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Research Note

# Assessment of stableness for male sterility in newly developed CMS lines in sunflower (*Helianthus annuus* L.)

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**Abstract**
Diversification of parental lines both CMS and restorer inbreds are the absolute necessities in sunflower heterosis breeding programme for developing hybrids with high yield, high oil content as well as biotic and abiotic stress resistance. A total of 11 inbred lines with high oil content and high yield from TNHSF 239 population and also promising inbreds from a three way cross (TNHSF 239 x Wild 1-3-2) x Morden derivatives were utilized in conversion programme for developing new CMS lines in sunflower. Eleven newly developed CMS lines from $BC_6$ back cross population were evaluated for their stability across three locations namely Coimbatore, Vamban and Chettinad. All the CMS lines except COSF8A and COSF 9A exhibited stable sterility across the locations and all the maintainers showed 100% fertility at all the three locations. Three CMS lines namely COSF 6A, COSF 7A and COSF 12A were identified for their high oil content (40-43%). Hybrids of these CMS lines showed positive heterosis for yield and yield attributing traits. Therefore, newly developed promising CMS lines can be effectively utilized in hybrid breeding programme for developing high yielding and high oil hybrids in sunflower.

**Keywords:** CMS, sunflower, stability, pollen fertility

Sunflower is an important oilseeds crop which contributes around 12% of the global production of vegetable oil worldwide (Meena *et al.,* 2019). With respect to production, sunflower takes fourth position after oil palm, soybean and canola oil and also it occupies second place after maize regarding heterosis breeding (Rauf *et al.*, 2017). Until the beginning of 1970's, open pollinated varieties were primary source for sunflower production worldwide. Identification of cytoplasmic male sterility (Leclercq, 1969) and its corresponding restorer genes (Kinman, 1970, Manivannan *et al.,* 2011) led the sunflower breeding to a newer altitude. Currently, more than 90 percentage of the sunflower area is occupied by hybrids due to their high yield potential. However, the success in hybrid/heterosis breeding can merely be achieved by the development of inbreds with wide genetic base (Girriraj, 1998, Reavanth *et al.,* 2021). Development of CMS lines and restorer inbreds with good combining ability for yield related traits are very significant in sunflower breeding programme.

A total of 11 inbred lines with high oil content (40-42%) and high yield developed from TNHSF 239 population and also inbreds from a three way cross derivatives , TNHSF 239xWild) x Morden, were utilized for developing new CMS lines in sunflower (**Table 1**). Above inbreds were crossed and $F_1$s were evaluated for complete male sterility maintenance and repeated back crossings was done with male parent upto $BC_6$ generation. The experiment was carried out at the Department of Oilseeds, Tamil Nadu Agricultural University, Coimbatore during 2005-2012. At $BC_6$ generation, 11 newly developed CMS lines were selected based on the homogeneity for

**Table 1. Pedigree details of inbred line utilized for conversion programme**

| | |
|---|---|
| COSF 6A | CMS 17A X TNHSF 239-1 |
| COSF 7A | CMS 234A X TNHSF 239-2 |
| COSF 8A | CMS 234 A X 8-1-1-4-1-7 (TNHSF-239-68-1-1-1B X (WILD 1-3-2 X MORDEN)) |
| COSF 9A | CMS 234 A X 8-1-1-5-1-9 (TNHSF-239-68-1-1-1B X (WILD 1-3-2 X MORDEN)) |
| COSF 10A | CMS 234 A X 17-1-1-1-5-15-1 (TNHSF-239-68-1-1-1B X (WILD 1-3-2 X MORDEN)) |
| COSF 11A | CMS 234 A X 17-1-1-1-1-15-2 (TNHSF-239-68-1-1-1B X (WILD 1-3-2 X MORDEN)) |
| COSF 12A | CMS 234 A X 17-1-1-3-2-19-1(TNHSF-239-68-1-1-1B X (WILD 1-3-2 X MORDEN)) |
| COSF 13A | CMS 234 A X 17-1-1-3-3-19-2 (TNHSF-239-68-1-1-1B X (WILD 1-3-2 X MORDEN)) |
| COSF 14A | CMS 234 A X 17-1-1-5-1-23-1 (TNHSF-239-68-1-1-1B X (WILD 1-3-2 X MORDEN)) |
| COSF 15A | CMS 234 A X 17-1-1-5-2-23-2 (TNHSF-239-68-1-1-1B X (WILD 1-3-2 X MORDEN)) |
| COSF 16A | CMS 234 A X 17-1-1-5-3-23-3(TNHSF-239-68-1-1-1B X (WILD 1-3-2 X MORDEN)) |

