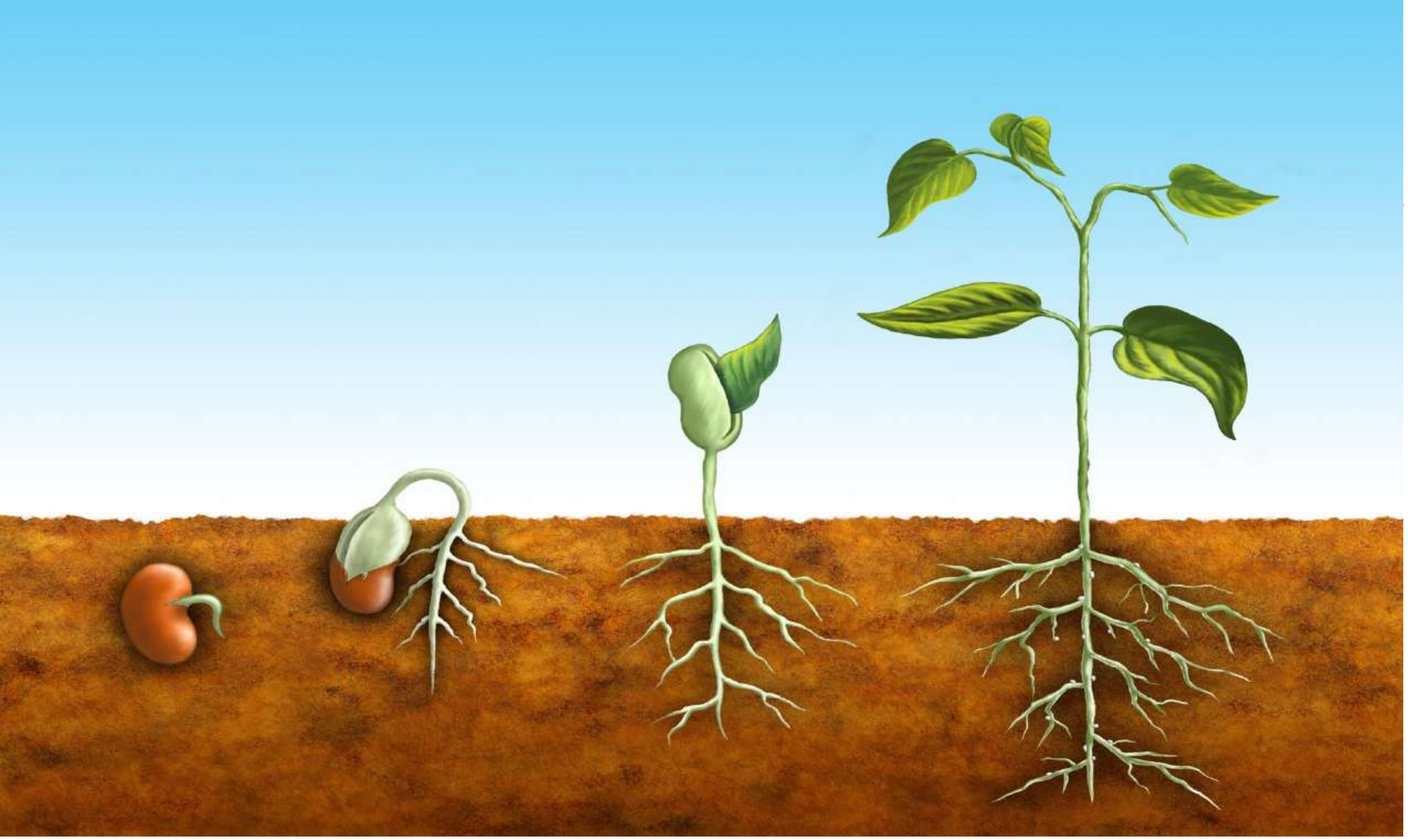

Embryo rescue techniques in Horticultural crop

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Received: **Feb 21, 2022;** ***Revised:*** **Feb 22, 2022** ***Accepted:*** **Feb 22, 2022**

