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IMPACT OF CYTOPLASMIC MALE STERILE SOURCES ON SEED YIELD AND YIELD COMPONENTS IN SUNFLOWER

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SUMMARY

In order to study the influence of different alloplasmic male sterile lines on quantitative characters, three alloplasmic male sterile lines of the inbred line 852 were developed. The three different CMS sources used are CMS 852A (*H.petiolaris*), FMS 852A (*H.petiolaris* ssp. *petiolaris*) and IMS 852A (*H.annuus* ssp. *lenticularis*). These three lines were crossed to three restorers Acc. Nos. 1229, 232 and TUB 365 producing 9 hybrids (3 hybrids in three different sources). Similarly inbred line IB24A in two backgrounds FMS IB24A and IMS IB24A were crossed to four restorer lines 1229, 232, Tub 365 and 346 producing another set of 8 hybrids. These 17 hybrids along with their parents were evaluated during rainy season in the field by following randomized complete block design with three replications. Observations were recorded on seven quantitative characters. The different CMS sources did not significantly influence the traits such as plant height, days to maturity, head diameter, percent seed set, test weight and seed yield per plant. Thus alloplasmic hybrids were uniform suggesting that the new CMS sources can be commercially exploited like classical source with out any negative effect. However, in case of seed oil content the CMS source from *lenticularis* showed superiority over the classical cytoplasm by producing hybrids with significantly higher oil content. Therefore, these new male sterility sources can replace the classical source with added advantage.

Key words: ***Helianthus annuus* L., cytoplasmic male sterility, diversification, alloplasmic**

INTRODUCTION

The discovery of cytoplasmic male sterility (CMS) in sunflower by Leclereq (1969) and subsequent identification of genes for fertility restoration have resulted in the development of commercial hybrids since 1972. However, all the sunflower

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hybrids that are commercially grown have a single source of CMS discovered by Leclereq leading to homogeneity and potential risk that was evident in case of maize. Diversification of CMS sources is inevitable in any hybrid-breeding program. Fortunately in sunflower more than 62 new CMS sources of different origin have been reported (Serieys, 1999). The diversity of the new sources was assessed mainly based on cytoplasmic male sterility and fertility restoration systems (Serieys and Vincourt, 1987; Serieys, 1994). Only a few investigators have described interactions between cytoplasms and nuclear genes in the expression of several qualitative and quantitative characters and beneficial cytoplasmic nuclear interactions have been reported in various crops (Jan, 1992). In sunflower, a unique cytoplasmic nuclear interaction caused reduction in chlorophyll, photosynthetic rate and overall reduction in vigour (Jan, 1990) and positive effect and oil content (Serieys, 1992). The objective of this study was to study the effect of cytoplasmic male sterility sources on yield and yield components to exploit them in hybrid development programs.

MATERIAL AND METHODS

Alloplasmic male sterile line 852A in three different wild cytoplasmic male sterility background *viz*., *Helianthus annuus* ssp. *lenticularis* (IMS 852A), *Helianthus petiolaris* ssp. *petiolaris* (FMS 852A) and classical Leclereq cytoplasm (CMS 852A) and inbred line IB24 in two CMS background IMS IB24A and FMS IB24A were used as females in this study. These CMS lines were crossed to germplasm lines Acc. Nos. 1229, 232 and Tub 365 and Tub 364 producing 17 hybrids as given below.

I Set		
CMS 852A x 1229	FMS 852A x 1229	IMS 852A x 1229
CMS 852A x 232	FMS 852A x 232	IMS 852A x 232
CMS 852A x Tub 365	FMS 852A x Tub 365	IMS 852A x Tub 365
II Set		
IMS IB24A x 1229	IMS IB24A x 1229	
IMS IB24A x 232	IMS IB24A x 232	
IMS IB24A x Tub 365	IMS IB24A x Tub 365	
IMS IB24A x Tub 346	IMS IB24A x 346	

These 17 hybrids and their parents were grown during rainy season in the field following randomized complete block design with three replications. Each entry was grown in a row length of 45 m / replication with a spacing of 60 × 30 cm. Along the border 3 rows of Morden was grown and on both the sides of the experiment a large segregating population of sunflower was grown to provide sufficient quantity of pollen for male sterile hybrids, if any. Hand pollination during flowering was also carried out to ensure complete seed set in the hybrids. Five plants per replication were randomly chosen to record observations on eight quantitative characters. The

mean values of different hybrids were compared to assess the influence of cytoplasm on selected characters.

RESULTS AND DISCUSSION

The mean performance of hybrids in three different cytoplasmic backgrounds is presented in Table 1.

