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Can More Intensive Plantings of Avocado Orchards be Maintained?

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ABSTRACT

For various economic advantages more intensive plantings of 400 or more trees per hectare are gaining favour It was previously speculated that the removal of trees at an early age (five to seven years) when encroachment occurs, is an indefensible action. As an alternative it was suggested that orchard orientation and layout be adapted and that trees be trained to a pyramidal shape. In this way the removal of trees will hopefully be eliminated or at least delayed for as long as possible.

In this paper the results thus far obtained will be discussed. The degree of success achieved with the shaping of trees to a pyramidal form will also be discussed. Techniques and rules to be followed will briefly be explained. Preliminary results with regard to yields will be given. Although a lot of attention is given to ways of curbing plant vigour at certain periods, a great deal of experience has been gained with regard to avocado tree manipulation.

Future research will concentrate still further on early fruiting, control of plant vigour, regulating yield and improving fruit quality. A more efficient avocado tree is the ultimate aim. The use of bio-regulators to overcome some of these problems will be tested. Initial results showed that more work on the timing and the concentrations of these bio-regulators needs to be done.

Trials to rejuvenate encroached and inefficient older trees, have provided many positive results and are presently being expanded.

INTRODUCTION

The avocado producer of today is faced with the situation of early encroachment in the higher density orchards. This is due to the initial high density plantings, embarked on for early returns on investment (Köhne & Kremer-Könne, 1991). Excessive growth and the recent rainy seasons enhanced tree growth. The current general recommendation for managing a higher density orchard is a programmed orchard thinning by tree removal (Toerien & Basson, 1979; Whiley, 1994). The growth habit of the avocado tree is such that tree removal has to take place before these trees have given economic yield, and the need for an alternative is increasing. Research done recently proved that in the short term, pruning of trees together with chemical growth control did curb vigour and increased yield (Köhne & Kremer-Köhne, 1987; 1991; Köhne *et al,* 1991). However follow-up trials to test the results over longer periods were not reported on. Research done in Spain showed that light pruning during the on-year had positive results on the

leaf canopy and enhanced a more regular bearing pattern (Farre *et al,* 1987). With renewed interest, trials were recently started and some proposals and early results with regard to pruning of avocados were reported on by Stassen, *et al,* (1995) as well as by Snijder & Stassen (1995). According to some of the results from these researchers an avocado tree shaped at a very early stage to a central leader could easily be planted at higher densities, without the necessity of early tree removal if these trees were pruned and shaped regularly. Simultaneously, pruning of older less productive trees improved light penetration into the tree and tree recovery due to the formation of new shoots in the tree canopy. These trials are continuing and this paper will show some of the results obtained to date and give guidelines for pruning. Results with some of the bio-regulators will also be discussed.

MATERIALSAND METHODS

All the trials are carried out in the Burgershall/Kiepersol area and in Levubu. The pruning of mature trees is done in the Tzaneen area. The cultivar Hass is used in all cases, except for the site at the Burgershall Research Station where all five the commercial export cultivars are used.

Kiepersol I

The orchard was planted at the Burgershall Research Station in October 1995. All five commercial export cultivars on clonal Duke 7 were used. The planting consists of two spacings 5,5 x 3m (667 trees/ha) and 4,5 x 1,5m (1 666 trees/ha). All the trees were shaped into central leaders before planting, and bio-regulators are used on the vigorous cultivars to curb the excessive growth. The orchard is planted on a high potential soil with micro-irrigation. Fruit counting on 84 Hass trees/density was done.

Kiepersol 2

This orchard is a semi-commercial planting consisting of a standard planting of 5 x 5m (400 trees/ha) and 5 x 2,5m (800 trees/ha). The orchard was planted on clonal Duke 7 rootstocks in November 1994 on high potential soils under micro-irrigation. Pruning is done on the high density orchard to a central leader. Pruning commenced in January 1995. Fruit counting was done on 150 trees/density.