morphological characters like days to flowering, maturity, plant height and head diameter. The 11 selected CMS lines and their maintainer inbreds (*i.e.*) the isogenic lines were evaluated for male sterility /male (pollen) fertility alteration behavior and stableness of CMS lines across the environment with three replications and plot size of 5.2m$^2$. Stability experiment was carried out at three locations namely, Department of Oilseeds, Tamil Nadu Agricultural University, Coimbatore, National Pulses Research Centre, Vamban and Dryland Agricultural Research Station, Chettinad, Sivagangai Dt. of Tamil Nadu during *Rabi* 2018-19.

Inbred lines from TNHSF 239 population and three way cross derivatives , selected for their high oil content (40-42%), head diameter, seed yield, delayed maturity ( 90-95 days) and dwarfness were crossed with CMS lines *viz*., CMS 17A and CMS-234A. CMS 17A and CMS-234A is a good combining male sterile line for high seed yield, oil content and oil yield. Eleven newly developed CMS lines

**Table 2. Sterility and fertility behavior of *cms* lines and their maintainers**

| S.No. | Lines | Sterility/Fertility behaviour of *cms* lines | | | Pollen fertility |
|---|---|---|---|---|---|
| | | Coimbatore | Vamban | Chettinad | |
| 1 | COSF 6A | S | S | S | 0 |
| 2 | COSF 6B | F | F | F | 100 |
| 3 | COSF 7A | S | S | S | 0 |
| 4 | COSF 7B | F | F | F | 100 |
| 5 | COSF 8A | S | S/F | S/F | - |
| 6 | COSF 8B | F | F | F | 100 |
| 7 | COSF 9A | S | S/F | S/F | - |
| 8 | COSF 9B | F | F | F | 100 |
| 9 | COSF 10A | S | S | S | 0 |
| 10 | COSF 10B | F | F | F | 100 |
| 11 | COSF 11A | S | S | S | 0 |
| 12 | COSF 11B | F | F | F | 100 |
| 13 | COSF 12A | S | S | S | 0 |
| 14 | COSF 12B | F | F | F | 100 |
| 15 | COSF 13A | S | S | S | 0 |
| 16 | COSF 13B | F | F | F | 100 |
| 17 | COSF 14A | S | S | S | 0 |
| 18 | COSF 14B | F | F | F | 100 |
| 19 | COSF 15A | S | S | S | 0 |
| 20 | COSF 15B | F | F | F | 100 |
| 21 | COSF 16A | S | S | S | 0 |
| 22 | COSF 16B | F | F | F | 100 |

from $BC_6$ population were evaluated for their stability for male sterility across three locations. All the entries were replicated thrice in all the locations. Male sterility and fertility behavior of CMS lines and their maintainers are presented in **Table 2**. Results showed that all the CMS lines except COSF8A and COSF 9A exhibited stable male sterility across the locations and all the maintainers recorded 100% fertility in all the three locations.

A significant variation among CMS lines was also found in morphological and quantitative traits (**Table 3)**. Data revealed the range of days to 50% flowering from 50 days (COSF 14A) to 57 days (COSF 8A and COSF 9A) and maturity duration of 83 days (COSF 14A) to 90 days (COSF 8A and COSF 9A) (**Table 3**). Head diameter is a significant trait in sunflower which is directly related to yield increase by accommodating more number of seeds. It ranged here from 11.3cm (COSF 8A) to 17.8cm (COSF 15A).

