

FERTILISATION

a basic, sustainable strategy

With fertilisation, the emphasis should be on maintaining tree health and sustaining the ability of an orchard to maintain sufficient good-quality yields. By Pieter Raath and Coenraad Fraenkel



In addition to the negative publicity that the agricultural sector faces regarding the detrimental impact of unnecessary fertilisation on the environment, the escalating cost of fertilisers is forcing producers to pursue ways to reduce fertilisation inputs. Therefore, a proper balance between unreasonably conservative fertilisation and unwarranted application of nutrients is required. A producer who wants to manage his fertilisation inputs judiciously needs to understand certain principles and take them to heart.

Soil and leaf analysis is cheaper than unnecessary fertilisation. The first habit to develop is a routine of taking proper, representative soil and leaf samples (refer to the *Handbook for Fertilisation of Citrus in South Africa*, or the video on the CRI Website for detail on soil sampling methodology). Soil samples do not have to be taken annually, but informed decisions regarding fertilisation requirements cannot be made without proper knowledge of the orchard's soil chemistry and nutrient content. Foliar analysis provides insight into the extent to which nutrients in the soil are taken up, and might point you to a need to address root health and functioning. Leaf analysis also provides insight into the need to apply nutrients like P, Ca and Mg that one might want to avoid due to their added cost.



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The trees can perform better than you think, with less fertilisation.

Be conservative in your fertilisation approach – citrus trees do not perform better when

supplied with more than the required nutritional rates. Although prolonged undersupply of necessary nutrients will lead to diminishing tree performance, it is not affected overnight. Furthermore, trees with healthy roots can utilise the pool of available P, K, Ca and Mg effectively and for a long time – which makes fertilisation redundant or reduces the need for it. It is also worthwhile calculating the extent of the available pool of these nutrients before drawing up a fertiliser programme.

Example: calculating the pool of nutrients available in the soil

- If soil analysis indicates the soil P = 80 mg/kg, and the minimum norm for that soil is = 30 mg/kg, it means that you can use 50 mg/kg before there is a need to fertilise again
- If, for example, the trees' roots occupy 60 cm (deep) x 3 m (wide) x 3 m (in row) = 5.4 m³ soil per tree, i.e., per ha the trees' roots occupy (6 m x 3 m = 555 trees/ha) = 2 997 m³ soil
- Average bulk density of soil is = 1 300 kg/m³, this means you have 1300 x 2 997 = 3.9 x 10⁶ kg soil/ha
- The P that you can use in the soil occupied by roots before having to replenish it, is therefore (50 mg P/kg x 3 900 000 kg soil/ha)/1000 000 (to convert mg to kg) = 195 kg P/ha. This is a significant reserve, and if an average crop utilises 20 kg P/ha/year, you will only be required to apply P fertiliser after 10 years!



Figure 1. Root development of this orchard is restricted to 40 cm due to the subsoil being excessively wet

Over-irrigation is a waste of fertilisers.

The sustained performance of many orchards during years of drought when less irrigation water is available and less is applied, can be ascribed to maintained tree nutrition. Healthier roots and less leaching from the root zone improve nutrient uptake. Avoid over-irrigation at all costs – it impacts negatively on root health and restricts root development. **Figure 1** illustrates how root development occurred within one season in the zone below the cup of the wetting front detector. It caught the irrigation water to maintain a drier regime directly below the cup, resulting in rapid root growth in this area.

Trees with large root systems require less fertilisation.

The larger the volume of soil occupied by the roots, the longer it takes to deplete the nutrients to a deficient level. It has also been shown that by applying as low as 40% of crop removal of P and K, one is able to keep the soil P and K near optimal levels, while not reducing crop yield and quality in the short term. Active, protected roots close to the soil surface can potentially utilise substantial amounts of N from organic material being mineralised. In contrast, roots affected by nematodes or Phytophthora (mostly due to over-irrigation) will not function optimally, and efficiency of nutrient uptake will be

reduced. Producers need to ensure that root health is maintained.

The law of diminishing returns.

Tree performance will improve linearly from extremely deficient levels, as nutrients are supplied. But as the optimal nutritional status of the tree is progressively reached, the additional benefit of increased fertiliser reduces (**Fig. 2**). Eventually, any further inputs have no advantage and can even be harmful to the trees or the crop.

With these principles in mind, the following practical guidelines might be useful to consider. The authors think that if producers implement these guidelines, they can save up to 30% on their fertilisation costs without having any impact on tree performance – provided that they do not over-irrigate, which is a most unproductive, wasteful practice.

