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Fertilisation guidelines for high yields and good fruit quality in avocado

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INTRODUCTION

The following key issues were highlighted by the fertilisation working group which consisted of Dr J S Köhne (Convener), Messrs T J Koen, C J Partridge, D Westcott, A W Whiley, D B Woods, R A Abercrombie, J Botha and D Farrell:

1 The method of selection of index leaves for leaf analysis must be clarified. A standard index leaf must be identified.

2 Leaf analysis norms must be confirmed / re-established through research based on the standardised index leaf.

3 The phenological growth cycle approach to avocado tree management must be recommended and adopted for use by growers.

SITE SELECTION

The first and most important step when planning a new avocado plantation is to examine the soil for suitability regarding depth, drainage and compacted layers. According to Nel (1983), a soil suitable for avocado production should possess the following characteristics:

— Red colour.

— Clay content of between 20 and 40%.

— Well-drained.

— No compacted, clayey or patchy layers.

— Soil depth > 2 m.

— pH (water) around 6,0.

Persons with knowledge of the soil classification system should determine the soil form and soil series of representative soil pits, and have them assessed for suitability (risk) for avocado production.

SOIL PREPARATION AND TREE NUTRITION DURING THE FIRST 2-3 YEARS

After taking soil samples, deep-ripping, applying lime and phosphate according to soil requirements, plough the fertilisers in as deeply as possible and take other soil

preparation steps (eg ridging and cover-cropping) as advised by Koen and Langenegger (1980). When the soil selected for avocado cultivation fulfils the above requirements, planting can commence (± three months later). Extra fertiliser in the planting holes is not advised (Bower, 1980).

It is important not to fertilise newly planted trees too soon. The trees must first become well established and grow vigorously before any soil applications of fertiliser are made. In most cases the young trees do very well without any soil-applied fertiliser in the first year (Koen and Langenegger, 1980).

Because soils suitable for avocado growing (described above) are usually very low in zinc and boron, foliar applications of these two micro-elements are essential (Wolstenholme, 1987). Foliar sprays are recommended during the time of active shoot growth, and should start soon after the trees are planted. Zinc and boron should be applied monthly, while the trees are flushing. The two elements may be combined in one tank at the following rates:

Zinc: 200 g Zinc oxide/100ℓ Water

Boron: 100 g Solubor/100ℓ water.

It is recommended that spraying is done during cool periods of the day, to improve leaf penetration.

Chronic boron deficiencies can be corrected by soil applications of Solubor (4 g/m^2 drip area) applied in spring or summer (Whiley pers comm).

Young, healthy looking trees in their second year from planting probably require no soil-applied fertilisers. 'Pushing' tree growth is easy, but it does not make sense in high density plantings (eg 400 trees/ha or more) as it counteracts precocity. However, if there are good reasons for 'pushing' trees (eg some trees look somewhat deficient), nitrogen, phosphorus and potassium can be applied at the rates given in Table 1. It is recommended to spread fertiliser evenly around the tree, about 0,2 m from the stem to about 0,5 m outside the drip area.

LEAF AND SOIL ANALYSIS

Sampling

Sampling of leaves for leaf analysis should start when the young trees go into their second or third year, depending on their size. Leaf samples must be taken from non-fruiting branches, which are not showing signs of flush (Koen and Langenegger, 1981). Leaf samples should be taken when the summer flush has come to an end, i.e. March/April. The same trees should be used for sampling from season to season.

Soil samples should be taken evenly from the whole sampling area. A sampling area (eg an orchard or part of an orchard) should, as far as possible, be selected on the basis of its uniformity of soil type. The more care is taken to get samples that are representative of one soil type, the more accurate and useful the resulting recommendations will be. Samples from two different depths (0 — 15 cm and 15 — 30 cm) should be taken, always keeping these two separated. Thoroughly mix soil

collected from a particular soil type and depth and take off 500 g to 1 kg for analysis. Remember to keep the representative samples separate and clearly labelled. Leaf and soil analysis should uncover any extreme deficiencies or excesses. Leaf and soil analysis norms are given in Table 2.