Table 1: Mean performance of hybrids and parents in respect of eight quantitative characters in sunflower

Hybrid	Plant height (cm)	Days to flowering	Days to maturity	Head diameter (cm)	% seed set	100 seed weight (g)	Oil content (%)	Seed yield / plant (g)
CMS 852A x 1229	162	61	85.7	11.0	77.4	2.7	31.6	11.8
FMS 852A x 1229	154	62	89	11.1	74.8	2.8	34.8	13.5
IMS 852A x 1229	153	62	87	10.0	66.7	2.5	33.9	11.4
CMS 852A x Tub 365	145	60	86	11.8	76.5	2.6	31.1	18.7
FMS 852A x Tub 365	147	60	86.7	10.6	80.2	2.7	31.4	13.8
IMS 852A x Tub 365	161	61	87.3	1.09	76.9	3.2	34.2	14.6
CMS 852A x 232	140	60	85	10.2	84.5	3.1	34.2	13.8
FMS 852A x 232	149	62	87.7	10.7	83.2	3.2	36.3	14.4
IMS 852A x 232	157	60	87.7	10.7	81.8	3.1	30.2	15.2
IMS IB24A x 1229	150	62	87.3	11.0	88.2	2.7	33.2	15.5
FMS IB24A x 1229	163	63	88.3	10.8	67.9	2.7	31.1	12.1
IMS IB24A x 232	164	63	87.3	10.3	82.5	2.8	34.4	14.9
FMS IB24A x 232	168	62	87.0	11.0	85.2	3.1	32.3	16.2
IMS IB24A x Tub 365	181	63	89.3	10.9	83.6	3.4	35.4	16.8
FMS IB24A x Tub 365	194	63	89.0	11.0	79.1	3.1	35.9	15.7
IMS IB24A x Tub 346	168	68	88.3	11.0	82.3	2.4	34.1	16.2
FMS IB24A x Tub 346	159	62	86.7	8.8	76.4	2.5	28.6	8.5
LSD at P=0.05	29	3	3.4	2.2	13.5	0.7	1.7	7.5

The hybrids showed significant variations for plant height, head diameter, percent seed set, test weight, oil content and seed yield. However, the differences were not high enough to be significant for the same hybrid in different cytoplasmic backgrounds for all the traits studied except oil content. There was no significant nuclear cytoplasm interaction for plant height, days to maturity, head diameter, percentage seed set, test weight and seed yield per plant. Such uniformity between different alloplasmic hybrids in sunflower was reported earlier (Serieys, 1992; Christov, 1992). In general the hybrids based on new CMS sources were taller and late maturing, while the hybrids based on classical cytoplasm showed marginal superiority for seed yield per plant, percent seed set and head diameter (Table 2). Similarly, Serieys (1992) observed that some CMS sources produced taller hybrids with late maturity compared to Leclercq's source. In second set of hybrids the

hybrids derived on IMS background were marginally superior compared to FMS (Table 3).

Table 2: Mean performance of hybrids in different cytoplasmic male sterility background

CMS source	Plant height (cm)	Days to 50% flowering	Days to maturity	Head diameter (cm)	% seed set	100 seed weight (g)	Yield (g/plant)	Oil content (%)
IMS (*lenticularis*)	157	62	88	10.33	76.34	2.85	13.07	34.60
FMS (*petiolaris*)	150	62	88	10.77	79.38	2.99	13.80	34.15
CMS (classical)	146	60	85	10.99	79.47	2.78	14.74	32.29

Table 3: Mean performance of hybrids of IB24A in two cytoplasmic male sterility background

CMS source	Plant height (cm)	Days to 50% flowering	Days to maturity	Head diameter (cm)	% seed set	100 seed weight (g)	Oil content (%)	Seed yield per plant
IMS	162	63	89	10.8	83.99	2.83	34.26	15.84
FMS	177	62	88	10.4	77.10	2.84	31.97	13.12

The hybrids developed based new CMS sources (FMS and IMS) recorded significantly higher oil content compared to corresponding hybrids based on classical source. The mean oil content of IMS based hybrids was 34.60 followed by FMS (34.18). In the second set also hybrids derived from IMS were superior compared to FMS for oil content (Tables 4 and 5). Similarly, Serieys (1992) showed that a new source EXT 1 acted positively on oil content.

Table 4: Performance of hybrids based on three alloplasmic lines for % of oil content in sunflower

Cross	Background				
	CMS	FMS	IMS	IMS-CMS	FMS-CMS
852A x 1229	31.54	34.74	33.86	2.32*	3.20*
852A x Tub 365	31.16	31.40	34.23	3.07*	0.24
852A x 232	34.16	36.32	35.72	1.56	2.16*
Mean	32.29	34.15	34.60		

*Significant at P=0.05

Table 5: Performance of hybrids based on alloplasmic lines for % of oil content in sunflower

Cross	FMS background	IMS background	Mean	FMS-IMS
IB24A x 1229	31.07	33.15	32.11	-2.08**
IB24A x 232	32.27	34.42	33.34	-2.15**
IB24A x Tub 365	35.92	35.37	35.64	8.55
IB24A x Tub 346	28.60	34.11	31.36	-5.51**
Mean	31.97	34.26	33.12	

**Significant at P=0.05

These results revealed that the hybrid developed using two new CMS sources are similar to hybrids having classical *petiolaris* cytoplasm with respect to many quantitative traits with added advantage of higher oil content. Therefore, these new

sources can replace the classical source if more number of restorers are identified. However, the cytoplasmic sources identified are to be tested over different environments and seasons to test their stability as sunflower is grown in wide range of agro-climatic conditions in India.

