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Research Information

Diversification of cytoplasmic male sterility in Indian varieties through back cross breeding

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Abstract
25 CMS lines received from CIMMYT, Mexico and 5 CMS lines from IARI, New Delhi were used for parental diversification in Indian wheat backgrounds through backcross breeding. Indian varieties were used as recurrent parent in order to recover their agronomic background. The extent of male sterility was taken into consideration during each backcross. A number of diversified CMS lines showing complete male sterility were evaluated and based on plant height and heading, 56 CMS lines were found promising for further utilization in hybrid wheat development programme.

Key words: bread wheat, hybrid cultivars, cytoplasmic male sterility, maintainer line, diversification

Introduction
India has a remarkable success story in wheat production and at present it is second largest wheat producing country after China. Wheat recorded all time highest production in India during 2013-14 but the yield levels are hovering around 3tonnes/hectare. At present the estimated wheat production of wheat in India is 93.50m tones (Anonymous, 2016). Major wheat areas of the country are now facing stagnation in yield levels that needs newer approaches to break yield barriers. Exploitation of heterosis and development of hybrids is an innovative approach in cereals for breaking yield barriers and realizing higher yields. Indian hybrid wheat programme has re-oriented in 1995 with introduction of some cytoplasmic male sterile (CMS) lines from CIMMYT, Mexico but these could not be utilized due to their agronomic background. In 2005, the diversification of these CIMMYT lines was initiated with the objective to develop new CMS lines in the agronomic background of Indian wheat varieties so that these can be further utilized in hybrid wheat development programme.

Materials and methods
25 CMS lines received from CIMMYT, Mexico and 5 CMS lines received from IARI, New Delhi were used as source of cytoplasmic male sterility. The lines from CIMMYT at CIMMYT were developed using *Triticum Timopheevii* cytoplasm in the base varieties MTSA 2A, Chuan 13A and Chuan 18A. CMS lines from IARI were also based on *T. timpheevii* cytoplasm. These CMS lines were used as female parent in first cross with Indian advanced varieties and elite material as male parent. Thereafter 8 generations of backcrosses were made with Indian varieties as recurrent parent in order to recover the respective agronomic background. In each cross, more than 100 spikes were pollinated. In every generation, five spikes of recipient population were bagged just after emergence from the flag leaf in order to ensure complete male sterility as indicated by no seed set (Virmani *et al.*, 1997).

After eight backcross generations, the resultant 73 male sterile lines were planted in the field along with their recurrent parent as maintainer line. These CMS lines were pollinated

Table 1. Performance of diversified new CMS (A) lines and their maintainers (B) lines for male sterility, heading days and plant height.

S No.	Line ID	Base CMS line	CMS (A) Line			Maintainer (B) line		
			Male sterility (%)	Days to heading	Pl. ht (cm)	Base line	Days to heading	Pl. ht. (cm)
1.	CMS 1A/8*PBW343	MTSA 2A/BCN	100	100	94	PBW343	100	96
2.	CMS 10A/8*PBW343	CHUAN 18A/CHUAN 18B//7*KAUZ/HEVO	100	101	91	PBW343	100	97
3.	CMS 11A/8*PBW343	CHUAN 18A/CHUAN 18B//7*PARUS	100	101	101	PBW343	100	95
4.	CMS 12A/8*PBW343	CHUAN18A/CHUAN18B/3/7*SERI/NKT//2*KAUZ	100	101	101	PBW343	100	99
5.	CMS 13A/8*PBW343	CHUAN 18A/CHUAN 18B//7*CMH80A542/ CNO79	100	102	98	PBW343	102	101
6.	CMS 17A/8*PBW343	CHUAN18A/3/7*KAUZ*2/MNV//KAUZ	100	102	95	PBW343	102	97
7.	CMS 20A/8*PBW343	CHUAN18A/3/7*HE1/5*CNO79//BORL95	100	99	95	PBW343	103	98
8.	CMS 3A/8*DBW17	CHUAN 18A/PRINIA	100	97	86	DBW17	97	88
9.	CMS 5A/8*DBW17	CHUAN 13A/CHUAN 13B/4/7*KAUZ/PFAU/VEE 5/3/KAUZ	100	97	85	DBW17	97	92
10.	CMS 8A/8*DBW17	CHUAN13A/5/7*ATTILA/3/HUI/CARC//CHEN/CHTO/4/ATTILA	100	97	90	DBW17	97	91
11.	CMS 10A/8*DBW17	CHUAN 18A/CHUAN 18B//7*KAUZ/HEVO	100	97	89	DBW17	97	92
12.	CMS 12A/8*DBW17	CHUAN18A/CHUAN18B/3/7*SERI/NKT//2*KAUZ	100	97	82	DBW17	97	85
13.	CMS 13A/8*DBW17	CHUAN 18A/CHUAN 18B//7*CMH80A542/ CNO79	100	97	86	DBW17	97	89
14.	CMS 14A/8*DBW17	CHUAN18A/6/7*WL6736/5/2*BR12*3/4/IAS55*4/CI14123/3/IAS*55/ALD	100	97	91	DBW17	97	87
15.	CMS 15A/8*DBW17	CHUAN18A//7*ATTILA/3BCN	100	97	84	DBW17	97	85
16.	CMS 18A/8*DBW17	CHUAN18A/4/7*KAUZ//VORONA/CNO79/3/KAUZ	100	97	85	DBW17	97	92
17.	CMS 21A/8*DBW17	CHUAN18A/6/7*KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ	100	97	86	DBW17	97	88
18.	CMS22A/DBW17	CHUAN18A/ 2*CHUAN 18B/3*HE1/ 3*CNO79// *SERI/ 3/ATTILA	100	97	86	DBW17	97	87
19.	CMS 25A/8*DBW17	CHUAN18A/ 2*CHUAN 18B/3*URES /BOW//OPATA	100	97	85	DBW17	97	85
20.	CMS 26A/8*DBW17	Pusa 2019A-11	100	97	87	DBW17	97	83
21.	CMS 30A/8*DBW17	Pusa 2338A-20	100	97	86	DBW17	97	87
22.	CMS 2A/8*DBW16	MTSA 2A/8*RAYON	100	98	94	DBW16	98	98
23.	CMS 8A/8*DBW16	CHUAN13A/5/7*ATTILA/3/HUI/CARC//CHEN/CHTO/4/ATTILA	100	98	96	DBW16	98	92

