Growing Australian and South African Native Plants in Soilless Media©

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Much of the Australian and South African flora have evolved on soils of low fertility. Those of heathland soils have had to evolve mechanisms for growing in soils with extremely low levels of total and "plant-available" phosphorus. Application of phosphatic fertiliser to these heathland soils eventually leads to the death of these species and the invasion of weeds. From the late 1970s, it has been known that heathland species being grown in soilless potting media must be provided with only very low amounts of phosphorus. This knowledge has often been extended without question to include our entire diverse flora. However, many of our flora are not particularly sensitive to phosphorus. For good growth, they require as much phosphorus as most northern hemisphere plants. This paper explores the different requirements for phosphorus of different groups of species within our flora. It offers practical guidelines for the successful propagation and growing of these diverse groups of species in soilless media.

INTRODUCTION

The flora of Australia and South Africa are wonderful to see in their native habitats, especially when they are in flower, but they are also wonderful to see in our gardens, city landscapes, and patio containers. Transfer from the bush, fynbos, and veldt to urban environments requires the production of seedlings or vegetatively propagated plants in containers, and those containers must be filled with a growing medium. At least in Australia, early efforts at container-growing used natural soils or such soils that had been amended with manures and composts. This was essentially the system devised in England at the John Innes Institute. Success rates were sometimes good, but often poor. These soils were typically amended with 1.5 $kg \cdot m^{-3}$ of single superphosphate. Success rates became worse as soil was replaced by peat (as in the University of California method) and composted wood wastes such as pine bark and sawdust. Nichols et al. (1979) showed that the particularly poor success rates with members of the Proteaceae family (especially grevilleas and proteas) were due to toxicity produced by excessive supply of phosphorus (P) (still from the same addition of single superphosphate). Nichols and Beardsell (1981) provided guidelines for the rates of P from controlled-release fertiliser (CRF) to be used so that P toxicity was avoided when various Proteaceae were grown in soilless media.

As the guidelines produced for P-sensitive Proteaceae were applied in production nurseries, a myth developed in Australia that **all** Australian native plants were sensitive to P. So we had marketed (and to a small extent still do) low-P fertilisers that were labelled as being suitable for all Australian native plants and South African Proteaceae. This inevitably led to the situation in which many Australian native plants, even some Proteaceae, did not grow well in containers of soilless media. They were suffering from P deficiency. The myth was extended also to proteas being grown in soil for cut flowers. If P was left out of the fertiliser applied to these often-depauperate soils, growth was poor. I have seen strange recommendations for overcoming P toxicity in such plants, even though tissue analysis indicated the extremely low P concentrations of P deficiency.

The point I want to make is that while some Australian and South African species are highly prone to P toxicity, and some are moderately sensitive, the majority are not. This majority do not need the level of P input that might be provided to tomatoes, but they do need more than the tiny amounts tolerated by sensitive species. They have evolved on soils that might have 100 to 300 $mg \cdot kg^{-1}$ of total P (Norrish and Rosser, 1983). In contrast, the soils on which P-sensitive plants evolved often contain less than 20 $mg \cdot kg^{-1}$ total P and as little as 1 $mg \cdot kg^{-1}$ (Bell et al., 1994). Nursery practice must reflect this diversity of origins. The rest of this paper provides guidelines for producing our native plants in soilless media without the hassles of either P toxicity or P deficiency. Because much of the research that provided these guidelines was done in Australia on Australian plants, most of my examples are for the Australian flora.

KNOW YOUR PLANTS

If you do not know the P sensitivity of a new species you want to grow, a first clue is to know its family. If it is classified into Proteaceae or one of the pea-flower families, there is a reasonable probability that it is sensitive to very sensitive. Gymnosperms, succulents, halophytes, annuals, and most Myrtaceae, Casuarinaceae, Cupressaceeae, Asteraceae, and rain forest species (including Proteacea that grow in rain forests) are not sensitive. Acacias are difficult: they range from extremely sensitive to highly tolerant of P. Just to complicate matters, within some species, there can be a range of tolerance to P depending presumably on the properties of the soil on which a particular provenance evolved. A listing of over 800 Australian species is contained in Handreck and Black (1994).

