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Tissue Culture in the Eastern Caribbean - The experience of a production laboratory in Barbados

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In the past decade much has been said and written concerning the various ways in which tissue culture technology may contribute to agricultural production and crop diversification within the Caribbean. There have been successes, but in many respects, the true potential of this technology still remains untapped. The present paper briefly restates the rationale behind the use of tissue culture and examines the experience of the CARDI laboratory in Barbados. The case is put that, should countries within the region wish to benefit from the increasing availability of germplasm, resources should be allocated for the establishment of simple yet productive reception centres that are capable of handling tissue culture products imported from overseas.

Keywords: Tissue Culture; Germplasm; Root crops; Barbados

Introduction

In recent years there has been much discussion throughout the Caribbean region about the need of agricultural and horticultural enterprises to strengthen and develop the production and marketing of a wide variety of products. At the highest levels, policy makers see the wisdom of encouraging farmers to grow crops not only for export but also to contribute towards import substitution. Fundamental to the success of such projects is the provision of suitable planting material which has not only the potential of producing good yields of high quality but will also provide a satisfactory return on the farmers' investment.

The marketing of certified 'true seed' is well established in the region and has given growers the opportunity of raising a wide variety of vegetables. There are, however, many major crop species such as the root crops and other staples that are generally only regenerated vegetatively. Within the Caribbean basin and worldwide there is a great diversity of these crops, many of which would no doubt yield well on the islands of the Eastern Caribbean. However, the threat of introducing new and potentially devastating diseases and plant parasites from one territory or locality to another, severely restricts the exchange of any vegetative planting material. It is in this context that micro-propagation or tissue culture techniques and the facilities available at the production laboratories of the Caribbean Agricultural Research and Development Institute (CARDI), in Barbados and Dominica are likely to make a significant contribution to the regional crop diversification programme in the years ahead.

Tissue culture techniques

Traditional propagating methods rely on the use of seed, cuttings, grafting, budding and divisions, etc. Tissue culture techniques represent a refinement of these age old practices, for under aseptic laboratory conditions, fragments of tissue or bundles of cells, when placed in a suitable nutrient medium and held under appropriate

environmental conditions, may be encouraged to regenerate into entire miniature plants which are genetically identical to that of the parent material.

While tissue culture can serve a diverse number of purposes, in terms of rapidly improving the production of designated crops, the technique may be used for:

1) The derivation of disease free germplasm from valuable parent material
2) The maintenance and conservation of these genetic resources
3) The mass propagation and distribution of economically important clones.

Germplasm may be maintained in a disease free environment. When required, clones may be regenerated at any time of the year and in many instances the rate of propagation is far more rapid than by the alternative conventional methods. The ability to maintain large numbers of plantlets in relatively small growth rooms also obviates the need to service extensive museum plots in the field. On the debit side, tissue culture techniques are not a universal panacea, micro-propagation technology brings with it its own problems, laboratories are expensive to run and are not immune from disasters. However, within limits, micro-propagation will no doubt play an increasingly important role in agricultural research and development.

The micro-propagation of yams

To illustrate how tissue culture techniques are able to contribute to the development of agriculture in the Caribbean, I would like to refer to the process by which CARDI personnel developed the virus-tested yam material which is now widely available throughout the region (see Figure 1).

CARDI's involvement with aspects of tissue culture technology may be traced back to the work already in progress when the organisation was established. In the early 1970's, surveys undertaken by the 'Yam Virus Research Project' (Scheme No. R2672) funded by the British Ministry of Overseas Development (ODM), indicated that virus diseases were widespread in all five major yam species found in the Commonwealth Caribbean (i.e. *Dioscorea alata, D. cayenensis, D. esculenta, D. rotundata and D. trifida*) (Haque and Mantell, 1980). Although the intensity of infection was often low, field studies revealed that the virus particles present were associated with gross reductions in tuber yields and in the case of *D. alata* at least, a bacilliform virus was also implicated as the cause of the condition known as 'Internal Brown Spot' (IBS) which had adversely affected the sale and export of yams since the mid-1960's (Mantell, 1978; Mantell and Haque 1978 & 1979b).

Research work by CARDI in conjunction with the University of the West Indies (UWI) resulted in the development of an apical meristem technique which, when combined with thermotherapy, was able to produce what is believed to be, virus free cultures of 'White Lisbon' and 'Oriental'. Both are popular cultivars of *D. alata* (Mantell, et al 1980). Towards the close of the 'Yam Virus Project', micro-propagation techniques were developed to facilitate the rapid multiplication of 'virus-tested' yam material from the original meristem-tip cultures (Mantell et al, 1978 & 1979, Mantell and Haque, 1979a) and in 1979 a proposal was put forward for the establishment of a yam seed propagation scheme in Barbados to ensure the future availability of disease free yam material to growers in the region.

