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# METHODS OF INCREASING AVOCADO FRUIT PRODUCTION

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## *ABSTRACT*

*Low yields in avocado are often associated with vigorous vegetative growth. Orchard management practices reducing vigorous growth of avocado can increase production. The influence of rootstocks and cultivars, root rot control, fertilisation, irrigation, physical and chemical tree growth manipulation and other factors influencing avocado fruit production, are discussed.*

## INTRODUCTION

In the Tzaneen area avocado yields are low, averaging eight tons per hectare in orchards older than four years (Tuffin, 1987), Climate and soil conditions encourage vigorous growth, especially in trees cured of Phytophthora root rot. The canopy size of healthy young avocado trees increases by 50 100 per cent per year. Crowding of trees occurs four to five years after planting, where trees were planted at an initial spacing of 5 x 5 meters. Orchards must be thinned several times, leaving the farmer with a tree population of 25 50 huge trees per hectare in mature orchards.

Management practices to control tree growth are therefore required, as less vigorous trees would have distinct advantages in terms of orchard maintenance and production costs. By reducing the vigorous, competitive spring growth flush of avocado trees, yields may be improved (Könne & Kremer-Köhne, 1987). Furthermore, smaller trees would offer the opportunity to increase yields by planting at higher densities in order to achieve maximum production at a relatively early stage in the life of the orchard.

Factors influencing fruit production of avocado trees are discussed in this paper.

## IMPROVING FRUIT PRODUCTION OF AVOCADO ORCHARDS

### Control of *Phytophthora cinnamomi*

Control of *Phytophthora cinnamomi (Pc)* in avocado orchards by judicious use of fungicides and sound cultural practices, remains the most important single factor for increasing production (Wolstenholme, 1979; Kotzé *et al,* 1987). A dramatic increase in yield was found in trees recovering from *PC* after chemical treatment (Darvas *et al,* 1984; Pegg & Whiley, 1987; Wood *et al,* 1987). However, completely healthy, vigorously growing trees do not seem to be the most productive ones. Mature Fuerte trees slightly affected by *PC,* i.e. trees with a disease index of about 1 2 (index 0 = healthy, 10 = dead, Darvas *et al,* 1984) yield better, probably due to reduced vegetative growth on these

trees (Partridge, personal communication). The latest avocado census shows

that 30 per cent of South African avocado trees still have a disease index of between four and nine (Tuffin, 1987).

## Irrigation

A particular effort should be made not to over-irrigate avocados on problem soils. When *PC* is present, the trees are unable to take up water efficiently, thus water requirements should be monitored as carefully as possible (Zentmyer, 1979; Bower, 1979). Irrigation scheduling of healthy and diseased trees should therefore be planned separately (Whiley *et al,* 1986). Tensiometers should be used to determine water usage and to monitor the soil water situation (Zentmyer, 1979; Slabbert, 1987). Soil moisture potential should be maintained between approximately -25 kPa and -60 kPa with irrigation beginning not later than -50 kPa (Bower, 1979).

In Australia, vegetative growth of irrigated peach and pear trees was reduced by applying less water, without reducing yield (Chalmers *et al,* 1984). In avocado orchards which are growing too vigorously, reduced irrigation in winter should be investigated as a means of slowing down growth.

## Fertilisation

The removal of macro-nutrients by the avocado is low in comparison to many other crops. With a crop of 10 tons of avocados per hectare, approximately 11 kg nitrogen, 2 kg phosphorus, 20 kg potassium, 2 kg calcium and 5 kg magnesium are removed (Lahav & Kadman, 1980).

Application of fertilisers should be based on actual requirements determined by leaf and soil analysis. Results of avocado fertiliser experiments differ considerably. In many cases no relationship was found between the level of most nutrients in the leaves, and subsequent yields. Nevertheless, foliar analysis is a useful auxiliary tool for fertiliser recommendations, because it reveals any extreme deficiency or excess which demands special fertiliser treatment (Lahav & Kadman, 1980).

Under local conditions calcium, zinc, boron and nitrogen levels should receive special attention. Most soils in the eastern Transvaal are low in calcium (Fouché, 1981). Broadbent and Baker

(1974) claimed that *PC* did not occur in soils with a calcium status of 2 000 mg per kg. Liming reduced root rot on young avocado trees (Snyman & Darvas, 1982). Du Plessis and Koen (1987) showed that moderate amounts of liming material and gypsum applied annually increased avocado production. Zinc and boron deficiencies are often observed and can be corrected easily (Koen & Langenegger, 1980).

