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SCOPE AND CHALLENGES OF EXPLOITATION OF MALE STERILITY FOR DEVELOPING NEW HYBRIDS IN ORNAMENTAL CROPS

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Abstract

Hybrid seed are highly demanded in ornamental crops due to their vigour and uniformity. In Ornamental crops hybrids are preferred as both loose flower and bedding plants. Traditional method of emasculation and hybridization is very labour intensive and thus increase the cost of production of hybrid. Exploitation of male sterile lines for development of hybrids not only reduces labour cost but is quit practical also. Presently male sterile line has been reported in few ornamental crops only and further work is going on other crops regarding development of male sterile line in more ornamental crops.

Key word: male sterile line, hybrids

Introduction

Flowers have been associated with mankind since time immemorial, as they have been used for religious offerings, social ceremonies and other purposes. Growing of loose flowers mostly for worshipping, garland making and decoration forms the backbone of Indian floriculture. F_1 hybrids are gradually getting popular with the growers due to their several advantages, *viz*., large size of bloom, uniform flower, better yield, etc (Goldsmith ,1968). This trend led to increased demand for their seed, Globalization of Indian economy and subsequent liberalization of Seed Act paved the way for the advent of hybrid seed production in India. It is a lucrative business having high returns per unit area. (Kundu and Mehta, 2005). The term heterosis, often used synonymously with hybrid vigour, refers to the superiority of the F_1 hybrid in one or more characters over its parents. Generally heterosis is manifested as an increase in vigour, size, growth rate, yield or some other characteristics. Development of hybrid varieties for genetic improvement of yield is referred to as heterosis breeding. Heterosis can be fully exploited in the form of hybrids and partially in the form of synthetic and composite varieties. Expression of heterosis is confined to the first generation only. Heterosis may be positive or negative both positive and negative heterosis are useful in crop improvement, depending upon the breeding objectives.

Traditionally emasculation and subsequent hybridization technique is used to form hybrid which is a very labour intensive procedure. But with the discovery of male sterile line this tedious work of emasculation can be substituted with plantation of male sterile line. This technique is now very commonly used for making hybrid in vegetable and agronomical crop such as rice but in ornamental crops application of male sterility for hybrid seed production is limited to few crops only. Male sterility is defined as the failure of plants to produce functional anthers, pollen, or male gametes. Male sterility is manifestations as absence or malformation of male organs (stamens) in bisexual plants or no male flowers in dioecious plants or failure in development normal microsporogenous tissue- anther. Abnormal microsporogenes formation or nonviable pollen also results is male sterility. Abnormal pollen maturation or inability of pollen to germinate on compatible stigmata also causes male sterility. Sometimes pollen may be viable but there is nondehiscent, this type of male sterility is sporophytic control. Barriers other than incompatibility also preventing pollen from reaching ovule and results in non fertilization.

Male sterility could be genetically controlled such as genic male sterity. Male sterility could also result due to some mutation i.e., In stamenless male sterile mutant very often the stamen can be deformed to a varying extent, undeveloped or do not form a stamen at all. It is controlled by a single recessive gene – *sl* (Stamenless) (Hanson and Bentolila, 2004). Male sterility could be due to maternally inherited trait such as cytoplasmic male sterility. Male sterility can also be artificially induced using some certain chemicals.(Mac,1985)

Occurrence male sterility in ornamentals

Among ornamental, both genic and cytoplasmic male sterility is found in petunia. Many deleterious side affects are associated with CMS in Petunia CMS is also found in petunia which is associated with environmental factors. Welzel(1954) reported induced genic male sterility within the commercial variety 'Rose of Heaven' by X-rays. It had tapetal failure linked with reduced plant and flower size. Genic male sterile mutant RL-a6 isolated from cultivar 'Moonstone' of petunia (Wiering, 1979).This was controlled by single recessive gene.