TABLE 1 Kg of N, P and K per annum per ha in the first three years of growth

Age (years)	LAN (28% N) or equivalent	Superphosphate (11,3% P)	Potassium chloride (50% K)
1	10	15	5
2	15	20	10
3	25	25	15

TABLE 2 Leaf and soil analysis norms per avocado

SOIL ANALYSIS NORMS

Element		Shortage	Below normal	Normal	Above normal	Excess	Measured in
Phosphorus (Bray 1)	(P)	20	21 — 29	30 — 90	91 — 129	130	mg per kg of soil
Phosphorus (Hars)	(P)	2	3 — 7	8 — 27	28 — 45	46	mg per kg of soil
Potassium	(K)	100	101 — 149	150 — 250	251 — 499	500	mg per kg of soil
Calcium	(Ca)	250	251 — 749	750 — 1000			mg per kg of soil
Magnesium	(Mg)	50	51 — 99	100 — 300			mg per kg of soil
Aluminium	(Al)			0 — 30			mg per kg of soil
pH (water)		4,5	4,6 — 5,4	5,5 — 6,5	6,6 — 7,5	7,6	
Resistance				> 500			Ohms
Ca:Mg Ratio				2,5 — 5			
(Ca + Mg) : K Ratio				5 — 10			
Nitrogen (Hass)	(N)	1,40	1,41 — 2,19	2,20 — 2,40	2,41 — 2,69	2,70	% of dm
Nitrogen (Fuerte)	(N)	1,30	1,31 — 1,69	1,70 — 2,00	2,01 — 2,49	2,50	% of dm
Nitrogen (Other)	(N)	1,30	1,31 — 1,89	1,90 — 2,20	2,21 — 2,49	2,50	% of dm
Phosphorus	(P)	0,05	0,06 — 0,07	0,08 — 0,15	0,16 — 0,24	0,25	% of dm
Potassium	(K)	0,35	0,36 — 0,74	0,75 — 1,25	1,26 — 2,24	2,25	% of dm
Calcium	(Ca)	0,50	0,51 — 0,99	1,00 — 2,00	2,01 — 2,99	3,00	% of dm
Magnesium	(Mg)	0,25	0,26 — 0,39	0,40 — 0,80	0,81 — 0,99	1,00	% of dm
Sodium	(Na)			0,01 — 0,06	0,06 — 0,24	0,25	% of dm
Sulphur	(S)	0,05	0,06 — 0,19	0,20 — 0,60	0,61 — 0,99	1,00	% of dm
Chlorine	(Cl)			0,07 — 0,23		0,25	% of dm
Copper	(Cu)	3	4	5 — 15	16 — 24	25	mg per kg of dm
Iron	(Fe)	40	41 — 49	50 — 150	151 — 249	250	mg per kg of dm
Manganese	(Mn)	19	20 — 49	50 — 250	251 — 749	750	mg per kg of dm
Molybdenum	(Mo)	0,01	0,02 — 0,04	0,05 — 1,00			mg per kg of dm
Zinc	(Zn)	20	21 — 24	25 — 100	101 — 299	300	mg per kg of dm
Boron	(B)	14	15 — 49	50 — 80	81 — 149	150	mg per kg of dm

* dm = dry mass

Interpretation of the results

The analyses should be done each year for each block, so that previous results are at hand. It is important to have an ongoing record to determine trends, as this, coupled with direct knowledge of the orchard, facilitates good decision making. If not already done, work out the ratio for the soil analysis.

How do the results compare with the norms given in Table 2? What do the trees look like now; are they giving a satisfactory yield; which, when and how much fertiliser was previously applied; are irrigation systems working well and according to proper schedules? If necessary some quick changes can be made (eg irrigation blockages, use of tensiometers, etc), but others may require changes in the record keeping system. If results from leaf and soil analysis are not satisfactory and sampling was done correctly, **stop** and consider all the aspects affecting the results **before** using fertiliser.

Look at the norms for individual elements in the soil analysis and then the ratios. Liming may be required but not dolomitic if, for example, there is enough magnesium. Poor tree performance may be because of Phytophthora root rot, or due to soil compaction, restricting soil depth and root growth.

If analyses are above normal, cut out the relevant fertiliser entirely for a year or two or even more. It is worse to overreact and apply fertiliser, than to do nothing if any of the factors affecting results are in question (Partridge, 1989).

FERTILISATION IN ESTABLISHED ORCHARDS

The timing of fertilisation should be according to the tree's phenological growth cycles (Figure 1). The fertilisation programme should therefore be flexible. By recognising the three growth stages, namely root, shoot and reproductive growth, and timing applications as outlined in Figure 2, a fertilisation programme which leads to productivity gains can be implemented. A guideline for nitrogen, phosphorus and potassium application rates is given in Table 3.