Nitrogen deficiency symptoms are expressed by restricted growth, pale, small leaves, early leaf shedding and in cases of acute lack of nitrogen, veins turn yellow (Lahav & Kadman, 1980). The author has never observed signs of nitrogen deficiency in avocado trees cured of *PC* on Westfalia Estate and restricted growth is not a problem in any of

the orchards on the Estate. On the contrary, excessive vegetative growth occurs, especially in nonor low-producing trees. Similar observations nave been made by growers in other avocado producing areas. Applying nitrogen simply for the sake of applying it should be avoided, as too much nitrogen can aggravate excessive vegetative growth and reduce production. Routine leaf analysis should rather be used to determine whether nitrogen applications are necessary or not. According to Wolstenholme (1987), leaf nitrogen levels in Fuerte should be kept below 1,8 per cent in order to reduce the vigour of the spring growth flush.

Too little is known about the nitrogen balance in avocado orchards, i.e. what amount of nitrogen is gained or lost under a specific orchard management system. The amount of nitrogen mineralised from organic matter (eg legume mulches) in spring, should be evaluated critically as available nitrogen encourages vegetative growth which should rather be minimised in spring. Determination of soil mineral nitrogen content in spring, using the '$N_{min}$ - Method', has been used successfully to establish nitrogen fertiliser requirements of fruit trees (Wehrmann & Scharpf, 1980). It might be worthwhile to use this method in conjunction with leaf analysis in order to optimise nitrogen fertilisation in avocados, and further work in this regard is indicated.

**Physical tree growth manipulation**

Pruning reduces the number of reproductive sites, as avocado trees flower on terminal shoots produced during the previous summer. Severe pruning, in order to maintain a more manageable tree size, results in a severe drop in production (Toerien & Basson, 1979) and even more vegetative growth.

Tree shape manipulation, by bending and tying branches to a horizontal position with no pruning, is not invigorating. Where trees were trained to an oval shape, crowding occurred one to two years later, compared to traditional round shaped canopies (Köhne, unpublished data).

Ringbarking of all main branches of a tree at flowering, considerably increases yield (Toerien & Basson, 1979). At the same time, ringbarking reduces average fruit size and causes a decline in tree condition. One year before thinning an orchard, ringbarking can be recommended to increase production in healthy, temporary trees of cultivars that do not have a small fruit problem (eg Fuerte, Edranol and Pinkerton).

**Chemical tree growth manipulation**

Foliar application and injection of paclobutrazol at full flowering, shortened internodes and increased fruit retention in Fuerte (Köhne & Kremer-Köhne, 1987).

In spring 1985, paclobutrazol was applied as a basal drench around the stem of six-year-old Hass trees at Westfalia Estate. At the start of the experiment, canopy size of the trees was approximately 12 $m^2$. Two rates of paclobutrazol were applied (0,4 g ai and 0,8 g ai/ $m^2$ canopy area) to five trees each. Another five trees were kept untreated. No effect of paclobutrazol was observed during the first 12 months after application. After harvest in 1986, a follow-up treatment of half the initial dose was applied. Eighteen

months after the start of the experiment shoot length on trees treated with paclobutrazol was reduced by 50 per cent. There was no difference in growth reduction between the two rates of paclobutrazol. Yield in treated and untreated trees did not differ statistically.

In tests with potted and newly planted avocado trees, the growth retarding effect of paclobutrazol drench treatments was observed within one to three months after application, provided the trees were actively growing at the time of application. Paclobutrazol drench treatments are most effective on young avocado trees with a compact rooting zone around the base of the stem (Köhne, unpublised data).

Foliar application of paclobutrazol, aimed at a reduction of vigour of the spring growth flush, will probably be an effective means for increasing production, especially in Fuerte. Growth on young, non-bearing trees of all cultivars can be reduced by soil drench treatments of paclobutrazol. Crowding is, therefore, delayed for much longer than in untreated trees; thinning can be postponed and production per hectare should increase.

### Other factors influencing productivity

Clean cultivation of the entire orchard floor with herbicides, is likely to result in an encrusted soil surface with poor aeration and can cause excessive run-off and erosion in sloping orchards. Mulching is of great benefit to the structure of the top soil. Frequently mown, short grasses control soil erosion and create easy working conditions for people and machinery. Using herbicides to eliminate weeds within the tree strip in combination with mowing of grass along the tractor track, is presently being evaluated at Westfalia Estate. In addition, experiments with tree spacing and canopy management, key factors in maximising and maintaining orchard productivity, are under way.

More attention should be paid to individual trees; yield records of individual trees might change thinning patterns and increase production. Individual tree records are a prerequisite for identifying trees with outstanding bearing capacity. Clonal stock and scion duplicates ('copy' trees) of such outstanding trees should out-produce present standards.

Hanging the fruit until late in the season, i.e. picking fruit with high oil content, severely depletes the reserves of the tree (Wolstenholme, 1987) and can be expected to negatively affect the following season's crop.

