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Characterization of different male sterile lines on morphological characters of India mustard [*Brassica juncea* (L.) Czern & Coss] along with their maintainer

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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. *Ogura, Tournefortil 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

Brassica juncea popular known as Indian mustard is an amphidiploid *Brassica campestris* and *Brassica nigra*, Brown sarson and Toria are the botanical varieties of *Brassica campestris. Brassica juncea* and Brassica campestris are the two oliferous 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 *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 CMS lines are of the following cytoplasmic background. *Ogura system,Tournetortii system, Brassica oxyrrhina system, Moricandia arvensis system & 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 *Trachystoma* genotype and smallest in *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 *Trachystoma* genotype where the male sterile plantwere significantly taller than their maintainer plants. In *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 *Ogura, Oxyrrhina, Trachystoma* and *Moricandia* genotypes.

The average number of maximum primary branches (11.70) was observed in *Trchystoma* male sterile line but plants of its maintainer line had minimum number of primary branches (7.50) In *Ogura. Tournefortii, Oxyrrhina* and *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 *Trachystoma* and *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 *Tournefortii*

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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. In rest of the three systems, the difference in number of secondary branches in between male sterile and their maintainer lines 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 in between male sterile and their maintainer lines remained insignificant (Table-01).

The average length of pod varied from 2.28 to 4.82 cm in male sterile lines. The maximum pod length of 4.82 cm was attained by *Oxyrrhina* genotype whereas minimum (2.28 cm) by *Moricandia* male sterile plants. On the other hand the maximum length (4.82 cm) of pod in maintainer lines was observed in *Oxyrrhina* genotype and the minimum (3.57 cm) was observed in *Tornefortii* genotype. On comparison, pod length in maintainer lines was larger than their male sterile line except in *Ogura* genotype which showed pod length of male sterile line slightly larger than maintainer line but in *Oxyrrhina* genotype pod length of male sterile and maintainer lines remained the same

When length of pod was analyzed statically the difference in *Tournefertii* 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 maintainer lines 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 maintainer lines (Fig.1 (A&B).

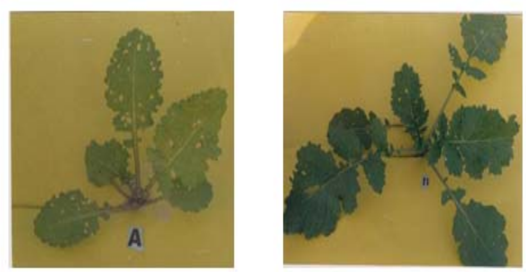

Fig. (1) (A) 25 days old seeding of *Moricandia* male sterile showing partial chlorosis. (B) 25 days old seedling of *Moricandia* maninrainer plant with normal leaves and better plant growth.

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).

(A) **(B)** **(C)** **(D)**

Fig. (2) (A-D) Flowers of male sterile plants alongwith maintainers showing comparative account of nectary glands, petals and gynoecia.
(A) *Ogura,* (B) *Tournefortii,* (C) *Oxyrrhina,* (D) *Trachystome*
Male sterile flowers are arranged on left side.

(Table-01) – Genetic Variability of parameter in male sterile and maintainer lines of Indian mustard (*Brassica juncea)*

