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Artificial Seed / Synthetic Seed Production – Brief Procedure – Advantages and Limitations

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Abstract

Synthetic seeds are the artificially encapsulated somatic embryos, shoot buds, cell aggregates, or any other tissue that possess the ability to convert into a plant under in vitro or in vivo conditions, retains the potentiality also after storage. Due to the quick development of somatic embryos it possess the potentiality for conservation and propagation of rare, endangered, critically endangered and threatened plants which are difficult to regenerate through conventional methods due to low seed set and poor seed germination. An improved artificial seed production technique is considered a valuable alternate technology of propagation in many commercially important crops and a significant method for mass propagation of elite plant genotypes. There are several advantages of artificial seeds such as ease of handling, low production cost, ease of exchange of plant materials, genetic uniformity of plantlets, direct delivery to the soil, shorten the breeding cycle and reduction of the storage space.

Introduction

Nowadays, artificial seed technology is one of the most important tools to breeders and scientists of plant tissue culture. It has offered powerful advantages for large scale mass propagation of elite plant species. The demand for artificial seed technology started after the discovery of somatic embryo production in various plant species in vitro. Artificial seeds, which are also known by other names such as "synseeds", are firstly described by Murashige. He defined artificial seeds as "an encapsulated single somatic embryo". An artificial seed can be defined as "a somatic embryo that is engineered for the practical use in commercial plant production". It is an alternative to traditional micro propagation for production and delivery of cloned plantlets. Artificial or synthetic seed is a bead of gel containing somatic embryo or shoot bud and the nutrients, growth regulators. The concept of artificial seeds was then limited to those plant species in which the production of their somatic embryos could be demonstrated. Various plant materials have since been used for artificial seed production including somatic embryos, shoot tips, auxiliary buds, nodal segments, protocorm-like bodies (PLBs), microshoots, and embryogenic calluses. Pesticides, antibiotics etc needed for the development of a complete plantlet from the enclosed somatic embryos or shoot bud.

Two types of artificial seeds (encapsulated somatic embryos) are commonly produced: desiccated and hydrated.

Desiccated Artificial Seeds

Desiccated artificial seeds are achieved from somatic embryos either naked or encapsulated in polyoxyethylene glycol followed by their desiccation.

Desiccation can be applied either rapidly by leaving artificial seeds in unsealed petri dishes on the bench overnight to dry, or slowly over a more controlled period of reducing relative humidity. These types of artificial seeds can be only made in plants whose somatic embryos are desiccation-tolerant.

Hydrated Artificial Seeds:

Hydrated artificial seeds can be produced by encapsulating somatic embryos in hydrogel capsules. They are produced in plant species which are recalcitrant and sensitive to desiccation. Encapsulation has been expected to be the best method to supply protection and to convert the in-vitro micro-propagules into 'artificial seeds' or "synseeds", and it is an important application of micro-propagation to develop the success of in vitro-derived plant delivery to the field.

Artificial Seeds may be produced by one of the two following ways-

In the desiccated system the somatic embryos are first hardened to withstand desiccation and then are encapsulated in a suitable coating material to yield desiccated artificial seeds. Somatic embryo may be hardened either by treating or coating mature somatic embryos with a suitable polymer followed by drying or treating them with ABA during their maturation phase ABA treatment also improves germination of somatic embryos.

In the Hydrated systems, somatic embryos are enclosed in gels which remain hydrated. Of the many gels evaluated "calcium alginate is the most suitable. Artificial seeds can be made easily as follows. A 2% solution of Sodium alginate is filled in a burette and allowed to drip drop by drop into a 100 millimolar $CaCl_2$ solution. As the sodium alginate bead or drop forms at the tip of the burette, a somatic embryo is inserted into it with the help of a spatula before the drop falls into the $CaCl_2$ solution. The beads become hardened as calcium alginate is formed. After about 20-30 min the artificial seeds are removed, washed with water and used for planting hydrated seeds are sticky and difficult to handle on a large scale and dry rapidly in the open air. These problems can be resolved by providing a waxy coating over the beads. Alternatively, a desiccated system may be use to produce a synthetic seeds. However it is not possible to store, except at low temperature and for a limited period hydrated artificial seeds and they have to be planted soon after they are produced.

Applications

- Seed propagation of sterile plants.
- High efficiency in multiplication.
- Fixation of hybrid vigour, eliminate the need of inbred lines to produce F1 hybrids.
- Elimination of the need of edible seeds or tubers for propagation.
- Multiplication of Genetically engineered individuals, which may be sterile and unsuitable during sexual production.
- Production of virus and disease free plants.
- Protection of seedlings by incorporating useful chemicals in the encapsulation material.
- Provide the advantages of true seed (case of handling and transportation) for vegetative propagation.

Limitations

- Large scale production of high quality somatic embryos is a costly affair.
- Poor germination of synthetic seeds due to lack of supply of nutrients, sufficient oxygen, microbe invasion and mechanical damage of somatic embryos.
- Occurrence of somaclonal variation.
- Special skills are required to carry out the work.
- The difficulties of sowing artificial seeds directly in soil or in commercial substrates such as compost, vermiculite, etc., under non-sterile conditions are considered to be one of the main limitations of the practical use of this technique.

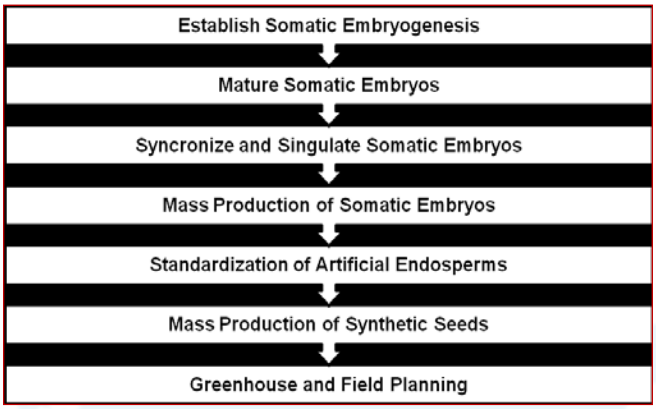

Figure 1: Procedure for Production of Artificial Seeds

Problems

- Artificial seeds that are stable for several months requires the procedures for making the embryos quiescent.
- Artificial seeds need to be protected against desiccation.
- Recovery of plants from artificial seeds is often very low due to incomplete embryo formation or difficulties in creating an artificial endosperm.
- The embryo must be protected against microorganisms.

Conclusion

Synthetic seeds technique is a rapid tool of plant regeneration because of its wide use in conservation and delivery of tissue cultured plants. Procedures were optimized and proper plantlets were obtained. For critically

endangered plant species, it is the rapid means of conservation and multiplication. This technique has great advantages such as: a cost-effective delivery system, minimization of the cost of plantlets, simple methodology with high potential for mass production, a promising technique for the direct use of artificial seedlings in vivo, and a high storage capacity. However further research is needed to perfect the technology so that it can be used on a commercial scale.

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