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ARTIFICIAL SEED AND ITS APPLICATIONS IN AGRICULTURE

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Introduction

The concept came into practical in 1970s. The term artificial seed was coined by Murashige. It is also known by other names like manufactured seeds, synthetic seed. Though Murashige proposed encapsulation of somatic embryos to produce synthetic seed, the concept was further advanced by Redenbaugh *et al.* (Plant Genetics Incorporation, California) and Kitoo and Janick (Purdue University). Redenbaugh *et al.* (1988) patented this artificial seed technology.

Artificial Seeds

Artificial seeds are the living seed-like structure which is made experimentally by a technique where somatic embryoids derived from plant tissue culture are encapsulated by a hydrogel and such encapsulated embryoids behave like true seeds if grown in soil and can be used as a substitute of natural seeds. Artificial seed is an encapsulation of somatic embryo, shoot buds or aggregates of cell or any tissues which has the ability to form a plant in in-vitro or ex vivo condition. Artificial seed is a promising technique for the propagation of transgenic plants, polyploids with elite traits on seed producing plants and plant lines that has problem in seed propagation. Artificial seed is clonal technique and it cuts short the laborious procedure of conventional recombination breeding and can bring the advancements of biotechnology to the doorsteps of farmer in a cost effective way.

A seed is basically a zygotic embryo with food storage tissue (endosperm) and covered with a protective layer and this layer protects the seed against desiccation and increases its durability and protects it against external damages. Seeds with zygotic embryo are combination of sexual reproduction between two parents. After the discovery of somatic embryogenesis in 1950 now it was possible to have the alternate of conventional zygotic seeds. Somatic embryo produces from the somatic cell of single parent. They differ from zygotic embryo because are produced in in-vitro culture technique without protective coats and they do not become quiescent.

General procedure for the production of artificial seeds

- Somatic embryogenesis or callus culture
- Somatic embryo maturation or shoot bud formation
- Encapsulation of above with suitable matrix
- Evaluation of the resulted artificial seeds
- Mass production
- Open field / green house planting

Artificial seed production methods: Synthetic seed production methods can be of two types

- Desiccated system
- Hydrated system

Desiccated system for artificial seed production

Prior to encapsulation, somatic embryos are first hardened to withstand desiccation. Then these hardened embryos are encapsulated artificially with the use of appropriate growth medium.

Hydrated system for artificial seed production

The gel used to enclose somatic embryo remains hydrated. Various water soluble gels can be used for the purpose of encapsulation, like alginate, gel rite, locust bean gum, sodium alginate with gelatin. However, alginate is the most suitable gel.

Methods for artificial seed encapsulation: There are two methods for encapsulation listed as follows.

1. Dropping method
2. Molding method

Dropping method

- i. Somatic embryos are dipped in hydrogel, this step encapsulate SEs.
- ii. Hydrogel used may be any of the following.
 - a. alginate – sodium alginate, agar from sea weeds
 - b. seed gums like guar gum, locust bean gum
- iii. Here we have considered sodium alginate solution (1 – 5%), prepared in MS basal medium solution. SEs are dipped in this solution.
- iv. These coated beads are added one by one with the help of pipette (5mm) into a complexation solution flask kept on magnetic stirrer and kept such for around 20-30 minutes. Here we considered calcium nitrate solution (100mM) as complexation solution.
- v. Embryos get covered by calcium alginate which is a stable complex due to ionic bond formation, become harder. Seeds become harder. Then gelled embryos are washed with water or MS basal medium.
- vi. The synthetic seeds are ready.
- vii. Alternatively, a burette is filled with sodium alginate solution (1 – 5%), dripped into a calcium nitrate solution (100mM) drop by drop. Somatic embryo is inserted into the drop formed at the burette tip. Sodium alginate drop along with SE falls into the solution of calcium nitrate.
- viii. Useful adjuvants like growth regulators, herbicides, insecticides, fungicides and mycorrhizae such can be supplied to the SE while encapsulation along with the matrix.
- ix. This method is applicable for embryo / auxiliary / apical / adventitious buds.

Molding method

- This method follows simple procedure of mixing of embryos with temperature dependent gel (e.g. gel rite, agar).
- Cells get coated with the gel at lowering of the temperature.

Merits of artificial or synthetic seed are listed below.

- **Easy handling** – during storage, transportation and planting, as these are of small size.
- **Inexpensive transport** – reason behind is small size.
- **Storage life** – much longer, seed viability remains good for longer time period.

- **Product uniformity** – as somatic embryos used are genetically identical.
- **To avoid extinction of endangered species** – e. g. in hedgehog cacti (*Echinocereus* sp.)
- **Large scale propagation** – very much suitable for large scale monoculture.
- **Mixed genotype plantations** – suitable for this too, as for monoculture.
- **Germplasm conservation** – important in germplasm conservation.
- **Elite plant genotypes** – artificial seed technology preserves / protects and permits economical mass propagation of elite plant genotypes.
- Not a season dependent technology

Artificial seeds have a wide range of applications in agriculture.

- 1) Propagation of hybrid plants is very easy through artificial seeds.
- 2) Genetically modified crops and endangered species of plants can be propagated through artificial seed technology.
- 3) Germplasm of elite lines and endangered species can be preserved with artificial seed technology.
- 4) Cereals crops, fruits, vegetables and medicinal plants can be studied anywhere in the world using Artificial (synthetic) seeds.
- 5) Genetic uniformity of crops and varieties of crop can be easily maintained by using is Artificial seed technology.
- 6) Artificial seed provides disease free conditions to plant material or explants which is present inside of capsule.
- 7) During the production of artificial (synthetic) seed encapsulation herbicides can be added to the formulation, this herbicide will provide extra protection to the explants against pests and diseases.
- 8) In cross pollinated crops like maize where the production of hybrids is wide spread practice. Artificial seed technology helps in production of hybrids without creation of parental lines that are costly and time consuming.
- 9) Synthetic seed crops are easy to maintain because of uniform genetic constituent.
- 10) Artificial seed technology improves the food production and also produces environment friendly plantation.

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