Characters	Parametars	Ogura A	Ogura B	Tournefortii A	Tournefortii B	Oxyrrhina A	Oxyrrhina B	Moricandia A	Moricandia B	Trachystoma A	Trachystoma B
Plant hight In cm	Mean±	177.80 ±5.88	194.40±4.57	206.90±4.92	207.40 ±3.28	201.50± 4.24	214.00± .2.23	91.00±26.28	203.60± 7.03	223.00± 3.42	203.20±2.0514
	Range	150-202	171-216	180-228	190-224	180-219	202-222	50-190	180-223	205-240	90-212
	t-value	2.226*		.084NS		2.608*		4.139**		4.960**	
Primary Braches	Mean±	9.00±.81	9.30±.60	9.10± .78	10.70± 86	9.80±1.13	9.00±.61	3.00±.71	8.60±9.2	11.70±1.01	7.50±.76
	Range	6-14	7-12	6-13	7-15	6-17	6-12	1-5	6-11	7-18	2-11
	t-value	297NS		1.377NS		.618NS		4.802**		3.314**	
Secondary Branches	Mean±	25.00± 2.21	18.00±1.91	33.40 ±3.93	42.10± 4.32	29.30±5.67	29.30±3.56	5.00±1.64	24.20±3.05	33.40±4.18	25.20±1.91
	Range	16-36	7-25	29-48	28-66	42-67	14-50	1-10	15-32	14-54	5-33
	t-value	2.393*		1.489NS		.000NS		5.533**		1.783NS	
Main shoot length in cm	Mean±	79.00± 5.27	85.50±5.40	62.20 ±3.59	75.40± 2.77	76.30±4.92	82.70±7.03	28.40±4.00	81.80±6.63	80.70±3.58	80.00±6.93
	Range	51-98	64-113	45-78	64-90	50-97	42-109	20-45	70-96	65-100	50-120
	t-value	861NS		2.805**		.745NS		8.289**		.090NS	
No . of siliquae on main shoot	Mean±	57.10± 2.74	55.40±5.30	51.50 ±3.83	59.50± 1.75	52.10± 3.24	50.10± 4.30	9.00±.59	52.40± 2.61	45.10± 2.23	46.80±3.07
	Range	45-71	36-89	35-69	50-70	38-68	20-65	3-15	45-60	35-56	2-63
	t-value	.285 NS		1.898NS		.371NS		16.212**		.447NS	
No.of seed per siliqua	Mean±	14.20± .74	16.50±.05	20.50 ±1.28	15.80± .48	15.00±.44	12.80±.66	2.20±.86	17.60±.94	11.80±.44	11.80±.93
	Range	10-18	15-18	15-28	14-18	13-17	10-16	0-5	13-18	10-14	12-15
	t-value	2.829*		3.427**		2.759*		12.03**		.000	
Pod length In cm	Mean±	4.81±.18	4.48±.15	2.66± .09	3.57±.07	4.82±.11	4.82±.24	2.28±.95	4.50±.65	3.78±.19	4.36±.25
	Range	4-5.6	3.8-5.1	2.2-3.0	3.2-3.9	4.2-5.3	3.8-5.8	2.0-3.0	4.2-5.4	2.5-4.4	3.2-5.5
	t-value	1.38 NS		7.67**		.000 NS		3.45*		1.86 NS	
1000 seed weight (gm)		4.56	3.64	2.25	3.32	3.98	4.59	1.75	4.59	2.03	4.53
Seed yield Per plant (gm)		20.20	40.71	20.02	50.99	41.90	78.57	00.84	44.82	29.93	33.06

S = Not Significant
*=Significant at 5 percent probability level.
**= Significant at 5 percent probability level.

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 *Ogura* 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 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.

Fig. (3) Showing petaloid stamens fused Fig. on the male Gynoecia in *Tournefortii* Sterile line showing petaloid stamen

Fig. (4) Reproductive part of Trachystoma male sterile flower. and crooked gynoecium

(Table-02) Extent of seed set in five male sterile lines and their maintainers in Indian mustard (*Brassica juncea).*

Name of system	Seed set percent in CMS Lines (A)	Seed set percent in maintainer (B)	T- Value
Ogura	92.31	93.93	3.42**
Tournefortii	75.19	93.52	5.52**
Oxyrrhina	93.25	93.79	2.52*
Moricandia	14.02	86.70	27.78**
Trachystoma	81.49	92.33	3.72**

* Significant at 5 percent probability.
**Significant at 1 percent probability.

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 unusal 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 *Tournfortii* 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 siliquae 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 siliqua 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 siliqua 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.

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