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The Multi-Dimensional Aspects of Plant Tissue Culture Research

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Plant tissue culture refers to growth and multiplication of cells, tissues and organs on a defined solid or liquid media under aseptic and controlled environment. Plant tissue culture technology is being widely used for large-scale plant multiplication. The commercial technology is primarily based on micropropagation, in which rapid proliferation is achieved from tiny stem cuttings, axillary buds, and to a limited extent from somatic embryos, cell clumps in suspension cultures and bioreactors.

The term tissue culture is actually a misnomer burrowed from the field of animal tissue culture. It is a misnomer because plant propagation is concerned with the whole plantlet and not just isolated tissues, though the explants may be a particular tissue. Although most nurserymen have been introduced to the techniques and advantages of micropropagation, few have ventured to use it as a propagation tool. Some firms having established tissue culture facilities on commercial scale operations are presently in operation for the mass propagation of apples, crabapples, rhododendrons, and a few other selected woody species. The applicability of micropropagation for woody trees has been demonstrated as feasible since all aspects of the technology have confirmed the fact that trees produced by this method look like and grow like their counterparts produced by traditional methods of cloning. The potential for selecting pathogen free plants, for selecting stress-tolerant and pathogen-resistant clones of plants, and the novel genetic combinations to be achieved through somatic hybridization are all lines of research which can have a profound impact on the nursery industry.

Plant improvement through tissue culture

The updates of plant tissue culture reveals that major impact of tissue culture technology would not be in the area of micropropagation, but rather in the area of controlled manipulations of plant germplasm at the cellular level. Researches on the ability to rearrange, and reorganize the constituents of higher plants is already being conducted on ornamental trees and shrubs with the intent of obtaining new and better landscape plants.

Multiplication of plants with enhanced stress or disease resistance

The most widely researched area of tissue culture today is the concept of selecting disease, insect, or stress resistant plants through tissue culture. As significant, gains in the adaptability of many species have been obtained by selecting and propagating superior individuals, so the search for these superior individuals can be tremendously accelerated using *in vitro* systems. Recent research in this area extends across many interests including attempts to select salt tolerant lines of tomato, freezing resistant tobacco plants, herbicide resistant agronomic crops, and various species of plants with enhanced pathogen resistance.

Production of pathogen free plants

Obtaining, maintaining, and mass propagating of specific pathogen-free plants is another purpose for which plant tissue culture has been utilized. Plant tissues which are free of pathogen under consideration (viral, bacterial, or fungal) are primarily selected as the explants for tissue culture. Cultures which reveal the presence of the pathogen are destroyed, while those which are indexed free of pathogen are maintained as a stock of pathogen-free material. The impact of obtaining pathogen-free nursery stock can only be speculative, since little research documenting viral, bacterial, or fungal diseases transmitted through propagation of woody ornamentals is available.

Somatic hybridization

The non-conventional genetic process of fusion between isolated somatic protoplasts under *in vitro* conditions and subsequent development of their product to a hybrid plant is known a somatic hybridization. Protoplasts are single cells which have been stripped of their cell walls by enzymatic treatment. A single leaf treated under these conditions may yield tens of millions of single cells, each theoretically capable of eventually producing a whole

plant. The potential use of somatic hybridization to bring about novel combinations of genetic material has been demonstrated in the genera *Petunia* and *Nicotiana*. Research funded in part by the Horticultural Research Institute at the University of Wisconsin is investigating the feasibility of using such techniques with woody species. Brent McGown and co-workers have succeeded in obtaining naked cells from tissue cultures of *Betula* and *Rhododendron*, but as of yet, they have neither obtained plants from single cells not achieved cellular fusion. Not only is the desired information transmitted to succeeding generations of bacteria, but the bacterial cultures become synthesizers of insulin as well. Plant cells can be made to take up foreign genetic codes, but evidence that this can be transmitted into the daughter cells and serve the intended function is lacking.

Secondary metabolites production

The production of secondary metabolites has long been a subject of interest for biotechnologists. The tissue cultured plants have advantages in metabolite production over intact plants. About 25% prescription medicines and various raw materials used in the industries are obtained from plants. Further, the number of patents on pigments, cosmetics, perfumes and food additives has increased in recent years. Manufacturing these products from natural source are not enough to meet the consumer's demand and efforts have to be made to develop technology for their production at the industrial level. Considering the high economical and pharmacological importance of secondary metabolites, industries are deeply interested in utilizing plant tissue culture technology for large-scale production of these substances.

In conclusion, the last four decades have seen rapid and exciting advances equal to any seen in biology and the applications of the technology have had global implications. There is no doubt, however, that the combination of genetic modification, and cell and tissue culture applied with due caution presents immense opportunity for progress. Like any other area of science, it started as an academic exercise to answer some questions related to plant growth and development, but proved to be of immense practical value, as an aid to plant propagation, raising and maintenance of high health-status plants, germplasm storage, and a valuable adjunct to the conventional methods of plant improvement

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Further reading

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