ICL Technical Fact Sheet

No. 4

Topic: Growing Phosphorus Sensitive Crops

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Phosphorus Sensitive Crops

Most Proteaceae plants originate in the southern hemisphere and have unique soil and nutritional requirements. They generally prefer well drained soils, are intolerant of frosts and are sensitive to moderate phosphorus (P) levels in the soil. As always, broad generalisations are not accurate for every species and variations between individuals (especially with seed grown stock) can be considerable.

For example, *P. grandiceps*, P. *repens* and Telopea *speciosissima* are frost tolerant; P. *grandiceps*, P. *exima*, P. *repens*, and *Leucodendron saligna* are relatively phosphorus tolerant.

In addition, the effects of some environmental conditions can be interrelated. For example, at two locations with the same phosphorus levels, the crop may perform quite differently due to influences of other factors. There are many relationships that will be discussed in this bulletin.

ICL has completed many studies in Australia that have broadened our understanding of the nutrition of Proteaceae species, including phosphorus sensitive Australian native plants. The following comments and recommendations are based on the results of these studies, literature reviews and experience.

Some major factors that can affect the success of Proteaceae production are shown in Table 1 and are discussed in further detail below

Table 1. Some factors that may affect the success of Proteaceae production.

Factors	Influences
A) Phosphorus toxicity	Total P in soil, soil pH, available Fe and Al, development of proteoid root clusters, nutrition
B) Root pathogens (e.g. phytophthora)	Soil drainage, soil pH, nutrition (general health and vigour)
C) Foliar disease	Planting density, pruning, nutrition
D) Other nutritional disorders	Nutrition, soil type, soil pH

A) Phosphorus Toxicity

In plants, phosphorus is used within cell membranes (phospholipids) and is critical for the transfer of energy (ATP) in the photosynthetic process. Phosphorus can therefore be a relatively mobile nutrient within the plant. Even P sensitive Proteaceae species require some available P for these essential plant functions.

Phosphorous toxicity is usually first seen as iron deficiency in new leaves with its characteristic interveinal yellowing, the veins remaining green. This is followed in the older leaves first by the leaf margins discolouring brown, black or grey taking on a 'burned' appearance and eventually dropping. Severe toxicity results in new growth yellowing and dying.

Phosphorus deficiency is also known in inert potting media or light sandy soils. Under P deficiency, leaves can initially turn darker green, followed by reddening of older leaves (Figure 2). An overall lack of vigour, thinner stem diameter, smaller leaf size and poor branching can also result.

Experiments with Proteaceae species culminated in the formulation of Osmocote Pro Low P 16-1.3-13.3+1.8Mg+TE (8-9 or 12-14 months) for optimal growth of P sensitive plants.

i) Influences on P Availability in Soils and Media

There are several factors that profoundly influence the solubility and availability of P to plants. There are also several test methods used to determine P availability in soils, each having different critical values. This should be remembered when interpreting soil test results and especially when trying to compare results from different test methods.

The soil type, its pH and clay content have a large influence on P availability. Phosphates can be immobilised in soils by microbes using the P or by adsorption of P with iron and aluminium oxides. Adsorption predominantly occurs in very low pH (acidic) clay soils. In high pH (alkaline) calcareous soils, calcium forms insoluble compounds with phosphorus, which reduces its availability to plants. While important in field soils, these reactions are typically unimportant in potting media because of the absence of clay, moderate pH and low levels of calcium carbonate.

When plants are grown in field soils, the risk of P toxicity may be marginally reduced by maintaining a low soil pH (e.g. 5.0-5.5). Low pH increases iron availability to the plant and can also reduce P solubility. The addition of iron sulphate to soils high in P may help to lower pH (depending on the rate applied and soil buffering capacity) to 'tie up' available P and increase Fe availability to the plant.

If plants are already exhibiting P toxicity symptoms, a foliar application of Micromax Iron or Micromax TE-mix may help (dilute in water to 0.5 g/L prior to application).

The generalised statement that Proteaceae prefer acid soils is likely due to the above.

ii) The Proteoid Root Cluster

Why is P toxicity such a problem with many plants from the Proteaceae family? The root systems of Proteaceae plants have highly specialised cluster roots that exude acids, dissolving mineral phosphates in the soil. Cluster roots have a high surface area that allows the plant to efficiently absorb the solubilised P.

