Characterization of different male sterile lines on morphological characters of India mustard \( \textit{Brassica juncea} \) along with their maintainer

Prem Kumar Gautam\(^1\), R.K.S. Rathore\(^2\), A.R. Sutar\(^3\) and B.B. Mangle\(^1\)  

\(^1\)Department of Botany G.T.P. College, Nandurbar 425412 (M.S.), India  
\(^2\)Department of Botany R.B.S. College, Agra-282003 (U.P.), India

Abstract  
Male sterility in plants can be controlled by nuclear genes cytoplasm or by both. There are three types of male sterility as G.M.S, C.M.S and C.G.M.S. Science a good number of CMS lines are availed in Indian mustard now a day; it is desirable to have a complete data base for their identification at earliest possible stage of growth with morphological characterization. The present investigation to work the characterization of male sterility in five CMS systems in Indian Mustard along with their maintainers based on morphological characteristics. The CMS system taken for investigation include. \textit{Ogura, Tournefortii Oxyrrhina, Moricandia and Trachystoma}.

The seeds obtained for above mentioned material were sown in the R.B.S college Agricultural research farm, Khandri Agra. A set of ten characters were observed in all the male sterile and their maintainer line. These characters include plant height, Number of primary branches and secondary branches, main shoot length, number of seeds per siliqua, Number of siliqua on main shoot, Pod length, 1000 seed weight, Seed yield per plant.

Keywords: Agra, Floral Biological Characters, Male Sterility mustard

INTRODUCTION  
\textit{Brassica juncea} popular known as Indian mustard is an amphidiploid \textit{Brassica campestris} and \textit{Brassica nigra}. Brown sarson and Toraia are the botanical varieties of \textit{Brassica campestris}. \textit{Brassica juncea} and Brassica campestris are the two olerous Speciea grown widely in India for their edible oil. Significant research investigations carried out during the period 1950-2001 have resulted in an increase of 33.29 percent in the mean production. There are number of ways to improve the productive and one such approach is the exploitation of F1 hybrid vigour which observed up to 300 percent in some of the diverse crosses in Indian mustard. The production of hybrid seeds on commercial basis is possible by use of male sterile lines.

Male sterility in plants can be controlled by nuclear genes, cytoplasm or by both. Broadly there are different mechanisms for control of male sterility in \textit{B. juncea}. A experiment was conducted at our research farm during 1999-2000 for characterization of different male sterile lines of Indian mustard based on morphological characters.

MATERIAL AND METHODS  
The experimental material comprises five CMS lines along with their maintainers. There are CMS lines of the following cytoplasmic background. \textit{Ogura system}, \textit{Tournefortii system}, \textit{Brassica oxyrrhina system}, \textit{Moricandia arvensis system} \& \textit{Trachystoma ballii} (Trachy) system.

This experiment is will be comprised at different male sterility system along with their maintainer lines. A single row of each above material was planted for the study. The experimental data were recorded for the following characters on 10 randomly chosen plants in each system. Plant height, Primary branches, Secondary branches, Length of main shoot, Siliquae on main axis, Length at siliqua, Seed per siliqua and seed setting percentage 1000 seed weight, Seed yield.

Observations  
The average plant height varied from 91 to 223 cm in five male sterile lines under present investigation. Tallest plants were recorded in \textit{Trachystoma} genotype and smallest in \textit{Moricandia} genotype. When the plant height of male sterile lines was compared with their respective maintainer lines, it was observed that the maintainer of each male sterile line was taller except in \textit{Trachystoma} genotype where the male sterile plantwere significantly taller than their maintainer plants. In \textit{Tournefortii}, although male sterile plants were less tall than their maintainer the difference was statistically insignificant (Table-01). Significant differences inbetween plant heights of male sterile and their maintainer lines were recorded in \textit{Ogura, Oxyrrhina, Trachystoma} and \textit{Moricandia} genotypes.

