DEVELOPING THE MARKET FOR MICROPROPAGATED PLANTS

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Tissue culture, as a propagation technology, will only develop if it can deliver plants which provide clear economic benefits over those propagated by conventional means. In developing the market we are seeking those species and cultivars where the technology can deliver the benefits.

Twyford Plant Laboratories is principally active in the ornamental plant sector and it is here that tissue culture is growing fastest as a propagation technique. Over the last 10 years, the market for tissue-cultured plants in Europe in the ornamental sector has grown from under 10 million to approximately 100 million in 1987/88.

There are seven major factors which account for this outstanding growth.

This paper will take each of these attributes in turn and examine how one company, Twyford Plant Laboratories has used each of them to develop a market.

1. High health plants. In this area we have looked for plants which have significant disease problems arising from repeated conventional vegetative propagation. These are generally viruses and their impact will vary depending on the activity of the vector or the particular season. Most propagators need to start with the highest health status material possible and so, for this reason, we have been delivering thousands of high health chrysanthemum plants from tissue culture each year since 1983, which are then used as motherstock for future conventional propagation. Clearly, once out of the laboratory, the health status of the crop deteriorates and so there is a recurring need for this quality of plant material.

In addition to chrysanthemum, we have delivered high health plant material of potato this year for the first time. This was one particular cultivar for use on the Channel Islands where the quality of stock currently in use was so poor that replacement was essential. It is likely that these tissue culture plants will be used for propagation through one or two seasons before being replaced themselves.

2. Rapid introduction of new cultivars. The cut gerbera crop in Europe is currently about 24 million plants per year and around 90 per cent of these are now produced through tissue culture. Before 1980, propagation was almost entirely through cuttings, which had two distinct disadvantages:

i) It took a very long time to introduce a new cultivar, and

ii) plant producers had to keep very large stocks of mother plants in heated glass over winter from which to take cuttings in the following spring. This was expensive, it limited output, and it restricted the range of cultivars the growers had access to. In addition, it could also give rise to disease problems.

The impact of micropropagation on this market was very significant. Breeders could introduce a new cultivar in perhaps 3 years compared with up to 8 years using conventional methods. It has also had an impact on the overall market for gerbera because removing the mother stock bottleneck gave the crop additional scope for expansion. We estimate that consumption of gerbera plants in Europe has risen approximately 3-fold in the last 10 years, although the last 2 to 3 years has shown a levelling off in total demand.

The same argument holds for the lily crop, where propagation of new cultivars is again a lengthy process. Even with relatively high multiplications at scaling, it still takes 2 to 3 years for the bulb scale to reach a size where it can be scaled again. A breeder needs a minimum of 10,000 bulbs of a cultivar to introduce it into the market. These could be achieved from a single bulb in tissue culture in one year, and then with a further two years growing on would give a total time to introduction of three years. The time for conventional propagation is at least double that and if your competitors are using micropropagation, by the time the cultivar reaches the market the opportunity for the cultivar may have disappeared.

3. Improved uniformity and rapid propagation of elite clones. Clearly, the improved uniformity that one can gain from tissue culture should mean the plants are uniformly good, not uniformly poor. These are examples from three very different crop sectors:

i) pot gerbera from the ornamental sector;

ii) asparagus from the vegetable sector, and

iii) oil palm from the plantation sector.

Pot gerbera is normally propagated by seed and the resulting crop is somewhat variable both in colour, date of flowering, and quality of plant. Propagation through tissue culture enables the grower to select his very best plant and produce a whole glasshouse crop which is identical to that plant. It is only worth doing if it saves costs or if the additional revenue he gets justifies the additional cost of the tissue-cultured plant over seed. This is certainly the case for pot gerbera. The idea of a uniform, programmable, predictable pot crop which the grower can rely on all the year round that does not have the variability of colour, flower form, and flowering date that is prevalent with seed-produced crops, is just what the market requires.

