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Tissue Culture Technology: Tool For Tomorrow in Fruit Crops

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Tissue Culture:

The term "tissue culture" was coined by American pathologist Montrose Thomas Burrows. It broadly refers to the in vitro cultivation of seeds, plants, and plant parts (tissues, organs, embryos, single cells, protoplasts) on nutrient media under closely controlled and aseptic conditions. It is a type of micropropagation in which the growth of tissue or cells in an artificial condition for the production of virus-free plants. It helps to produce exact copies of plants that produce particularly desired traits. Tissue culture is common in fruit crops are- banana, pineapple, papaya, fig, jackfruit, citrus, pomegranate, and strawberry.

History of Tissue culture:

Henri-Louis Duhamel du Monceau (1756) pioneered the experiments on the wound healing in plants through spontaneous callus (unorganised mass of cells) formation on the decorticated region of elm plants. Later on, Vochting (1878) suggested the presence of polarity as a key feature that guides the development of plant fragments. The theoretical basis for plant tissue culture was proposed by Gottlieb Haberlandt in his address to the German Academy of Science in 1902 on his experiments on the culture of single cells of *Tradescantia* in artificial conditions. The first true plant tissue cultures were obtained by Gautheret from the cambial

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tissue of *Acer pseudoplatanus*. Gautheret successfully established the first continuously growing tissue cultures from carrot root cambium in 1939. India, work on tissue culture began in the mid-1950s at the Department of Botany, University of Delhi, under the pioneering leadership of Panchanan Maheshwari, often revered as the father of embryology in India. The first Commercial tissue culture was born in India in 1987 when NV. Thomas & Go. ltd in Kerala established their commercial unit for large-scale production of cardamom.

Current scenario of Tissue Culture:

In the global context, tissue culture technology has become a pivotal tool in the cultivation of fruit crops. It enables rapid multiplication of plants with desirable traits, such as disease resistance, improved yield, and quality consistency. In India, tissue culture technology in fruit crops has gained significant traction over the past few decades. It plays a crucial role in determining the challenges such as disease management, crop uniformity, and ensuring quality planting material. States like Karnataka, Maharashtra, Tamil Nadu, and Andhra Pradesh have emerged as key hubs for tissue culture production, particularly in crops like banana, mango, citrus, and pomegranate. The adoption of tissue culture has helped Indian farmers access disease-free and high-yielding varieties, thereby boosting productivity.

Importance of Tissue Culture:

Tissue culture helps in the mass propagation of the desired line of plants which means it produces a large number of plants with desirable traits (disease resistant, high yield, good size and colour). Tissue culture allows the rapid propagation or multiplication of plants from a small part of the plant (tissue or cell), which is particularly beneficial for the species that take time to grow with having difficult to propagate. The plants produced through tissue culture are genetically identical to the parent plant or clone of the parent ensuring the desirable traits are transferred to the offspring. Tissue culture produced materials are free from disease and pathogens as these are produce in aseptic conditions by which crop losses are reduced and improves overall plant health and through this disease-free planting material are produced. Throughout season production of tissue culture plant material as tradition method of propagation depends on the season and cannot be done in the whole year but in tissue culture planting materials are produced in a controlled environment thus it is seasoning independent production which ensure continuous supply of plating material. It helps in to preserve the germplasm of the species which have rare or distinguished characteristics for the future

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prospective and studies. Planting material produced from the tissue culture requires less space than traditional nurseries and This efficiency can also reduce production costs and optimize resource use.

Procedure of Tissue Culture:

The mother plant that is selected for micropropagation should be healthy, vigorous and disease free. Any part of the plant are selected (leaf, apical meristem, bud, root, leaves) which is called Ex-plant. For example: Crown of Pineapple should be use as ex-plant. This ex-plant is used for the entire process which are described below:

Stage 0: Preparation of donor plant: Any part of the selected plant can be used for introduction into in vitro conditions to reinforce the probability of success, The mother plant should be cultivated ex vitro under optimal conditions to minimize contamination within the in vitro culture.

- **Stage I**: Initiation stage: This stage describe as the ex-plant is undergo surface sterilized and transferred into the nutrient medium (macronutrients and micronutrients, carbon source, vitamin, plant growth regulators, vitamins, pH buffers, Gelling agent). Generally, both bactericides and fungicides is often recommended. The choice of products depends on the type of plant parts being used. It's crucial to sterilize the surface of these parts with chemical solutions to remove contaminants while causing minimal damage to the plant cells. Common disinfectants used for this process include sodium hypochlorite, ethanol, and mercury chloride (HgCl2). The cultures are then placed in a growth chamber, either with light or in darkness, depending on the propagation method.
- **Stage II**: Multiplication Stage: the aim of this stage is to extend the number of propagules or the ex-plant. It will continue to multiplies in the repeated sub culture until the specified number of the plant is attained.
- **Stage III**: Rooting Stage: As this stage is related to rooting which means the rooting of the ex-plant is simultaneously occur within the same culture media used for multiplication of the ex-plants. The plant growth regulators which are included in nutrient media help to develop the strong root system.
- **Stage IV**: Acclimatization Stage: At this stage, the in vitro plants are weaned and hardened. Hardening is completed gradually from high to low humidity. The plants are