Table 1 (*continued*)

24.	CMS 10A/8*DBW16	CHUAN 18A/CHUAN 18B//7*KAUZ/HEVO	100	98	91	DBW16	98	96
25.	CMS 11A/8*DBW16	CHUAN 18A/CHUAN 18B//7*PARUS	100	98	88	DBW16	98	90
26.	CMS 12A/8*DBW16	CHUAN18A/CHUAN18B/3/7*SERI/NKT//2*KAUZ	100	98	95	DBW16	98	96
27.	CMS 15A/8*DBW16	CHUAN18A//7*ATTILA/3BCN	100	98	96	DBW16	98	97
28.	CMS 18A/8*DBW16	CHUAN18A/4/7*KAUZ//VORONA/CNO79/3/KAUZ	100	98	91	DBW16	98	99
29.	CMS19A/8*DBW16	CHUAN18A/4/7*ATTILA//ALTAR84/AOS/3/ATTILA	100	98	92	DBW16	98	90
30.	CMS21A/8*DBW16	CHUAN18A/6/7*KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ	100	98	91	DBW16	98	89
31.	CMS 23A /8*DBW16	CHUAN18A/ 2*CHUAN 18B/3*KONKITU	100	98	90	DBW16	98	88
32.	CMS 1A/8*PBW502	MTSA 2A/BCN	100	102	98	PBW502	102	94
33.	CMS 6A/8*PBW502	CHUAN13A/CHUAN13B/3/7*OASIS/SKUAZ//4*BCN	100	102	102	PBW502	102	101
34.	CMS 21A/8*PBW502	CHUAN18A/6/7*KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ	100	102	104	PBW502	102	95
35.	CMS 5A/8*DBW55	CHUAN 13A/CHUAN 13B/4/7*KAUZ/PFAU/VEE 5/3/KAUZ	100	99	94	DBW55	99	98
36.	CMS 9A/8*DBW55	CHUAN13A//7*OASIS/5*BORL95	100	99	92	DBW55	99	97
37.	CMS 15A/8*DBW55	CHUAN18A//7*ATTILA/3BCN	100	99	93	DBW55	99	98
38.	CMS 24A/8*DBW55	CHUAN18A/ 2*CHUAN 18B/3*SERI/KAUZ	100	99	95	DBW55	99	96
39.	CMS 21A/8*DBW55	CHUAN18A/6/7*KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ	100	99	91	DBW55	99	90
40.	CMS 8A/8*DBW60	CHUAN13A/5/7*ATTILA/3/HUI/CARC//CHEN/CHTO/4/ATTILA	100	93	98	DBW60	91	102
41.	CMS 20A/8*DBW60	CHUAN18A/3/7*HE1/5*CNO79//BORL95	100	93	101	DBW60	91	104
42.	CMS 23A/8*DBW60	CHUAN18A/ 2*CHUAN 18B/3*KONKITU	100	93	103	DBW60	91	106
43.	CMS 26A/8*DBW60	Pusa 2019A-11	100	94	101	DBW60	91	98
44.	CMS 2A/8*CBW38	MTSA 2A/8*RAYON	100	99	102	CBW38	99	105
45.	CMS 10A/8*CBW38	CHUAN 18A/CHUAN 18B//7*KAUZ/HEVO	100	99	106	CBW38	99	108
46.	CMS 15A/8*CBW38	CHUAN18A//7*ATTILA/3BCN	100	99	101	CBW38	99	102
47.	CMS 2A/8*RAJ3077	MTSA 2A/8*RAYON	100	95	103	RAJ3077	95	105
48.	CMS 8A/8*RAJ3077	CHUAN13A/5/7*ATTILA/3/HUI/CARC//CHEN/CHTO/4/ATTILA	100	95	104	RAJ3077	95	110
49.	CMS 14A/8*RAJ3077	CHUAN18A/6/7*WL6736/5/2*BR12*3/4/IAS55*4/CI14123/3/IAS*55/ALD	100	95	101	RAJ3077	95	98