The average number of maximum primary branches (11.70) was observed in \textit{Trachystoma} male sterile line but plants of its maintainer line had minimum number of primary branches (7.50) In \textit{Ogura, Tournefortii, Oxyrrhina} and \textit{Moricandia} systems the number of primary branches per plant ranged in between (8.60 to 10.70) Moreover the difference in number of primary branches in male sterile lines and their maintainer lines was statistically insignificant except in \textit{Trachystoma} and \textit{Moricandia} which was significant even at 1 percent level of probability (Table 01). Among the male sterile lines average maximum number of secondary branches (33.40) per plant was recorded in \textit{Tournefortii}
and Trachystoma systems whereas minimum average number (5.00) of secondary branches per plant was observed in CMS Moricandia genotype. Among the maintainers Tournefortii genotype had maximum average number of secondary branches (42.10) when analyzed statistically, the difference in the number of secondary branches was found significant at 5 percent probability level in Ogura genotype and at 1 percent probability level in Moricandia genotype. The maximum difference in the length of main shoot was observed in male sterile and its maintainer line. This difference was, however, insignificant in statistical comparison of main shoot length in male sterile lines with their maintainers, it was found that main shoot of maintainer lines was larger. Than male sterile lines except in Trachystoma genotype which showed main shoot of male sterile line slightly larger than its maintainer. This difference was, however, insignificant in statistical terms. Maximum difference in the length of main shoot was observed in male sterile and its maintainer line of Moricandia genotype, followed by Tournefortii system. In Oxyrrhina and Ogura systems the average length of main shoot in male sterile line with respect to their maintainer lines also remained insignificant (Table-01).

The average length of main shoot varied from 28.40 to 80.70 cm in male sterile lines. The maximum shoot length of 80.70 cm was attained by Trachystoma genotype whereas minimum (28.40 cm) by Moricandia male sterile plants. On the other hand, the maximum length (85.50 cm) of main in maintainer lines was observed in Ogura genotype and the minimum (75.40 cm) in Tournefortii genotype. On comparison of main shoot length in male sterile lines with their maintainers, it was found that main shoot of maintainer lines was larger. Than male sterile lines except in Trachystoma genotype which showed main shoot of male sterile line slightly larger than its maintainer. This difference was, however, insignificant in statistical terms. Maximum difference in the length of main shoot was observed in male sterile and its maintainer line of Moricandia genotype, followed by Tournefortii system. In Oxyrrhina and Ogura systems the average length of main shoot in male sterile line with respect to their maintainer lines also remained insignificant (Table-01).

Among the male sterile lines average maximum number of siliquae on main axis (57.10) per plant was recorded in Ogura system whereas minimum (9.00) in CMS Moricandia genotype. Among the maintainer Tournefortii genotype had maximum average number of siliquae on main axis (59.10) when analyzed statistically, the difference in the number of siliquae on main axis was found significant at 5 percent probability level in Moricandia genotype. In rest of four systems, the difference in number of siliquae on main axis was found significant at 1 percent probability level in Moricandia system at 5 percent probability level. In rest of three systems, the difference of pod length in between male sterile and their maintainers remained insignificant (Table-01).

When length of pod was analyzed statically the difference in Tournefortii showed significant at 1 percent probability level and in Moricandia system at 5 percent probability level. In rest of three systems, the difference of pod length in between male sterile and their maintainers remained insignificant (Table-01).

Percentage of seed setting was recorded in five CMS line and their maintainers. Five randomly selected plants for each culture were tagged and ten siliquae from the main axis were plucked from each plant randomly. In CMS Moricandia, it was difficult to randomly select 10 pods form each main axis because the pod setting was very poor due to late flowering in the male sterile lines. Therefore, fifty siliquae form five plants were collected to evaluate the seed set percentage in this culture.

The data recorded is processed and presented in (Table-02). The perusal of table reveals that highest seed setting occurred in CMS Oxyrrhina followed by Ogura, Trachystoma and Tournefortii systems. In CMS Moricandia the seed setting was very low (14.02 percent) due to non-availability of sufficient viable pollen grains form its maintainer Flowers because the difference in flowers initiation in its maintainer and male sterile line was about 35 days. This difference in flowering is attributed to the abnormal growth pattern in CMS Moricandia. In this male sterile line the seedling, after emerging form the seed, remains with yellow leaves for several days. This chlorosis in leaves is gradually removed but a clear cut difference in growth pattern is seen in the male sterile and maintainers (Fig.1 (A&B)).

The other factor responsible for variation in seed setting in the male sterile line is due to their less developed nectary glands (Fig.2) (A&D).
Thus due to non availability of nectar in the male sterile flowers, the visits of pollinators (honey bees) are limited. In CMS Trachystoma, although nectary glands in male sterile flowers are fairly developed the seed setting was affected due to frequent occurrence of crooked carpels (Figs. 3 & 4).

The average 1000 seed weight varied from 1.75 to 4.56 gm in male sterile lines. The maximum seed weight 4.56 gm was observed in Ocura male sterile line whereas minimum 1.75 gm was observed in Moricandia male sterile system. Among the maintainers Oxyrrhina and Moricandia genotypes had maximum average seed weight of 4.59 gm each, followed by Trachystoma, Ogura and Tournefortii. On comparison of seed weight of maintainers (Table-2) was more than their male sterile lines except in Ogura genotype which showed seed weight of male sterile line slightly larger than its maintainers.
maintainer.