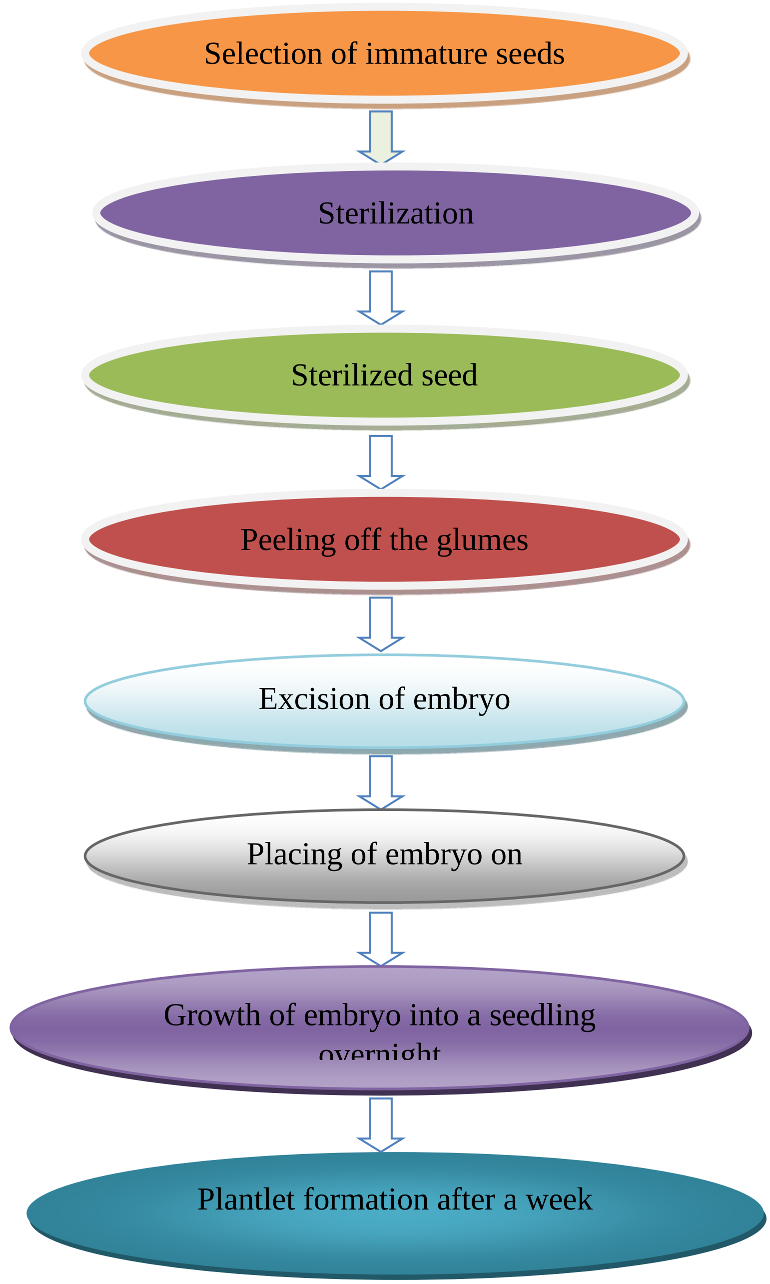
Introduction

Improvement of cultivated plants depends on introducing natural variability through traditional and biotechnological breeding techniques. Selective breeding based on interspecific and intervarietal crossings has improved the quality and yield potential of almost every major crop. In order to transfer desirable genes from wild to domesticated plants, interspecific hybrids are created. Many factors, such as pre-zygotic and post-zygotic, make extensive crosses between species difficult to achieve. Hybrid plants in the horticulture industry have been established by overcoming post-zygotic obstacles such endosperm abortion and embryo degradation, both of which reduce reproductive success. The purpose of embryo rescue is to produce a viable plant by isolating and developing an immature or mature zygotic embryo in an aseptic nutrition media under sterile circumstances. It is used to save embryos that would otherwise be aborted or that would not progress through the stages of development. Dissection and diverse nutritional medium requirements make this process tough. Isolating the embryo without harm producing a proper nutritional media and encouraging embryogenic growth and seedling formation are the keys to this techniques success. Embryo culture has been used to learn about the physical and nutritional requirements for embryonic development, bypass seed dormancy, shorten the breeding cycle, test seed viability, provide material for micropropagation, and save immature hybrid embryos from incompatible crosses since the early 1940s. It is common for plant breeders to save embryos that are prone to degeneration. In addition to the genotype, the maturation stage and the composition of the media are critical for successful plant development from cultured embryos. Distant hybridization is characterized by embryos being aborted at one or both stages of development. Hybrid embryo rescue is a popular method for raising hybrids. Embryo rescue is currently showing significant promise for wide crossings and for producing haploid plants while also reducing the breeding cycle.

Embryo rescue

Embryo rescue is an in-vitro technique that has been used to save the hybrid products of fertilization when they might otherwise degenerate.

Procedure of embryo rescue:



Applications of Embryo Rescue Techniques:

Shortening of breeding cycles:

Embryo culture has also been utilized to minimise breeding cycles in horticultural crops reducing effective germination time from years to months. Endogenous inhibitors, low temperatures, dry storage requirements, light requirements and immature embryo responsible for dormancy in plants. It is possible to reduce the breeding cycle by removing the embryos from the seed coat and endosperm or both impacts of these elements. Shortening