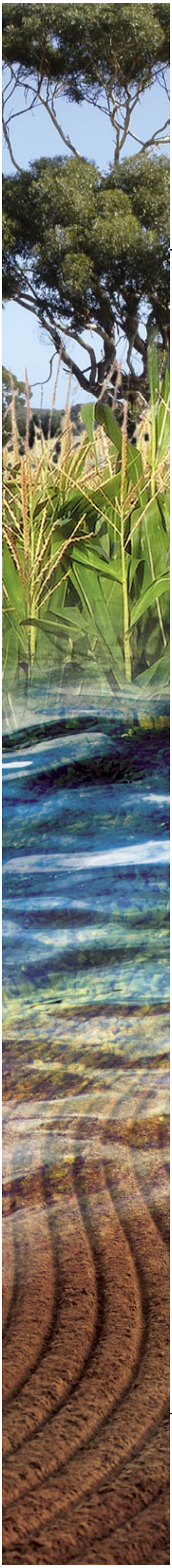

Sydney Environmental & Soil Laboratory

Specialists in Soil Chemistry, Agronomy and Contamination Assessments

Nutrition Cycles and Effective Nutrition Management in Flower Growing

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Nutritional management for any kind of professional growing requires the soil or growing medium to be well balanced chemically and have good physical fertility. The most critical aspect of physical fertility is oxygen supply. Once these basic parameters are properly set the nutritional needs and ratios of nutrients required are fairly similar for all crops. The most important exception to this is for Proteaceous crops and some others where phosphorus must be lower and iron in superabundant supply. After starting a nutritional program there are important manipulations of the K/N ratio that will help either improve the photosynthetic canopy after a cut or stimulate the next flowering event.

Physical fertility

The most limiting element in flower growing is oxygen. Plant roots cannot grow and function properly below around 5% partial pressure of oxygen (Oxygen is at 21% in the atmosphere). The growing root tip is responsible for most plant nutrient uptake, particularly for calcium which is exclusively taken up by the unsuberinised root tip (Morgan 2000 and Nichols 2000). Thus, without growth of the root system and the production of healthy white root tips the plant's ability to respond to a nutritional program is limited.

Physical fertility is the ability of a soil to provide water, air, nutrients and structural support to the plant. Important aspects of soil physical properties related to plant growth are thus -

1. Water infiltration
2. Gaseous exchange, i.e. oxygen diffusion
3. Resistance to root penetration (compaction and soil strength)

Physical properties can usually be assessed from simple observations by the grower. You should be able to push your fingers easily into a good horticultural soil. A soil should appear granular and porous (soil structure) and preferably dark in colour (organic matter). The appearance of worm holes and voids (structure) should coincide with the observation that water enters rapidly and easily after irrigation or rain. As the soil dries out the surface should remain porous and granular. In tray or artificial soil culture the porosity must be very high to allow the elimination of the capillary fringe which eliminates root growth at the bottom of the tray.

The appearance of impeded drainage, a surface crust upon drying which is harder than the soil below it, and a lack of obvious pores and voids indicates a physical problem in loamy or clayey soils. Very sandy soils have no structure but porosity is maintained by the pores between grains. It is difficult to induce structural problems in coarse sandy soils but fine sandy soils can pack down (collapse of structure like a bad cake) excluding oxygen entry and suffocating roots.

The two pillars of soil physical fertility are organic matter, and the balance of the cation exchange capacity. Organic matter is the "glue" that binds soils particles together. Since it, like clay, shrinks when it dries, pores and cracks are opened up. Rotation or under planting with green manure crops or the importation of organic matter, particularly in indoor growing, are the only ways to address this problem. Chook poo does not contribute to organic matter as it is so high in nitrogen that the organic matter is simply "burned up" by microbes.

A further, and critically important aspect of physical fertility is drainage. Drainage implies air entry to the profile and is essential to allow leaching of unwanted salt and nutrient accumulations. How many times have we seen a gross accumulation of fertiliser salts which are extremely difficult to remove by leaching because the house has no drainage and we are already battling over-wetness and the attendant low soil oxygen levels.

Basic Chemical Fertility

pH

The acid/alkali balance is very important in maintaining optimum availability of applied nutrients. At very acid pHs soluble aluminium can become toxic, phosphate is unavailable, and calcium levels can be low. At high pHs iron and other trace elements are rendered unavailable because they are locked up as hydroxides and carbonates.