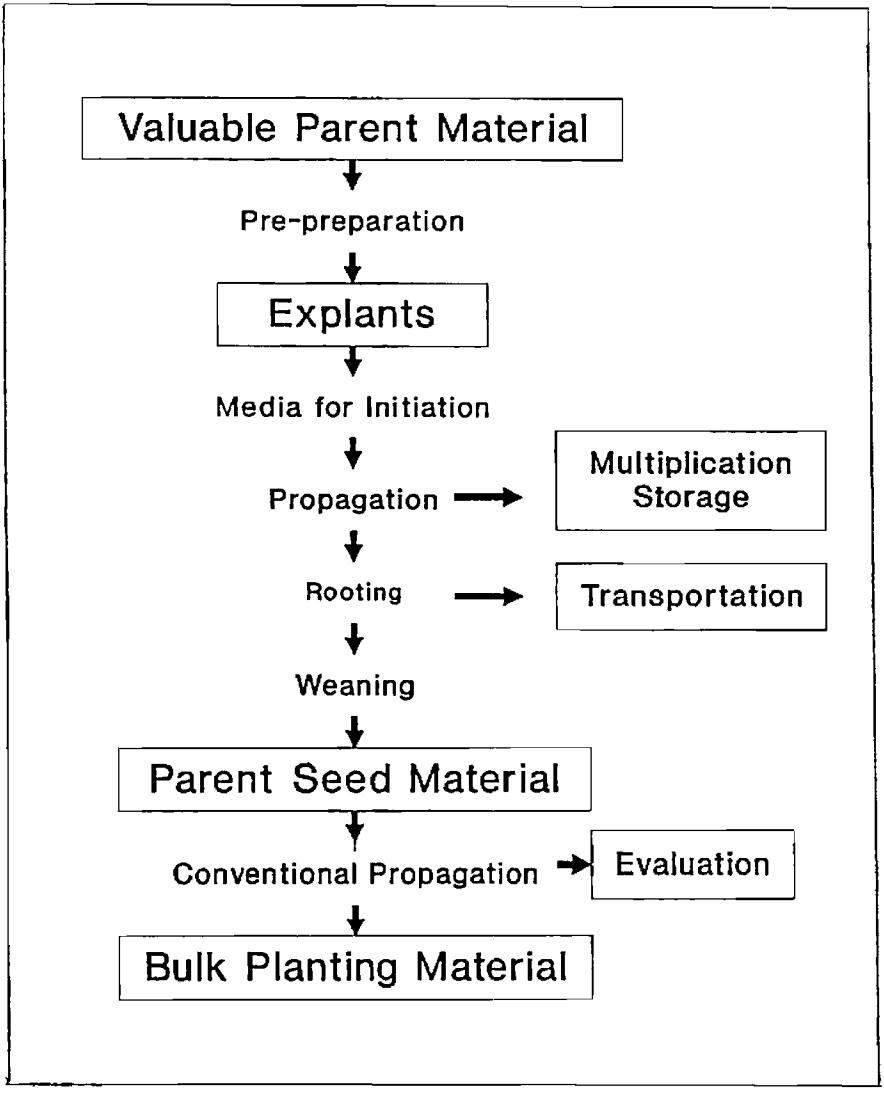

Figure 1 Essentials of micro-propagation process

With the support of the European Development Fund (EDF), CARDI was able to put this project into effect and between the years 1980 and 1984, the present 'Tissue Culture and Yam Propagation Centre' was constructed and made operational (CARDI, 1984). By the end of the project, the propagation unit had produced and made available over two million pounds of virus-tested yam tubers to farmers in eleven countries of the Caribbean. On more developed farms, the use of the virus tested plant material was found to increase the yield of tubers by some 35% (Mantell, 1979a). Under conditions of low technology and among many small farmers, yield increases, without extra inputs were estimated at over 90% (George and Pilgrim, 1982).

Today, the work on *D. alata* continues. The germplasm of the original virus-tested material is maintained in the laboratory. The fields of those registered growers involved in the conventional propagation of the improved yam lines are rogued annually to remove virus infected plants, and in the coming seasons it is planned that once again new stocks of parent material regenerated from cultures will be bulked up for release to the same registered growers and ultimately to the general farming public in Barbados and elsewhere to improve the planting material.

