all performance of plants when potted up or lined out in the field.

Information is deficient at present on the transition of plantlets from culture to establishment in compost and their growth to point of sale. It is hoped that ADAS development work and monitoring will be concentrated upon this particular area as resources allow.

CONCLUSIONS

The preceding comments are hopefully optimistic in outlook and emphasise my belief that micropropagation has a significant place within the UK nursery industry. The technique will not solve all problems (new technology never does) but can be usefully exploited to commercial advantage in many situations. Like any technique of propagation it will have to find its place in the same way as mist or chip budding or hardwood cuttings.

Like so much new technology micropropagation is a very good servant but a dangerous master. One of the major limitations to its successful utilisation is the problem of effective management. It is essential that clear objectives are set for its use on a very narrow range of plants. Once successful this firm base can be used to investigate the feasibility of micropropagating other plants.

WEANING AND GROWING-ON OF MICROPROPAGATED PLANTS

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The Concise Oxford Dictionary definition of "to-wean" is — teach to feed otherwise than from the breast — by enforced abstinence or counter attractions.

H.J. Welch in his book, "Mist Propagation and Automatic Watering," discusses the weaning problem thus, "I must confess to being skeptical about there being, in fact, any such thing. Even the term "weaning" seems to be singularly inappropriate, the allusion to an infant being gradually taught to accept solid food instead of milk bearing no real connection with what is happening to the rooted cutting.

To a certain extent I think Welch's skepticism justifiable where more traditional propagation is concerned. But I do see

some relevance in the case of tissue propagation. "Plants" in culture are incubated in a growth room, where temperature and light levels are closely controlled. Nutrients are provided in the culture medium and a high level of hygiene minimises the risks from injurious pathogens. Not too dissimilar from in a mother's womb I would suggest and feeding at the breast synonymous with a stage of weaning from that highly protected and cossetted environment.

Eventually, usually after a period of multiplication, rooting cultures are initiated. These cultures are kept under conditions very similar to those for multiplication. Normally, within a few weeks, roots develop on the small cuttings and the stage called weaning has arrived. For some subjects, generally for those plants which are difficult to propagate by more traditional methods this can be a particularly difficult phase. However, for the majority of plants, regularly cultured these days, this is not the case. Provided a few basic principles are understood and the correct facilities are provided — plus a bit of common sense — there should not be too much of a problem in weaning tissue-cultured plans.

Admittedly, plants produced in vitro tend to be very "soft" and the transfer from a sterile, non-stressed, fully supporting environment to one where temperature, moisture, and nutrition are constantly changing must be fairly traumatic. The young plants are also highly susceptible to diseases at this stage. Any roots produced are usually fragile and sparse and apparently without root hairs. The young plants do not develop much of a wax layer over the leaves because there is no stress in the *in vitro* environment. Additional wax quickly forms on transplanting though, as do leaf hairs which also tend to be sparse or absent initially.

Some propagators root their tissue cuttings out of culture but the same conditions, possibly even more sensitively regulated than for a rooted propagule, are required. In addition, there is the lengthy rooting period to contend with before weaning can commence in earnest.

Generally the most critical weaning period is over the first few days or so. Humidity is particularly important. So, too, are temperatures and light. Excessive watering should be avoided. *Botrytis* tends to be the biggest potential hazard in the early stages of weaning. Levels of hygiene must be high at all times.

The stage, or degree, of rooting is, in my opinion, important. For most subjects I prefer the roots to be just emerging and certainly not too long. In most cases the type of substrate selected does not appear to be critical provided it is well-aerated and well-drained. It should have a pH appropriate to

the plant with adequate but not excessive nutrients and be free from harmful organisms.

The type and size of container can have more effect. Within reason, depending on the plant subject, the efficient and economic use of expensive space, the larger the container the more rapid growing and better plant developed. There is, of course, a greater risk of over-watering in the early stages with a relatively large volume of substrate.

Personally I prefer a "closed case", or high humidity created by fogging to that provided by misting. With the latter it is too easy to apply excessive water, and nutrients are leached from the young plants. The facility to shade heavily if necessary is also very important. A fungicidal spray, particularly to combat *Botrytis*, is essential. A regular and thorough cleansing of benches, equipment, etc. between successive batches of plants is also to be recommended.

At our experimental station we use a double-skinned poly tent. The outer skin is milky white in the summer months. A high pressure misting line is provided inside the tent but this is only used during the early stages of weaning if it is felt necessary to top up the humidity. There is provision for additional overhead shading should this be considered necessary. Base warming is provided by under-bench heating and there are 400 watt sodium lamps giving 2500 lumens M^2 for supplementary lighting.

Procedure for weaning micropropagated plants:

1) Acclimatization. If possible the ideal is to remove the lids from the culture containers and then stand the containers in the weaning situation for a few days before transplanting takes place.

2) Remove plants from culture containers. As much agar as possible should be washed from the roots. If too much is left on the plantlets there can be problems with fungal growth. Also hormonal residues can have an effect on plant development. One of the advantages of rooting *ex vitro* is that these problems are more easily avoided.

3) Transfer to an open, well-drained substrate, water in well but not excessively. Before closing the case we treat the young plants with a fungicide using a fairly coarse spray giving sufficient to wet the soil surface and the neck of the plant.

The case is then sealed and not disturbed (unless it is suspected that something is not going quite right) until it is apparent that new root and shoot growth has occurred.

In the summer shading is fairly heavy initially, the amount being reduced as weaning progresses. For most sub-

jects bed temperatures of around 19° to 20°C are maintained and we don't mind if the air temperatures rises into the 30's°C, provided the humidity is high. In the winter (from September to March) supplementary lighting, a minimum of 16 hr up to 24 hr a day, is given.

4) Ventilating the case. This is the most critical period of the weaning process. Air is admitted gradually, increasing the shade if necessary during the first few days. If the substrate appears to be drying then a light watering is given. Subsequent waterings usually contain a feed. A further fungicide spray is given at this stage, too. Gradually the amount of ventilation is increased, humidity and shading reduced. Once the young plants are sufficiently hardened and growing well they are transferred to their growing-on areas. The conditions and treatment subsequently will, of course, be appropriate to the individual crop's needs.

WEANING PLANTS FROM TISSUE CULTURE

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I would like to relate my experiences with the weaning from tissue culture of the following classes of roses: Hybrid Tea, Floribunda, Miniature, and Rugosa, as well as the following herbaceous plants: *Bergenia* (cultivars), *Hosta*, *Linum*, *Potentilla*, *Rodgersia*, and *Dicentra*.

Plants received from the laboratory must be in first class condition, free from infection, all clean with a good root system of even size and ideally be kept in a cool room for two days prior to potting into soil.

Compost should be nice and open — a fairly coarse peat containing sand and grit, or alternatively, 40% perlite. I have been very pleased with roses grown in a compost containing Enmag.

It is essential that compost be well soaked prior to pricking off plants. Two days prior to planting we drench the compost with Cryptonol at 12 fl. oz in 25 gal. water.

ROSES

Containers for roses are AP40's or Propapaks which we find are good, practical modules to use, although we are unable to sterilise them for second time around and have, there-