Use of urea, ammonium sulphate, and sulphate of iron causes the development of acidity. Use of these fertilisers should be combined with regular soil pH checks to keep pH within the range 5.5 to 6.5 (water extract or 5.3 to 6.0 in calcium chloride). pH in $CaCl_2$ is given more emphasis usually.

Iron deficiency (chlorosis and overall paleness) is commonly seen in neutral and alkaline soils. In such soils constant responses to iron sulphate additions will be seen. It is sometimes possible to acidify alkaline soils with iron sulphate and get rid of excess lime but the usual method of control is frequent use of iron chelates. Iron deficiency chlorosis is particularly a problem in the iron inefficient plants (Thecaceae, Rutaceae and Proteaceae as well as many natives). Other trace elements may also need to be applied as foliar chelates.

Cation Exchange Properties

In general, soluble fertiliser programs do not contain calcium and it is difficult to combine calcium with phosphates due to insolubility problems. A and B liquid feeds keeping the calcium and phosphate separate while concentrated have evolved for hydroponic or semi-hydroponic systems. With in-ground systems we generally rely upon the soil to supply calcium and hence the cation exchange capacity must be properly balanced and regularly checked.

Table 1. Normal Ranges for Exchangeable Cations

Cation	Normal Range % of CEC	Comment
Sodium	< 5	Sodium is not a nutrient
Potassium	5-10	Lower amounts in heavy clays
Calcium	60-75	Calcium must be 3-6 times the Mg level
Magnesium	15-25	Important in chlorophyll production
Aluminium	<2	Toxic element in larger amounts

Calcium is also important in maintaining soil physical fertility as it improves the structure of clay soils. Calcium depletion through the use of acidifying fertilisers and nitrate leaching is very common and much attention is focussing on calcium lately as the big "hidden deficiency". (Nichols 2000.)

Phosphorus

This important element is subjected to a lot of misunderstanding due to the commonly held view that Australian Soils are all low in P. While this may be true for most unimproved soils, in intensively used soil we often find excessive amounts due to an overemphasis on P in nutritional programs. We use the Data in Table 1 to interpret result of a Bray extract.

Table 2. Guide to Phosphate sufficiency Bray No 1 extract.

mg/kg of P	
0-5	inadequate for all but some P sensitive native plants
5-20	adequate for most native plants
20-40	adequate for most exotic cut flowers if maintained
40-80	adequate for most high yielding cut flowers
> 80	excessive in almost all situations.

We analysed a cut flower soil recently and found 640 mg/kg of available P after 8 years of in-house growing! At these sorts of levels insoluble metal phosphates form, causing chronic trace element problems for iron, copper, zinc, and even manganese.

For most non P sensitive native cut flower growers around 10-20 mg/kg of available P is usually adequate, For growers of the Proteacea, Mimosaceae and some Rutaceae you would be ill advised to allow available P to rise over 20mg/kg in a soil or around 5 mg/l in the AS 3743 extract for artificial media and even then an adequate Fe supply must be present. For some very sensitive plants, particularly Grevilleas and some Banksias soil levels of less than 5mg/kg (Bray) and less than 3 mg/l (AS 3743) must be maintained (Handreck, K. A (1991).

Even in non-sensitive crops such as Kangaroo Paw we have seen phosphorus induced iron deficiency. Various tables are available to assess the degree of P sensitivity of your crop. Tables 3 and 4 provide such guides.

Table 3
Maximum concentrations of P tolerated by species growing in a soil-less potting medium at two levels of extractable Fe. After: Handreck (1991)

Fe (ppm)in the mix		Species
34	19	
3	<3	*Acacia merrallii, Grevillea leucopteris, Hakea bucculenta, H. francisiana, H. petiolaris*
5	<3	*A. imbricata, Banksia benthamiana, B. brownii, B. lemanniana, B. leptophylla, B. sphaerocarpa, G. banksii, H. salicifolia*
5	3	*A baileyana, A. decurrens, A. spectablis, H. sericea*
8	7	*A. dealbata, A. glaucoptera, A. ligulata, A. lineata, A. montana,*

