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Apomixis: A Tool for Fixation of Heterosis

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SUMMARY

Apomixis means development of embryo without fertilization. Applying apomixis produces plants as a clone of mother plant and overcomes the problem of breaking heterosis due to segregation. This means that hybrid seed needs to be constantly renewed and parental stocks maintained and stored and this increases cost of hybrid seed.

INTRODUCTION

In traditional plant breeding hybridization means a cross made between genetically dissimilar parents. Whatever F_1 produced by hybridization show superiority over both parents in economic characteristics called as heterosis. We cannot maintain heterotic gene combinations in F_2 and subsequent generations due to segregation This means that hybrid seed needs to be constantly renewed and parental stocks maintained and stored. Strategies are often required to minimize contamination of hybrid seed with unwanted seed progeny from each parent, further adding to the cost of production. Economies in hybrid seed production could be made if heterosis could be fixed and maintained in successive seed generations. Heterotic gene combination can be fixed by vegetative propagation, by apomixis and by balanced lethal system (in *Oenothera*).

Apomixis

In Apomixis (asexual seed formation) is a phenomenon in which a plant bypasses the most fundamental aspects of sexual reproduction meiosis and fertilization to form a viable seed. Plants can form seeds without fertilization, and the seed genotype is consistent with the female parent. The major advantage of apomixis over sexual reproduction is the possibility to select individuals with desirable gene combinations and to propagate them as clones. In contrast to clonal propagation through somatic embryogenesis or in vitro shoot multiplication, apomixis avoids the need for costly processes, such as the production of artificial seeds and tissue culture. It simplifies the processes of commercial hybrid and cultivar production and enables a large-scale seed production economically in both seed and vegetatively propagated crops. The transfer of apomixis an asexual mode of seed formation to agricultural crops where it is largely absent may enables perpetuation of hybrid vigour and economies in commercial hybrid seed formation. Apomixis had the potential to fix heterosis because meiosis does not occur during embryo sac formation. Embryo formation is fertilizer independent with the embryo maintaining a maternal genotype and functional endosperm development occurs with or without fertilization. The fixation of heterosis in crop species by apomixis resulting decrease in the cost of seed production.

Fixation of Heterosis by Apomixis:

Apomixis is common among citrus fruits, black berries, roses, blue grasses and several other ornamental plants. If F_1 and its progeny produce only apomictic seeds having 2n embryos, the F_2 and the subsequent generations will be identical in genotype to the F_1, therefore, fixing the heterosis. There could be possibility of modification of sexually reproducing crops into apomicts by isolation of genes controlling asexual seed production and incorporation in sexual crops. 'Harnessing apomixis genes for plant improvement offers the potential for quantum leaps in agriculture production – an 'asexual revolution', the benefits of which could dwarf those of the 'Green Revolution'– First International Conference on Apomixis (September 1995, College Station, TX, USA). For apomictic hybrid seed production, female parent reproduction should be sexual, while the male preferably obligate apomict. For F1 and subsequent generations to produce only apomictic seeds, the dominance of apomixis over sexuality is must. Apomixis preserves the maternal genotype by parthenogenetic embryo development, maintaining heterozygosity and epistasis. Unfortunately, major crop species are devoid of natural occurrence of apomixis (except Citrus, mango and mangosteen, having adventitious embryony). Introduction of apomixis is being attempted in sexual crops by traditional plant breeding e.g. in maize by introgression from *Tripsacum*, an apomictic wild relative (Dijk and Damme, 2000). The one-line hybrid breeding for fixation of heterosis in rice could be realized by using EAGS rice or apomictic rice (Hwa and Yang, 2008)

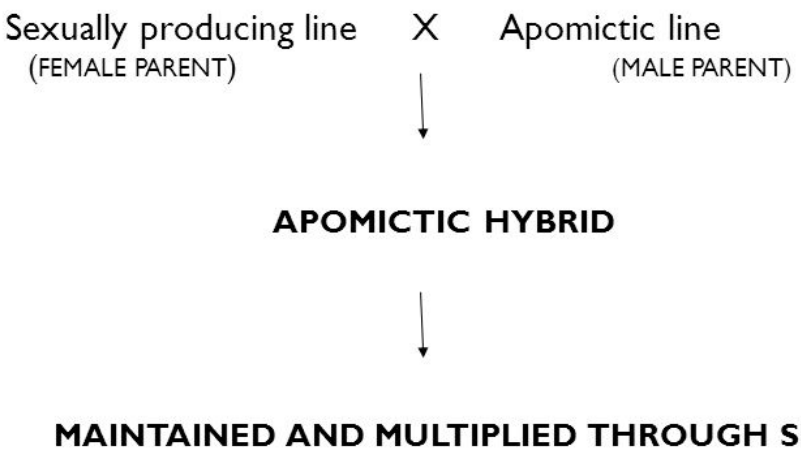

Fig. Fixation of Heterosis by Obligate Apomixis Governed by Dominant Gene

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