Some Proteaceae plants appear to suppress cluster root development when P is readily available. This has commercial implications. For example, if cuttings or seedlings are grown initially in media containing some available P, few root clusters are produced. This means that when this plant is potted on or field planted into soils containing moderate P, phosphorus toxicity is less likely to result. This is a generalisation that is true of most Proteaceae. However, some very sensitive cultivars may not reduce cluster root development in the presence of P.

Propagation and CNS production using zero phosphorus fertilisers may inadvertently exacerbate the problem of P toxicity at plant out. Check with your propagator as to their practice and check your planting stock for the predominance of proteoid root clusters, recognisable as a 'starburst' of roots usually 1-2cm across on the outside of the rootball after the pot is removed (Figure 1).

Figure 1. Proteoid root clusters have an extremely high surface area that allows the plant to efficiently absorb P.

B) Pathogens

The greatest influence on the prevalence of soil borne pathogens is the ability of the soil to drain. Standing water or high soil moisture levels provide an ideal environment for the proliferation (water borne spore dispersal) of root fungi.

The general health and vigour of the plant is also important. You may notice that plants are often lost to root disease when the plant was looking poor already. Correct nutrition will help to ensure a healthy and vigorous crop better able to defend itself from and cope with root pathogens.

Banrot® 400WP and 80G are broad spectrum soil fungicides for the control of root and stem rot soil pathogens. They control Pythium, Phytophthora, Rhizoctonia and Chalara. Banrot 400WP is applied as a soil drench. Banrot 80G can be incorporated or top-dressed. They give long residual activity as a curative or preventative fungicide.

C) Foliar Disease Incidence

Open well-spaced bushes will encourage good air flow through the foliage. This will help foliage dry out faster in the mornings, creating an environment less conducive to fungal and bacterial reproduction and growth.

Adequate levels of all essential nutrients will encourage healthy leaf and stem growth that is less susceptible to invasion by pathogens. Nutrient deficiencies weaken cell walls and membranes, which markedly increases susceptibility to pests and diseases.

D) Other Nutritional Disorders

In trying to determine what may have caused a leaf symptom, it can be useful to note whether the old or new leaves are affected first.

If the older leaves are affected first there are two possibilities-

- a deficiency symptom of a mobile element as the plant translocates nutrients from the older foliage to supply to the new foliage (Figure 2), or
- toxicity of an immobile element due to excessive accumulation.

Figure 2. Typical P deficiency symptoms in Melaleuca decussata showing reddening of older leaves while new growth appears normal.

Figure 3. Symptoms of either Fe deficiency or P toxicity on Banksia sp., displaying severe chlorosis of young leaves while older leaves appear unaffected.

If the symptoms appear on the new leaves first, again there are two possibilities-

- a deficiency of an immobile element or
- a toxicity of a mobile element.

Fertiliser Recommendatiions

For in ground production, a comprehensive soil analysis is an essential prerequisite to guide management decisions and to fine tune fertiliser applications. The soil analysis will allow accurate adjustments to be made prior to planting or during annual fertiliser applications. It will dictate what liming material should be used (if any) but dolomite should be favoured as it contributes magnesium as well as calcium.

A water analysis will also provide useful information as regular irrigation of hard, very soft or saline water may affect soil chemistry and soil physical properties. Water analysis is also beneficial when growing plants in soilless growing media.

When the basic soil properties such as sufficient drainage, low salinity levels and pH are within a suitable range, the use of Osmocote controlled release fertiliser will provide excellent results. Osmocote Low P can be used exclusively or supplemented with either Peters or Universol as a regular liquid feed throughout the growing season. Fertigation adds complexity but may be helpful if you need to vary nutrient availability or adjust the nitrogen and potassium supply at different growth stages.

A) Field Plant Out

Apply Osmocote Pro Low P 16-1.3-13.3+1.8Mg +TE in the planting hole and to the side of the root-ball. Typical practice is to place Osmocote to the side or base of the hole away from the root ball. A layer of soil should be placed between the fertiliser and the root ball. The lower application rate is suitable when planting into relatively fertile soils and the higher rate for sites with lower fertility.

Typical Rates are:

- 150mm (6") pot, 30 - 50 grams per plant.
- 50mm (2") tube, 10 - 20 grams per plant.

Fertigation

Vigorously growing plants may benefit from additional liquid feeding with Peters or Universol. The above Osmocote Pro rates are generally adequate if there is no liquid feed capability.

