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PLANT TISSUE CULTURE AND ITS APPLICATION IN AGRICULTURE

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ABSTRACT

In the very fast developing scenario of biological science, the plant tissue culture has taken lead because it is the most promising areas of biotechnological tools for today and tomorrow agriculture. The areas range from micro propagation of horticultural crops, ornamental and forest trees etc. Over the100 years ago, Haberlandt envisioned the concept of plant tissue culture and provided the bottom work for the cultivation and production of plant cells, tissues and organs in culture. Due to the changes in consumption patterns, demand for fruits, vegetables, dairy, meat, poultry and fisheries has been increasing. Hence, a need to raise crop diversification and improve allied activities. It may be noted that the slowdown in agriculture growth could be attributed to structural factors on the supply side, such as public investment, credit, technology, land and water management, etc., rather than to globalization and trade reforms. In this situation, plant tissue culture offers remarkable opportunities in vitro propagations, plant quality improvement and production of plants with desirable agronomical quality and quantity. It‟s now possible to develop virus-free plant regeneration, herbicide resistance, salinity tolerance, disease resistance, incorporation of high protein content and genetically engineered plants for desirable traits.

KEYWORDS: Plant, Tissue, Vegetable, water Management, quality.

INTRODUCTION

Plant tissue culture is a technique that involves the aseptic culture and propagation of plant cells, tissues, and organs in a controlled laboratory environment. It provides a means to regenerate whole plants from small plant parts, such as cells, explants (small tissue pieces), or even individual plant cells. By manipulating the culture conditions, such as nutrient media composition, hormones, and environmental factors, researchers can induce specific responses and control the growth and development of plant cells.

Application of plant tissue culture in agriculture: Plant tissue culture has revolutionized various aspects of agriculture and has numerous applications. Some of the key applications include:

1. **Micropropagation:** Tissue culture allows for the mass production of disease-free and genetically identical plants through the process of micropropagation. This technique enables the rapid multiplication of elite plant varieties with desirable traits, providing a consistent and reliable means for large-scale plant production.
2. **Germplasm conservation:** Plant tissue culture serves as a valuable tool for the preservation and conservation of plant germplasm. It allows for the long-term storage and maintenance of plant genetic resources, including rare and endangered species, in the form of in vitro cultures or cryopreserved materials.
3. **Genetic transformation:** Tissue culture plays a crucial role in plant genetic engineering and the production of genetically modified organisms (GMOs). Through tissue culture techniques, foreign genes can be introduced into plant cells, and these cells can be regenerated into whole plants with the desired traits, such as improved resistance to pests, diseases, or abiotic stresses.
4. **Production of secondary metabolites:** Tissue culture can be employed to produce valuable secondary metabolites, such as pharmaceutical compounds, flavors, and fragrances. By manipulating the culture conditions and stimulating specific metabolic pathways, plant cells or tissues can be induced to produce and accumulate these compounds in higher quantities.
5. **Disease elimination:** Plant tissue culture techniques, such as meristem culture and shoot tip culture, are used for the elimination of viral, bacterial, and fungal pathogens from infected plant materials. This allows for the production of disease-free plants for further propagation.

6. **Crop improvement:** Tissue culture can aid in crop improvement through somaclonal variation and somatic hybridization. Somaclonal variation refers to the genetic variation that arises from tissue culture-induced mutations, which can lead to the development of novel traits. Somatic hybridization involves the fusion of protoplasts from different plant species, allowing for the combination of desirable traits from different parents.

The technique offers immense potential for the advancement of plant science, sustainable agriculture, and the production of high-quality plant-based products.

Basic requirement for plant tissue culture

There are some important aspects of tissue culture. These are:

A. Aseptic condition
B. Aeration
C. Equipment‟s
D. Nutrient medium.

Tissue culture is the method of „in vitro' culture of plant or animal cells, tissue or organ on nutrient medium under aseptic conditions usually in a glass container. Tissue culture is sometimes referred to as „sterile culture‟ or „in vitro‟ culture.