Firstly, in micro-irrigated orchards, no P must be applied if the concentration in the soil is above the minimum norm (as specified in the *Handbook for Fertilisation of Citrus in South Africa*) – even on high pH soils. The same applies to K on soil with a clay content of >10%. Furthermore, take more detailed soil samples to represent differently performing sections in an orchard. If the soil P concentrations differ, apply differentiated amounts of granulated fertiliser according to the requirement – use a variable spreader for this. The same applies for K on heavy soil, while areas with sandy soils are marked for maintenance fertilisation.

Drip-irrigated blocks require special attention. Sampling of soil for analysis needs to be done meticulously and more regularly. Avoid depletion of any nutrient in the wetted zone – this is a risk since all nutrient requirements must be met by the limited volume of soil occupied by the roots. Optimal nutrient uptake should be sought by applying each nutrient intermittently, and then at the specific concentration that each

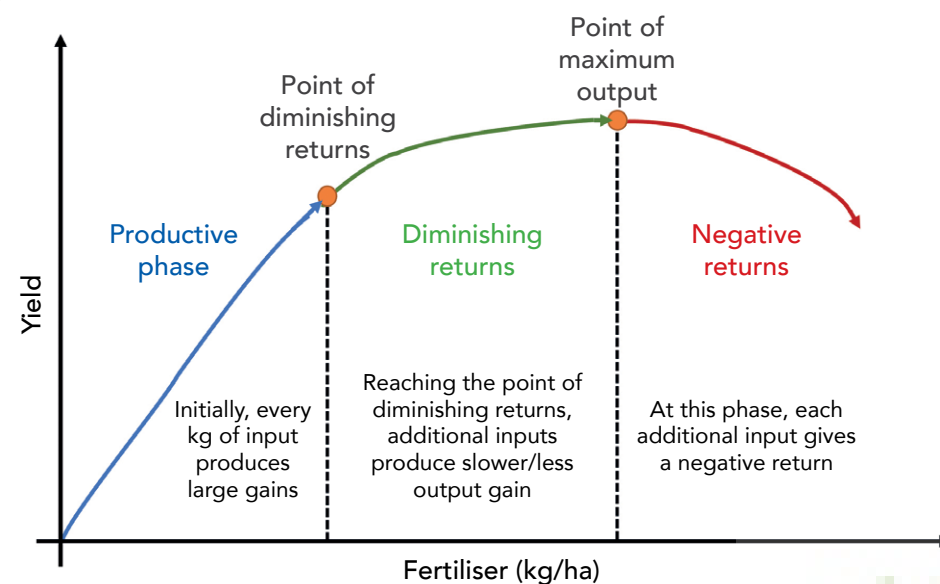


Figure 2. The law of diminishing returns

is most effectively taken up (as specified in the *Handbook for Fertilisation of Citrus in South Africa*). If the soil pH_{KCl} is below 6.0, the fertiliser mixture should also be buffered to a pH of between 6 and 7.

In sandy soil, over-irrigation and consequently leaching of nutrients, must be avoided through exact management of irrigation cycle lengths – the leaching loss of N and K can be especially high in drip-irrigated orchards. Ensure you know the depth of the root zone and monitor the depth of water movement after an irrigation cycle - either by making a profile hole, installing wetting front detectors just below the root zone, or using a probe. Although the cost of organically enriched fertilisers might not always justify the benefits, or these products may not always reduce leaching losses, the theory behind them justifies experimentation, especially in regions with high summer rainfall.

Responsible soil management can assist tree nutrition and reduce the over-all fertiliser requirement, or improve fertiliser use efficiency. For example, in a biologically active soil (i.e. that has a fair amount of organic material) more nitrogen becomes plant-available through the predation and excretion of plant-available nitrogen by soil organisms. Through biological nitrogen

fixation, done primarily by bacteria in association with legume plants, additional amounts of N can be obtained. The practice of establishing or maintaining legumes as an inter-row cover crop should be considered.

The history of each orchard must also be considered, especially foliar nutrient

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concentrations. If an orchard traditionally has high concentrations of a specific nutrient, the applied amounts of that nutrient should be reduced accordingly. It is also very important to note that when interpreting foliar analysis, any level above the minimum norm should be regarded as optimal. The amount of fertiliser required to obtain a shift from a low level to a higher level within the traditionally acceptable ranges can

be excessive, and without any benefit. In cases where leaf analysis indicates deficient nutrient levels, scrupulous application of foliar nutrition might be a more cost-effective short-term method to address deficiencies than soil application. This applies specifically to micro-nutrients and even more so, where high soil pH reduces micro-nutrient availability. Furthermore, "scrupulous" foliar application implies that producers ensure application protocol that will be most effective, e.g. the correct concentration, a suitable application volume spray mixture that is properly buffered, and application when trees have young leaves.