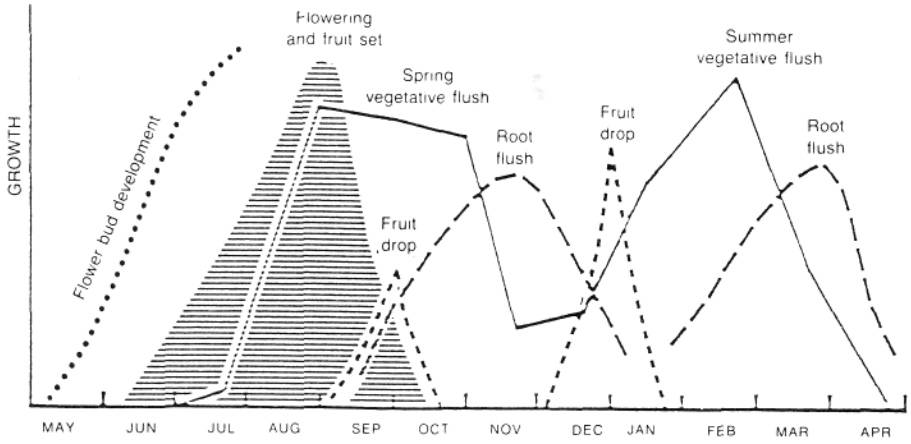

Fig 1 Phenological growth cycle of the avocado tree.

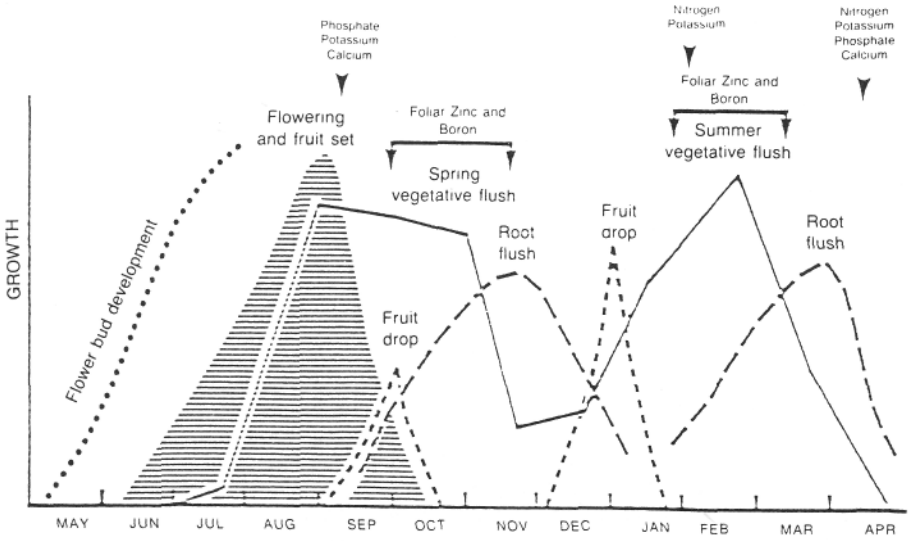

Fig 2 Fertilising by the growth cycle.

TABLE 3 Kg of N, P and K per annum in established orchards

LAN (28% N) or equivalent	Superphosphate (11,3% P)	Potassium chloride (50% K)
25 — 50	25 — 50	25 — 50

The nutrients for avocado trees in terms of vegetative growth and productivity, can be classified as manipulators or non-manipulators. Nitrogen is the only manipulator, while P, K, Zn, B, Ca, Mg, S, Fe, Cu and Mn are all non-manipulators and these have a broad optimal range band. The application time of the non-manipulators is not critical. The levels, however, must be maintained within the optimal ranges (soil and leaf levels). The timing of nitrogen fertilisation on the other hand is critical. Applying nitrogen increases vegetativeness at the expense of fruitfulness, while withholding it will temporarily favour fruitfulness. However, overall productivity will decline if trees become nitrogen-deficient over a period of time. Nitrogen applied at the right time and rates is the most important management tool to manipulate vegetative and reproductive growth.

Nitrogen should be applied after fruit-drop has subsided, in January/February. Applying it earlier will cause an increase in vegetative growth, which would result in increased fruit-drop. The nutritional management of the summer flush is vital as it influences current and future productivity of the tree. By providing nitrogen during the summer flush (as shown in Figure 2) the tree will have sufficient amounts of the nutrient to take it through to the following summer (Whiley, Saranah, Cull and Pegg, 1988).

It must be emphasised that for the best results, leaf and soil analysis must be done every year, records of fertiliser applications and timing must be kept accurately, and observations of stages of growth of the orchards must be made regularly.

Mulching

Mulching with cover crops such as legumes is advisable where soils are deficient in nitrogen and where root rot is a problem (Whiley, pers comm). However, to cope with excess nitrogen in soil, use cover crops which have a high C:N ratio, such as oats, maize, wheat or napier grass. Oats may also be useful as there is evidence that roots secrete a substance which antagonises *Phytophthora* (Wolstenholme, 1990).

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