(a) Aseptic condition: Tissue culture should be done in completely aseptic condition. Dry heat is used to sterilise equipment‟s in an incubator. Wet heat sterilization is done in an autoclave at 120°C at 15 lb pressure for 15 minutes. Liquid media, which are unstable at high temperature are sterilised by ultrafiltration. Chemicals, such as alcohol is used to sterilise working area and instruments. The tissue to be cultured is surface sterilised chemically some of the commonly used sterilising agents are: (I) 9-10% calcium hypochlorite, (I) 2% sodium hypochlorite solution, (III) 10-12% hydrogen peroxide, (IV) 1-2% bromine water. Some other sterilising agents are: 1% chlorine water, mercuric chloride, silver nitrate, antibiotics etc.

(b) Aeration: Proper aeration of the tissue in the culture medium is essential. Those tissues, which are cultured on semi-solid medium do not require any special method for aeration. But those tissues, which are cultured in liquid medium require special device for aeration.

(c) Equipment glassware: Used for tissue culture should be of borosilicate glass (Pyrex glass), because soda glass may hamper the growth of the tissue.

(d) Nutrient media plant tissue culture: Medium contains all the nutrients required for the normal growth and development of plants. It is mainly composed of macronutrients, micronutrients, vitamins, other organic components, plant growth regulators, carbon source and some gelling agents in case of solid medium (Murashige and Skoog, 1962). Murashige and Skoog medium (MS medium) is most extensively used for the vegetative propagation of many plant species in vitro. The pH of the media is also important that affects both the growth of plants and activity of plant growth regulators. It is adjusted to the value between 5.4 - 5.8. Both the solid and liquid medium can be used for culturing. The composition of the medium, particularly the plant hormones and the nitrogen source has profound effects on the response of the initial explant.

Methods of plant tissue culture

There are several methods commonly used in plant tissue culture. Here are some of the key techniques:

1. **Micropropagation: Micropropagation,** also known as vegetative propagation, is a method for the rapid multiplication of plants through tissue culture. It involves the culture of small explants, such as shoot tips, nodal segments, or axillary buds, on a nutrient medium supplemented with appropriate hormones. The explants develop into shoots, which can be further multiplied by repeated subculture. The shoots can then be rooted and acclimatized to form complete plants.
2. **Callus culture:** Callus culture involves the induction and proliferation of undifferentiated mass of cells called callus. This technique is often used for genetic transformation studies, somatic embryogenesis, and the production of secondary metabolites. Explants, such as leaf segments or hypocotyls, are cultured on a medium containing auxins, which stimulate the formation of callus. The callus can be maintained and subcultured or induced to differentiate into shoots or somatic embryos.
3. **Organogenesis:** Organogenesis refers to the process of inducing the formation of complete organs, such as shoots or roots, from explants in tissue culture. This technique is often used for clonal propagation and regeneration of whole plants. Depending on the plant species and the type of explant used, different hormone combinations and culture conditions are employed to induce the desired organ formation.
4. **Somatic embryogenesis:** Somatic embryogenesis involves the direct induction of embryos from somatic cells, bypassing the zygotic embryogenesis process. It is a valuable technique for the mass production of somatic embryos, which can be converted into complete plants. Somatic embryos can be induced from various explants, including zygotic embryos, immature seeds, or callus cultures. The embryos are then matured, germinated, and converted into plantlets.
5. **Protoplast culture:** Protoplast culture involves the isolation and culture of plant cells with their cell walls removed. Protoplasts can be obtained from various plant tissues by enzymatic digestion. The isolated protoplasts are cultured in a liquid medium or on a solid agar medium supplemented with appropriate nutrients and hormones. Protoplasts can be used for various applications, including somatic

hybridization, genetic transformation, and the study of cell physiology and development.