S. Izhar and R. Frankel in 1973 compared free amino acid contents in the anthers of male fertile, cytoplasmic male sterile (*cms*) and genic male sterile (*gms*) petunia lines at different developmental stages of the male gametophyte and found that there was quantitative differences in the amounts of free amino acids between the fertile and male sterile lines and between the *cms* and *gms* lines. The differences between the sterile lines were correlated with the different developmental stages at which the breakdown in microsporogenesis occurred. In the Rosy Morn (*RM*) *cms* line, where breakdown of microsporogenesis occurred at the end of prophase 1, there was an associated increase in asparagine and decrease in the other amino acids. In the *RM gms* line, in which breakdown occurred at the tetrad stage, an accumulation of asparagine in the anthers corresponded with an accumulation of glutamine beginning at prophase 1. Compared with fertile anthers, the sterile anthers accumulated much proline at the early meiotic stages, but no γ-aminobutyric acid. Comparison of the free amino acids of the fertile and the male sterile lines indicates that certain biochemical events leading to breakdown of microsporogenesis precede the observed cytological breakdown. The results from adding asparagine and glutamine to extracts of anthers at different developmental stages suggest that the amino acid balance may contribute to the changes in pH in the fertile and male sterile anthers

Apetalous male sterile inflorescence is found in zinnia. These line are referred as "femina", their head are entirely pistillate. Cowen and Ewart(1990) reported single recessive inheritance of male sterility in zinnia in apetalous male sterile line MS_1, MS_2, MS_3 and MS_4 .The apetalous and male sterile characters are very likely pleiotropic. Ewart (1981) reported Genic male sterilty in *Salvia spendens* and concluded that it has single recessive inheritance. Savchenko, L. F. (1980) studied environmental effect on expression of male sterility in salvia and reported that Under optimum soil moisture conditions (80% full field capacity), normal anthers developed on long filaments in fertile forms of Salvia regardless of fluctuations in air temperature. Artificial drought combined with increased air temperature resulted in the appearance of sterile anthers, generally on long filaments. In forms of S. sclarea with cytoplasmic male sterility, only sterile stamens differing from the norm in the length of their filaments were formed under both normal and drought conditions. An increase in air temperature under fairly moist soil conditions increased the number of sterile anthers on long filaments, while soil drought increased the number of short filaments. A fertile allopolyploid form of M. piperita proved resistant to fluctuations in soil moisture and formed fertile flowers at both 100% and 50% full field capacity. A decrease in soil moisture after meiosis led to a reduction in the number of fertile flowers. A sterile hybrid of M. piperita generally produced sterile flowers; a few fertile anthers developed only when the plants were well supplied with moisture.

Tower (1961) reported apetalous male sterile association in genus *Tagetes*. He coined the term "femina" for inflorescence of this type. The occurrence of the unique apetalous characteristics associated with the male sterile trait is extremely beneficial for hybrid seed production as they are easily recognized. Apetalous and male sterile characters are pleiotropic. Inheritance of apetalous male sterility in marigold was also found to be governed by a single recessive gene i.e., *msms*. (Gupta *et al*., 1999). Since almost all male sterile lines reported in different flowering annuals are recessive in inheritance. So they segregate into male sterile and male fertile plants in 1:1 ratio. Hence, only 50% of female parent population can be utilized for hybrid seed production and rest goes waste. To avoid wastage of 50% of population which is generated at the cost of huge labour charges, field maintenance and several other inputs, otherwise can be used effectively for some other purposes. To avoid this *in vitro* technique to clone male sterile line was standardized (Ajit Kumar *et al.,2003).* Sykorova, O (1975) found a new type of male sterility in the snapdragon cultivar 'Slavia' and reported that Male sterile plants produced no fertile pollen grains. Crossing of sterile plants with fertile ones from the same cultivar gave a 100% fertile F1 population; in the F2 generation there was a segregation 3:1 in the fertile: sterile plants. Crossing a sterile form with some chlorophyll mutants of the wild snapdragon, produced, in F2 populations, few plants with the parental phenotype. The amount of fertile pollen grains in fertile plants ranged 0-100%. A study of the anatomical development of anthers showed differences between a sterile form, a form with 0-10% viable pollen grains and plants with higher percentage of viable pollen grains. More than 1 system of genetic control apparently acts in this type of male sterility.

Conclusion

Although there is large domestic and international market for hybrid seeds but still technique of male sterility is rarely used for development of new hybrid particularly in case of ornamentals. Moreover farmer at local domestic market also prefer self pollinated seed as compared to hybrid due to its high cost. So there is an urgent need for development of commercial strategies for exploitation of heterosis includes economizing the cost of hybrid seeds. There should be scope for the development of more efficient male sterility systems in respective crops Hybrid must satisfy the needs of the customer for all important traits. It must ensured that price of hybrid seed must be low enough to enable the customer to make substantial profits from annually recurring investments but price must be high enough to enable the seed company to make substantial profits from its investments in research, production and sales.

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