

Hi-tech seed potato

production system in India

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To enhance the quality of seed potatoes, a number of technical advancements have been or are now being examined and promoted. Many of them are rather ancient, but they have lately been reviewed and often modified for their use in certain contexts, especially when resources are limited. Some of these technologies deal with the fast multiplication of early-generation seeds as well as the management of seeds on farms.

Keywords: Aeroponics, Apical rooted cuttings, *In vitro* plants, Microtubers, Seed

INDIA is the second-largest producer of potatoes in the world. Seed is a single most important input in potato cultivation. High seed rate (2.5-3.0 t/ha), low rate of multiplication, progressive viral degeneration, storage and transportation are major issues of potato seed production in the country. Potato seed alone accounts for 40-50% of the total potato production cost and also, huge quantities of edible food is put back in the soil as potato seed. Delayed reach of new improved varieties to the farmers' fields due to slow multiplication rate and frequent seed replacement because of degeneration are associated issues. To circumvent these issues, continuous efforts are being made by the potato researchers to develop innovative technologies for quick multiplication of initial healthy breeder's seed of the released varieties in sufficient quantities to meet the demand in our country. A paradigm shift in potato seed production methods has taken place globally since the early 1900s. Major potato producers of the world have shifted from conventional to the hi-tech seed production system to improve the seed quality and enhance seed multiplication rate.

New innovations can overcome many of the problems associated with potato seed production, particularly in tropical and sub-tropical countries.

Hi-tech seed potato production including aeroponics is a potential alternative to overcome the everlasting shortage of quality seed potatoes in the country due to the advantages that seeds under hi-tech system are produced from typically pathogen tested basic material and can be produced in any region under controlled conditions. Seed potato production involving micro-propagation is finding favours among the seed potato entrepreneurs. The new / Hi-tech system of seed potato production involves raising of *in vitro* plantlets followed by production of mini-tubers under protected conditions and their subsequent multiplications in the field.

Seed production through Hi-tech system has been started by Central Potato Research Institute Shimla in the recent past. Under this system, there are four different sub-systems:

- Microplant based seed production system
- Microtuber based seed production system
- Aeroponic based seed production system.

- Apical rooted cutting (ARC) based seed production system.

The use of micropropagation for commercial seed production has moved potatoes from test tube to the field. The first establishment of tissue culture from potato tubers was attempted as early as 1951 and since then a variety of tissues from different plant organs, such as leaves, petioles, internode segments, ovaries, anthers, stems, roots and shoot tips have been successfully demonstrated. Seed potato production involving micropropagation technique can overcome many of the problems associated with the traditional seed production system. The adoption of Hi-tech seed production technologies developed by the Institute has led to opening of more than 30 tissue culture labs throughout the country. These labs (Table 1) procure virus free *in-vitro* plantlets from CPRI for further multiplication in their labs.

Minituber production in soil: Minitubers are small seed potato tubers that can be produced in glasshouses or aphid-proof nethouses from *in vitro* propagated plantlets planted at a high density. Minitubers can be produced using either microplants as planting material (Fig. 1) or microtubers. In

Table 1. List of firms procuring virus free microplants

Firm
M/s Anuj Agri Farm, Bisauli, Badayun, Uttar Pradesh
M/s Merino Industries Limited, Village-Achheja, PO-Hapur, Uttar Pradesh
M/s Sekhon Biotech Pvt. Ltd, Jalandhar, Punjab
M/s Bhatti Tissue Tech. Vill.-Alipur, PO-Mithapur, Teh & Distt.- Jalandhar, Punjab
M/s Hyfun Agrilink Pvt. Ltd., Gujarat
Centre of Excellence for Potato, Jalandhar, Punjab
M/s Rahul Biotech Seed, Singhirampur, Farrukhabad, Uttar Pradesh
International Potato Centre (CIP), College of Horticulture, GKVK, Bengaluru
M/s GRS Bioplants Pvt. Ltd. (Shanti Devi Cold Storage), Distt.- Firozabad, Uttar Pradesh
Institute of Horticulture, Greater Noida, Uttar Pradesh
International Potato Centre (CIP), Bhubaneswar, Odisha
M/s Banas Dairy, Palanpur, Gujarat
The Energy and Resources Institute, TERI-GRAM, Gurgaon
M/s KF Biotech Pvt. Ltd., Karnataka
M/s Utkal Tubers India Pvt. Ltd, Bengaluru, Karnataka
M/s Jain Irrigation Systems Limited, Jalgaon, Maharashtra
M/s Handa Bio. Agritech, Potato Seed Company, Kurukshetra, Haryana
West Bengal State Seed Corporation Ltd., West Bengal
PTC, Karnal, Haryana
CIP, Bhubaneswar, Odisha
Dr YSP University of Horticulture and Forestry, Nauni, Solan (Himachal Pradesh)
Horticulture and Food Processing Department, Lucknow, Uttar Pradesh
M/s Madhav Agri Tech, Tundla, Firozabad, Uttar Pradesh
M/s S.F. Agritech Pvt. Ltd., Etawah, Uttar Pradesh
M/s GMS Agritech Pvt. Ltd., Research & Development, Bahiri, Birbhum, West Bengal
M/s Narmada Jivan Agrotech Pvt. Ltd., Bareilly, Uttar Pradesh
M/s Nazia Hussain Agritech Co., Teh & Dist.-Patiala, Punjab
M/s UPL Sustainable Agri Solutions Limited, Mumbai, Maharashtra
M/s Shandil Plantech Pvt. Ltd., Palampur, Dist.-Kangra, Himachal Pradesh
M/s Sangha Biotech, Jalandhar, Punjab
M/s Sashanka Agro Tech. Pvt. Ltd., Morabadi, Ranchi, Jharkhand
M/s Kavya Agro Potato Seeds, Distt.- Bulandshehar, Uttar Pradesh
M/s HBS Agro & Aqua Services Pvt. Ltd., Telangana
Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Raja Pancham Singh Marg, Gwalior
M/s Technico Agri Sciences Ltd., Tehsil Baddi, District-Solan, Himachal Pradesh
M/s Govardhan Dass Pal Biotech Seed Farm, Singhirampur, Farrukhabad, Uttar Pradesh
M/s Falcon Agrifriz Foods Private Limited 804, Z-One, Bodakdev, Ahmadabad, Gujarat
M/s Kisan Agritech (Jai Ganga), Noida, Uttar Pradesh