A second clue comes from knowledge of the native habitat of the particular species. If the soils of this habitat are highly acidic, and/or deep, light-coloured sand, and/or of low organic matter content, and/or formed from ancient metamorphic rocks, particularly sandstones such as those of the Sydney region, there is a high probability that many of the Proteaceae, pea-flowers, and acacias growing there will be sensitive to P. Calcareous soils and those derived from volcanic rocks, including granite, tend to have few P-sensitive species (Handreck, 1997a).

A third clue, rarely available, is the total P content of the topsoil of the area from which the species, or the parents of a cultivar, came. The lower this is in the range 1 to 100 $mg \cdot kg^{-1}$, the greater the probability that species growing in the soil are sensitive to P.

IRON SUPPLY

It was early recognised that the growing medium for P-sensitive plants needed to be quite acidic (Higgs, 1970). Low pH minimises the availability of the P in the medium, but it also maximises the availability of iron. The environment around plant roots must be of pH 5.6 or lower if the plant is to get enough iron for optimum growth and colour. Either the soil itself must be this acidic or the plant must have an ability to secrete acid from its roots. As the roots of many of the plants that evolved on acidic soils do not secrete acid (they did not have to waste energy

Table 1. Guidelines for supplying P to plants growing in soilless potting media. (Based on Handreck, 1997a, b).

Category of P-sensitivity	P concentration in 0.2 mM DTPA extract ($mg \cdot L^{-1}$)	Typical basal P application rate	Pws concentration in controlled-release fertiliser incorporated at $3g \cdot L^{-1}$ (%)*	Approximate weekly need for P by young seedlings (mg)	Approximate weekly needs for P of plants approaching saleable size
Non-sensitive	3–8	0.3 $kg \cdot m^{-3}$ single superphosphate	2.2+	0.3 to 0.6	4
Moderately sensitive	<3	Nil	1.3	0.3	0.5
Highly sensitive	<1	Nil	0.4	0.2	0.3

Pws= Water-soluble P in fertiliser.

*Data for 5-month-release fertilisers in containers up to 0.4 L capacity. Data assume some losses of P through leaching and immobilisation by microbial activity. Use lower rates and/or P concentrations for larger containers.

on doing this) the pH of potting media for them must be no higher than 5.6. But low pH is of no use unless there is enough iron in the medium to be dissolved. In Australia, most of our potting media consist largely of composted pine bark (from *Pinus radiata* in the south and *P. elliottii* and *P. pinaster* selections in the subtropics). These barks typically contain less than 100 $mg \cdot kg^{-1}$ total iron, so extra must be added to them when they are formulated into potting media. For general nursery production, about 1 $kg \cdot m^{-3}$ of $FeSO_4 \cdot 7H_2O$ (or 0.6 $kg \cdot m^{-3}$ of the monohydrate) is added, but for P-sensitive species up to double this rate can be used. In contrast, in South Africa, most pine barks have much higher natural levels of iron and extra iron is generally not needed. Rather than simply relying on a recipe-book approach to formulation, the level of plant-available iron should be determined chemically. A 0.2 mM DTPA extract (1 : 1.5, v/v) of the medium should contain at least 25 $mg \cdot L^{-1}$ of Fe for all plants (native and otherwise) and 35 $mg \cdot L^{-1}$ for P-sensitive plants (Handreck and Black, 1994; Standards Australia, 2003). It should be noted that these analytical criteria do not apply if the main source of iron is a synthetic chelate.

PHOSPHORUS SUPPLY

If you try to grow *Melaleuca* or *Eucalyptus* species from seed without any P in the potting medium, you will find that as soon as the P in the seed is used up the seedlings stop growing; the smaller the seed, the sooner the growth cessation. In potting media, non-P-sensitive species must be supplied with soluble P from the time of germination. In contrast, for highly P-sensitive plants the level of soluble P in the medium must be very low. Table 1 gives guidelines.