Peters CalMag Grower (15-2.2-12.4 +5Ca +1.8Mg +TE) or Universol White (15-0-15.8 +6.4Ca +1.2Mg +TE), both low in P, can be applied once per fortnight after dilution in water to 0.7 g/L.

B) Mature Crop Fertilisation

At the start of each growth season, an application of Osmocote Pro 16-1.3-13.3+1.8Mg +TE will encourage good, sturdy growth, producing a more branched (and therefore more flowers) bush without resulting in soft growth associated with high nitrogen granular feeds (e.g. urea).

Typically, 10-20 g of Osmocote Pro Low P can be applied per 30cm of plant height, distributed equally around the drip-line of the plant.

Fertigation

1) Vegetative growth phase

If additional nutrition is required, Osmocote Pro Low P can be supplemented with a liquid feed in a fertigation system. The following can be applied from the beginning of the growth season up until 4 weeks prior to bud set:

- Peters CalMag Grower (15-2.2-12.4 +5Ca +1.8Mg +TE) or Universol White (15-0-15.8 +6.4Ca +1.2Mg +TE) at 1 g/L once per fortnight.

2) Flowering Period

From four weeks prior to bud set throughout the flowering period the following can be applied to encourage strong stems and good flower colour:

- Peters CalMag Finisher (13-2.2-16.6 +5Ca +1.2Mg +TE) or Universol White (15-0-15.8 +6.4Ca +1.2Mg +TE) at 1 g/L once per fortnight.

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C) Potted Crops

To an open well drained media that has been pH adjusted to 5.5-6.0 apply:

- Osmocote Pro Low P 16-1.3-13.3+1.8Mg +TE, 8-9M at 4-6 kg/m3 or 12-14M at 5-7 kg/m3. More vigorous species will benefit from the higher application rate and less vigorous plants the lower rate;
- Micromax Premium: 500-750 g/m3;
- Osmoform 38N: 0.5 kg/m3;
- Hydraflo 2 (Granular Soil Wetting Agent) at 1.5 kg/m3.

The recommended rate of Osmocote Pro Low P should be sufficient for most species. However, if additional nutrients are required, Peters CalMag Grower (15-2.2-12.4 +5Ca +1.8Mg +TE) or Universol White (15-0-15.8 +6.4Ca +1.2Mg +TE) can be diluted to 0.75 g/L in water and applied through fertigation or as a drench as required.

D) Propagation

A higher strike rate and subsequent potted growth can be achieved by selecting cuttings from mother stock that has received good nutrition. (See mature crop fertilisation (B) above).

By applying some phosphorus during propagation, the cuttings are discouraged from producing proteoid root clusters. When planted into the potting mix described in potted crops (C) above the plants should grow away with minimal check and produce a better plant for field plant out success.

Seedlings appear to be more sensitive to phosphorus inputs than cutting material, possibly due to the phosphorus content of the seed itself.

Propagation Nutrition

To a pH adjusted (5.2-5.6) propagation mix incorporate the following:

- Osmocote Exact Mini (5-6 M) (15-3.9-9.1+1.2Mg+TE) at 1-2 kg/m3;
- Micromax Premium: 300-500 g/m3;
- Coarse Gypsum: 0.3 g/m3 (calcium supply to cuttings and seedlings is crucial).

Liquid feeding can begin after root growth has initiated or when an initial growth response is seen in the cutting tops. Peters CalMag Grower (15-2.2-12.4 +5Ca +1.8Mg +TE) can be diluted with water to 0.3 g/l and applied once per week. For seedlings the application frequency can be reduced to once per fortnight.

E) Tube Production

Following the above propagation sequence the rooted cutting or seedlings can be tubed into an open well drained mix with a pH of 5.2 - 5.6 containing the following additions:

- Osmocote Pro Low P 12-14M (16-1.3-13.3+1.8Mg +TE) at 4-5 kg/m3;
- Micromax Premium at 300-500 g/m3;
- Coarse Gypsum at 0.5 kg/m3.

Liquid Feed

- Peters CalMag Grower (15-2.2-12.4 +5Ca +1.8Mg +TE) @ 0.5 g/L once per fortnight if required.

As some Proteaceae species have unique requirements we recommend that you trial before making any changes to your current fertiliser practice.

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