		A. myrtifolia, A. retinoides, H. laurina
11	3	*B. tricuspis, H. rostrata*
11	10	*A. argyrophylla, A. baileyana purpurea, A. burkittii, A. calamifolia, A. florabunda, A. iteaphylla, A. menzelii, A. microcarpa, A. papyrocarpa, A. paradoxa, A. rigens, A. rivalis, A. rotundifolia, A. sclerophylla, B. aculeata, B. laricina, B. speciosa, G. intricata, G. robusta, H. suberea*
>20	14	*A. cyclops, A. fimbriata, A. hakeoides, A. longifolia sophorae, A. melanoxylon, A. nyssophylla, A. pendula, A. ramulosa, H. muelleriana*
>20	>25	*A. longifolia, A. saligna, A. truncata, A. victoriae, H. leucoptera*

Table 4. P susceptibility of selected Cultivated Proteacea
(After Nichols 1981).

Highly Susceptible.
Protea compacta, P. harmeri, P. nerifolia,
Leucadendron uliginosum, L. salicifolium
Leucospermum cordifolium.

Moderately Susceptible
Protea cyanoides, P. longifolia, P. coronata.
Leucadendron coniferum,
Dryandra formosa.

Slightly susceptible
Protea eximia, P. speciosa, P. grandiceps, P. macrocephala, P. punctata,
Leucadendron linifolium, L. orientale L. rubrum, L. elimense, L. teratifolium,
L. strobilinium,
Serruria florida
Aulax pinifolia

Tolerant
Protea repens, P. roupelliae, P. mundii, P. nana, P. obtusifolia, P. longifolia,
Leucadendron salignum, L. procerum, L. gandogeri.

Development of a Nutritional Program.

The first steps are to ensure good physical conditions and basic chemical conditions as discussed above. Regular soil or growing media testing is needed to maintain this balance and to develop a pattern of how quickly the conditions may change because of your fertiliser program. For example, if using urea as an N source you might be surprised at how quickly pH drops due to its acidifying affect.

If the basic soil or media properties are well balanced it is our experience that the following generalisations can be made, with the provisos as discussed-

1. Most crops have similar requirements nutritionally.

The notable exceptions to thus rule are usually familial. P sensitivity, for example, is confined to families such as the Proteaceae and is a good example of exceptions to this rule. However, except for the phosphorus and a need for extra iron, the needs of the Proteaceae are much the same as any other plant.

Another apparent exception is the apparently high boron requirement of certain families particularly the Brassicaceae, Caryophyllaceae (eg Carnation), and many Compositae (eg Chrysanthemum). Boron is needed for shoot and root tip growth and flower formation (Handreck and Black 1994). Given the strong relationship between boron and calcium uptake (Nichols 2000), and the fact that oxygen limits calcium uptake, it is not unlikely that much boron deficiency may in fact be due to limiting root oxygen levels. This is particularly true when an analyst sees apparently adequate boron levels in the soil but obvious signs of boron deficiency in the crop. Under normal conditions these crops will grow well where boron is not massively elevated in the way some growers advise. Salinger (1992), for example, recommends 1 ppm of boron for liquid feeding carnation whereas, for hydroponic feeding Handreck and Black (1994) cite Dutch recommendations of 0.2-0.3 ppm as being adequate for many crops including carnations and non flowering crops. This indicates no special requirements for these plants at all.

In our experience frequent low air filled porosity in artificial media may have grossly complicated the conclusions many growers have come to with these crops and their need for boron. We often see highly deformed carnation heads with more than adequate soil boron levels.

2. Many, if not most, commonly available fertilisers and liquid feeds will give good results.

This statement is understandable if the ratio of nutrients within a plant is recognised. After correcting the inherently low phosphorus content of a new Australian soil it is not necessary, for example, to feed with a fertiliser with an NPK ratio of 10:8:3. A plant (more or less regardless of species), has an NPK ratio of around 3:0.3:3. If you examine the NPK ratio of most reputable liquid feeds you will see an NPK ratio that reflects this need. If this is the case then the liquid feed should give reasonable results and you can be more certain of replacing those exact nutrients lost by the removal of harvested parts. Failure to observe this will result in frequent need to rebalance the soil and leach due to the accumulation of unused nutrients.

So provided the soil is well balanced and aerated, the liquid feed or fertiliser program is reputable and has a fair NPK ratio, (as well as reflecting any special crop needs albeit that these are less common than is popularly thought) there is little more we can do?

Growing the crop rapidly will depend on presentation of nutrients. Manipulation of the crop will depend on crop cycles and your response to those.