Table 1 (*continued*)

50.	CMS 8A/8*DBW76	CHUAN13A/5/7*ATTILA/3/HUI/CARC//CHEN/CHTO/4/ATTILA	100	94	104	DBW76	91	111
51.	CMS 21A/8*DBW76	CHUAN18A/6/7*KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ	100	93	103	DBW76	91	107
52.	CMS 2A/8*UP2338	MTSA 2A/8*RAYON	100	99	97	UP2338	99	104
53.	CMS 7A/8*GW411	CHUAN13A/CHUAN13B/3/7*URES/BOW//OPATA	100	100	103	GW411	98	101
54.	CMS 14A/8*PBW550	CHUAN18A/6/7*WL6736/5/2*BR12*3/4/IAS55*4/CI14123/3/IAS*55/ALD	100	93	89	PBW550	91	90
55.	CMS 14A/8*RAJ4037	CHUAN18A/6/7*WL6736/5/2*BR12*3/4/IAS55*4/CI14123/3/IAS*55/ALD	100	92	97	RAJ4037	90	101
56.	CMS 28A/8*PBW175	Pusa 2046A-8	100	95	103	PBW175	95	110

with maintainer lines for getting seeds of the CMS lines. During crop seasons 2014-15 and 2015-16, fifty six uniform cytoplasmic male sterile lines (A lines) were selected out of 73 and these were planted with respective maintainer lines (B lines) in 2B:4A:2B row ratio. All the recommended agronomic practices were adopted to raise a good crop. Five randomly selected spikes of these CMS lines were bagged at just after emergence from flag leaf and the seed set was observed in these un-pollinated spikes for calculating seed set percentage (Virmani *et al.*, 1997; Aruna *et al*., 2013). The data were also recorded on days to heading and plant height for evaluating their suitability to hybrid wheat programme.

Results and discussion

The diversification of cytoplasmic male sterility in Indian varieties was initiated with varieties suitable for high fertility, timely sown irrigated conditions. New CMS lines were diversified in 14 different backgrounds namely, PBW 343, DBW 17, DBW 16, PBW 502, DBW 55, DBW 60, CBW 38, Raj 3077, PBW 550, DBW 76, UP 2338, GW 411, Raj 4037 and PBW 175. The seed set was observed among these lines and the results indicated no seed set in the bagged un-pollinated spikes of the CMS lines. This indicated complete male sterility in the new lines (Table 1). The heading among the new CMS lines was ranged between 92-102 days with mean value of 98 days. Compared to this, the heading among maintainer lines ranged between 90-103 days with mean value of 97days. The plant height was also taken into consideration for identification of promising lines for use in hybrid programme. The plant height was ranged between 82-106 cm among CMS lines and 83-111 cm among maintainer lines. Mean plant height was 97 cm and 96 cm in new CMS lines and maintainer lines, respectively.

In hybrid development programme based on three line system, the maintenance of CMS lines is very crucial. An ideal CMS line should flower earlier than the maintainer line to get maximum seed set in the CMS line and it should be lesser in height for abundance availability of pollen grains. The results indicated that 44 lines out of 56 were earlier flowering than the respective maintainer lines and 41 CMS lines have less plant height. Among these, 32 lines were ideally had earlier flowering and dwarf plant stature compared to the respective maintainer lines. The diversified lines are in the agronomic backgrounds of PBW 343, DBW 17, DBW 16, DBW 55, CBW 38, Raj 3077, PBW 550, UP 2338 and PBW 175. These may be easily maintained by planting with maintainer lines. Similar results were also reported by Venkatesh *et al*., 2012, Aruna *et al.*, 2013. On the other hand, none of the new CMS line in the background of PBW 502, DBW 60, DBW 76, GW 411 and Raj 4037 had earlier heading and dwarf plants in combination. These lines may require additional support like rope pulling for facilitating pollination while maintaining them.

It may be concluded that these new diversified CMS lines may be used intensively for development of hybrid wheat for Indian conditions so that new breakthrough may be achieved in wheat productivity.

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