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Systems and Advantages of Male Sterility in *Tagetes* spp.

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Introduction:

Marigold (*Tagetes* spp.) is an ornamental plant belonging to *asteraceae* family. It is grown as an ornamental crop for loose flowers and as landscape plants for beautification due to its variable height and colour.

Different Species of Marigold:

There are about 53 species in the genus *Tagetes.*

Two common cultivated species of marigold, both annuals, *viz.*, African marigold (*T. erecta*) with and French marigold (*T. patula*) are native to Mexico and Gautemala. Other species like *Calendula officinalis* (Pot marigold), *Tagetes Tenuifolia* (Signet marigold) and *Tagetes Minuta* (Southern cone Marigold) also included in *Tagetes* spp.

African marigold plant is hardy annual plant with pinnate leaves and lanceolate leaflets grow about 90 cm. Serrated flowers with large globular heads and lemon yellow to yellow, golden yellow or orange in colour.

French marigold is a bushy annual plant with dark green pinnate leaves and linear leaflets grows to about 30 cm height. It has small yellow to red colour flowers and reddish stem. African Marigold is diploid and French marigold is teraploid and triploid hybrid is also developed from crossing tetraploid with diploid.

Flower Structure of Marigold:

Inflorescence of marigold is a capitulum composed of hundreds of florets with two different types, ray (female) florets in the periphery, and disk (bisexual) florets in the centre. Besides, flower with only ray or only disc florets are also observed.

Importance of marigold:

It is highly suitable for herbaceous border, shrubbery, hanging and window boxes. Prospects of commercialization of marigold are increasing, because it is ease grow, low nutrient requirement and easy availability of planting material.

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Marigold is a source of pigment for food colour, and poultry feed. Carotenoids are responsible for colour in marigold, the principal components xanthophylls and lutein offer an alternative to synthetic colours and used as natural food colorant. The extracted pigments have application in medicine and cosmetics. Marigold roots contain alpha- terthinyl which has nematicidal activity due to that in agriculture marigold is used as natural nematicide to control root knot nematode.

Male sterility:

The inability of plants to produce functional pollen, anthers or male gametes is known as male sterility.

Advantages of Male Sterility:

- Avoids enormous manual work of emasculation and pollination and reduced cost of hybrid seed production
- Production of uniform and stable male sterile lines increase the yielding ability and quality of F_1 hybrids, ultimately resulting in high productivity
- Speeds up the hybridization programme hence commercial exploit hybrid vigour.

Types of Male Sterility in *Tagetes* spp.

Three distinct male sterile systems are identified in marigold and classified as apetaloid, petaloid and gynomonoecious types based on their floral morphology and sexual expression. A thorough investigation revealed variations in inheritance pattern, utilization and maintenance.

- Apetaloid male sterility is controlled by single recessive gene and are maintained by intercrossing between sterile and fertile plants within the line.
- Petaloid and gynomonoecious male sterile systems are under the control of cytoplasmic inheritance and are maintained by vegetative propagation.

Apetaloid Male Sterile lines:

- Male sterile flowers with no petals and homeotic conversion of all floral organs turned into filament like structure.
- Absence of anther and devoid of pollenin sterile flowers. All the florets consisting of well-developed gynoecium with a style and stigmatic lobes.

Maintenance:

Such Genetic male sterile lines are maintained by repeated selected intercrossing between sterile and fertile plants, then stabilized through segregation in 1:1 fertile and sterile

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plants. Segregation pattern after selfing of fertile plants, is 3: 1 fertile and sterile plants confirmed apetaloid sterility being controlled by single recessive gene.

Homozygous recessive (msms) was apetaloid sterile plants and fertile plants of sterile line were heterozygous (Msms).

Petaloid male sterile lines:

In petaloid male sterile lines, flower capitulum is devoid of disc florets and only ray florets present. Each ray floret has functional gynoecium with style ending in stigma, but no androecium.

Maintenance:

Crossing of petaloid male sterile lines with pure fertile lines resulted in progenies with all petaloid sterile plants (100%) and indicated cytoplasmic inheritance of petaloid male sterilty. Identification of appropriate fertile cytoplasm line for maintenance of CMS is essential for seed propagated lines, however, maintenance through vegetative propagation avoids the necessity of maintainer line.

CMS petaloid lines are advantageous over GMS apetaloid overcoming the problem of rouging male fertile plants.

Gynomonoecious line:

Lines with two types of flowers in a capitulum, i.e. petaloid and hermaphrodite flower Petaloid female male sterile ray florets and fertile hermaphrodite disc florets.

Ray florets produce seeds when cross pollinated, disc florets produce seed when self or cross pollinated.

Maintenance:

Petaloid male sterile florets of gynomonoecious line cross with fertile line give all 100% petaloid male sterile plants and possible cytoplasmic inheritance of male sterility. Male sterile and hermaphrodite florets within a plant and selfing of hermaphrodite florets give 66.5% petaloid sterile plant, 19.3% fertile, 14.2% of gynomonoecious plant. Ratios varied between generations, no fixed ratio could be obtained from on selfing and intercrossing.

Among all three male sterile line, gynomonoecious lines are mostly prefer by consumer because these lines have Petaloid female male sterile ray florets and fertile hermaphrodite disc florets in capitulum and these lines could be maintained by vegetative propagation.

Future Thrust:

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- Identification of diverse source of male sterility within species is essential to avoid inherent risk associated with single source
- Genetic transformation of male sterile marigold and generation of stable transgenic plant should be investigated further
- Development of mass multiplication of thermotolerant petaloid male sterile line for commercial use over varied environments can be approached
- Protocol should be standardized for asexual propagation and maintenance of GMS lines
- Male sterility as mechanism to enhance shelf life can be exploited in marigold breeding programme besides its utility in hybrid development