7. Loach, K. 1987. Mist and fruitfulness. *Horticulture Week*. 201:28–29.
8. Loach, K. 1988. Controlling environmental conditions to improve adventitious rooting. Chap. 18 in, Adventitious Root Formation in Cuttings. eds. T. D. Davis, B. E. Haissig and N. Sankhla. Dioscorides Press, Portland, Oregon, pp. 248–273.
9. Loach, K. 1988. Characterisation of optimal environments for leafy cuttings. *Acta Hort.* 226:403–412.
10. Loach, K. and D. N. Whalley. 1978. Water and carbohydrate relationships during the rooting of cuttings. *Acta Hort.* 79:161–168.

WEANING AND AFTERCARE OF MICROPROPAGATED NURSERY STOCK

MARGARET A. SCOTT

Agricultural Development and Advisory Service
Efford Experimental Horticulture Station
Lymington, Hampshire

While there was initial enthusiasm from nurserymen to wean micropropagated propagules received directly from the laboratory, their success rate was variable. As a result most laboratories now have their own specialised weaning units to produce the rooted plantlet/liners for sale to growers, which can be handled in a similar manner to conventionally propagated material.

A specialist ADAS micropropagation unit at Brogdale Experimental Horticulture Station in Kent is, in collaboration with Efford EHS, investigating factors involved in successful weaning-off and growing-on of micropropagated material.

Work so far has concentrated on relatively high value crops, particularly those in the Ericaceae group, most of which are suited to growing under protection thus capitalising on the potential for growth from micropropagated material, e.g. *Rhododendron*, deciduous *Azalea, Pieris, Camellia, Kalmia,* and *Magnolia*.

This paper reviews the larger scale weaning and growing-on work in progress at Efford E.H.S.

Weaning has been defined as the acclimatization of the micropropagated material (propagules) from the precise laboratory medium and environment (*in vitro*) to typical horticultural growing environments and composts (*in vivo*). There are two distinct stages:

1. Transfer of propagules from culture media to compost and rooting under high humidity environments.

2. Hardening off and acclimatization of rooted material from high humidities to "normal" horticultural environments (under protection).

Laboratory treatments can have a marked influence on success

of weaning and quality of plantlets produced. Treatments given during the weaning stages can also have a substantial effect on plant quality and growth in the industry.

Table 1. Grade-out of propagules from tissue culture (percentage).

Plant material	Propagule Grade (1= largest 4= smallest)			
	1	2	3	4
Rhododendron 'Wilbrit'	26%	17%	10%	40%
R. 'Blue Diamond'	9	27	16	23
R. 'Cilpinense'	4	43	13	40
Camellia 'Debbie'	25	42	33	—
Pieris 'Forest Flame'	14	35	51	—
P. 'Firecrest'	22	25	22	31

Table 2. Influence of propagule grade of rhododendrons on percentage and size of plantlets weaned.

	Propagule grade from tissue culture			
	1	2	3	4
Percent weaned	90	81	63	77
Percent first grade plantlets	52	17	8	10

INFLUENCE OF LABORATORY TREATMENT ON SUBSEQUENT WEANING

Trials have shown that the media recipes used *in vitro* can have a marked influence on the ability of the propagule to wean successfully *in vivo*, even though there appears to be little difference between them in the laboratory.

Work is showing that stage of rooting *in vitro* can have a significant effect on weaning. With certain species (*Magnolia*), propagules will root and establish when taken directly from the multiplication medium as mini-cuttings. Other species (*Pieris*) have failed to root or will root unevenly from this type of material and require transfer to a "root triggering" medium for the final laboratory sub-cultures.

Time spent on the root triggering medium can also be critical, most species benefiting from transfer to weaning prior to roots actually developing. Root-initiated material at this stage is much easier to handle. There is considerable variation among species and even cultivars within a species as to the correct treatment to obtain the best results.

There is still substantial variability in size of propagules received ex-laboratory which must be graded at weaning, not only to obtain even batches of plants, but also to enable differential treatment of grades, since the larger material roots and establishes faster. The smallest material is normally discarded as it roots poorly and is less vigorous. The influence of propagule grade follows through to establishment and potting. More evenly graded material

at the laboratory stage could lead to a reduction in costs since wastage could be reduced (See Tables 1 and 2).