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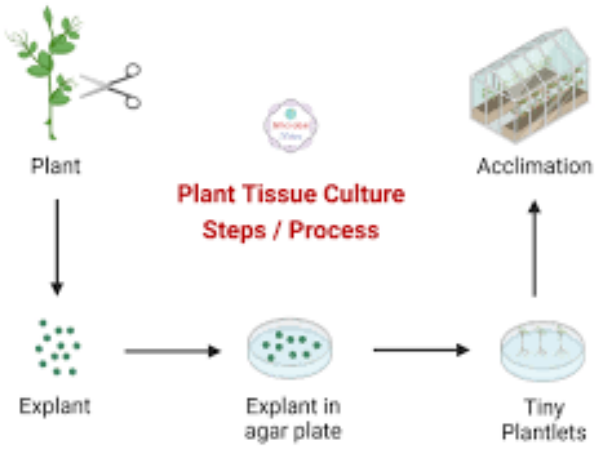
then transferred to an appropriate substrate (such as sand, peat, compost etc.) and gradually acclimatized or hardened under greenhouse conditions.



Application of Tissue Culture:

- **Somatic embryogenesis**: It is a process where structures similar to plant embryos develop from cells that aren't from fertilized seeds. These embryos grow independently from their original tissue and don't have connections to plant veins. In most of the important fruit crops, tissue culture is well established for plant regeneration via somatic embryogenesis. Example: *P. mume* cv. Nanko through Immature cotyledon, *P. avium* through Zygotic and Somatic embryo, *P. cerasus* through Immature cotyledon.
- **Somaclonal Variations**: It is described as it is described as genetic changes or differences that occur in plants regenerated from tissue culture It is much cheaper than other methods of genetic manipulation and it doesn't require containment process. Through this Novel variants – Thornless Blackberry released in New Zealand and Disease resistance- Banana - (F. *oxysporium* spp. *cubens*) Apple- (*Phytopthora cactorum*) Peach- (*Xanthomonas comp*. pv. *pruni*) *(Pseudomonas syringae* pv. *syringae*).
- **Embryo culture**: It is an in-vitro technique that is used to save hybrid products of fertilization when they might otherwise degenerate. embryo culture involves isolating and growing an immature or mature zygotic embryo under sterile conditions on an aseptic nutrient medium to obtain a viable plant. It is used for the recovery of distant hybrids, shortening the breeding cycle, and overcoming dormancy. It is used in grapes and *prunus spp.*

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- **Somatic hybridization**: It is defined as protoplast fusion is a key method for creating hybrids between different species or genera of plants. In somatic hybridization, this technique involves merging the protoplasts (cells with their cell walls removed) from two different types of plants. These selected cells are then grown to develop into hybrid plants with combined traits from both parent plants. Cybrids regenerated via symmetric protoplast fusion in Citrus are - *C. trifoliate*.cv. Shekwasha + *C. sinensis* cv. Valencia, *C. sinensis* cv. Salustiana + *C. aurantifolia* cv. Mexican lime.
- **Anther / Pollen Culture**: Pollen or another culture involves growing pollen grains or anthers in a special nutrient solution in vitro condition. The production of homozygotes is important both for genetic studies and hybrid seed production in highly cross-pollinated crop. It is used for obtaining haploids as well as for producing homozygous diploids. Another culture of sour orange plants was performed and haploid-derived homozygous diploid and aneuploid plants were obtained.

Future prospects of tissue culture:

The plant tissue culture industry holds promise for the future of Agriculture. Biotechnology, recognized for its transformative impact, can greatly enhance agricultural productivity and reduce labour needs. Plant tissue culture methods offer the potential to produce high-quality plants, yet this potential remains underutilized in many developing countries. These techniques are crucial in modern plant breeding, enabling the rapid introduction of improved plant varieties. Traditional methods of breeding can take many years to bring new and improved plants to market, especially if plants multiply slowly. In contrast, in vitro propagation can significantly accelerate this process. In present scenario, where the growers face the problem of shortage of disease-free planting material, the tissue culture is a potential means to tackle this problem, Expanding the existing genetic resource in fruit crops, Conservation of wild species. Therefore, the agricultural extension workers of concerned Universities and experts should work together to disseminate the information of plant tissue technology to the farmers for handling and growing tissue cultured plants for further multiplication under high health status. These trends have augmented the firm footage of tissue culture industry as an established input into agriculture and have further opened up avenues for future growth.

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