Other root crops

In the last two years the Barbados tissue culture unit has also been supporting the 'Cassava Production Project' (CARDI/USAID/FSRD-538-0099) funded by the USAID. In early 1986, ten 'elite' cassava (*Manihot esculenta* Crantz) varieties were imported from CIAT in Columbia. In much the same way as the yams, these cultures have been micro-propagated and mature plantlets have been released to nursery plots. Sufficient material has now been produced to enable extensive agronomic trials to be undertaken. The results of these trials will help the agronomic staff of the CARDI unit in Barbados to determine which cassava varieties are best suited to the local environment. It is hoped that the cassava varieties now available will find a market for human consumption as well as on the farms where the entire plant may be processed for livestock and poultry feed.

In the latter part of 1986 and early 1987, the Barbados unit took delivery of a number of sweet potato (*Ipomoea batatas* L.) cultivars developed by the breeders associated with Clemson University in South Carolina, USA. These lines have now been propagated *in vitro* and certain cultivars have already been distributed to Antigua and St. Lucia. Cultures are also due to be released to Dominica in the next few weeks. Over a period of time, it is envisaged that a cooperative exchange of sweet potato germplasm will develop between South Carolina and the states of the Commonwealth Caribbean. To facilitate this work, the tissue culture unit will act as a 'staging post' for material entering or leaving the region.

Propagation of ornamentals

Although root crops have been and will remain a major component of the tissue culture work carried out in Barbados, it is recognised that exotic tropical pot-plants and cut flowers of high quality are additional horticultural products of potential importance and great commercial value. The ornamentals of enduring popularity that appear eminently suited to exploitation are *Anthurium andraeanum* Lind., a member of the *Araceae* and various *Heliconia* spp. Under the correct

growing conditions both these plant species will produce spectacular blooms throughout the year. At the request of an ornamental grower in Barbados, CARDI has already started to micro-propagate Anthurium plantlets. It is envisaged that the project will expand and develop in the next few years.

Germplasm transfer and storage

Looking to the future, a major component of the laboratory's work will be the implementation of the recently endorsed 'Yam and Cassava Development Project' (TCP/RLA/6768) which is to be funded by the FAO. Under the terms of this sub-regional project, it is proposed that the Barbados tissue culture laboratory will become one of the regional centres dedicated to the intensive micro-propagation and distribution of improved and disease free root and tuber crop germplasm. Essentially, by building on the experience of the past, the Barbados unit will develop and expand existing projects with a view to fulfilling the following objectives:

1) To assemble and maintain *in vivo* and *in vitro*, the major germplasm groups of yam, cassava, tannia and sweet potato clones of the region.

2) To micro-propagate and distribute to participating countries, selected disease-free cultivars of yam, cassava and sweet potato.

In order to achieve the first objective, the tissue culturalists involved in this proposed project require not only the thoughts and ideas, but also the active participation of the region's agriculturalists. In the CARICOM countries, although tissue culture facilities are available on the U.W.I. campuses of Jamaica and Trinidad, most of the production work will be based in the laboratories in Barbados and Dominica. Our resources and manpower are limited. We cannot at present hope to store, maintain and propagate vast numbers of different root crop cultivars. Thus to do the job well, the staff of CARDI will have to concentrate on a limited number of cultivars of each of the major crop species already mentioned. In order to make a valid judgment about which cultivars should be selected, we need to know what types of germplasm are already available in the region and also which products would be most acceptable to the consumer. Armed with this information, it should be possible to identify and select superior germplasm from both collections overseas and from material within the region and hence propagate those cultures best suited to the needs of the farmer and the market place.

The Caribbean states in general are well placed to take advantage of the tissue culture technology available both within the region and worldwide. It is not necessary for each small territory to develop elaborate laboratory facilities, for international research centres and private companies have increasingly large collections of the economically important plant species which are potentially available to both the development agencies and individual growers. Unlike true seed, however, such material is transported as miniature plantlets in culture. This poses something of a problem, for although the process of transferring plantlets from culture to a soil based medium is relatively simple, rough handling, inadequate moisture and exposure to harsh environmental conditions at this critical stage can lead to high rates of loss. To minimise such wastage, some forms of reception centre are called for.

On a number of islands certain agencies, ministries or even private growers are able to provide greenhouse or screenhouse facilities to overcome the problems of weaning valuable plant material. On other islands such facilities may be poor or absent. Under the auspices of the FAO project, it is hoped that a small number of reception centres may be established where they are most needed. Once operational, such centres would be able to receive germplasm from whichever sources proved most appropriate.

The international exchange of germplasm is essential for the further development of many crop species worldwide. The ultimate provision of suitable reception centres in all of the territories of the region will facilitate the distribution of those crops that may not be available in the form of certified 'true seed'.

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