7.72	49	CMSMori x EJ-22	8.67
20	CMSNDRE-4 x NML-100	3.12	50	CMSMori x NML-100	2.00
21	CMSNDRE-4 x NPJ-135	17.66	51	CMSMori x NPJ-135	18.56
22	CMSNDRE-4 x DRMR-904	0.00	52	CMSMori x DRMR-904	4.13
23	CMSNDRE-4 x RH-0749	0.00	53	CMSMori x RH-0749	2.11
24	CMSNDRE-4 x RH-0704	8.72	54	CMSMori x RH-0704	11.12
25	CMSNDRE-4 x Divya-22	14.15	55	CMSMori x Divya-22	16.25
26	CMSNDRE-4 x HYT-33	0.00	56	CMSMori x HYT-33	0.00
27	CMSNDRE-4 x NPJ-149	0.00	57	CMSMori x NPJ-149	9.15
28	CMSNDRE-4 x Divya-33	16.61	58	CMSMori x Divya-33	18.12
29	CMSNDRE-4 x RGN-73	4.43	59	CMSMori x RGN-73	5.23
30	CMSNDRE-4 x Maya	2.61	60	CMSMori x Maya	12.13

Table 2. Mean performance of different CMS lines and their F_1's in Indian mustard.

Characters	CMSNDRE-4		CMSMori	
	Male Parent	F_1	Male Parent	F_1
Days to 50% flowering	71.33	71.49	68.00	71.34
Days to maturity	120.67	121.68	120.33	121.69
Plant height (cm)	163.20	157.07	168.73	173.93
No. of primary branches per plant	5.13	5.37	5.20	5.44
No. of secondary branches per plant	9.67	12.70	10.60	12.82
Length of main raceme (cm)	62.80	66.08	70.13	70.93
No. of siliquae on main raceme	33.80	38.54	39.47	42.10
No. of seeds per siliqua	13.80	14.50	14.87	14.78
1000-seed weight (g)	4.99	5.22	4.83	5.53
Biological yield (g)	29.33	32.06	29.33	31.13
Harvest index (%)	27.16	27.72	27.29	28.00
Oil content (%)	42.41	41.78	41.44	41.77
Seed yield per plant (g)	7.97	8.90	8.00	8.71
S.E.	1.87	1.89	1.90	1.93
C.D(P=0.05)	4.08	4.12	4.13	4.20

Table 3. Per cent heterosis (SV_1 and SV_2) over different CMS lines in Indian mustard

Characters	CMSNDRE-4		CMSMori	
	SV_1	SV_2	SV_1	SV_2
Days to 50% flowering	-10.26	-5.52	-10.45	-5.72
Days to maturity	1.97	-3.42	1.98	-3.42
Plant height (cm)	1.81	-1.91	12.74	8.62
No. of primary branches per plant	20.13	7.4	21.70	8.8
No. of secondary branches per plant	19.02	12.09	20.15	13.15
Length of main raceme (cm)	-12.04	-8.06	-5.59	-1.31
No. of siliquae on main raceme	-12.15	-5.54	-4.03	3.19
No. of seeds per siliqua	-2.03	22.88	-0.13	25.25
1000-seed weight (g)	21.68	1.36	28.90	7.37
Biological yield (g)	-6.61	-12.57	-9.32	-15.11
Harvest index (%)	-3.81	2.93	-2.84	3.97
Oil content (%)	1.21	5.53	1.19	5.51
Seed yield per plant (g)	-9.81	-10.00	-11.15	-12.02
S.E.	0.064	0.049	0.140	0.132

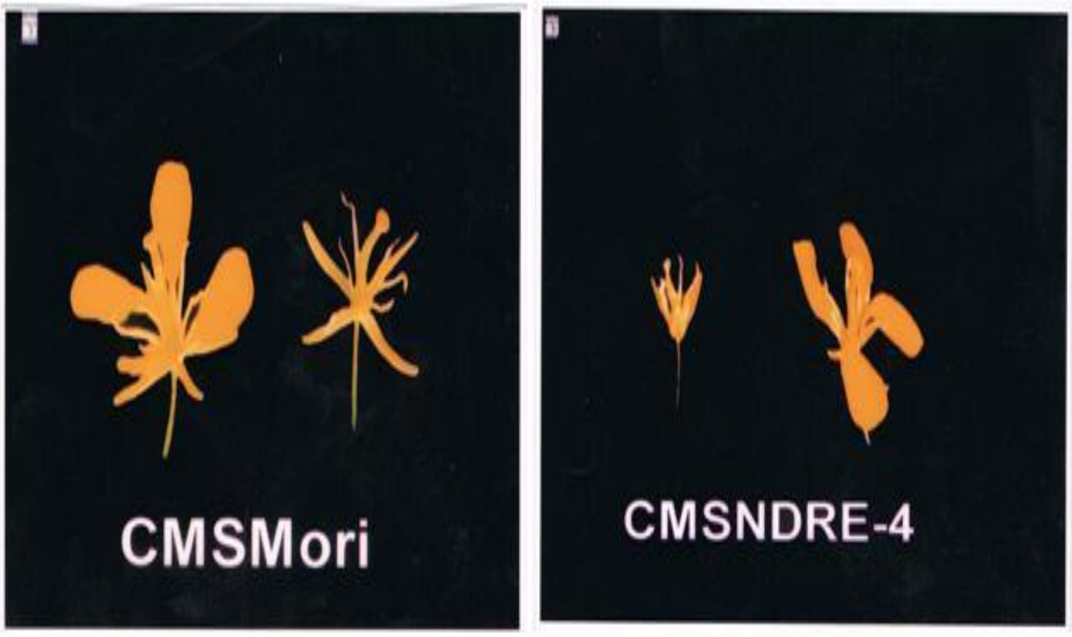

Fig: The flower character of cytoplasmic male sterile lines *i.e.* CMSMori and CMSNDRE-4.