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UGE 223, COMMERCIAL PLANT BREEDING

Male Sterility

For the production of hybrid seed, removal of anthers before fertilization is essential to avoid selfing. Manually removing of anthers is very tedious and time consuming process in almost all the crops except in Maize and Castor which are monoecious. The pre-requisites for successful hybrid seed production in large quantities are:

1. Existence of male sterility or self-incompatibility through which hand emasculation can be avoided.
2. Sufficient cross-pollination should be there to get good seed set.

Male sterility is characterized by non-functional pollen grains while female gametes functions normally. It occurs in nature sporadically due to mutations.

MS can be classified into three groups:

1. Genetic 2. Cytoplasmic 3. Cytoplasmic genetic

I. Genetic male sterility: GMS is mostly governed by single recessive gene ms, but dominant genes governing male sterility are also known eg: Safflower, MS alleles arise spontaneously or can be induced artificially. A GMS line can be maintained by crossing it with heterozygous male fertile plant. Such mating produces 50% m.s. & 50% MF plants msms x Msms (Male sterile) (Male fertile) msms : Msms (1:1) (Male sterile) (Male fertile)

Identifying the male fertile plants from the above progeny is difficult and time consuming. Hence GMS is not commonly used in hybrid seed production. In USA it is used in Castor. In India it was being used in Redgram, but presently it is being used in safflower.

Marker genes which are linked to male sterility/fertility can be used to identify the male fertile plants before flowering stage. For example in Maize there is a gene, pigmented hypocotyls (P) and green hypocotyl (P) which is closely linked with sterility locus

P S - Pigmented & Sterile

P F – Green & Fertile

At seedling stage all the green plants are to be removed and pigmented plants are retained, as they are sterile.

II. Cytoplasmic Male Sterility: In crops like Maize, Bajra and Sorghum, two types of cytoplasms were noticed. One is normal cytoplasm and the other is sterile one which interferes with the formation of normal pollen grains. This follows maternal inheritance therefore all the off springs will be ma le sterile.

As the F1 is male sterile, this system cannot be used in crops where the seed is economic part. Hence its utility is confined to certain ornamental species or where a vegetative part is of economic importance. Eg: Onion, Fodder Jowar, Cabbage, Palak
etc.

III. Cytoplasmic Genetic Male Sterility System: 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 used in almost all seed crops.

This system involves

1. Cytoplasmically determined MS plants known as A line in the genetic constitution.
2. Fertile counter parts of A line known as maintainer line or B line with the genetic constitution.
3. Restorer plants used to restorer the fertility in commercial seed plots known as R lines in the genetic constitution.

Transfer of Male Sterility from Exotic lines to Nature lines:

Most of the times the MS lines obtained from other countries may not be suitable to our condition. Examples are:

Crop Source of cytoplasm Drawbacks

Maize Texas Cytoplasm Susceptible to Helminthosporium leaf blight Sorghum Combined kafir Black glumes and chalky endosperm Pearlmillet Tift 23 A (Tifton) Susceptible to Green ear & downy mildew

Rice Wild abortive Incomplete panicle exertion

Sunflower H petiolaris H gigantis

Tobacco Microcephalan Reduced vigour in F1 hybrids

Wheat Aegilops caudata Susceptible to pistiloidy

Due to these drawbacks, the well adapted local lines should be converted into male sterile lines. This can be done by repeated back crossing of the local lines to the exotic MS lines.

Transfer of Male Sterility to a New Strain

Maintenance of Male Sterile Line or A line: Since A line does not produce pollen, seed is not formed for maintaining A line. It has to be crossed with its fertile counterpart having similar nuclear genes with fertile cytoplasm which is known as B-line.

Production of Hybrid seed: For production of hybrid seed, A-line has to be kept as female parent and the pollen parent should posses the restorer genes in order to induce fertility and seed development in the next generation. Such line is known as restorer line and denoted as R line. The A line & R line should be of different genetic constitution and should be able to give maximum heterosis.

Limitations in using Male Sterile Systems:

1. Existence and maintenance of A, B & R Lines is labourious and difficult
2. If exotic lines are not suitable to our conditions, the native/adaptive lines have to be converted into MS lines
3. Adequate cross pollination should be there between A and R lines for good seed set.
4. Synchronization of flowering should be there between A & R lines.
5. Sterility should be stable over the environments.
6. Fertility restoration should be complete otherwise the F 1 seed will be sterile
7. Isolation is needed for maintenance of parental lines and for producing hybrid seed.