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The Use of Tissue Culture in Virus Free Plant Production

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In order to meet our future needs through agricultural diversification, new technology in agriculture must be adopted. Without the best planting material, the best cultural practices, fertilization, and pest control techniques won't produce the required outcomes. In the horticultural industries of many nations, tissue culture has played a key role in the production of disease-free planting materials for vegetatively propagated crops. Potatoes, sweet potatoes, bananas, and citrus are the main crops that are intensively propagated among these to provide planting materials free of disease. In contemporary horticulture and agriculture, the need for disease-free, healthy plants is critical. Tissue culture is one of the best methods for accomplishing this; it has completely changed the way that plants are propagated. Viral-free plants may be produced quickly thanks to tissue culture, which improves crop yields, quality, and sustainability. The advantages of in vitro plantlets over conventional ones in terms of productivity per unit area, especially for horticultural crops, have been the subject of numerous research studies. Due to their lack of disease load, in vitro plantlets perform noticeably better than traditional in terms of uniformity, earliness, yield, and quality, according to almost all research findings. From a farming perspective, the cost of in vitro plantlets is prohibitive when compared to conventional methods, and these plants necessitate better maintenance and more attention. This sector has made a variety of unusual commercial plant species, including ornamentals, available.

Keywords: Tissue culture, Micropropagation, Fertilization, Virus free plant, In-vitro culture.

Introduction

Micropropagation, another name for tissue culture, is the process of growing plant cells, tissues, or organs in vitro under carefully monitored circumstances. Plants can be grown from tiny portions, including leaf or stem tissues, in sterile conditions thanks to this technique. The procedure usually consists of the following stages: acclimation, rooting, multiplication, and initiation. The technology of plant tissue culture is now well-established. Its evolution has included stages such as scientific curiosity, research tool, novel applications, and mass exploitation, just like that of many other technologies. In the beginning, attempts were made to cultivate and examine the development of small, isolated segments of plant tissues or isolated cells using plant tissue culture as a research tool. One biotechnological method of vegetative proliferation is tissue culture. Stem, root, or leaf tissues are used to create the plants, and technology typically helps produce desired crop varieties in large quantities. In addition to embryonic tissue, tissue culture is helpful in the regeneration of genetically modified cells into whole plants. Ilan and WorkSafe's list the benefits and drawbacks of this approach, which include a controlled environment, controlled plant development that allows for a very high rate of multiplication, and clean circumstances for plant development that

result in micro-plants free of several pests and diseases. The modest size of the propagated plants saves nursery space and plant transport costs. The primary drawback of TC plants is the high cost of production. The number of plant species used in commercial TC propagation is limited by this problem. For its widespread usage, the reproduction of planting materials from vegetatively propagated crops poses a number of logistical challenges.

Plant tissue culture techniques

Meristem culture: Extracting material from viruses and other systemic pathogen infections is typically possible through the development of meristematic tissue. The tissue culture (in vitro) technique known as "micro-propagation" is used to quickly and accurately replicate plant growth on synthetic nutrient media in a controlled setting. The most extensively used method of plant tissue culture for commercial purposes is micropropagation, which is used to provide high-quality planting material for species that are vegetatively propagated. Large numbers of disease-free propagules can be obtained from a single plant in a short amount of time, propagation can be done year-round and the propagating material can be accommodated in a small space, labour costs for maintaining germplasm can be reduced, field inspections and environmental hazards can be avoided, material for micropropagation is easily available, and rapid multiplication can occur are the main benefits of micropropagation.

Chadha and Choudhary state that checking parent material for the presence of viruses and related diseases (viroid's and phytoplasmas) is one of the processes involved in producing pathogen-free plantlets by meristem tip culture. In order to generate plantlets, the meristem tip can be removed under aseptic conditions, the apical dome and one or two leaf primordial Dia can be cultured on an appropriate medium, or the parent material can undergo chemotherapy or thermotherapy if disease-free material is not available. After plantlets are indexed for the presence or absence of viruses, they are moved to the soil, pathogen-free nuclear plant stocks are maintained, and meristem culture is used to propagate the virus-free plants in vitro.

Steps involved in tissue culture techniques

- Explant selection and preparation
- Sterilization
- Culture initiation
- Multiplication
- Rooting
- Acclimatization

Applications of micro propagation

Plant tissue culture is extensively utilized in plant science and has several commercial applications, including:

- Screening cells instead of whole plants for beneficial traits, such as herbicide resistance or tolerance.
- Cultivating plant cells on a large scale in liquid culture within bioreactors to produce secondary metabolites, like recombinant proteins for biopharmaceuticals.
- Facilitating the crossing of distantly related species through protoplast fusion, enabling the regeneration of novel hybrids.
- Implementing embryo rescue, where embryos formed from cross-pollination that would typically perish are cultured in a medium to save them.
- Producing doubled monoploid plants from haploid cultures, allowing for faster development of homozygous lines in breeding programs, often using colchicine to double the chromosome number.

- Serving as a medium for transformation, which can be used for short-term testing of genetic constructs or the regeneration of transgenic plants.
- Conserving germplasm in vitro, particularly for plants that do not produce seeds or have seeds that cannot be stored under standard conditions, such as vegetatively propagated crops like roots, tubers, ornamentals, medicinal plants, and various tropical fruits.

Advantages of micro propagation

Micropropagation provides several unique advantages that conventional propagation methods cannot offer:

- Quick Cloning: It enables the rapid multiplication of genetically uniform plants (clones) with desirable characteristics. A single explant can produce thousands of plants in a short period. Once established, these actively growing cultures continuously supply micro cuttings, allowing for year-round plant production in greenhouses without seasonal breaks.
- Seedless Multiplication: This technique allows for the production of multiple plants even without seeds or the necessary pollinators for seed formation.
- Genetic Modification Regeneration: Micropropagation facilitates the regeneration of entire plants from genetically modified cells. This allows nurserymen to swiftly introduce large quantities of selected superior clones of ornamental plants, significantly impacting the landscape market.
- Disease Control: Plants produced in sterile containers can be transported with a greatly reduced risk of spreading diseases, pests, and pathogens.
- Germination of Challenging Seeds: This method can successfully generate plants from seeds that typically have low germination and growth rates.
- Virus Elimination: It allows for the cleansing of specific plants from viral and other infections, enabling the rapid production of 'cleaned stock' for horticultural and agricultural applications.

Disadvantages of tissue culture plantlets

1. The primary limitation of using in vitro plantlets for farmers is their higher cost compared to conventional methods.
2. Tissue culture plants require more careful handling and enhanced management. Because they lack nutrient reserves at the time of transplanting, they are particularly vulnerable to external stress in the initial months after being planted.
3. Most pathogens are eliminated during the tissue culture process, some crops, such as bananas, can still transmit viruses through in vitro plants.

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