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Distant Hybridization in Fruit Crops

D. U. Pujar*, U. U. Pujar, Shruthi, C. R., A. Wadagave, S. S. Hiremath

University of Horticultural Sciences, Bagalkot, Karnataka, India

*Corresponding Author E-mail: deepapjr13@gmail.com

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ABSTRACT

Wide (Interspecific and Intergeneric) hybridization is an important research approach for developing useful variability for breeding populations in crop. Desirable traits like resistance against pathogens or abiotic stress within varying environments, composition of metabolites or morphological traits and their responsible genes are often found only within wild species (treasure of valuable genes), related species and genera of the cultivars but these are lacking in cultivated species mostly. So, wide hybridization helps in gathering all desirable traits in one species or nucleus. However, there are several problems associated with distant hybridization, but by overcoming those problems it is possible to generate useful hybrids.

Key words: *Hybridization, Distant, Fruit crops*

INTRODUCTION

Most of the fruit crops are perennial in nature, they stand for long time in field. Hence, they prone to several biotic and abiotic stress during their growth and development. We can achieve resistance or tolerance through many methods of breeding, such as introduction, hybridization, mutation, genetic engineering and selection. However, among them hybridization is a only reliable method of crop improvement for biotic and abiotic stress tolerance or resistance. Wild species are the treasure of valuable genes. Exploration of these genes could be possible through distant hybridization. Crossing between individuals from different species belongs to the same genus (interspecific hybridization) or two different genera of same family (intergeneric hybridization) is termed as distant hybridization and such crosses are known as distant crosses or wide crosses.

There are two types, Interspecific (crossing between two species of same genus) and intergeneric (crossing between two genera of same family). Distant hybridization is an important approach for developing useful variability for breeding populations in crop. Desirable traits like resistance against pathogens or abiotic stress within varying environments, composition of metabolites or morphological traits and their responsible genes are often found only within wild species (treasure of valuable genes), related species and genera of the cultivars but these are lacking in cultivated species mostly. So, distant hybridization helps in gathering all desirable traits in one species or nucleus.

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However, there are several problems associated with wide hybridization such as occurrence of self and cross incompatibility which lead to poor recovery of viable seeds or hybrids. These barriers are broadly categorized into three major barriers *viz*., temporal and spatial isolation of species (difference in climatic and ecological region of cultivated and wild species), Pre fertilization barriers (due to presence of pollen germination inhibition factors) and Post fertilization barriers (due to breakdown of embryo). However, success can be achieved after overcoming incompatibility barriers. The techniques such as mentor pollination, use of bridge species, embryo rescue and protoplast fusion have played significant role in recovering of hybrids.

Techniques to overcome barriers in wide hybridization:

There are several problems associated with wide hybridization such as occurrence of self and cross incompatibility which lead to poor recovery of viable seeds or hybrids. But there are many techniques to overcome these problems leading to successful cross.

1. **Manipulation of ploidy level:**

Strawberry: Instrawberry it was found that *Fraggaria nilgerrensis* (wild species) is having typical peach aroma.Most of the time strawberry will be used for processing purpose. With the invent of new aroma in wild species resulted in restricted or no use of synthetic aroma compounds. Interspecific hybridization between *F.* x *ananassa* cv. Toyonoka and *F. nilgerrensis*var. Yunnan resulted in transfer of peach flavor from wild species (*F. nilgerrensis* var. Yunnan) to cultivated species (*F.* x *ananassa* cv. Toyonoka). But resulted progeny is triploid without any seeds that can be overcome by restoring fertility by doubling chromosome with treatment of colichicne (mutagen). This resulted in development of hybrid TN-13-125 which is having fruit quality and taste similar to cultivated strawberryspecies with added advantage of peach flavor from wild species. This helps in development of strawberry with special aroma which is having commercial importance in processing industry[6].

Banana: Availability of fertile seeds upon crossing in banana is very difficult task. Since it is triploid which results in no seeds. By doubling chromosome by colichicine to tripolds helps in recovering fertile seeds[5]. In banana they have produced fertile triploid interspecific hybrids which are high yielder and resistant to major diseases. By treating with colichicine these sterile seeds could be restored s fertile seeds. Theses seeds could be used as a base material for breeding purpose for crop improvement programme.