Also provided in the table are some guidelines for the rates of supply of P from fertilisers, both controlled-release and fertigated. The important number is not the concentration of P in the fertiliser, but the **amount** provided each week to the plant. Of course the amount needed will increase as the plant grows. Differing amounts are easier to provide via fertigation than via CRF's incorporated into the medium, but as CRF's release their P more slowly than their N and K (Handreck, 1997c), there is some tolerance to a CRF addition that is slanted towards provision for later growth. It is especially important to reduce the rate of CRF incorporation ($g \cdot L^{-1}$) as container size increases, so that the amount of P (and N) supplied still matches plant requirements.

If you do not know the tolerance of a particular plant to P, and you do not have time to run a trial, the safest approach is to use a potting medium and fertiliser designed for highly P-sensitive plants and then add extra P if deficiency symptoms appear.

OTHER PRACTICALITIES

Growers can increase their chances of success if they tightly specify key properties of their potting medium. The pH must be below 6.5 for all plants and below 5.5 for highly-P-sensitive plants. The initial P concentration must be as given in Table 1 and the extractable iron concentration must be as high as is required (above). Of course all other nutrients must also be supplied.

Checking the pH and water-soluble P concentration of potting medium at delivery can prevent large-scale disasters. Several kits are available from chemical supply houses for testing for water-soluble P. One is the Merck Aquaquant P (VM) kit (Handreck and Anderson, 1994). All you do is shake 1 volume of the moist medium with 1.5 volumes of water, filter, and measure the P concentration in the filtrate. Any medium that is not up to specifications ($<1\ mg \cdot L^{-1}$ P for P-sensitive plants) must be rejected.

Products such as blood and bone, crushed bone, animal manures, and biosolids should be used with caution in potting media for P-sensitive plants. All contain P sources that continue to release soluble P for many months. The lower the pH of the medium, the more rapid the release. For bone, an upper limit for P-sensitive plants is about $0.4\ g \cdot L^{-1}$ and for biosolids (of 1.6% P) about 0.2% (v/v). As little as 0.5% of such biosolids can supply all the P requirements of nonsensitive plants (Handreck, 1997a).

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Breeding and Selection of *Brachychiton*©

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INTRODUCTION

Why *Brachychiton*?

- Beautiful trees naturally
- Ornamental trunks and foliage
- Free flowering
- Colours, white, red, pink, orange, and greenish
- Flowers up to 50 mm long and 40 mm wide in some species
- Many are deciduous flowering plants
- Flowering period can be many months
- Drought tolerant
- Not likely to become weeds

These make ideal characteristics for breeding.

BREEDING

Some Drawbacks. Some species may have flowers that upon falling could be a slip hazard to pedestrians and motorcycles. *Brachychiton discolor* F. Muell is such a species that produces mucilaginous excretions from fallen flowers. This results in an extremely slippery surface when it falls onto hard paved areas.

Substantial juvenility periods may hinder breeding and assessment programs.

Background. This genus contains many familiar species that are important ornamental and agricultural trees. *Brachychiton populneus* (Schott and Endl.) R.Br. kurrajong is considered an important fodder species during droughts, providing valuable feed for livestock, and has been planted for this purpose.

The other, more popular species are ornamental trees such as the Illawarra flame tree *B. acerifolius* (Cunn. Ex Endl.) Macarthur, Queensland lace-bark *B. discolor* F. Muell., and the Queensland bottle tree *B. rupestris* (Mitchell ex Lindley) Schumann. The latter has a spectacular bottle-shaped trunk that can grow to several metres in diameter (Guymer, 1988).

Assessment of Hybrids. The hybrids will be assessed on their:

- Precociousness, flower colour, size, and inflorescence size; flowering period, annual flowering, and duration of flowering season.
- Foliage colour and shape and the colour of the new growth.
- Tolerance to drought, frosts, and wet conditions.
- Mature size when compared to the three parameters for selection, specimen trees, trees under powerlines, and tub specimens.