

Review Article

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## Diverse Cytoosteriles in Sunflower: A Review

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### ABSTRACT

Sunflower (*Helianthus annuus* L.), a member of the family Asteraceae, is the fourth most important oilseed crop in the world. In India commercial cultivation of sunflower was started during 1972 while first sunflower hybrid developed in 1980 based on new sources of cytoplasmic male sterility (CMS). Single source of cytoplasm PET-1 derived from an interspecific cross between *H. petiolaris* and *H. annuus* has been exploited extensively for hybrid production in sunflower. Which give red alert of genetic vulnerability. Introduction of different cytoplasmic backgrounds into hybrid production will permit to increase the general variability of the cultivated sunflower and to avoid problems like genetic vulnerability. For the purpose new CMS sources have been obtained from *H. petiolaris*, *H. annuus*, *H. argophyllus*, *H. bolandery*, *H. debilis*, *H. exilis*, *H. giganteus*, *H. maximiliani*, *H. neglectus*, *H. niveus*, *H. praecox*, *H. rigidus* (*pauciflorus*) and *H. strumosus* etc.

#### Keywords

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### Introduction

The cultivated sunflower (*Helianthus annuus* L.) is evolved in North America, but now it is cultivated in warm temperate, subtropical and tropical climates throughout the world. It is the fourth most important oilseed crop in the world after soybean, Rapeseed-mustard and groundnut. It is extensively grown in Russia, Ukraine, Argentina, Rominia, China, Bulgaria, Spain, Kazakistan and India. It is taking prime

position in the oilseed economy both at global and national level. From breeding point of view the constraints of extending sunflower cultivation may due to:

The depending on synthetic and open pollinated varieties produced locally in its cultivation and the unavailable of suited hybrids characterized with high yield potential due to the unstable yield.. Commercial cultivation of sunflower was started in India

during 1972. In India, first ever sunflower hybrid developed by Seetharam (1980), the sunflower hybrids development is based on new sources of cytoplasmic male sterility (CMS) i.e. PET-1. Till date entire sunflower hybrids depend on single cytoplasmic background which favours the danger of genetic vulnerability.

### **CMS in sunflower**

CMS is a unique phenomenon, being not only an abnormality, transferred from one generation to another, but also a proved means of the production of hybrid seeds from varieties with heterotic effect. Spontaneous CMS, discovered in sunflower varieties were reported by Shtubc in 1958, Gundaev in 1966 and Volfin (1966).

These first CMS sources were peculiar with the lack of total maintenance of their sterility. Leclercq reported in 1969 the discovery of full of male sterility in some BC4 generations, obtained from a cross, made in 1964 between the species *Helianthus petiolaris* as a female parent and cultivated sunflower line, originating from variety Annavirskii 3497 as male parent and designed as PET1.

Furthermore, fertility restoration gene was identified by Kinman (1970), Leclercq (1971) and Enns *et al.*, (1972). According to Leclercq the cytoplasm of *H. petiolaris* influences the genome of cultivated sunflower and causes sterility. PET-1 is being used for commercial hybrid seed production. In present days sunflower hybrids mostly based on PET1 source for hybrid production, which may lead to the genetic vulnerability to biotic and abiotic stress. To reduce the chances of genetic vulnerability due to use of single CMS for hybrid seed production as in bajara (Tift 23A) and maize (T-cytoplasm), there is need to discover new CMS sources for hybrid production in sunflower.

### **Ways to produce CMS diversity**

For a great diversity in the CMS system as a fertility restorer different ways of CMS producing have been used. The experimental approach to obtaining new CMS sources in sunflower appears to be a very laborious task which and take a lot of time to create material suitable for the breeding work. Producing new CMS sources adds to the knowledge about the cause inducing the appearance of male sterility, its maintenance and the fertility restoration of the sterile material as well. Few methods are mentioned below used for production of novel CMS sources:

### **Interspecific hybridization**

Crossing of cultivated species with other or wild species of sunflower is one of the common and popularly used method for developing new CMS lines. During the fertilization process the nuclear material from the cultivated sunflower pollen combines with the nucleus of the female gamete belonging to the wild species. By merging the two nuclear materials changes occur in a new genome which is developed in hybrid. Changes occur in nuclear genome put forth impacts on mitochondrial genome. According to Sager a larger part of the mitochondrial proteins are coded by nuclear genes and are also synthesized in the cytoplasm. In the biogenesis of the mitochondria the nuclear genome and also the genomes of these organelles participate. This indicates that there is a significant correlation between the two kinds of genomes. Therefore changes in nuclear genome can cause changes in mitochondrial genome. As pollen producing genes are present in mitochondria, pollen sterility and fertility might get affected. Different wild species have been used for practicing inter-specific hybridization to get novel CMS sources. Wild species like; *H. petiolaris*, *H. agrophyllus*, *H. giganteus*, *H.*

*neglectus*, *H. petiolaris*, *H. exilis*, *H. maximiliani*, *H. annuus* (wild forms) etc.

