A Review of Materials for Propagation Media

Ian Gordon
Department of Plant Production, University of Queensland, Gatton College

INTRODUCTION

The aim in plant propagation is to produce healthy, well-grown plants, with minimum losses, in the shortest possible time. We must bear in mind that the propagation stage is the most vulnerable growth stage in nursery production and any adverse factors which affect the number and quality of plants being propagated is felt all the way down the nursery production line. This paper reviews the materials which are used in plant propagation media and attempts to determine how propagation management practices may influence propagation success.

FACTORS OF IMPORTANCE IN THE SELECTION OF INGREDIENTS FOR PROPAGATION MEDIA—A REVIEW

1) Hygiene Status. Media materials must be free of all pests, diseases and weeds. Some materials, such as vermiculite, perlite, and rockwool, are processed at very high temperatures and there should be no requirement for hygiene treatments, provided they are stored in hygienic conditions in the nursery.

Other materials, such as peat, bark, and sawdust will not necessarily be free from pathogens and some hygiene treatment may be necessary. This also may be determined by the way in which these materials are stored on the nursery.

During propagation, pathogens that cause damping-off diseases will spread very rapidly due to the highly favorable conditions provided in the propagation environment and if you know that a particular ingredient is contaminated, it should either be treated or replaced.

2) Available Air. The amount of air contained in propagation mixes is very important as watering is frequent during propagation and there is a constant danger of waterlogging, especially if mist propagation is used.

The amount of air in a mix is expressed as the "air-filled porosity" (AFP) of the mix, which is the percentage of the total volume of the container that is air space. In normal potting mixes the desired air-filled porosity is in the range of 15% to 20%, but for propagation mixes it is desirable to build in more air. The greater the possible risk of waterlogging of propagation media, the higher the air-filled porosity should be. AFPs of 25% to 40% are not uncommon for propagation mixes.

It should be borne in mind that as the proportion of air in a mix increases, the amount of available water decreases and mixes with a high AFP must be watered frequently. Ingredients with a large particle size will have a higher AFP than ingredients which are very fine. Therefore it is important to avoid the use of materials which have a high proportion of very fine particles. The type of mixer and the duration of mixing can have an effect on the particle size, and therefore the AFP. Avoid mixing for any longer than is absolutely necessary to achieve a uniform blend.

3) Available Water. The amount of water available within a propagation mix will determine the frequency of watering required with the mix. It is probably fair to say that in propagation over watering is a more common problem than under watering and we should take great care to avoid watering containers unless it is clear that the medium requires water. Most nurseries have the capacity to water propagation containers on a regular schedule so in the design of propagation mixes it is more important to concentrate on building in a sufficiently high air-filled porosity than a very high water-holding capacity.

4) The Presence of Toxic Substances. Wood waste products such as hardwood sawdust and pine bark may contain toxic substances such as phenol compounds. In general potting mixes these compounds may cause few or no problems, but young plants at the propagation stage are likely to be vulnerable to even small quantities of wood-based toxins. Both bark and sawdust are being successfully used in some nurseries as alternatives for expensive imported peat in propagation mixes, but adequate composting must be carried out and the materials heavily leached to wash out these toxic substances.

5) The Problem of Nitrogen Drawdown. Wood-based products have the additional problem that nitrogen may be temporarily depleted as a result of bacterial decomposition of the particles, which requires the presence of nitrogen. There is a danger that the small quantities of nitrogen added to the mix to cater for the initial growth of the plants being propagated will be utilized by the bacteria in this process of decomposition and there is no nitrogen available for plant growth. The use of slow-release nitrogen sources in mixes which contain large amounts of organic matter will minimize this problem.

6) Other Factors. The nursery producer will take a number of other factors into consideration in the formulation of a suitable propagation medium. These factors include:

- Correct pH
- Soluble salt levels
- Consistency of quality
- Ease of mixing
- Weight of the finished mix
- Simplicity of the mix formula
- Cost of the mix

However, these other factors are outside the scope of this paper and will not be considered further.

