Growing Plants Hydroponically for Cutting Production©

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INTRODUCTION

The application of hydroponic growing techniques for the production of plant propagules, across a range of genera, is a reasonably recent practice. The system is used widely in South America, Brazil, and Uruguay for the maintenance of stock plants and subsequent production of plant propagules of *Eucalyptus* hybrids, for use in the forestry plantation industry.

At Narromine Transplants, we have endeavored to broaden the range of genera that can be treated in this way and have had success with *Prunus* spp., in particular sweet cherry cultivars, and a range of cherry root stocks.

BACKGROUND

After two visits to South America, Chile, Brazil, and Uruguay, to investigate the propagation of *Eucalyptus* hybrids and single species in the early and mid 2000s, we found that stock plants were being maintained via a number of different treatments. These included in-ground, sand beds with drip lines, and ebb and flow systems. The methods being employed in the latter two cases incorporated the use of hydroponic solutions both as run to waste systems and as ebb and flow.

In addition, the stock plants were physically treated in such a way that they retained juvenility thus maximising the number of propagules that eventually formed roots. The comparison between in-ground grown stock plants spaced at 1 m, which were essentially used for the production of macro-cuttings, was in stark contrast to sand bed and ebb and flow culture where the stock plants were grown in densities of up to 340 plants per square meter.

The adaptation of this system to suit Australian conditions as well as reducing the capital outlay and ongoing costs associated with both sand beds and ebb and flow, has been quite successful and has now been further adapted to other genera.

MATERIALS AND METHODS

Since the late 1990s we had grown our *Eucalyptus* stock plants in 50-liter bags and taken a range of cutting material without much concern for the age of that material, it would take another 12 years before we fully realised the significance of maintaining the stock plant in a continual state of juvenility. We adapted our system, still in 50-liter bags, so that we could take what is now termed mini-cuttings mainly by constantly taking cuttings from the stock plants.

However after the two visits to South America and an escalation in demand for clonal hybrids, we needed to dramatically increase our strike rates and our production volumes.

We initially approached the problem by costing the purchase of an ebb and flow system or constructing sand beds both of which would need to be under cover. These systems proved to be expensive and as well, in the case of sand beds, the medium needed to be replaced every 2 years and the ebb and flow system required the renewal of the nutrient solutions periodically, and the dumping of the old in an environmentally accepted way.

A friendly competitor, Jayfields Nursery, was also searching for a way of economically producing *Eucalyptus* clones and happened to see Ball Australia conventionally growing New Guinea impatiens in coir bags routinely used in Australia by the hydroponic greenhouse tomato industry. Jointly we decided to adopt this medium using a Netafim drip system.

We had learned in South America, particularly from Teotonio de Assis (De Assis, 2004; De Assis and Fett-Neto, 2004), at the time a plant breeder and propagator with the pulp and paper company Aracruz and the University of Sao Paulo, of the need to carefully treat *Eucalyptus* stock plants with the correct nutrient solutions. The reasoning for this was that the propagules that were subsequently produced under this regime would have just the right degree of hardness and maintain their turgidity under mist, not need supplemental nutrition while under mist, would not require the use of hormone to assist callus and eventual root initiation, and would allow a high percentage strike rate.

As most of the literature on the subject in the early stages of our experimentation was in Portuguese we had to rely on a translator who had no training in chemistry or nutrition to decipher what little information we had. We started with a very basic A and B solution which we gradually refined, initially through trial and error and eventually with the help of Teotonio de Assis and Aracruz (Tables 1 and 2).

Table 1. Stock solutions for *Eucalyptus* stock plant maintenance.

Stock solution A	$g \cdot L^{-1}$	Stock solution B	$g \cdot L^{-1}$
$CaNO_3$	32.0	KNO_3	4.0
KNO_3	4.0	KH_2PO_4	7.25
Fe (as EDTA)	2.0	$MgSO_4$	7.25
		Mn	0.05
		Z	0.05
		Cu	0.005
		B	0.15
		Mo	0.00125
		Co	0.0005

We found that to fine tune these solutions we needed to take regular tissue samples for analysis and to continually monitor the EC and pH of the delivered nutrients.