### Application of mutagens

Mutation is a way to make heritable changes in cytoplasmic (mitochondrial) genes. Mutation has been used in the cytoplasm of the cultivated sunflower. Mutation could be used in two ways to affect cytoplasmic male sterility.

The first way can be achieved by direct use of mutagens on cytoplasm to directly affect pollen producing genes. Whereas the second one includes application of mutagens on

nuclear genes. A reaction takes place which is similar to that obtained in the inter-specific hybridization.

### Spontaneous appearance

Spontaneous appearance of CMS might be due to spontaneous and natural mutation caused by an unknown source of influence. Some inner biological factors might be responsible for genomic changes. The results as well as the process of spontaneous sterility appearance are the same as these causing the appearance of sterile plants obtained by inter-specific hybridization and experimental mutagenesis.

**Table.1** Overview of CMS sterility in sunflower

CMS Code	Origin
PET1	<i>H. petiolaris</i>
ANL1	<i>H. annuus ssp. lenticularis</i>
ANL2	<i>H. annuus ssp. lenticularis</i>
ANT1	<i>H. annuus ssp. texanus</i>
ARG1, ARG2, ARG3	<i>H. argophyllus</i>
PET2	<i>H. petiolaris Nutt</i>
GIG1	<i>H. giganteus</i>
MAX1	<i>H. maximiliani</i>
NEG1	<i>H. neglectus</i>
RIG1	<i>H. rigidus</i>
EXI2	<i>H. exilis</i>
ANO1	<i>H. anomalus</i>
BOL1	<i>H. bolanderi</i>
PEF1	<i>H. petiolaris ssp. fallax</i>
PEP1	<i>H. petiolaris ssp. petiolaris</i>
PRH1	<i>H. praecox ssp. hirsutus</i>
PRR1	<i>H. praecox ssp. runyonii</i>
STRP 555-1	Streptomycin mutant
MUT1	Irradiation of 'Hemus'
MUT2	Sonification of 'Peredovik

### CMS diversity

Diverse CMS sources in sunflower are thought to be derived from wild relatives of sunflower. Inter-specific hybridization with wild ones play an vital role for CMS diversity in sunflower. Several practices were made for inter-specific hybridization after discovery of PET-1 like.

### CMS ANL1

Anashchenko *et al.*, (1974) reported cytoplasmic male sterility in plants derived from crosses of *H. lenticularis* Dougl, with cultivated sunflower. Subsequent crosses of CMS plants and the cultivar Armavirets produced a stable, male sterile line Serieys (1987) designated this

cytoplasm as ANL1. Leclercq (1983) examined fertility of progenies from crosses of CMS ANL1 and CMS PET1 to 15 maintainer or restorer lines and concluded that CMS ANL1 and CMS PET1 were cytoplasmically different from one another.

### **CMS PET2, CMS GIG1, and CMS MAX1**

Whelan and Dedio (1980) reported and released three germplasm composite crosses, CMG-1, CMG-2, and CMG-3, utilizing *H. petiolaris* Nutt., *H. giganteus* L., and *H. maximiliani* Schrad., respectively. Wolf & Miller (1985) back crossed cytoplasmic male sterile plants from each source with the maintainer line HA 89 and produced the stable, male sterile lines designated as CMS PET2, CMS GIG1, and CMS MAX1. In a backcross system, HA 89 substitute its genome into the wild species cytoplasm background.

### **CMS ARG1**

Christov, (1990) made inter-specific crosses of *H. argophyllus* Torrey and Gray and cultivated sunflower which yield CMS ARG1.

### **CMS RIG1**

RIG1, derived from *H. rigidus* (Cass.) Desf., was obtained from VNIIMK, Krasnodar, USSR.

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