The same argument holds true for both asparagus and oil palm, which exhibit a high degree of variability from seed-propagated crops. Tissue-cultured asparagus plants that have been selected for high quality, high yield, and improved vigour, can increase yields by up to 100 per cent over conventional production and this economic benefit can be transferred across the whole of the grower's production by clonal planting.

Asparagus is in the ground for up to 10 years, which is a long time to enjoy these yield benefits and enables the grower to justify paying something extra for his starter plants. For oil palm the same argument applies, but it can take some time to select the elite tree. The effort is well worth it, as once the selection has been made and clonal propagation undertaken the yield benefits accrue over almost 30 years.

5. Propagation of plants which are difficult conventionally. This is perhaps where many plant propagators held out a great deal of hope for micropropagation techniques but the unfortunate reality is that many plants that are difficult to propagate conventionally are also fairly recalcitrant in aseptic culture. One example of where micropropagation has widened the market for micropropagated plants under this category is *Phoenix dactylifera*, date palm.

Conventionally, date palms are propagated by offshoots which grow from the base of the palm, but this only happens during the vegetative period of the palm's life and some of the most desirable cultivars produce very few offshoots and those offshoots sell for several hundred dollars each. Using the tissue culture technique of somatic embryogenesis several tens of thousands of date palms have been produced and exported to the Middle East for crop production. The first tissue-cultured palm fruited in autumn, 1987, which was about three years after its planting date.

6. Overcoming seasonality. This applies to a wide range of plants, particularly in areas such as foliage or flowering pot plant production. For crops such as ficus or syngonium, the demand for starter plant material is virtually all year round because growers producing these crops have to keep their benches full. It is difficult using conventional propagation to produce uniform supplies of quality plantlets on a year round basis. However, using *in vitro* conditions, this is clearly possible.

7. Decreasing unit costs. As tissue culture techniques improve and the volumes of plants propagated increase, so the unit costs of individual plants should come down. This will require a number of technological breakthroughs in certain areas and we are not yet in a position where it is possible to produce plants from tissue culture with totally uniformly predictable multiplication rates of all cultivars that we would wish. Clearly the technology is developing all the time and with every step forward the market itself becomes wider. Labour is the largest variable cost of tissue culture plant

production and much of the development work focuses on ways of reducing the labour input by either improving the multiplication rate that it is possible to achieve *in vitro*, or exploring areas such as mechanisation or automation.

PITFALLS IN MICROPROPAGATION AND HOW TO AVOID THEM

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Micropropagation has established a market niche largely in the higher value sector and value-added areas of introduction of new cultivars and virus-free stock. High production costs have limited its market share but the latter is likely to increase with the introduction of automation (18).

The aim of this article is to attempt a state-of-the-art appraisal of micropropagation strategies so that the purchaser of microplants can be reasonably assured that they are likely to be fit for the purpose intended.

Micropropagation pathway analysis. The micropropagation procedure involves critical decision and monitoring steps as outlined in Figure 1. The nursery operator should appreciate the significance of these decisions and make sure that the micropropagator has adopted the appropriate strategy for any given cultivar. These steps are discussed below.

Genetic selection. Genetic selection, allied to the cloning pathway chosen is of critical importance to the production of true-to-type progeny. Many cultivars are inherently unstable in micropropagation because of their genetic construction. Cultivars to avoid, or to accept for micropropagation only after consideration, are chimeras—usually, but not always recognisable visually, e.g. *Pelargonium* × *hortorum* 'Mme. Salleron', 'Mr. Wren', 'Skelly's Pride'; beneficially-infected cultivars, e.g. *Abutilon sellovianum* 'Marmoratum' and those with unstable loci, e.g. *P.* × *domesticum* 'Grand Slam' (1). Only the breeder or grower may be adequately familiar with a cultivar or its antecedents to recognise its instability, but mutation-bred cultivars and those which tend to sport would be included. If these are to be micropropagated, significant levels of variation should be anticipated and the level of acceptability decided.

Guidelines for genetic selection, aside from the exclusions listed above, have been published by Johansen *et al.* (12) for potato,