

## Original Research Article

### Maintenance of Male Sterility in CGMS – A Lines in Safflower

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#### ABSTRACT

Two cytoplasmic genetic male sterile A line of safflower (*Carthamus tinctorius* L.) and their corresponding B lines developed at oilseeds Research Unit Dr. Panjabrao Deshmukh Krishi Vidyapeeth were tested for male sterility percent for three contiguous years. Male sterility ranged from 97-100% could be maintained in A lines by their corresponding B lines sterile plants in both the CGMS liens showed absolute sterility. Totals 34 genotypes of *C. tinctorius* were tested as R. lines for their fertility restoration in the two A lines. All those genotypes were able to restore 80-100% fertility. There was no deleterious effect of sterile cytoplasm of A-lines on test-cross (AXR) progenies. The present investigation indicated that A-lines tested were stable in male sterile expression and their corresponding B lines were effective to maintaining high male sterility percent in a A lines over years and across locations.

#### Keywords

Sterility,  
Fertility,  
CGMS,  
Safflower

#### Introduction

Safflower (*carthamus tinctorius* L.) is an important- *rabi* crop of India especially grown for its edible oil. Safflower is most suitable crop for cultivation under residual soil moisture. It is predominantly self-pollinated crop but out crossing recorded exceeding 50% depending upon genotypes (Rudolphi *et al.*, 2008). High to medium degree of heterosis especially for yield and yield attributing characters has been reported in safflower by many research workers. Heterosis can be exploited only where hybrid seed production is economically feasible. Commercial safflower hybrids have been produced using recessive genetic male sterility (Anjani, 1998) and cytoplasmic genetic male sterility (Hill, 2001) systems. First cytoplasmic genetics male sterility (CGMS) system were

reported by Hill (1989). The hybrids developed using this system reported 25-35% yield advantage over the best varieties in USA. The GMS based hybrid developed in India could yield up to 30% higher yield than best varieties. Though hybrids showing remarkable yield advantage over ruling varieties, however hybrids covered very negligible area in India seed production agencies should cool response mainly because of requirement of removal of 50% male sterile plant appearing in genetic male sterile female parent.

If the seed production problems if overcome, exploitation of hybrid vigour at commercial level would be possible in safflower. CGMS is proven effective system for large scale hybrid seed production in

many crops was reported. In India safflower CGMS system was first reported from cross between *C. oxycantha* and cultivated species. (Anjani, 2008).

The major problem in development of CGMS system in safflower is maintenance of high male sterility percentage in CGMS A lines for development of male sterile line. At Akola centre selfed seed CMS base F<sub>1</sub> hybrid was grown in block in 2005-06. After identification of male sterile plant in F<sub>2</sub>, it was crossed with male fertile plant of germplasm and GMS lines in all 150 pair wise crosses were made by using five genotypes GMU 2351, MMS (Non spiny), MS(0) 9, MMS spiny and ASD 07-03 with several backcrossing from 2005-2006. 65 pairs were selected on the basis of good opening of sterile flower, agronomic acceptability and showing 65 -85% sterility in rabi 2010-11, Out of Which MD-4-4.1 designated as AKSCMS 2A &B and MD 4-4.5 designated as AKS CMS 3A and B showed 100% sterility in 2011-2012 and 2012- 2013. The maintenance of male sterility in two cyto sterile A lines and fertility restoration of these A-lines discussed in the present paper.

### **Materials and Methods**

Two CGMS lines AKS CMS 2 A and B and AKS CMS 3A and B were used in this study fertility / sterility in A and B lines was assessed on individual plant basis during year 2011-12, 2012-13 and 2014-15. Male sterility assessed on main, primary, secondary and other order capituls, by visual observation for anther size and pollen presence, Anthers of sterile plants were also squashed and observed under microscope using acetocarmine to observe present of fertile pollen grains. The plants without pollen production were considered as male sterile. Pollen sterility in each A and B line

was recorded by taking mean at all plants. Test crosses were also made during 2012-13 and 2014-15. Total thirty four genotypes of *carthamus tinctorius* were tested for their fertility restoration all these genotypes were able to restore 80-100% fertility. Out of which seven lines were identified showing restoration above 80% Restorer lines are maintained by selfing using butter paper bags.

