TISSUE CULTURE TECHNOLOGY: PRACTICAL APPLICATION OF SOPHISTICATED METHODS

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Introduction

The application of tissue culture and rapid propagation methods in potato production continues to become more widespread in both developed and developing countries. While rapid propagation consists of a number of methods for rapid increase in the number of propagules, tissue culture techniques can be widely applied, not only to increase propagation rates, but also to modify the germplasm itself.

It is important to see tissue culture not as a scientific discipline but rather as a range of techniques. These techniques are of differing degrees of complexity forming a complete spectrum of technologies; for agricultural application the most important feature is the integration of these techniques to improve potato production in its widest possible sense. In this presentation individual technologies of differing degrees of sophistication are analyzed indicating the existing and potential impact of the said technique on potato production.

The use of the terms 'sophisticated' and 'applied' is also relative when used in an international context, as problems and constraints in one country may be favorable attributes in another; for this reason I have chosen to analyze the widest possible spread of tissue culture techniques and applications; however, the comments should be taken in a context appropriate to the reader's working environment.

The Tissue Culture Technology Spectrum

For many years tissue culture has been applied to improve potato production by means of micropropagation, pathogen elimination and germplasm conservation (22, 23, 25). However, some of these techniques are still being refined and improved (6, 5). Intermediate level technologies such as in vitro tuberization (29), and embryo and anther culture are having some direct application on germplasm distribution and germplasm improvement (26). The most sophisticated technologies such as genetic engineering and protoplast fusion have enormous potential to improve potato production but care must be exercised in the translation of that 'potential' into reality. The article will analyze this technology spectrum in relation to its impact on potato production.

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ADDITIONAL KEY WORDS: Germplasm, micropropagation, genetic engineering.
1. IN VITRO GERMPLASM CONSERVATION

A number of tissue culture methods have been applied for conservation of potato germplasm in vitro; these include the use of growth retarding compounds (32), reduction in incubation temperature (24) and less importantly freeze preservation by cryopreservation (9, 30). Most potato programs apply tissue culture germplasm conservation to some extent; this may be the maintenance of a few genotypes used in a seed program or it may be a major germplasm collection such as that at CIP with over 3000 accessions.

A number of advantages exist for in vitro germplasm collections over that of field maintained collections. The material is available all the year round, it is protected from environmental and pathogen risks and it is relatively simple to produce multiple copies of the collection to maintain duplicates in different geographical locations.

(a) Use of Growth Retardants

A wide range of chemical growth retardants has been tested on in vitro potato plantlets; the objective in using these compounds is to lower the growth rate of the in vitro plantlets in order to lengthen the time between subcultures.

Maleic hydrazide (MH), an active compound in a number of commercially available growth retardants, has been shown to promote tuberization in cultured stem sections of *S. tuberosum* cv. British Queen (12). Diaminozide (B995) is normally used extensively as a foliar spray on ornamental plants such as chrysanthemum and azalea; however, Humphries and Dyson reported a 10% increase in tuberization after spraying it on plants of *S. tuberosum* cv. Majestic (17), and it also retarded plant growth. Phenolic compounds such as trans-cinnamic acid (TCA) have been shown to stimulate tuberization from stem cuttings in vitro. Abscisic acid (ABA) is present in potato tubers and it is involved in the control of dormancy where it has been used to act as a natural growth retardant.

An approach to retarding growth has been made by increasing the osmotic pressure of the medium, by adding the metabolically inactive sugar alcohol mannitol, in order to reduce the water available to growing cultures (3).

Changing the available carbon, generally sucrose, can have a very marked effect on growth rate, either as a nutritional factor or an osmotic factor. The use of different concentrations of sucrose has yielded interesting results. Increasing the sucrose concentration in the medium up to 8% is an effective method to retard growth; however, there are problems of high mortality rates after 6 months of storage. These additives are very effective for regulating in vitro plantlet growth.

(b) Growth Regulation by Reduced Incubation Temperature

Plants, like most organisms live within a fairly restricted temperature range. Plant growth processes are under the control of a large number of