breeding cycles in apples has also been achieved by embryo culture, where effective germination is decreased from years to months by breaking dormancy. Vernalization of separated embryos can also help to reduce the amount of time spent breeding. Anderson and colleagues created rapid generation cycling techniques in chrysanthemum that allowed them to more quickly develop theoretical models for inbreeding depression or genetic burden, heterosis, F1 hybrid formation and self-incompatibility genetics in a shorter amount of time. When embryo culture is used in conjunction with embryos that have been qualitatively improved by ethrel treatment, the breeding cycle of papaya can be shortened by approximately 3 months, i.e., the period (generally 6–9 months) from pollination to seedling establishment can be shortened by approximately 3 months using these breeding techniques.

Wide crosses:

Embryo rescue has also been employed to overcome post-zygotic obstacles in case of self- and cross-incompatibility, as well as for other purposes. It was possible to construct a successful technique for the development of embryos of lilium seeds that did not include an endosperm and that were derived from interspecific crossings involving *Lilium lankongens*. Using embryo rescue techniques, it was possible to create interspecific hybrids in the pelargonium. The successful rescue of embryos and regeneration of plants in the *Hylocereu*s genus has been demonstrated in cacti after interspecific crosses were performed. It has also been demonstrated that the vine cacti *Hylocereus* and *Selenicereu* are capable of producing ovaries. Through the use of embryo rescue, different genomic combinations in inter-section hybrids derived from crossovers in primulas were discovered. Using embryo rescue, it was feasible to achieve interspecific hybridization in the Rhododendron. Interspecific crossing barriers in tulips were overcame using embryo rescue by successful direct transfer of *Tulipa kaufmanniana* Regel germplasm into that of *T. gesneriana* L. In banana, commercially popular varieties are seedless owing to their triploid status. Interspecific hybrids between *Musa acuminata* and *M. balbisiana* were developed using embryo rescue techniques. Crosses between diploid and tetraploid species are also recovered through embryo rescue.

Seedlessness

Many seedless grape cultivars are stenospermocarpic, meaning that after fertilization, embryo development stops and seed production fails. Embryo rescue was first used in grapes, and further research has enhanced this procedure. Progeny from the hybridization of seedless grapes with seedless grapes can now be developed after embryos were salvaged from stenospermocarpic seedless grapes. The role of embryo culture techniques in seedless lime improving fruit quality was investigated.