Three CMS lines namely, COSF 6A, COSF 7A and COSF 12A were identified as best cms lines for their high oil content 40-43% and COSF 6A recorded highest oil content of 41-43%. These CMS lines were also tested for their heterotic potential for seed yield and other yield contributing traits. Promising CMS lines (COSF 6A, COSF 7A, COSF 10A, COSF 11A, COSF 12A, COSF 13A, COSF 14A, COSF 15A and COSF 16A) were crossed with three restorer inbreds namely RHA95C-1, CSFI 8002 and CSFI 99 and $F_1$s were evaluated for various yield attributing traits. Hybrids of CMS lines *viz.,* COSF6A, COSF 7A, COSF 11A, COSF12A and COSF 15A showed positive standard heterosis for plant height, head diameter, 100 seed weight, seed yield and high oil content. Three CMS lines namely COSF 10A, COSF 11A and COSF 14A showed negative heterosis for days to 50% flowering and days to maturity. Early hybrids are also preferable wherever hybrids are cultivated in rainfed condition with residual moisture and drought prone areas (Meena *et al.,* 2019).

Hence, these lines can be effectively utilized in heterosis breeding programme for developing high yielding hybrids with high oil content.

Thus parental line diversification especially in CMS base is pressing priority in sunflower for the development of high yielding hybrids with high oil content with biotic and abiotic stress resistance. Present study helped to identify the stable CMS lines *viz*., COSF 6A, COSF7A, COSF10A, COSF11A, COSF12A, COSF13A, COSF14A, COSF15A and COSF16A across the locations. Quantitative data revealed that three CMS lines namely, COSF 6A, COSF 7A and COSF 12A were high in oil content 40-43% and

**Table 3. Morphological and quantitative characters of newly developed *cms* lines**

| S. No. | *cms* and their maintainer lines | Days to 50% flowering | Days to maturity | Plant height (cm) | Head diameter (cm) | 100 seed weight (g) | Volume weight (g/ 100ml) | Oil content (%) | Seed yield/ plant | Disk floret colour or ray floret colour | Stigma colour | Pollen colour of maintainer line | Seed coat stripes on seeds | Head Shape at maturity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | COSF 6A/6B | 55 | 88 | 100-120 | 14.5 | 4.5 | 32 | 41-43 | 25.5 | Yellow | Cream | Yellow | Absent | Convex |
| 2 | COSF 7A/7B | 56 | 89 | 100-120 | 13.5 | 4.7 | 32 | 40-41 | 25.0 | Yellow | Cream | Yellow | Absent | Convex |
| 3 | COSF 8A/8B | 57 | 90 | 80-100 | 11.3 | 5.2 | 33.5 | 37-38 | 22.5 | Yellow | Purple | Yellow | Absent | Convex |
| 4 | COSF 9A/9B | 57 | 90 | 80-100 | 11.5 | 5.4 | 34 | 37-38 | 22.0 | Yellow | Purple | Yellow | Absent | Convex |
| 5 | COSF 10A/10B | 52 | 85 | 80-100 | 13.0 | 6.2 | 42 | 38-39 | 18.0 | Yellow | Purple | Yellow | Absent | Convex |
| 6 | COSF 11A/11B | 52 | 85 | 80-100 | 13.7 | 6.5 | 40 | 38-39 | 19.5 | Yellow | Purple | Yellow | Absent | Convex |
| 7 | COSF 12A/12B | 54 | 87 | 90-110 | 17.5 | 6.5 | 38 | 39-40 | 30.0 | Yellow | Purple | Yellow | Absent | Convex |
| 8 | COSF 13A/13B | 54 | 87 | 90-110 | 17.4 | 7.0 | 47 | 38-39 | 30.0 | Yellow | Purple | Yellow | Absent | Convex |
| 9 | COSF 14A/14B | 50 | 83 | 90-110 | 15.8 | 6.7 | 44 | 38-39 | 35.0 | Yellow | Purple | Yellow | Absent | Convex |
| 10 | COSF 15A/15B | 55 | 88 | 90-110 | 17.8 | 7.2 | 40 | 38-39 | 35.0 | Yellow | Purple | Yellow | Absent | Convex |
| 11 | COSF 16A/16B | 55 | 88 | 90-110 | 16.2 | 7.2 | 39 | 38-39 | 35.0 | Yellow | Purple | Yellow | Absent | Convex |

also hybrids of these lines showed positive heterosis for yield contributing traits such as plant height, head diameter, 100 seed weight, seed yield and high oil content. Hence, the newly developed promising cms lines can be effectively utilized for heterosis breeding programme in sunflower.

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