Synthetic seed production: Applications and its Significance

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Introduction
Applications of biotechnological tools and its advancement over the last two decades has provided wider scope for further increase in production of plant population of several economically important crops including woody plant species in addition to endangered medicinal and aromatic plant species. The production of synthetic seeds for plant propagation in addition to development into a complete plantlet has led to the commercialisation and uplifftment of agricultural and horticultural industries. Synthetic seeds can be defined as artificially encapsulated somatic embryos, shoot buds, cell aggregates or any other meristematic tissues that can be used as functional mimic seed for sowing, possesses the ability to convert into a plant under invitro or exvitro conditions and can also be stored for a period of six to eight weeks (Ara et al 2000). Encapsulations of explants either through invitro or exvitro raised seedlings involving sodium alginate for production and development of synthetic seeds would be a liable system to deal with propagation and cryopreservation.

Encapsulation technology
Encapsulation techniques of seeds involve sodium or calcium alginate encapsulation of invitro or invivo regenerated explants which are suitable for further propagation and cryopreservation. Synthetic seeds are of two types 1) Desiccated synthetic seeds 2) Hydrated synthetic seeds. For preparation of hydrated synthetic seeds, somatic embryos are mixed with sodium alginate gel (0.5-5.0% w/v) and dropped into calcium chloride solution [CaCl2 (30–100 mM), Ca (NO3)2 (30–100 mM)] where ion exchange reaction occurs and sodium ions are replaced by calcium ions forming calcium alginate beads or capsules thereby surrounding the somatic embryos. The size of the encapsulated seed entirely depends upon the inner diameter of the pipette nozzle. The mixture is dropped with a pipette into a liquid culture medium containing calcium chloride solution (100 mM CaCl2) for 20-30 minutes. Usually 2% sodium alginate gel with a complexing solution containing 100 mM Ca2+ is used and is found to be suitable. Alginate beads are prepared using explants suspended in calcium free liquid MS basal medium containing lower concentration of sucrose with 3-4% (w/v) sodium alginate. Whereas in some cases, higher concentration of sucrose can also be used in MS medium for encapsulation of explants. Size of synthetic seeds usually varies from 4-5 mm in diameter and includes explants particularly somatic embryos that resembles globular, heart, torpedo and cotyledonary stages or embryogenic callus clusters.

Potential uses of synthetic seeds
For mass multiplication through micro-propagation and germplasm conservation, production and development of plantlets through the technique of synthetic seed technology would offer tremendous potential either by reducing cost of production or increase crop value. In addition it also has a potentiality of seed coat formation, maintaining genetic uniformity in plant, large scale propagation methods, rapid multiplication of plants, and ease in handling during storage in addition to long term storage and germplasm conservation with proper preservation techniques without losing viability (Piccioni and Standardi, 1995). Another use of synthetic seeds is to decrease the genetic variation by storing plants at temperatures below 0 degree Celsius since it reduces the frequency of sub culturing and adventitious regeneration. Moreover, encapsulated explants reduce respiration, decreases growth and allow their maintenance and storage.
Significance of synthetic seed coat
Alginate encapsulated seed coat has the feasibility of releasing nutrients, growth regulators and other components that are essential for the germination of synthetic seeds in addition to handling during storage, transport and sowing. In addition, synthetic seed coats have the potentiality of protecting the explants against physical and environmental damage particularly from dehydration and provide mechanical pressure by holding explants within the encapsulated coat during storage. In terms of regeneration, direct regeneration from encapsulated shoot tips occurs without any formation of callus which reduces the risk of somaclonal variation. Production and development of synthetic seeds by the use of various explants particularly shoot tips, somatic embryos and meristematic tissues helps in reducing the cost of micro-propagated plants in terms of commercialization.

Encapsulation Technology in Citrus
Apart from production and development of synthetic seeds in several commercial horticultural crops including medicinal and aromatic plants, synthetic seeds have also been produced through the use of invitro regenerated plant propagules (shoot tips) of Citrus aurantifolia (Lime) (Sharma and Roy, 2021). In terms of germination, encapsulated shoot tips produced maximum rate of germination with BAP supplemented MS medium. Synthetic seeds with emergence of well established roots and shoots were taken out from the culture bottles and transferred into plastic cups containing a mixture of sterile soil: sand and farmyard manure at a ratio of 1:1:1. Seedlings were further shifted in earthen pots and kept in a partial shed net house for 7 days. Those seedlings were finally transferred under the field conditions for acclimatization. In nutshell, synthetic seed technology could be used as a true-to-type plant propagation method in mass-multiplication of Citrus spp. Shoot tips are suitable for encapsulation studies of artificial seeds as they possess great potential for plant development from pre-existing meristematic tissues. Hence it encourages the use of encapsulated unipolar explants for synthetic seed technology.

Conclusion
Based on the significance of artificial seed production technology described so far, it could be concluded that encapsulation of plant propagules within the gel matrix offers a potential tool in plant biotechnology for an efficient and cost effective propagation, breeding, invitro conservation, non embryonic synthetic seed production in addition to germplasm exchange and storage. Moreover, another prospect of synthetic seed production could be conservation of germplasm through cryopreservation. Applications of recent biotechnological tools particularly synthetic seed production helps in producing true to type plants and minimizes further genetic variations in genotypes. This synthetic seed production technology is a high volume, low cost production technology which has become easy to transport, easy in handling plant propagules during germplasm exchange and storage and has the potentiality for long term storage without losing viability, rapid multiplication and maintains genetic uniformity of plants.

References