Male Sterility (Cotton)

Male sterility refers to "a condition in which pollen is absent or non-functional in flowering plants".

The first case of male sterility in flowering plants was reported by Koelreuter in 1763. In cotton perhaps the first case of male sterility was reported by Justus and Leinweber in 1960. Later on several worker reported male sterility in cotton.

Male sterile plants do not set seed on selfing. They set seed only when pollinated with other plants having functional pollens. Male sterility occurs in nature due to spontaneous mutations. It can be induced artificially by chemicals or physical mutagens. In cotton male sterility helps in reducing the cost of hybrid seed production.

Types of Male Sterility:-

There are three types of male sterility found in cotton viz.
i) Genetic male sterility ii) Cytoplasmic male sterility.
iii) Cytoplasmic-genic male sterility.

Genetic male Sterility:-

Genic Male sterility refers to pollen sterility caused by nuclear genes. GMS is found in both tetraploid and diploid species of cultivated cotton. GMS is governed by recessive as well as dominant genes. GMS is governed by single as well as double recessive genes. Dominant M.S. is seldom used in practical plant breeding. In GMS the maintainer line is heterozygous at one locus only.

Drawbacks of GMS:-

Three drawback i) 50% of population is male fertile has to be roughed out every gen.
ii) Sterility sometimes broken means sterile plants become fertile.
iii) Identification of M. sterile & M. fertile plants is possible only after anthesis. This problem can be over come by the use

of markers genes closely linked with male sterility.

ii) Cytoplasmic male sterility:-

The pollen sterility which is controlled by cytoplasmic gens or plasma genes is termed as CMS. The plasma genes are present in chloroplasts and mitochondria. This type of male sterility is not of any use in cotton breeding, because the cross between sterile and fertile strains gives rise to sterile F_1. When restorer line is identified, CMS becomes Cytoplasmic genic male sterility.

iii) Cytoplasmic-genic male sterility:-

When pollen sterility is governed by the interaction of cytoplasmic and nuclear genes it is known as CGMS.

CGMS is available in upland cotton. It is of great practical value in cotton breeding. CGMS is highly suitable & reliable. It is not affected by environment. The hybrid seed is produced by crossing A-line (male sterile) with R-line (restorer) Cytoplasmic Genic male sterility is maintained by crossing A line (male sterile) with B line (male fertile)

Inheritance of male sterility:- (msms)S × (ms/ms) F → (ms/ms)S
male sterile maintainer male sterile

In cotton genetic male sterility is governed by either single recessive gene or two recessive genes.

A cross between male sterile and male fertile strains will produce male fertile Plants in F_1 in both the cases. Selfing of F_1 plants will give rise to fertile & sterile plants in 3:1 ratio when sterility is controlled by single recessive gene and in 15:1 ratio when sterility is governed by two recessive genes. The CGMS line has sterile genes in both nucleus and cytoplasm i.e (ms ms)S The hybrid seed is produced by crossing CGMS (A line) with restorer (R) line.

Transfer of male sterility:-

Back cross method is used for transfer of male sterility. Generally 6-7 back crosses are sufficient to transfer male sterility For transfer of GMS the adapted variety is used as male parent in F_1 generation F_1 3:1, Sterile × adapted var for transfer of sterility For CMS male sterile × adapted var - F_1 × adapted var 6-7 B.C.

Similarly CGMS can be transferred but the gene to be converted should have recessive genes on nucleus otherwise it would become male fertile (2)

Sources of Male Sterility :-

There are three main sources of male sterility viz.
1) Spontaneous mutation 2) Induced mutation 3) inter specific crosses
In cotton spontaneous mutation and inter specific crosses are the main source of MS. Spontaneous (mutation) genetic male sterile plants have been observed in G. hirsutum and G. arboreum. CMS & CGMS have been obtained through inter specific crosses between cultivated and wild species of cotton. The cytoplasm of three diploid species viz. G anomalum, G. harknessii and G arboreum have been reported to interact with nuclear genes of upland cotton & produce male sterility. The first strains of cytoplasmic male sterility were released by Meyer in 1973. DES-HEM 16 & 277 Two fertility restorer DES-HAF 16 & 277.

G. harknessii is mostly used for CMS line. CMS cotton results from the transfer of G hirsutum or G barbadense chromosomes into G harknessii cytoplasm. Fertility restoration is obtained from a single partially dominant (Rf) gene transfered from G. harknessii. These genes give good fertility restoration in G. hirsutum when homozygous, but only fair fertility restoration when heterozygous as in F_1 hybrid.
The dominant recessive gene ~~Ms~~ MS$_4$ normally give complete male sterility ~~observ~~ in cotton.

Chemically Induced Male Sterility :-

Various chemicals which are used for induction of male sterility are known as male gametocides. In cotton two chemicals viz Maleic Hydrazide and FW450 have been found effective in induction of male sterility. Mutagen induced male sterility is heritable while gametocide induced male sterility is non-heritable. Male sterility has great significance in hybrid seed production.

Inheritance Pattern in three types of Male sterility

Crosses between Male Steriles	Male fertile	Resulting Genotypes	Remarks
1- Genetic Male Sterility			
(ms ms)	X (Ms Ms)	(Ms ms)	All male fertile
(ms ms)	X (Ms ms)	(Ms ms)	Male fertile (50%)
		(ms ms)	Male sterile (50%)
2 Cytoplasmic Male Sterility			
( )S	X ( )F	( )S	Male sterile
3- Cytoplasmic genic Male Sterility			
(ms ms)S	X (ms ms)F	(ms ms)S	Male sterile
(ms ms)S	X (Ms Ms)S	(Ms ms)S	Male fertile
(ms ms)S	X (Ms Ms)F	(Ms ms)S	Male fertile
(ms ms)S	X (Ms ms)S	(Ms ms)S	Male fertile
		(ms ms)S	Male sterile
(ms ms)S	X (Ms ms)F	(Ms ms)S	Male fertile
		(ms ms)S	Male sterile

Note: Letters inside brackets represent nuclear genes and letters out sid brackets show cytoplasmic genes.

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Inheritance of M. Sterility

ms ms × Ms Ms
Male sterile ♂ fertile

F1 (Ms ms) Male fertile

F2 1 Ms Ms, 2 Ms ms, 1 ms ms
Male fertile ♂ Sterile

♀ A × ♂ B
ms ms Ms Ms

(Alic) ms ms × Ms ms ♂

♂ 1 Ms ms — Seed not harvested
1 ms ms ♀ — Seed harvested

♂ 1 Ms ms × 1 ms ms ♀

1 Ms ms — Seed not harvested
1 ms ms — Seed harvested

Maintenance of ♂ sterile line.