INFLUENCE OF FACTORS APPLIED DURING WEANING

Weaning environment. The correct environment is crucial for successful weaning. Neither mist nor polythene covers were entirely satisfactory for the whole range of species, particularly the more delicate-leaved subjects. Closed propagators in a growing room are successful but are not a practical commercial proposition. Fog, on the other hand, appeared to offer a suitable compromise for a range of conditions and species. Fog must not be too wet; it must be evenly distributed and the droplets not too large. A pressurised air/water system ("dry fog") has given good results throughout the year.

Pest and disease. Sciarid fly has been a problem, but was successfully controlled using sticky yellow traps around the trays. Fungicide programmes based on those used for conventional cutting programmes have proved satisfactory for micropropagated material during weaning.

Supplementary Illumination. Use of supplementary illumination for weaning during the winter is being monitored and has produced excellent preliminary results with the test species, *Pieris*, improving speed of rooting, plantlet growth, uniformity, and quality. This is especially important for species that need potting early in the season to obtain the best results.

Compost/nutrition for weaning. Initial work used unfertilized media, but success with traditional cuttings from the inclusion of controlled release fertilizers (CRF) in the rooting medium prompted investigation of nutrition during weaning of micropropagated material. It was not possible to use the large granule CRF in the small-celled modules because of distribution problems but the Osmocote mini-granule (18:6:12) has been used successfully in these units. Feed requirement during rooting and weaning is species-dependent. Three groups can be identified:

A. *Fertilizer inclusion detrimental during weaning.* With *Kalmia*, fertilized media severely depressed rooting and establishment. However, once rooted and hardened off, a dilute feed programme prior to potting improved plantlet quality and establishment.

B. *Some fertilizers available during weaning of benefit in improving plantlet quality and early growth.* With *Rhododendron*, *Pieris*, and deciduous *Azalea*, non-fertilized material rooted and weaned satisfactorily but was smaller; with thinner caliper stems, compared to those from fertilized media. Liquid feed after stage 1 weaning improved plantlet quality but was still behind those where nutrients were available during stage 1 weaning.

C. *Incorporation of fertilizer during weaning an essential com-*

ponent. This was true for the production of quality plantlets to establish and grow away rapidly on potting, e.g. *Magnolia*.

Work on rates of mini-granules for incorporation in weaning media is still at an early stage, but 0.5 kg/m^2 in a peat-based mix has given good results (Table 3).

Table 3. *Camellia* 'Debbie'. Influence of nutrition during weaning on percentage of first grade liners produced.

	Nutrition during weaning		
	Nil	Mini-granule incorporated at Stage 1.	Liquid feeding during Stage 2.
Peat (sphagnum)	—	43%	25%
Peat:perlite (50:50)	3%	33	30
Peat:pine bark (50:50)	21	56	40
Mean	12.0	44.0	31.7

GROWING ON

A separate area of our work is looking at conditions/treatment/management influencing the growing-on of rooted plantlets, since this is the stage at which most nurserymen would be obtaining material. The work is still in its early stages and is considering:

Influence of time of year material is potted. Rooted plantlets ex modules are potted into 70 mm pots, ideally by early spring before the first flush of growth occurs. This encourages the root development that supports subsequent flushes of growth and produces quality liners by the end of the first season.

Grading. It is important to continue to grade at all stages and keep large and smaller grades separate. In a mixed batch, small grades become overwatered. This causes root problems and establishment of moss and liverworts. In addition, plants become crowded-out by the more vigorous grades.

Compost/nutrition. Most of the species involved in our trials come under the "salt-sensitive" category and over-nutrition can be a problem, especially at the young plantlet liner stage. Trials in progress are monitoring performance in response to type and formulation of CRF alone, and in combination with liquid feed programmes.

With micropropagated material it is important not to overwater, especially in the first few weeks after potting, in order to get roots established before the top begins growth. This can be encouraged by using a more open structured peat-based mix.

Stopping. Type and degree will vary with species. Early stopping of growth in *Rhododendron* is important to obtain good branching and to capitalise on the natural tendency of this material to break more freely than in conventional cuttings. Management of *Pieris* and *Camellia* is under review.