2. **Use of nutrient solution or growth regulators:**

Papaya: Most of the cultivated papaya varieties are susceptible to major disease PRSV (Papaya Ring Spot Virus) and also cold susceptible. Resistance source for both is present in *Vasconcellea* genus but they are incompatible with cultivated species *Carica papaya*. This intergeneric barrier could be broken by using nutrient solution (sucrose 5%) reported by Jayavalli *et al*[4]., which ultimately resulted in generation of viable hybrid embryo through enhanced pollen germination and pollen tube growth. Resultant hybrid progeny will be having resistance to both PRSV and cold. In this regard nutrient solution provides energy source for germination ultimately resulted in seed set.

3. **Embryo rescue and somatic embryogenesis technique:**

Papaya: Embryo rescue and somatic hybridization are the best techniques to overcome incompatibility barriers. Azad *et al*[1]., have reported that plant regeneration and somatic embryogenesis through interspecific hybridization between the local papaya varieties (Shahi and Ranchi) and the wild papaya species (*Vasconcellea goudotiana* and *V. cauliflora*) have been carried out successfully. They rescued embryo at different stage of its growth to know exact stage of embryo abortion. The cross between the native variety *C. papaya* cv. Shahi × *C. cauliflora* yielded the maximum number of fruits. The immature 90-day-old hybrid embryo of *C. papaya* cv. Shahi × *C. cauliflora* showed the highest percentage of germination, as well as plant regeneration indicating there will be no embryo abortion till 90 days after pollination. So with embryo rescue and somatic embryogenesis technique it is possible to get viable hybrid embryo.

4. Use of bridge species:

Bridge species can be used to overcome incompatibility barriers. Bridge species is used in between two incompatible species, wherein bridge species will be compatible to both the parents. It is just like use of interstock between two incompatible rootstock and scion in grafting technique. Brien and Drew[2] have reported use of bridge species *Vasconcellea parviflora* in between two incompatible species *viz*., *Carica papaya* and *V. cundinamrcensis* (resistant to PRSV and Cold). When they crossed *C. papaya* with *V. cundinamarcensis* resulted in inviable hybrid embryo. However, F1 of *C. papaya* with *V.parviflora* was crossed with *V. cundinamarcensis* resulted in viable hybrid embryo. So in this, *V. parviflora* act like a bridge species between two incompatible species *(C. papaya*and*V. cundinamarcensis*). By using bridge species, it is possible to overcome post fertilization barriers.

Applications:

1. Improvement of fruit quality

Custard apple: Jalikop and Kumar[3] have studied effect of different annona species (*Annona squamosa*, *A. reticulata*, *A. atemoya* and *A. cherimoya*) pollen on var. Arka Sahan and to know the best pollen source in both quality and yield wise. They found *Annona squamosa* followed by *A. reticulate* were best pollen source for Arka Sahan. Annona squamosa pollens resulted in increased taste, fruit shape and size.

2. Fruits with less seeds

Citrus: Smith *et al*[7]., have produced first intergeneric hybrid between *Citrus* and *Citropsis*. *Citropsis* is producing less number of seeds per fruit (4/fruit) and showing resistance to many diseases. They successfully produced viable intergeneric hybrid between *citrus* and *citropsis* and confirmed through molecular marker.

3. Abiotic stress tolerance

Mango: Vasugi *et al*[8]., have found interspecific crossability in mango by using both fresh and cryopreserved pollens. Among different varieties of *Mangifera indica* (Arka Anmol and Arka Neelkiran) and species *M. zeylanica* (salt tolerant) and *M. odorata* (good fruit quality) used in the experiment, species *M. odorata* recorded high fruit set when Arka Anmol is used as a female parent. But due to heavy fruit drop, matured fruit could not be recovered. However, this drop was not due to embryo abortion, but due to environmental factors as this was confirmed by dissecting the fallen fruits. This generated hybrid seeds can be used for further breeding programme for screening against salt tolerance.

Limitation:

During distant hybridization there will be transfer of many undesirable genes while transferring of one desirable gene due to undesirable linkage. Needs excellent management during crossing programme. Results in unviable hybrid embryo leads to low success rate.

CONCLUSION

Distant hybridization helps in tackling both biotic and abiotic stress and also in enhancing quality in fruit crops. But there is a need to develop techniques to break incompatibility and complete sequencing has to be known clearly for better crossing programme.

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