Production of haploids:

The biotechnological process of haploidization is used to produce plants with enhanced features that are beneficial to humans. To produce haploid or monoploid offspring, embryo culture can be used. Barley monoploids were created using this method. *Hordeum bulbosum* is used as a pollen parent in interspecific crossing, and the resulting hybrid embryos are grown. In contrast, these are monoploids of the female parent *H. vulgare* with *H. bulbosum* chromosomal deletion.

Resistance to biotic and abiotic stresses:

Disease and pest resistance have been recombined in diverse horticultural crops in some hybrids generated using embryo rescue. Embryo rescue technique was used to create interspecific crosses between *Chrysanthemum grandiflorum* and *C. makinoi* and *Naka*i. The MR1, MR2 and BC1F1 hybrids of these crossings were shown to have aphid and heat tolerance. Embryo rescue was also used to create interspecific hybrids between *Lycopersicon esculentum and L. peruvianum*.

Rapid testing of seed viability:

When it comes to determining the viability of seeds, Embryo culture has proven invaluable. It was discovered early on that embryos excised from non-after-ripened peach seeds grew just as well as those from after-ripened seeds, leading to the development of this procedure. In cases where seed dormancy may be bypassed, embryo culture provides for quick testing of seed viability.

Germination:

Endogenous inhibitors, specialized light requirements, low temperatures, dry-storage requirements and embryo immaturity are only a few causes of seed dormancy. Plant hormones in the tissues surrounding the embryo in a seed restrict germination in many types of seeds, which is known as conventional dormancy. There are many ways to increase the percentage of seedlings from planned hybridization, such as using embryo culture, in an apricot and cherry breeding programme.

Factors Affecting Embryo Culture's Success:

A quick review of elements impacting the use of embryo culture before discussing the use of embryo culture is important. The following are some of the elements that can affect the success of embryo culture:

Genotypes:

Embryo culturing success differed between genotypes. Significant variation in *vitro* germination was observed between the selected cultivars, San Ramon Tall (SNRT) (77.48 %), Sri Lanka Red Dwarf (SLRD) (67.28 %), Sri Lanka Green Dwarf (PGD) (71.85 %) and King Coconut (RTB) (52.5 %). Alstroemeria interspecific crosses resulted in considerable differences in the percentages of embryo germination and callus and shoot development.

Developmental stage of the embryo at isolation:

It is extremely difficult to grow embryos that are only a few days old. Despite advances in embryo culture, it is difficult to save embryos that have been aborted at a very early stage of development. The embryo of a particular species is transplanted into the endosperm of another seed of the same species in order to successfully grow very early embryos.

Composition of the nutrient media/growth environment:

For embryo culture, selecting the correct culture medium is a critical step in ensuring embryos are able to grow in an orderly and progressive manner. Different embryo cultures require different amounts of culture medium. They can either be post- or pre-germinal in nature. The purpose of post-germinal embryo cultivation is to expedite the germination process. Even sucrose or glucose solution can be used to achieve this. Immature embryos are cultivated to produce plantlets in pre-germinal embryo culture, where they require a complicated food medium.

Various Techniques of Embryo Rescue:

There are broadly two types of embryo culture:

Mature embryo culture:

Embryos from ripe seeds are used in the process of cultivation. When embryos are unable to survive in the wild or become latent for long periods of time, or when seed germination is inhibited, this form of culture is used.

Immature embryo culture:

The culturing of immature embryos, also known as "embryo rescue," is used to save embryos that have been lost in wide crossings, crosses involving seedless parents or in embryos that have had severe fruit drop. In order to avoid embryo abortion and produce a viable (hybrid) plant, this is primarily employed. Individuals from two different species of the same genus or separate genera are frequently crossed, resulting in the cross failing.

Conclusion:

In vitro breeding uses embryo cultivation. It is most commonly employed to save embryos from interspecific and intergeneric crossings, as well as non-developmental embryos. Use it to save seedless triploid embryos, make haploids, break seed dormancy and test seed viability. It helps comprehend embryonic morphogenesis and early germination.

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