The average seed yield varied from 0.84 to 50.99 gm in male sterile lines. The maximum seed yield per plant (50.99 gm) was observed in Tournefortii male sterile line whereas minimum (00.84 gm) was observed in Moricandia male sterile line. Among the maintainers maximum average seed yield per plant (78.57 gm) was observed in Oxyrrhina whereas minimum average seed yield per plant (33.06 gm) was observed in Trachystoma genotype (Table-01).

On comparison of seed yield per plant in male sterile with their maintainers it was found that seed yield per plant of male sterile line was lower than their maintainers.

### Result and Discussion

Morphological characters studied in five male sterile lines along with their maintainer lines include plant height, number of primary and secondary branches, main shoot length, number of seeds per siliqua number of siliquae on main shoot, pod length, 1000 seed weight and seed yield per plant.

On comparison of plant height it was found that the male sterile plants were significantly shorter than their maintainer plants in CMS Ogura, Tournefortii, Oxyrrhina and Moricandia whereas in Trachystoma system, the maintainer plants were shorter in height. Shiga, Brar et al. and Badwal and Labana [5, 2, 1] also observed shorter male sterile plants in comparison to their male fertile plants. Thus, taller male sterile plants than their fertile counterpart in Trachystoma system are an unusual feature observed by the present investigator.

On comparison of primary branches in male sterile and fertile plants of different CMS systems, it was observed that less number of primary branches are found in male sterile plants of Moricandia, Ogura and Tournefortii system whereas in Trachystoma and Oxyrrhina system male sterile plants have more Moricandia, Tournefortii and Trachystoma, whereas more siliquae per main shoot were present in Ogura and Oxyrrhina male sterile plants have more branches than its fertile counterparts. Shiga [5] in Brassica napus and Gupta et al. [3] in Brassica rapa have reported same number of primary branches in male sterile and fertile plants. Thus, Oxyrrhina and Trachystoma systems with more number of primary branches in male sterile plants are peculiar.

Regarding the number of secondary branches per plant it was observed that Oxyrrhina male sterile and fertile plant have equal number of secondary branches, whereas Trachystoma and Ogura male sterile plants have more number of secondary branches but Tournefortii and Moricandia male sterile plants have less number of secondary than their fertile plants. Malik et al. [4] observed that two CMS lines developed in Brassica juncea through wide hybridization, in general, have greater number of secondary branches in comparison to their male fertile plants. Thus, less number of secondary branches per plants than their maintainer counterpart in Tournefortii and Moricandia systems is a disadvantageous feature observed by the present investigator.

Trachystoma system having both primary as well as secondary branches in greater number in male sterile plants in comparison to their maintainer plants is best suited to produce more pods per plant.

Measurements of main shoot in male sterile and fertile plants of five systems under present study revealed that Moricandia, Ogura, Tournefortii and Oxyrrhina male sterile plants were shorter than their fertile counterparts. In Trachystoma the main shoots of male fertile plants were slightly shorter that it’s male sterile plants.

When number of siliquae on main shoot counted on male sterile and fertile plants of each CMS system it was found that more
siliqueae per main shoot were present in maintainer plants than their male sterile plants in Moricandia, Tournefortii and Trachystoma, whereas more siliquae per main shoot were present in Ogura and Oxyrrhina male sterile plants.

The number of seeds per silique was larger in male sterile plants in Tournefortii and Oxyrrhina systems and equal in number in Trachystoma male sterile and fertile plants. Whereas the number of seeds per silique was smaller in male sterile plants in Ogura and Moricandia systems.

Variable size of pods was recorded in male sterile and maintainer line of each system except in Oxyrrhina which had equal size pods in sterile as well as fertile lines. In Trachystoma, Tournefortii and Moricandia system, the pods of male sterile plants were shorter than their maintainer lines however in pods of male sterile plants were shorter than their maintainer lines however; in Ogura system pods of maintainer line plants were shorter than its male sterile plants.

Data recorded on 1000 seed weight in five male sterile systems revealed that maintainer line plants in general had more weight than their male sterile lines except in Ogura system which had heavier seeds in male sterile plants. The size of seeds in male sterile Ogura system has been exceptionally large.

On comparison seed yield per plant it was found that male sterile systems showed lower seed yield per plant than their maintainer lines. Oxyrrhina maintainer lines remained highest seed yielder followed by Moricandi. On comparison of seed set percent it was found that male sterile plant have significantly lower seed set percent in comparison to their maintainer line.

**ACKNOWLEDGEMENTS**

The authors are thankful to the Principal R.B.S college, Agra for providing necessary research facilities and to NRCRM, Bharatpur, for supply of seeds of CMS line of Indian Mustard (Brassica juncea).

**REFERENCES**


