

Lecture: - 6

Male Sterility

6.1 Male sterility:- It is characterized by non-functional pollen grains, while female gametes function normally.

- It occurs in nature sporadically, perhaps due to mutation.
- Occurs mainly in bisexual plants.
- J.K. Koelreuter (1763) observed anther abortion within species & species hybrids.
- Male sterility is classified into three groups: (1) genetic, (2) Cytoplasmic, and (3) Cytoplasmic - genetic.

6.2 Manifestation of Male Sterility:-

- Absence or malformation of male organs.
- Failure to develop normal micro-sporogenous tissue- anther.
- Abnormal micro-sporogenesis deformed or in-viable pollen.
- Abnormal pollen maturation.
- Non dehiscent anthers but viable pollen, sporophytic control.
- Barriers other than incompatibility preventing pollen

6.3 Classification:- Kaul (1988) Classified male Sterility in three major groups:-

- ✓ **Phenotypic Male Sterility** (Morphological):- Not found in Brassicaceae

It is of three types of sterility:

- **Pollen sterility:-** in which male sterile individuals differ from normal only in the absence or extreme scarcity of functional pollen grains (the most common and the only one that has played a major role in plant breeding).
- **Structural or staminal male sterility:-** in which male flowers or stamen are malformed and non functional or completely absent.
- **Functional male sterility:-** in which perfectly good and viable pollen is trapped in indehiscent anther and thus prevented from functioning.

- ✓ **Genotypic Male Sterility:-**

- GMS also called as nuclear male sterility.

- Ordinarily governed by single recessive gene ms. But some dominant gene governing male sterility. e.g. in safflower.
- GMS occurs widely in plant and in given plant species several different ms gene act monogenically to produced male sterility
- Male sterility alleles arise spontaneously or may be artificially induced.
- A male sterile line may be maintained by crossing it with heterozygous male fertile plants. Such a mating produces 1:1 male sterile and male fertile plants.

It is of four types:-

i) Environmental sensitive male sterility:-

- A) Temperature sensitive male sterility (TGMS & PGMS)
- B) Temperature insensitive male sterility

a) Temperature sensitive genetic male sterility (TGMS):-

- In this Type of GMS complete male sterility is produced by the ms gene at higher temperature .(e.g.,23.3° C or higher temperature **for rice**)
- Temperature below critical point there is a normal fertility.
- Generally used to develop hybrid rice in china.
- Two lines (UPRI 95-140 TGMS and UPRI 95-167 TGMS) have been isolated as spontaneous mutants and registered as germplasm.

b) Photoperiod sensitive genetic male sterility(PGMS):-

- In case of PGMS, Expression of ms gene is drastically affected by the prevailing photoperiod, provided the temperature is within a critical range (e.g., 23-290 C for rice PGMS) within this temperature range complete sterility obtained in rice plant grown under long day condition (Day length more than 13 hr 45 min).
- Generally short-day condition obtain normal fertility.

Cytoplasmic male sterility:-

- This type of male sterility is determined by the cytoplasm.
- Since the cytoplasm of a zygote comes primarily from egg cell, the progeny of such male sterile plants would always be male sterile.
- Nuclear genotype of male sterile line would be almost identical to that of the recurrent pollinator strain.

- The male sterile line is maintained by crossing it with the pollinator strain used as the recurrent parent in the backcross programme since its nuclear genotype is identical with that of this new male sterile line.
- such a male fertile line is known as the maintainer line or B line as it is used to maintain the male sterile line is also known as the A line
- Cytoplasmic male sterility may be utilized for producing hybrid seed in certain ornamental species, or in species where a vegetative part is of economic value.
- But in those crop plants where seed is the economic part, it is of no use because the hybrid progeny would be male sterile.
- Cytoplasmic male sterility is not influenced by environmental factors such as low or high temperature in other words the sterility is stable.
- This type of male sterility found in onion, fodder jowar, cabbage etc.

Cytoplasmic Genetic Male Sterility: - CGMS is also known as nucleoplasmatic male sterility:-

- In this system both nuclear gene and cytoplasmic gene controls the male sterility.
 - This is a case of cytoplasmic male sterility where a nuclear gene for restoring fertility in MS line is known.
 - The fertility restorer gene 'R' is dominant and is found in certain strains of species or may be transferred from a related species.
 - This gene restores fertility in the MS line hence it is known as restorer gene.
 - The cytoplasmic MS can be included in CGMS system as and when restorer genes for them are discovered.
 - Restorer genes can be found for all the cases of cytoplasmic MS if thorough search is made.
 - This system is also known in cotton,maize, jowar, bajra, sunflower, rice, wheat etc.
- ✓ **This system involves:-**
- Cytoplasmically determined MS plants known as A line in the genetic constitution.
 - Fertile counter parts of A line known as maintainer line or B line with the genetic constitution.
 - Restorer plants used to restorer the fertility in commercial seed plots known as R lines in the genetic constitution.
- ✓ **Limitations of CGMS in Plant Breeding:-**
- Undesirable effects of cytoplasm: Male sterile cytoplasm generally has undesirable side effects.
 - For example - Texas cytoplasm in maize is the most successful cytoplasm commercially, but slightly retards growth, reduces yield, plant height and leaf number.
 - It also makes the plants susceptible to Helminthosporium leaf blight.
 - The male sterile cytoplasm in tobacco could not be used due to its severe undesirable side effects.

- Unsatisfactory pollination: Natural pollination is often not satisfactory, except in wind pollinated crops like maize. This reduces the production of hybrid seed and thereby increases its cost. In some sp. the capsicum, this has prevented the use of male sterility in hybrid seed production
- ✓ **Chemically Induced Male Sterility:-**The chemical at a particular concentration is sprayed on the foliage prior to flowering and this inhibits production of viable pollen without injuring the gynoecium.
 - The flower set seed on cross-pollination.
 - The chemicals used for inducing male sterility are called male gametocides, pollen sterility are called male gametocides, pollen suppressants and chemical hybridizing agents.

6.4 Significance of Male Sterility in Plant Breeding:-

- Hybrid production requires a female plant in which no viable gametes are borne.
- Emasculation is done to make a plant devoid of pollen so that it is made female.
- Genetic male sterility is used in hybrid seed production but has limitations due to the need to maintain female parent lines as heterozygotes & segregation of fertile & sterile plants each generation.

6.5 Limitation in Male Sterile Line:-

- Existence and maintenance of A, B & R Lines is laborious and difficult.
 - If exotic lines are not suitable to our conditions, the native/adaptive lines have to be converted into MS lines
 - Adequate cross pollination should be there between A and R lines for good seed set.
 - Synchronization of flowering should be there between A & R lines.
 - Fertility restoration should be complete otherwise the F1 seed will be sterile
- Isolation is needed for maintenance of parental lines and for producing hybrid seed.