Kiepersol 3

Hass on Edranol seedling rootstocks planted at 5 x 5m (400 trees/ha) in October 1993 and interplanted to 5 x 2,5m (800 trees/ha) in September 1995. Row direction is north-south and pruning on the initially planted trees commenced in October 1994, while the newly planted trees were pruned after planting. All trees were pruned to a central leader system. This orchard is on a less vigorous soil than the other orchards, and dragline irrigation is used at the moment. Fruit counting was done on 10 trees.

Kiepersol 4

This orchard was planted in November 1992 at 6 x 6m (277 trees/ha) on clonal Duke 7 rootstocks. The first pruning was done in July 1994 and regularly thereafter. Some trees were pruned to a multiple (2-3) leader system, but most trees at the early age lend themselves to a central leader system. High potential soils and micro-irrigation enhanced the vegetative development of these trees. Fruit counting was done on 15 trees/treatment.

Levubu

This orchard was planted in March 1993 on Edranol seedling rootstock at 7 x 7m (204 trees/ha). The soil potential is less vigorous than the Burgershall/Kiepersol sites and micro-irrigation is used. Pruning commenced in July 1995 to a central leader system. During flowering in 1996 trees were sprayed with the bio-regulators paclobutrazol, 'Sunny', 'Cycocel' (1000ppm) and 'Fix' (1000ppm) to test their effectiveness in curbing growth and enhancing fruit set. Cincturing of main branches was done at the same time. Fruit counting was done on five trees/treatment.

Tzaneen

This orchard was planted at 5 x 5m in 1988 on clonal Duke 7 rootstocks. The trees are planted on a high potential soil with micro-irrigation. Tree encroachment is becoming a serious problem in this orchard and a management decision was made to take out every alternate row in a north-south direction in all the encroached orchards. The pruning trial is done in one of the encroached orchards and the following treatments were applied in July 1996. Full details on these treatments were discussed by Snijder and Stassen (1995).

Light encroachment situation

- Light corrective pruning of all the trees over three seasons to a pyramidal tree shape.
- Severe pruning of alternate rows, and corrective pruning over three years to a pyramidal shape of the remaining rows
- Control no pruning done

Severe encroachment situation

- Staghorning alternate rows in a North-South direction with corrective pruning to a pyramidal shape over three years of the remaining rows from the second year. Staghorned trees are shaped to a pyramidal tree and maintained thereafter.
- Removal of alternate rows in a north-south direction and corrective pruning of the remaining trees from the second year as for the above.
- Staghorning all the trees and subsequent recovery to pyramidal shaped trees.

• Tree training system according to Gray Martin (1995)[1] from California where alternate rows are cut back and trained into single leader trees, the remaining trees are not pruned until such time that the pruned trees are in full production.

• Tree training according to Len Francis (1994) from California where every tree is pruned. Two branches per tree per year are cut back, one a vertical branch the other a horizontal branch until the trees are renewed and their shape and size can be maintained.

• Control no pruning.

All the trees at all the sites were measured at the start of the experiments and measured every six months thereafter. Tree height, stem circumference and canopy diameter are measured. Fruit counts were done in November and in February and yield data taken at harvest consisted of total yield/tree (kg), number of fruit/tree and where possible the fruit count distribution is determined. In the bio-regulator trials branch length, thickness and number of leaves developed on each flush is measured separately.

RESULTS AND DISCUSSION

PRUNING

Yield results

The first two years yield data is presented in table 1. This table shows the yield data in ton/ha together with the number of fruit per tree. For the 1997 figure the yield is calculated as follows: Expected yield = number of fruit x number of trees/ha x average fruit mass (250g/fruit)

[1] Lecture given at the 3rd World Avocado Congress in Tel-Aviv, Israel 17-22 October 1995.