Butter paper bags were used for each capitula of A and B lines to avoid contamination before opening. unbagged capitulas of A and B lines were removed before opening. pollens of B lines used for maintaining A lines. Pollination was done with hand in morning hours for three days. One capsules / plant of A lines were not pollinated but bagged with butter paper before opening. At the time of harvesting these entire capsule harvested separately. Need base irrigation, crop production and protection measures were given to experimented plots every year.

### **Results and Discussion**

In India utilization of heterosis of hybrids will be very helpful as hybrids were proved to be more productive than highest yielding varieties. Hybrid seed production will be effective, stable and economical if pollination control mechanism is available. The inheritance pattern of male sterility in cytoplasm genetic male sterile lines developed at oil seeds Research Unit, Dr. PDKV, Akola need to be studied at present it shows dominance of fertility over sterility. The A-B lines and identified R lines showed 75-85 days for 50% flowering and took 130-140 days for maturity. CGMA A lines showed no deleterious effect on plant morphology. Male sterility was absolute to male sterile plants they remain sterile until maturity.

**Table.1** Evaluation of CMS lines for male sterility per cent at Akola and parbhani (2014-15)

Akola Location							Temp. during ( <sup>0</sup> C)				Relative humidity (%)			
CMS lines	Final plant stand	D F	D M	No. of sterile plants	No. of fertile plants	Male sterility	Bud initiation stage		Flowering stage		Bud initiation stage		Flowering stage	
							Max	Min	Max	Min	Max	Min	Max	Min
AKS CMS -2A	240	80	135	234	6	97	33.0	4.8	28.0	6.5	80	12	90	11
AKS CMS -3A	242	82	138	242	0	100	33.0	4.8	28.0	6.5	80	12	90	11

  

Parbhani Location							Temp. during ( <sup>0</sup> C)				Relative humidity (%)			
CMS lines	Final plant stand	D F	D M	No. of sterile plants	No. of fertile plants	Male sterility	Bud initiation stage		Flowering stage		Bud initiation stage		Flowering stage	
							Max	Min	Max	Min	Max	Min	Max	Min
AKS CMS -2A	450	87	137	445	5	99	26.8	17.8	32.8	16.0	88	61	80	28
AKS CMS -3A	315	89	138	311	4	98	26.0	13.7	30.8	13.8	86	43	77	22.5

**Table.2** Evaluation of CMS lines for male sterility per cent at Akola and parbhani (2011-12 and 2012-13)

CMS lines	2011-2012		2012-2013		Observations
	No. of plants	Sterility (%)	No. of plants	Sterility (%)	
AKS CMS-2A& 2B	11	100	200	100	Other characters - yellow-orange petal, opening of flower good.
AKS CMS-3A& 3B	16	100	180	100	White petal, spiny, opening of flower very good

Source: Annual report of Safflower 2012-13 and 2014-15.

No pollen grains were found in flowers of male sterile plants when tested under microscope.

Non pollinated capsules of male sterile plants were harvested separately no seed setting was observed, confirming absolute sterility of A lines. The flower head of A lines had good opening thin transparent looking anther with protruding styles useful for high cross pollination through honey bee

for hybrid seed production. Genotypes utilized for test crosses to A lines able to restore 80-100% fertility. This indicated that restoration of fertility is easy in present safflower CGMS system. Genotypes showing high restoration can be further restated using pair wise combination. There was no deleterious effect of sterile cytoplasm of A lines in test cross progenies with regards to seed germination plant morphology, growth and seed setting.

The male sterility present maintained in two A lines by their corresponding maintainer in different years is given in table 1 and 2. The maintainer lines (B lines) could consistently maintain high male sterility percent in A lines with the range 97-100%, Over the years and across the locations. The data of present investigation demonstrated that two A lines were stable in male sterility expression and their corresponding B lines were effective to maintain high sterility percent. For safflower hybrid seed production A lines were maintained through crossing between A and B lines and B lines were maintained through seed production under mosquito net or in isolation. These A lines showed stability for sterility of Vidarbha and Maharashtra location of Maharashtra state and will be useful for hybrid development and seed production for those major safflower growing areas.

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