6. **Embryo rescue:** Embryo rescue is a technique used to save developing embryos that are unable to mature or germinate in natural conditions. It involves the excision of immature embryos from their maternal tissues and their placement on a nutrient medium in vitro. The embryos are provided with suitable conditions for growth and development until they can be transferred to soil and further cultivated.

These are some of the commonly used methods in plant tissue culture. Each technique has specific applications and requirements, and the choice of method depends on the objectives of the study, the plant species, and the desired outcome.

CONCLUSION

In conclusion, plant tissue culture is a powerful technique that has revolutionized various aspects of agriculture. It allows for the aseptic culture and propagation of plant cells, tissues, and organs in a controlled laboratory environment. The technique has numerous applications in agriculture, contributing to the advancement of plant science, crop improvement, and sustainable agricultural practices.

Plant tissue culture finds application in micropropagation, enabling the mass production of disease-free and genetically identical plants. This technique plays a vital role in the rapid multiplication of elite plant varieties with desirable traits, providing a consistent and reliable means for large-scale plant production.

Plant tissue culture also plays a crucial role in genetic engineering, enabling the introduction of foreign genes into plant cells and the subsequent regeneration of whole plants with desired traits. This has significant implications for the development of genetically modified organisms (GMOs) with improved resistance to pests, diseases, or abiotic stresses.

The production of secondary metabolites, such as pharmaceutical compounds, flavors, and fragrances, can be achieved through tissue culture techniques. By manipulating the culture conditions, specific metabolic pathways can be stimulated to produce and accumulate these valuable compounds in higher quantities.

Tissue culture is also used for disease elimination, as specific techniques allow for the production of disease-free plants. Meristem culture and shoot tip culture are employed to eliminate viral, bacterial, and fungal pathogens from infected plant materials, ensuring the production of healthy plants.

Overall, plant tissue culture offers immense potential in agriculture, providing valuable tools for plant propagation, conservation of genetic resources, genetic engineering, secondary metabolite production, disease elimination, and crop improvement. Continued advancements in tissue culture techniques and their applications hold promise for the development of sustainable agriculture and the production of high-quality plant-based products.

REFERENCE

1. George, E. F., Hall, M. A., & De Klerk, G. J. Plant propagation by tissue culture: Volume 1. The background. Springer Science & Business Media, 2008.
2. Larkin, P. J., & Scowcroft, W. R. Somaclonal variation—a novel source of variability from cell cultures for plant improvement. Theoretical and Applied Genetics, 1981; 60(4): 197-214.
3. Thorpe, T. A. History of plant tissue culture. Molecular Biotechnology, 2007; 37(2): 169-180.
4. Murashige, T., & Skoog, F. A revised medium for rapid growth and bioassays with tobacco tissue cultures. Physiologia Plantarum, 1962; 15(3): 473-497.
5. Touraev, A., Forster, B. P., & Jain, S. M. (Eds.). Advances in haploid production in higher plants. Springer Science & Business Media, 2010.
6. Davey, M. R., Anthony, P., Power, J. B., & Lowe, K. C. Plant cell culture: Essential methods. John Wiley & Sons, 2005.
7. Dodds, J. H., & Roberts, L. W. Experiments in plant tissue culture. Cambridge University Press, 1995.
8. Reinert, J. Principles of plant genetics and breeding. Blackwell Publishing, 2002.
9. Karami, O., & Saidi, A. Plant regeneration from protoplasts: achievements, problems and prospects. Plant Cell, Tissue and Organ Culture, 2010; 104(2): 207-219.
10. Nieves-Cordones, M., Mohamed, S., Tanoi, K., Shinmyo, A., & Kobayashi, N. I. Plant hormone signaling in salinity and osmotic stress: recent advances and perspectives. Frontiers in Plant Science, 2017; 8: 8.
11. Srivastava, L. M. Plant growth and development: hormones and environment. Academic Press, 2002.