Table 1
Initial yield results of Hass avocados at different densities and different pruning systems

Locality/ Treatment	Year planted	1996 Yield (t/ha)	1996 Fruit number/ tree (June)	1997 Exp. Yield (t/ha)	1997 Actual Fruit number/ tree (Feb)
Kiepersol 1	1995				
667 trees/ha		0	0	0,5	2,8
1666 trees/ha		0	0	1,2	3,6
Kiepersol 2	1994				
800 trees/ha		0	0	2,9	14,3a
400 trees/ha		0	0	2,6	26,3b
Kiepersol 3	1993				
800 trees/ha		4,62*	58	9,04*	90,4
Kiepersol 4	1992				
pruned		4,07a	60,8	8,1	118,4a
unpruned		1,48b	25	5,7	82,4b
Levubu	1992				
pruned		2,54	62	2,61	50,5

Values with the same symbols do not differ statistically at the 5% level
* Work done on 400 trees/ha because interplants are not yet in production

From table 1 it can be seen that the pruning did not have negative results in terms of yield. At the same time tree size could be controlled within the space given until now. The increase in yield at Kiepersol 3 is something to note as the interplants are not yet into production. The low yield at the Levubu site is mainly due to poor flowering. This can be attributed largely to the adverse weather condition in the latter part of the winter season when these trees should have been in full flower. The low number of fruit at this stage in the Kiepersol 2 site at high density (800 trees/ha) is due to the fact that the trees are half the size of the standard planted trees and less fruit was left after thinning on these trees compared to the low density (400 trees/ha). However the expected yield/ha is still slightly higher than that of the standard planting. The trees in Kiepersol 1 and 2 at the higher density have started to fill their space and in the coming winter these trees will be pruned accordingly. Tree height control will be done in the Kiepersol 4 and the Levubu site this winter as these trees have reached their allotted height. Pruning will be done as soon as the crop has been harvested. The fruit size distribution for Kiepersol 4 is given in figure 1. From figure 1 it can be seen that there is no difference in fruit size distribution between the pruned and unpruned trees.

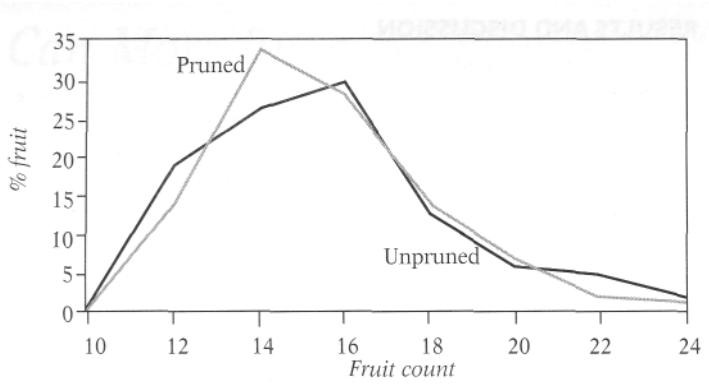

Figure 1
Effect of pruning on fruit size distribution of Hass avocado in the Kiepersol area for the 1995/96 season (Kiepersol 4)

Pruning method

The pruning of the avocado tree is a relatively easy task as the tree reacts predictably. The method that was used in mature trees is as follows:

- Select the leader(s) of the tree. If a multiple system is used (mainly in older trees and wider spaced plantings) these leaders must be symmetrical around the centre of the tree, and be strong, upright growing main branches.
- All the unwanted upright growing branches are cut back to weaker and horizontal side branches during the first year to shape the tree to a pyramidal shape. Do not remove more than 20% of the total leaf canopy of the tree.
- Side branches are cut back where necessary to ensure that light can penetrate the tree. Always ensure that the branches are pruned back to other branches. Do not leave stumps, as these forms a bush of new growth, undoing the initial process of opening up the tree.
- These first three actions are carried out in winter, after the crop has been taken off the tree and when an on-year is expected. This will ensure that the fruit will take much of the vegetative energy away for fruit growth. If the action is performed in an off-year the trees will react very vigorously.
- Follow-up treatments are very important to retain the initial light penetration into the tree. Water shoots and upright growing branches should be removed as soon as they develop. This is very important during the spring flush, as it can have *a* negative effect on the crop. Shoot competition does affect fruit drop. Any shoot thicker than one-third of the leader or branch it develops on, should be cut back severely to maintain the correct balance within the tree. Branches thicker than one-half of the leader or other branch that it develops on, must be completely removed.
- Keep the leaders free of competition. This will ensure that the correct shape and balance within the tree can be maintained.
- Summer pruning is done only to correct the balance and light penetration into the

tree. No major pruning should be done at this stage. Remember pruning does stimulate growth and the more severe the pruning, the more severe the reaction. Always be careful with nitrogen fertilizer application after pruning as overreaction by the tree occurs very easily.