MATERIALS AND METHODS

Samples of ten different formulations of propagation media were prepared in the Plant Nursery Unit at the University of Queensland, Gatton College and the air-filled porosity of each mix was determined.

Propagation Media Used

T1 Peat : Sand (ungraded) 50 : 50

This mix was formulated using New Zealand peat and a very coarse grade of sand which is widely used in the local nursery industry.

T2 Peat : Sand (graded) 50 : 50

This formulation contained the same New Zealand peat (as T1) but the sand was subjected to a grading process to remove the excessively large and small particles (<1 >2 mm).

T3 Peat : Vermiculite 50 : 50

This medium is widely used in the Lockyer Valley nursery industry for the production of cell-grown vegetable transplants. New Zealand peat was again used and the vermiculite used was grade 3.

T4 Peat : Vermiculite : Perlite 1 : 1 : 1

This is the standard cutting propagation mix used at Gatton College and consists of New Zealand peat, grade 3 vermiculite, and P500 perlite.

T5 Peat : Perlite 50 : 50 (ungraded)

This mix consisted of New Zealand peat and P500 perlite. The perlite which is available in Queensland has a very wide range of particle sizes from very small to coarse. This mix had no grading carried out.

Table 1. The air-filled porosity of the propagation media treatments

Treatment number	Description of treatment	Air-filled porosity (%)
T1	Peat : Sand	21.6
T2	Peat : Sand (graded)	17.5
T3	Peat : Vermiculite	35.0
T4	Peat : Vermiculite : Perlite	48.3
T5	Peat : Perlite	42.5
T6	Peat : Perlite (graded)	48.3
T7	Bark : Sand	19.1
T8	Sawdust : Sand	30.0
T9	Bark : Sawdust : Sand	17.5
T10	Bark :Peat	27.5

T6 Peat : Perlite (graded) 50 : 50

This mix had the P500 perlite graded by passing though a 1-mm screen to remove all fine particles. It had been suggested that grading of Australian perlite would improve the AFP which would in turn improve cutting performance in this mix.

T7 Bark : Sand 50 : 50

The bark used was composted slash pine (*Pinus elliottii*) bark with a coarse particle size for general potting. The sand used was ungraded coarse sand.

T8 Sawdust : Sand 50 : 50

The sawdust used was naturally weathered hardwood sawdust which had been allowed to weather on an outdoor concrete slab for over 2 years. The sand used was ungraded coarse sand.

T9 Bark : Sawdust : Sand 1 : 1 : 1

This mix consisted of equal parts of the three materials already described.

T10 Bark : Peat 50 : 50

This mix was included as a result of the author's observations of the hardy ornamental nursery stock industry in England. Very finely granulated Irish peat has caused problems in the English nursery industry and some growers add composted pine bark to the peat to improve the air-filled porosity.

The air-filled porosity of each mix was measured and the readings achieved are shown in Table 1.

Cuttings of two species of ornamental plants were propagated in each of these propagation mixes to determine the most successful combination of ingredients. The plant species used were:

- *Nandina domestica* 'Nana', the dwarf sacred bamboo
- *Callistemon* 'Kings Park Special', red flowered bottlebrush

Propagation Environment. The environment used was a shaded fiberglass propagation greenhouse with a high pressure fogging system set to maintain 90% relative humidity and a warm-water bench heating system set at 25°C. The media in the propagation containers was watered by hand throughout the trial as required.

Table 2. Rooting percentage and root quality in the propagation of *Nandina domestica* 'Nana' stem cuttings.