Table 2. Desired nutrient levels of leaves of *Eucalyptus* stock plants.

Macronutrients (%)					
N	P	K	Ca	Mg	S
2.5 to 3	0.2 to 0.4	1.5 to 2	1 to 1.5	0.25 to 0.4	0.15 to 0.25

Micronutrients ($mg \cdot kg^{-1}$)				
B (ppm)	Mn (ppm)	Zn (ppm)	Fe (ppm)	Cu (ppm)
40 to 70	100 to 500	50 to 60	100 to 200	10 to 15

Stock plants were fed on a daily basis via drippers spaced at every second plant and flushing with straight water took place every 10 days to ensure there was no accumulation of salts in the coir bags.

We commenced full production using hybrids based on *E. grandis* ×*E. camaldulensis* (gxc), probably two of the easiest species to propagate, using the mini-cutting system where stock plants are kept small and as juvenile as possible. With only a few errors along the way, we managed to launch into a production run of 3 million cutting produced trees over a 6-month period.

We found that as we proceeded we were able to dispense with the use of hormone and that our strike rates increased as well, from an initial 70% to as high as 92% in the middle of summer. We also found that bottom heat (22 °C) was essential to increase throughput, with rooting occurring within 12 days in midsummer, and cuttings were able to be removed from mist within 20 days. Without bottom heat these timings increased to 18 and 28 days, respectively.

Without doubt this system works exceptionally well when plants are kept as juvenile as possible. As we have subsequently found, not all *Eucalyptus* hybrids are as easy to propagate as gxc and they are not so prolific if the stock plants are derived from cutting material rather than from seed. Cutting-derived material does not develop a lignotuber from which we are able to harvest the most juvenile material.

An approach by a cherry grower to look at the propagation of grafted cherry trees led to us experimenting with the coir bag and hydroponic system to propagate root stocks for dormant grafting. We started with approximately 100 Colt® dormant, bare-root trees which we trimmed and first placed in 200-mm pots. We then took tip cuttings from these plants, propagated them under mist, grew them to a height of 100 mm, and then planted them into our coir bags.

Within a 1-year period we were able to increase our stock plant base to 5,000 in coir bags and we are currently harvesting green tip material from these plants for mist propagation. Success rates are as high as 90% utilising the same hydroponic regime as we are also using for eucalyptus-hybrid production. Cuttings were rooted and ready to be potted on within 21 days and we have found with cherry green tip cuttings that hormone is needed to ensure uniform rooting.

Cherry rootstock cutting production commences in late September and concludes in late January. Plants are grown in 800-ml pots and then dormant grafted the following winter and sold as a 1-year-old tree at the beginning of summer.

Table 3. Cherry cutting production from coir bags.

Coir bag	$3.11 (landed)
Bag life	3.0 (years)
Plants per bag	7
Cuts/m^2/month	100 (over 6 months)
Bag dimension	0.17 (m^2)
Cuts/bag/month	16.5
Cuts/plant/week	0.5 (minimum – Max = 3)
Cuts/bag/3.0 years	297 (6 months/year)

We are now confident enough with this system to proceed with other rootstock varieties, namely the Krymsk® series that are now in demand in Australia. We are also intending to test a range of peach, nectarine, and apricot rootstocks as well.

CONCLUSION

The use of a hydroponic growing system for the production of *Eucalyptus* hybrids and cherry rootstocks has been very successful allowing production to be carried out under cover and on benches. The system has also allowed us to maintain high standards of hygiene to which we are committed, under the Australian Nursery Industry Accreditation Scheme.

We believe that the system we are operating may also be adaptable to a range of other genera, probably with some adjustment to the solutions we are currently working with. It has also been our experience in using this system that once our staff are given a set of EC and pH parameters of the delivered solutions with which to work, as well as flushing dates, we have experienced very few problems with growth rates or nutritional problems.

LITERATURE CITED

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