International Journal of Natural and Engineering Sciences 3 (2): 07-09, 2009
ISSN: 1307-1149 www.nobel.gen.tr

Propagation Possibilities of Commercially Important Plants through Tissue Culture Techniques

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Received: December 19, 2008
Accepted: January 24, 2009

Abstract

Propagation of some commercial plants having difficulty in reproductions by seed or vegetative propagules conventionally is established by *in vitro* tissue cultures techniques. The techniques such as micropropagation provide fast methods for production of a large number of uniform plantlets in a short time.

As compared with conventional propagation methods, different culture techniques have many advantages such as a rapid propagation of valuable genotypes, production of disease-free plants, non-seasonal production during all the year and germplasm conservation.

Techniques used to propagate commercially important plants *in vitro* are relations with axillary branching, adventitious shoot formation and somatic embryogenesis. Most commercial micropropagated plants are derived from axillary shoot formations. Recently bioreactors including liquid culture media have been designed for multiplication of plants because of their advantages of scaling up and automation.

Tissue culture techniques used for propagation of many commercial plants have a few limitations such as high cost of production, requirement of high technology and educated staff, somaclonal variation risks on clones during culture, difficulties on development of a protocol for recalcitrant plants etc.

In vitro propagated plants under aseptic and highly protected conditions need an acclimation period for *ex vitro* conditions. Many ornamentals, fruit rootstocks, woody species, industrial, medicinal crops, and also the other plants have been propagated through tissue culture techniques successfully and transferred to *ex vitro* conditions for many years.

The micropropagation industry in Turkey is a growing sector with advantages such as lower labor cost and advanced knowledge of the academicians.

Key Words: Tissue culture, commercial plants, micropropagation, Turkey

INTRODUCTION

Plant tissue culture is the science of growing plant cells, tissues or organs isolated from the mother plant, *in vitro* conditions [1]. Micropropagation is used for the rapid multiplication of plants and consists of three main types of vegetative propagation: (1) Axillary shoot production, (2) Adventitious shoot production, (3) Somatic embryogenesis [2].

Five steps are important in a commercial micropropagation system. The lack of success at any step can make the total system unworkable. The first step involves an analysis of the potential market and general plant growth habit related with donor plant selection and preparation. The next four steps involve microculture of the plant including establishing an aseptic culture, shoot formation and production, rooting and transfer to the natural environment [1, 3].

Many different techniques for researches can be used on a small scale. Time and resources for general exploration are usually much more limited on a commercial scale. The final result has to be evaluated by yielding and economic factors [3].

Advantages and Disadvantages of Micropropagation

The aim of micropropagation is to mass-produce genetically identical, physiologically uniform, developmentally normal and pathogen-free plantlets, which can be acclimatized in a reduced time period and at a lower cost [4].

Micropropagation has significant advantages according to the conventional clonal propagation techniques.

These are the rapid large-scale propagation of genotypes, the use of small amounts of original and the production of pathogen-free propagules [5]. Additionally, only a small space is required to maintain plants or to increase their number. Some factors such as culture media (nutrient composition, growth regulator levels, vitamins, sugars) and also culture conditions (light, temperature, aeration of culture vessel) has to be taken into consideration for micropropagation. Therefore numerous plants can be propagated in a short while. Production can be continued all the year round and is more independent of seasonal changes [1].

Developments on environmental control systems and *in vitro* culture systems cause a reduction in production cost. Commercial use of micropropagation is still limited due to high production cost depending on labor costs, growth rate *in vitro* and survival rate of the plantlets during *ex vitro* conditions [6]. The procedures for micropropagation have to be improved successfully. The occurrence of somaclonal variation is very important problem *in vitro* conditions. But this potential is very high in suspension and callus-based systems. Contamination, browning and also vitrification are the other problems in commercial micropropagations [6].

New Approaches

Techniques regarding the high efficiency of micropropagation include simplified large-scale bioreactors, cheaper automatization facilities, efficient somatic embryogenesis and synthetic seed production, greater utilization of the autotrophic growth potential of cultures, good repeatability and quality assurance of the micropropagated plants [5]. Liquid media are very convenient for micropropagation because of plantlet production costs and automation. Liquid culture systems can provide uniform culture conditions, easy renewal of media and also container cleaning after a culture period, establishing of sterilization by microfiltration. In liquid culture systems, larger containers can be used and transfer times can be reduced [7].

Bioreactors are used for providing optimum growth conditions by regulating chemical or physical parameters in order to achieve either maximum yield and high quality of the propagules, or to keep the low production costs by integration of automated facilities and simple low-cost devices [8]. Bioreactors provide a rapid and efficient plant propagation system for many agricultural and forestry species. Various types of bioreactors are suitable for the production of clusters of buds, meristems or protocorms. For example, a simple glass bubble-column bioreactor for the proliferation of ornamental and vegetable crop species can results in biomass increase of 3 to 6-fold in 3-4 weeks. A disposable pre-sterilized plastic bioreactor (2 to 5-litre volume) can be used for the proliferation of meristematic clusters of several ornamental, vegetable and woody plant species [9]. Temporary immersion has also been utilized for micropropagation, preferring temporary contact between the plants and the liquid medium. Temporary immersion used for micropropagation provides good effects on shoot proliferation and microcuttings, microtuberization, somatic embryogenesis, quality of plant material, shoot vigour, morphologically normal somatic embryo formation, elimination of hyperhydricity and also acclimatization performance [7].

The factors such as culture vessel type, liquid media, alternative gelling agents, cheaper chemicals, natural light for culture growth, electricity consumption, bioreactors or robots have to be taken into consideration for cost reduction strategies [10]. Reliable power supplies, logistics, political stability and transportation issues are very important for commercial micropropagation companies [11].

Concluding Remarks

Commercial micropropagation is used for multiplication of elite plants in ornamentals, fruit crops and woody species, further for improvement in productivity of agricultural and field crops and for multiplying selected mutants and genetically engineered plants. However, high cost of production has limited the practical application of this technology. Solving this problem is a priority area for many R&D programmes [10].

At the present time in Turkey, there are approximately 10 commercial tissue culture laboratories. The most important crop of *in vitro* laboratories in Turkey is potato. The other important plants are ornamentals (especially pot plants), fruit rootstocks and medicinal plants mainly [12] (Fig. 1). Total production of commercial laboratories in Turkey is approximately 4-5 million plants per year. On the other hand, many universities and agricultural research institutes are working on plant biotechnology especially tissue culture.

Turkey has very rich endemic plants and presents a good opportunity for clonal propagation of many different kinds of plants through *in vitro* procedures. The micropropagation industry in Turkey has knowledge and also a proper infrastructure. This industry is developing and ready for new approaches.

(a)

(b)

(c)

Figure 1. *In vitro* micropropagated plants. (a) *In vitro Dahlia*, (b) *in vitro* Myrobolan (*Prunus cerasifera* L.), (c) Spanish lavender (*Lavandula stoechas* L.) [12].

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