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INFLUENCIA DE LAS FUENTES CITOPLÁSMICAS MASCULINAS ESTÉRILES EN EL RENDIMIENTO DE LA SEMILLA Y COMPONENTES DE RENDIMIENTO DE GIRASOL

RESUMEN

Tres líneas aloplasmáticas masculinas estériles, fueron creadas de la línea inbred 852 para que se investigara la influencia de diferentes líneas aloplasmáticas masculinas estériles en las propiedades cuantitativas de girasol. Se utilizaban tres fuentes diferentes de CMS: CMS 852A (*H.petiolaris*), FMS 852A (*H.petiolaris* ssp. *petiolaris*) y IMS 852A (*H.annuus* ssp. *lenticularis*). Estas tres líneas se cruzaban con tres restauradores (N^{o} 1229, 232 y TUB 365), con lo que se produjeron nueve híbridos (tres con cada una de tres fuentes). Similar a ello, dos variantes de la línea inbred IB24A (FMS IB24A y IMS IB24A) se cruzaron con cuatro restauradores (N^{o} 1229, 232, TUB 365 y 346) con lo cual se obtuvo un completo más de ocho híbridos. Estos 17 híbridos y sus padres respectivos se valuaron en el campo durante la temporada de lluvias en el ensayo establecido por el sistema bloque de azar en tres repeticiones. Se han investigado varias propiedades cuantitativas. Diferentes fuentes de CMS no han tenido una influencia significante en las propiedades como son la altura de la planta, el número de días hasta la madurez, diámetro de cabeza, porcentaje de polinización, masa hectolítroica y el rendimiento de semilla por planta. Por lo tanto, los híbridos aloplasmáticos se han mostrado uniformes, lo que indica que estas nuevas fuentes de CMS pueden utilizarse con fines comerciales, como una fuente clásica, sin cualquier tipo de efectos negativos. Pero, en el caso del contenido de aceite en la semilla, la fuente de CMS de la subespecie *lenticularis* se ha mostrado superior en relación con el citoplasma clásico, produciendo híbridos con un contenido de aceite significativamente

más alto. Esto representa una ventaja adicional de esta nueva fuente de esterilidad masculina en el caso de sustitución de la fuente clásica.

INFLUENCE DES SOURCES STÉRILES MÂLES CYTOPLASMIQUES SUR LE RENDEMENT DES GRAINES ET LES COMPOSANTES DU RENDEMENT DANS LE TOURNESOL

RÉSUMÉ

Trois lignes stériles mâles alloplasmiques ont été créées à partir de la ligne inbred 852 dans le but d'examiner l'influence de différentes lignes stériles mâles alloplasmiques sur les propriété quantitatives du tournesol. Trois différentes sources de CMS ont été utilisées: CMS 852A (*H.petiolaris),* FMS 852A (*H.petiolaris* ssp. *petiolaris*) et IMS 852A (*H.annuus* ssp. *lenticularis*). Ces trois lignes ont été croisées avec trois restaurateurs (Nos 1229, 232 et TUB 365), ce qui a produit neuf hybrides (trois avec chacune des trois sources). Semblablement, deux variantes de la ligne inbred IB24A (FMS IB24A et IMS IB24A) ont été croisées avec quatre restaurateurs (Nos 1229, 232, TUB 365 et 346) ce qui a produit un nouvel ensemble complet de huit hybrides. Ces 17 hybrides et leurs parents ont été évalués à l'extérieur au cours de la saison des pluies dans un champ ensemencé selon le système de bloc aléatoire avec trois répétitions. Quelques caractéristiques quantitatives ont été examinées. Les différentes sources de CMS n'ont pas eu une influence importante sur des caractéristiques comme la hauteur de la plante, le nombre de jours avant la maturité, la circonférence de la tête, le pourcentage de fécondation, la masse par hectolitre et le rendement des graines par plante. Ainsi, les hybrides alloplasmiques se sont-ils montrés uniformes, ce qui indique que ces nouvelles sources de CMS peuvent être utilisées à des fins commerciales tout à fait comme les sources classiques sans aucun effet négatif. Cependant, dans le cas du contenu d'huile dans la graine, la source CMS de la variété *lenticularis* s'est montrée supérieure au cytoplasme classique, produisant des hybrides à contenu d'huile beaucoup plus important. Ceci est un avantage supplémentaire de cette nouvelle source stérile mâle lors du remplacement de la source classique.