## ROOTSTOCKS AND CULTIVARS FOR FUTURE AVOCADO ORCHARDS

The choice of the rootstock is one of the main factors determining the vigour of the young tree. The ideal for local conditions a rootstock combining dwarfing characteristics with resistance to PCis unlikely to be found soon.

The emphasis on rootstock breeding in California is on *PC* tolerance (Bergh, 1987), resulting in inherently more vigorous selections. All clonally propagated rootstocks used commercially in South Africa, originate from California (eg Duke 7, G6 and Martin Grande). Fungicides can control *PC* very efficiently (Darvas & Bezuidenhout, 1987). It is up to the farmer to decide which degree of *PC* tolerance he requires keeping in mind that

the best rootstocks in terms of tolerance to root rot are unfortunately the most vigorous ones. However, one must be aware that resistance to fungicides used presently, might occur one day.

From Mexico interesting work has been reported on dwarf trees such as Colin V-33, trees with intermediate vigour (eg Colinmex, Colin V-101) and trees lacking apical dominance (Sanchez Colin & Barrientos Priego, 1987). Selection of dwarfing rootstocks is currently receiving attention, as is the use of Colin V-33 as a dwarfing interstock. Fuerte scions with Colin V-33 interstock showed a marked reduction in canopy size (Barrientos Priego ef a/, 1987). It would be most interesting to see how Mexican dwarf trees and interstocks perform under local conditions.

The behaviour and productivity of trees grafted on a given rootstock can change when grafted with different cultivars, or even different sources of scion of the same cultivar, and *vice versa* (Ben-Ya'acov, 1987). In Israel this topic has received intensive attention for more than 20 years, while very little is known about avocado rootstock/scion relationships in South Africa. Israeli findings on rootstock / scion relationship have little significance for local avocado production, due to differences in climate, soil and rootstocks used.

At present 53 per cent of all avocado trees in South Africa are Fuerte (Tuffin, 1987), a vigorously growing, early-season cultivar with rather low production. Fuerte fruit quality suffers from susceptibility to fruit diseases, cold damage and physiological disorders; the other commercial cultivars being less susceptible. Yield records on Westfalia Estate indicate highest production per hectare for Ryan, followed by Hass, Pinkerton, Edranol and Fuerte. Results for Ryan and Pinkerton are still preliminary as few data are available yet. In spite of its shortcomings, Fuerte still maintains its position, because there is no replacement cultivar for the first half of the picking season.

In California, Fuerte, once the backbone of the industry, has been increasingly replaced by Hass (Bergh, 1984). A comparison of yields of trees topworked with Hass and four of Bergh's most promising new selections (Gwen, Whitsell, Esther and Hx48), indicates that Hass itself can be outproduced (Bergh, 1987). The way preliminary results look now, Gwen or Whitsell are going to replace Hass in the long run (Tourney, 1985). In California, mature Gwen and Whitsell trees are much smaller than those of Hass, so twice as many can be planted per hectare compared to Hass (Anon, 1987).

However exciting the prospects of these dwarf cultivars may be, there is no information yet on how they perform under local conditions, or what their fruit quality and shelf-life, etc, will be like. Preliminary data should be available soon. Even if all expectations can be confirmed, it is unlikely that more than 10 per cent of the South African avocado trees will be Gwen or Whitsell within the next five to ten years, unless a massive top-working programme is introduced.

## CONCLUSIONS

Sound orchard practices in respect of *PC* control, fertilisation and irrigation are prerequisites for higher production. Once these are correctly managed, further steps can be taken, such as physical and chemical tree growth manipulation.

Growth regulators, such as paclobutrazol, can be useful tools for the manipulation of growth of avocado trees, especially if applied at stages critical for fruit retention and in young trees to delay crowding. However, caution is advised, as rather limited information on the practical use of growth retardants in the avocado is available as yet.

Skillful orchard management, aiming at an integrated approach using all horticultural practices described here and applied at the correct time, can significantly improve production of avocado orchards in the near future. More productive new cultivars and hopefully also dwarfing rootstocks, might eventually increase production further, but they will never rule out the importance of sound horticultural practices.

## REFERENCES


ANON, 1987. New UC varieties continue to outproduce old standbys. *Citrograph* 72{8), 163.

BARRIENTOS PRIEGO A, LOPEZ JIMENEZ A & SANCHEZ COLIN S, 1987. Effect of cv Colin V33 as interstock on avocado (Persea *americana* Mill) growth, cv Fuerte. S *A Avocado Growers' Assoc Yrb* 10*,* 62 - 64.

BEN-YA'ACOV A, 1987. Avocado rootstock/scion relationships. S *A Avocado Growers' Assoc Yrb* 10, 30 - 32.

BERGH B 0, 1984. Avocado varieties for California. *Calif Avocado Soc Yrb* 68, 75 - 93.