this system, the hardened virus-free microplants or microtubers are transplanted inside a nethouse

for the production of minitubers. The minitubers so obtained are multiplied usually in two subsequent

field generations (Generation 1 and 2) before supplying to farmers as seeds, thereby, reducing number of field exposures of initial disease-free material.

Microtuber production from microplants: Microtubers are miniature tubers produced *in vitro* under tuber-inducing conditions. These small dormant tubers are particularly convenient for handling, storage, transportation, and conserving germplasm. In general, 15-20 microtubers with an average size of about 100-200 mg, are obtained from each tissue culture flask. Microtubers are usually not used for raising commercial crops but utilized for the production of minitubers in greenhouses. The microtubers (Fig. 2) are planted in nursery beds under aphid-proof net houses (50 microtubers m²) to produce minitubers. This technology, however, has not become very popular because of the poor survival of microtubers (60-65%) as well as the poor crop emergence (50-60%) in nursery beds. Bioreactors have also been tried for the mass production of microtubers, however, bioreactors are expensive and add to the cost of microtuber production.

Soil-less aeroponic system: Aeroponics is a more recent technology that has made inroads into the potato sector in the last few decades. This technology has been developed for the production of minitubers by utilizing healthy *in vitro* plants. This system facilitates round the year production and adoption of phytosanitary standards. In this system, microplants are planted on the top of the growth chamber, and

**Fig. 1.** Steps in microplant based seed production system



Fig. 2. Steps in microtuber based seed production system

the developing root zone inside the chamber is fogged with nutrient solution (Fig. 3). The chambers are installed inside an insect-proof nethouse. The aeroponic chamber has a removable opening at the top with holes for holding the potato plants. The front of the aeroponic chamber is set with pivots and can be opened to harvest mini-tubers of ideal size at different time intervals. Picking of tubers begins after 45–50 days of planting when they attain a size of 3–10 g. Picking of minitubers is done every week, and around 10–12 harvests are taken during the whole crop season of 4–5 months. Normally, 40–50 mini-tubers can be harvested from a single *in vitro*

plant depending upon the variety as against 8–10 mini-tubers under the nethouse in nursery beds. The harvested minitubers are stored at 2–4°C to be utilized for planting in the next crop season. This system requires a high level of specialization in planning, operational expenses and standardization of genotype-responsive nutrient solutions, but it offers quality seeds and has revolutionized seed potato production in India. Variation for root morphology and yield traits of all Indian varieties under aeroponics has also been identified. This system has revolutionised the seed potato industry in India. This technology has been licensed to 30 seed

producing firms to increase the seed availability across India.

The aeroponic minitubers thus harvested are called as generation-0 (G-0) and are strictly planted under nethouse in Generation-1 (Gen. 1) at a spacing of 30 × 10 cm depending upon the size of mini-tuber. The produce of Gen. 1 is called as pre-basic seed. The produce of Gen. 1 (pre-basic seed) is further multiplied in generation-II (Gen. 2) at a spacing of 45–60 × 20 cm and the produce of Gen. 2 is called as breeder seed or basic seed.

Apical rooted cuttings (ARC) technology: Apical rooted cuttings have long been used in south-east Asia, and particularly in Vietnam.



Fig. 3. Steps in aeroponic seed production system



Fig. 4. Stepwise ARC based seed production system

The approach could be duplicated elsewhere in the developing world. On the same note, this technology has been successfully integrated into the potato breeder's seed production programme in India. ARC being simple, effective, easy to implement and has small production cycle, this has an edge over aeroponic technology, wherein, large capital investment and long production cycle are limiting factors. In ARC, the healthy buffer stock of microplants acts as initial planting material (Fig. 4) on nursery beds (400 microplants- m²). The first round of cutting starts after 15-20 days of planting of the mother stock. To follow the seed plot technique (i.e. growing potato seed crop under aphid-free period of the season) and to fit into the seed production window, only 3-4 cuttings are recommended in the north-western

central plains of India. Thus, one microplant can produce 6-8 rooted cuttings. Around 7-10 days old rooted cuttings are planted under insect proof nethouse for tuber production. Batch wise pedigree of the cuttings is maintained so as even if any plant out of a cutting is found infected with a virus during testing, all the counterparts of the cutting/sister counterpart tubers can be rejected. Based on the available data, 7-10 tubers weighing 10-70 g can be harvested from a single cutting, thereby, achieving multiplication rate of more than 50 depending upon the variety. This technology has immense potential if it can be fitted in seed production window following standard operating procedures to ensure seed health. This technology has been commercialized to 7-8 firms to enhance the seed availability.

Way Forward

The everlasting shortage of seed potatoes in most of the potato growing nations can be overcome through Hi-tech systems/ techniques on account of faster rate of multiplication. Besides, rapid multiplication, disease freedom on account of multiplication of disease free mother stocks under controlled conditions followed by reduced number of field exposures as compared to conventional multiplication system is an added advantage of seed potato production through these techniques. Due to these numerous advantages, the Hi-tech system of seed potato production is finding favours among the seed potato entrepreneurs.

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