- Pruning young trees from planting involves the same actions, but less drastic, as the branches tend to be smaller. Balance of side shoots in relation to main branches or leaders is very important.

Depending on the severity of the damage caused by overcrowding, correction should be done in phases over a three year period, starting with the shaping of the tree to a pyramidal shape during the first year. During the second year the tree width is corrected using the newly formed branches on the inside of the tree. In the third year the height of the tree is reduced, bringing the total tree back into a manageable size. During the second and third years maintenance of the earlier pruning is done regularly by removal of water shoots and upright growing branches.

GROWTH CONTROL

In figure 2 the results with regard to the growth control treatments are given. Only the data for the spring treatment are currently shown as the data for the summer treatments are not yet available.

From figure 2 it can be seen that no differences in growth control exists, except for the double 'Sunny' spray full bud and full flower and the standard registered paclobutrazol spray. In these two instances the spring growth was significantly inhibited, but the resulting fruit set showed that only the palcobutrazol spray treatment was better than the control. This is confirmation of work done by various researchers (Köhne & Kremer-Köhne, 1987; Wolstenholme *et al,* 1990; Köhne *et al.,* 1991). However the bio-regulators used in the current experiments were only tested at a single concentration and these trials will be extended to include different concentrations and timings of spraying. Similar results were obtained in the Kiepersol 2 site where some of the same bio-regulators were used at a different time (autumn). No differences could be found in terms of fruit set and growth retardation.

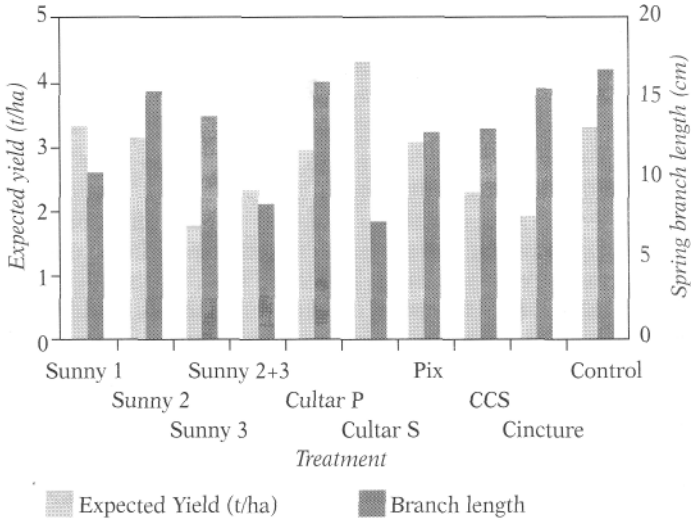

Figure 2
Effect of different growth retarding treatments on the spring flush and expected yield on Hass avocado in the Levubu area for the 1996/97 season

CONCLUSION

The initial results obtained in these long term trials are already encouraging, as they do show some positive results. No negative reactions have been experienced so far with the pruning of the trees, and the shape and size of the trees could thus far be maintained. The pruning action itself if done correctly is not very time consuming. However, if trees in production are to be shaped, more care and follow-up work needs to be done than is the case with trees trained from the beginning. The experiments with bio-regulators did not show very positive reactions, and these trials need to be expanded to include different concentrations, as well as different timing of the applications. Full results for these experiments are not yet available, as the crop will be harvested in May/June 1997.

Under the right conditions and management, pruning should be possible to retain the trees within their limited space for a much longer period than is currently the situation. Further research however, is needed to curb growth vigour under high potential soil conditions and encourage fruit production. Trials for investigating these aspects are currently under way and will be reported on in due course.

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