BERGH B O, 1987. Avocado breeding in California. *S A Avocado Growers' Assoc Yrb* 10, 22 - 24.

BOWER J P, 1979. Water relations of *Phytophthora* infected Fuerte trees and their influence on management. *S A Avocado Growers' Assoc Res Rpt* 3*,* 25 - 27.

BROADBENT P & BAKER K F, 1974. Behaviour of *Phytophthora cinnamomi* in soils suppressive and conducive to root rot. *Aust J Agric Res* 25, 121 - 137.

CHALMERS D J, MITCHELL P D & JERIE P H, 1984. The physiology of growth control of peach and pear trees using reduced irrigation. *Acta Horticul*furae146, 143 - 149.

DARVAS J M, TOERIEN J C & MILNE D L, 1984. Control of avocado root rot by trunk injection with phosethyl-AI. *Plant Disease* 68, 691 - 693.

DARVAS J M & BEZUIDENHOUT J J, 1987. Control of Phytophthora root rot of avocados by trunk injection. *S A Avocado Growers' Assoc Yrb* 10, 91 - 93.

DU PLESSIS S F & KOEN T J, 1987. Comparison of different calcium sources on avocado production. S *A Avocado Growers' Assoc Yrb* 10, 49 - 51.

FOUCHÉ P S, 1981. Bekalking van suurgrond. *S A Avocado Growers'Assoc Yrb* 4, 95 - 98.

KOEN T J & LANGENEGGER W, 1980. Fertilisation of avocados. *Farming in South Africa,* Avocados E2, Dep of Agric and Fisheries, Pretoria.

KÖHNE J S & KREMER-KÖHNE S, 1987. Vegetative growth and fruit retention in avocado as affected by a new plant growth regulator (paclobutrazol). *S A Avocado Growers' Assoc Yrb* 10, 64 - 66.

KOTZÉ J M, MOLL J N & DARVAS J M, 1987. Root rot control in South Africa: past, present and future. *S A Avocado Growers' Assoc Yrb* 10, 89 - 91.

LAHAV E & KADMAN, A, 1980. Avocado fertilisation. *Bull Int Potash Inst* No 6, Worblaufen-Bern, Switzerland.

PEGG KG & WHILEY AW, 1987. *Phytophthora* control in Australia. *S A Avocado*

*Growers' Assoc Yrb* 10, 94 - 96.
SANCHEZ COLIN S & BARRIENTOS PRIEGO A,
1987. Avocado production and breeding in Mexico. *S A Avocado Growers' Assoc Yrb* 10, 24 - 26.
SLABBERT M J, 1987. A comparison of irrigation scheduling by tensiometer versus evaporation pan. *S A Avocado Growers' Assoc Yrb* 10, 54 - 56.
SNYMAN C P & DARVAS J M, 1982. Die uitwerking van kalsium op wortelvrot by avokado. *S A Avocado Growers' Assoc Yrb* 5, 80 - 84.
TOERIEN J C & BASSON A M, 1979. An investigation into thinning of an avocado orchard. *S A Avocado Growers' Assoc Res Rpt* 3, 59 - 60.
TOUMEY J, 1985. By 2000, dwarf Whitsells on truly resistant stocks may be one solution to some of 1985's problems. *Avocado Grower* 9(2), 12 - 13.
TUFFIN A D, 1987. Avocado tree census. S *A Avocado Growers' Assoc,* Tzaneen.
WEHRMANN J & SCHARPF H C, 1980. Nitrogen fertiliser requirements of fruit trees as related to soil mineral nitrogen content in spring. In: *Mineral Nutrition of Fruit Trees,* ed D Atkinson, JE Jackson, RO Sharpies & WM Waller, Butterworths, London.
WHILEY A W, PEGG K G, SARANAH J B & FORSBERG LI, 1986. The control of Phytophthora root rot of avocado with fungicides and the effect of this disease on water relations, yield and ring neck. *Aust J Exp Agric* 26, 249 - 253.
WOLSTENHOLME B N, 1979. Prospects for integrated and biological control of avocado root rot some overseas impressions. *S A Avocado Growers' Assoc Res Rpt* 3*,* 17 - 20.
WOLSTENHOLME B N, 1987. Theoretical and applied aspects of avocado yield as affected by energy budgets and carbon partitioning. *S A Avocado Growers' Assoc Yrb* 10, 58 - 61.
WOOD R, BENNETT I C & BLANKEN P A, 1987. Injectable formulations of phosetyl-Al developed for root rot control in avocado trees in South Africa. *S A Avocado Growers' Assoc Yrb* 10*,* 97 - 99.
ZENTMYER *G* A, 1979. Report on Phytophthora root rot of avocado in South Africa. *S A Avocado Growers' Assoc Res Rpt* 3, 7 - 9.