Treatment number	Description of treatment	Rooting (%)	Root quality	Air-filled porosity (%)
T1	Peat : Sand	100	3.75	21.6
T2	Peat : Sand (graded)	100	3.58	17.5
T3	Peat : Vermiculite	100	3.75	35.0
T4	Peat : Vermiculite : Perlite	100	3.83	48.3
T5	Peat : Perlite	100	3.50	42.5
T6	Peat : Perlite (graded)	100	3.41	48.3
T7	Bark : Sand	83	2.50	19.1
T8	Sawdust : Sand	100	2.75	30.0
T9	Bark : Sawdust : Sand	83	3.58	17.5
T10	Bark : Peat	100	3.75	27.5

Propagation Container. Standard plastic seedling punnets were used with 8 cuttings per punnet. Three replications of each treatment were used.

Auxin Treatments. All cuttings were given a 10-sec dip in a 4000 mg/litre IBA liquid dip.

Fertilizer Treatment. All media treatments had the equivalent of 1 kg/m^3 mini Osmocote® incorporated during the mixing process.

RESULTS AND DISCUSSION

Two criteria, percentage rooting and rooting quality were used to determine the effectiveness of each media.

Percentage Rooting. This is a straight rooting percentage averaged over the three replicates of each treatment.

Root Quality. Root quality was obtained through the use of a 1 to 5 qualitative scale with 1 being the lowest and 5 being the highest quality rating.

Table 2 shows that with only two exceptions all treatments achieved 100 % rooting. This obviously suggests that dwarf nandina is a relatively easy plant to strike from cuttings. However, root quality varied considerably with treatments 3, 4, and 10 showing a somewhat better quality of root development.

There was a considerable degree of variability within replicates of the same treatment with dwarf nandina and this may suggest that there was variability within the cutting material selected.

The trial with dwarf nandina did not show any direct correlation with root development and air-filled porosity of the propagation mix.

Table 3. Rooting percentage and root quality in the propagation of *Callistemon* 'Kings Park Special' stem cuttings.

Treatment number	Description of treatment	Rooting (%)	Root quality	Air-filled porosity (%)
T1	Peat : Sand	58.0	3.14	21.6
T2	Peat : Sand (graded)	54.1	3.54	17.5
T3	Peat : Vermiculite	79.1	4.08	35.0
T4	Peat : Vermiculite : Perlite	79.1	4.12	48.3
T5	Peat : Perlite	56.2	3.37	42.5
T6	Peat : Perlite (graded)	54.1	3.50	48.3
T7	Bark : Sand	45.8	2.79	19.1
T8	Sawdust : Sand	4.16	2.00	30.0
T9	Bark : Sawdust : Sand	8.30	1.87	17.5
T10	Bark : Peat	95.8	4.54	27.5

In the propagation of *Callistemon*, treatment 10 was considerably better than all other treatments — both in percentage rooting and in root quality. A visual inspection of all treatments prior to final sampling confirmed this as all replicates of treatment 10 stood out clearly. The cuttings were a much darker green colour, bud development was much further advanced than all other treatments, and the root development was much better with a greater number of roots emerging from the stems.

The treatments with vermiculite were also substantially better than other treatments, both in percentage rooting and in root quality.

In the propagation of *Callistemon*, treatments containing hardwood sawdust performed very badly and this may be due to the effect of toxic phenols which can suppress root development.

Again, there was no direct correlation between the root development on *Callistemon* with the air-filled porosity of the propagation media.

CONCLUSION

On the basis of the results obtained with these two plant species, it is obvious that treatment 10, the bark and peat combination, warrants further investigation.

It is clear from these trials that air-filled porosity, per se, is not the predominant factor in root development. It is more likely that air-filled porosity in combination with the watering practices used in the propagation environment determines root development.

Where misting systems are used in propagation, large amounts of free water accumulate in the propagation media, and a very high AFP is required to compensate for this. However, in the Gatton College propagation house a fogging system is used for humidity control. This maintains a humid atmosphere without putting free water into the propagation media. This means that the media dries out and requires regular watering by hand to maintain moisture levels. Under these conditions, propagation media with lower AFPs can perform as well as media with higher AFPs.

Further work will be carried out to gain a better understanding of the factors which determine propagation success with a range of different propagation media.