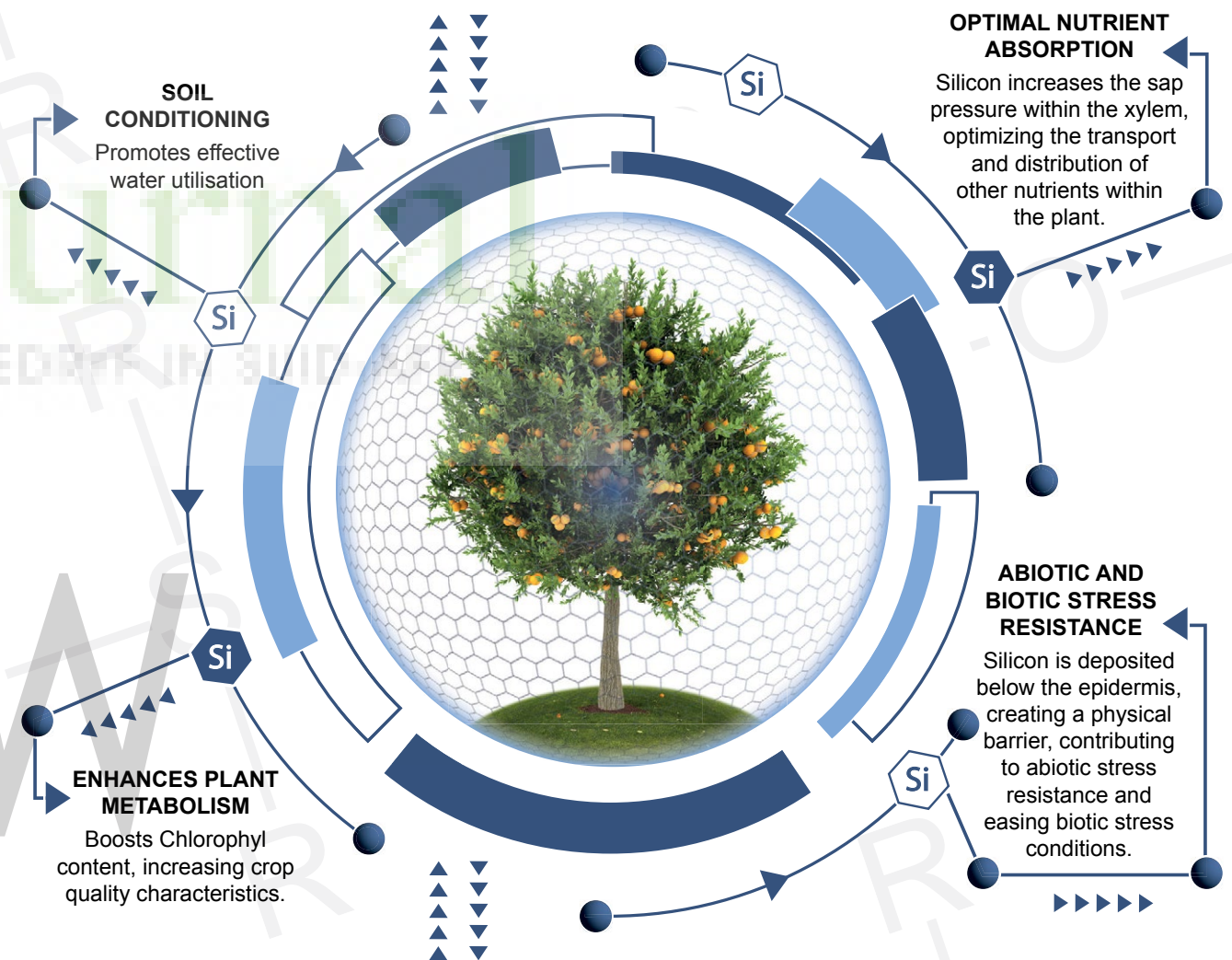
Choice of fertilisers is also a consideration. It would generally be recommended to avoid using mixtures since the cost per kg nutrient is often higher, and if you do not need a specific nutrient, it is not wise to apply it – even more so if it carries a cost. The use of organic materials, e.g. manure or compost, and enriched organic fertilisers should be considered based on cost. But if the composition does not correspond with what is required to maintain a balanced, optimal soil nutrient content, then it must not be used for more than a season or two. Lastly, prioritisation of orchards is required in times when exorbitant fertiliser prices threaten financial viability. Avoid under-fertilising all orchards, limit it to unprofitable, poor yielding ones. Nurture the healthy, well-performing, productive orchards.

It is hoped that the main message conveyed in these suggestions will be grasped, namely that producers who want to limit fertilisation costs must – rather than thinking of various alternative strategies – determine their soil nutrient concentrations, and avoid over-irrigation to ensure that well-managed citrus trees will not underperform with conservative, yet judicious, rates of fertilisation. ▶

The Handbook for Fertilisation of Citrus in South Africa is available from:
<https://www.citrusres.com/shop/>



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