Presentation

A nutrient program is delivered to the crop largely in dissolved form in the soil water. Analysts obtain a crude idea of the strength of the soil water solution using the EC measurement. An EC in the soil water for most crops should be in the range 2.5 dS/m for sensitive crops up to possibly 4.0 dS/m for salt tolerant crops. There seems little point in pushing plants above an EC of around 4.0 dS/m in any growing situation.

When pushing plants hard with soluble NPK it is most important to keep the immobile elements in mind. It is easy to puff a plant up with NPK only to find that the less mobile elements such as iron, boron, calcium cannot be kept up to the fast growing plant despite our best efforts (Nichols 2000). In the same growing media it is perfectly likely that in a slower growing situation the plants would not run out of these less mobile elements at all.

The lesson is that either we must grow a crop only at the rate that the less mobile elements can be taken up, or we must find a way of increasing the mobility of the slower elements. This need has given rise to the use of chelated elements as a means to supply nutrients that are in constant short supply due to the "NPK push". By researching your crop and keeping good records the pattern of chronic deficiency can be anticipated, and these elements can be presented to the crop in a form more likely to keep up with the rapid demand.

Presentation of growing solution at the right osmotic strength (EC) over time is not as easy as it might sound. Two examples of situations we have dealt with are worth mentioning.

Case 1. A grower thought that his injector was giving an EC in the liquid feed of about 2 dS/m presented to his potted azaleas. Being skeptical of such crude injection equipment we calibrated this with an EC meter and found the water entering pots was actually at an EC of 0.2 dS/m resulting in chronic starvation which we put down to back pressure issues with the irrigation lines. Recalculating the liquid feed to try to present an EC closer to 2.0 resulted in far better growth. The lesson is- always calibrate equipment once installed, never assume anything.

Case 2. A grower was presenting potted colour with an EC of 2.5 dS/m in a liquid feed just as one would expect. He used this twice a week which you might think would be adequate. By testing EC in sacrificed plants we established that the EC after liquid feeding fell within 12 hours back to background levels due to excessive irrigation after feeding. Conclusion, the plants are presented with adequate nutrition for only 24 hours of a 168 hour week. Solution- liquid feed every day and forget irrigation.

Presentation means presenting the crop with the right nutrient balance at the right strength, and at a fairly uniform rate over time.

Crop Cycles

Crops grow, cycle, and then die. Their cycles involve you removing energy and nutrients in the harvested portion and expecting the soil and climatic conditions to replace these as quickly as possible.

After removing nutrients and fixed photosynthate in the harvested portion the remaining canopy and stored reserves must create a new crop. It must make sense then to encourage the remaining canopy as much as possible. This canopy will provide the resources to develop the next crop of flowers.

To develop a vigorous growing canopy a good supply of nitrogen is the usual requirement. After a cut, or while the crop is young, a good supply of nitrogen to establish a large and vigorous canopy has something to be said for it. A well balanced but fairly normal feeding program should back this up. It would make sense then to increase N supply at such a stage while holding other nutrients the same.

After developing a good canopy there are various theories as to how to induce a good flowering event. What is widely held is the opinion that increasing EC and simultaneously increasing the K/N ratio will have some effect on improved flowering, colour, vase life and general resistance to stress. Handreck argues (Handreck and Black 1994) that there is little point in increasing K/N ratio above about 2.0 but that this should act as an aid to flower production. This is an area of incomplete research but we do have some growers who do this and their crops are certainly of high quality. If nothing else a drop in N may control vegetative growth in favour of the plant's other functions such as flowering.

This is best done by decreasing nitrogen and increasing potassium as well as increasing the overall EC of the solution at the same time. Thus if feeding say 190 ppm of N and 150 of K increase K to 250 and drop N to say 125 ppm giving an overall higher EC and a K/N ratio of 2.0.

Thus, towards the normal expection of a "flush" of flowers, and keeping the size and quality of the canopy in mind, it is good practice to decrease nitrogen supply but at the same time as "shocking" the plant with an increased osmotic pressure and increased K supply. After a cut back go back to the more balanced 1:1 N/K kind of levels to encourage canopy replacement.

This system works well with crops that flush periodically. For those that tend to flower more continuously an in-between approach with a K/N ratio of round 1.5:1 is probably fair advice.

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