

Pruning mature and encroached avocado trees to restimulate and maintain production and fruit quality

B. Snijder & P. J. C. Stassen

Institute for Tropical and Subtropical Crops, Private Bag X 11208, Nelspruit 1200

ABSTRACT

Many avocado plantings in South Africa are reaching the stage where a decision has to be made to either remove the orchard, thin out rows, or retain the trees by pruning them into a shape and size that is more manageable and will produce a commercial yield of good quality fruit. The Institute for Tropical and Subtropical Crops, together with producers, has been researching these problems over the past five years in various growing areas. Several strategies have been put forward and tested during this time. As a result of this research, more than one pruning option is available to the producer, ranging from light hand pruning to heavy mechanical pruning. Cost implications for these systems have to be taken into account to ensure the most economically beneficial result. Selective hand pruning can easily be applied in orchards where the encroached stage is not yet evident. Trained labour can carry out these operations. Yield does not drop dramatically in these situations and good fruit size and quality is maintained after pruning. Re-growth after the pruning operation is minimal and can be effectively controlled. In seriously encroached situations, a more drastic approach will be necessary and chain saws or other mechanical equipment are required to get the job done effectively. Regular removal of unwanted, upright watershoots also needs to be carried out. In higher potential soils growth regulators must be incorporated in the tree management programme to assist the producer in regrowth control. It is also important to follow the correct nutritional programme (especially nitrogen) to manage growth. An encroached orchard in the Kiepersol area was recently pruned after harvest using different pruning techniques for encroached orchards. This orchard will serve as demonstration to help producers in their decision-making about cost implications, time of recuperation, growth reaction, follow-up operations and so on. This paper will discuss these options, with the aim of providing growers with the information they require to maintain productive, well managed orchards.

INTRODUCTION

Encroached orchards are currently a common occurrence in the South African avocado industry. Decline in yield and fruit quality go hand in hand with this situation. Until

recently staghorned trees or a tree thinning process as described by Toerien and Basson (1979) was applied at the encroachment stage. However, without a tree management system in place this gave the remaining trees space to grow even larger, with encroachment again a problem in the future (Whiley & Schaffer, 1994; Stassen *et al.*, 1995). Israel has been hedging avocado trees since the early 1990's to prevent encroachment and to ensure light penetration into the rows (Homsy, 1995). In California the recommendation given by Francis (1994) is to remove two major limbs every year and train the regrowth to a set size to curb encroachment. In South Africa the growing conditions of avocados favour vegetative growth and many pruning practices showed negative effects in the past. Snijder & Stassen (1995) described strategies to alleviate the encroachment situation, and they also described strategies to prevent the development of encroachment. The main reason for applying these strategies was to shape the trees to ensure sunlight penetration into the trees and working rows. Snijder & Stassen (1995) recommended selecting three to four upright growing leaders and pruning back the other upright growing branches to get an open V-shape in the working row and light penetration into the trees. This would encourage new growth to develop on the inside of the trees. At the same time new shoots will develop at the base of the tree which makes it possible to bring the crop back to a manageable height and increased productivity. Follow-up pruning would ensure that tree size and shape will be maintained, and new productive bearing wood will develop, ensuring good yields (Snijder & Stassen, 1998; Stassen & Snijder, 1996).

In this paper, the pruning process for mature trees will be discussed, with special reference to regrowth control. Yield data from commercial producers, who have pruned mature orchards during the past few years, will be presented.

MATERIALS AND METHODS

The strategies as described by Snijder & Stassen (1995) were used in different orchards at different producers. These trials were all based on selective pruning systems to overcome the encroachment situation. A new trial has also been started in the Kiepersol area, comparing mechanical pruning with selective pruning. The first treatment entails a modified Israeli method where one side of the tree is pruned during the first year, followed by shaping and pruning the other side of the tree in the second year. The tree is then shaped in the third year to a pyramidal shape. The second mechanical treatment is to straightaway prune the trees into a pyramidal shape. This is done by pruning both sides of the tree at an angle. In the selective treatment the tops are opened up by making the leaders single and a more severe treatment with whole branches being removed to shape the trees, is described by Snijder & Stassen (1995). Summer pruning and chemical growth control measures are used for controlling regrowth.

The commercial orchards used are in the Kiepersol and Levubu areas. The orchards in the Kiepersol area were planted in 1982. The spacing of these orchards is 7 x 7 m and the trees reached an encroached situation in 1994. Selective pruning was done during July 1994, after the crop was harvested, by opening the tops of the trees. Follow-up pruning was done during spring to remove the watershoots and again during summer. This was repeated yearly. The orchards at Levubu were planted at 9 x 6m in 1989. Although no encroached state was reached, the trees were too high for effective

management. The trees were then mechanically pruned during June 1997 to a box-like hedgerow shape after the crop was harvested. No summer pruning was done, but after the 1998 crop was harvested, the trees again were pruned mechanically during June.

RESULTS AND DISCUSSION

Over the past five years the ITSC has been actively involved in the rejuvenation of mature avocado orchards. The results obtained thus far are excellent, with the understanding that pruning entails a package which includes follow-up management of regrowth, especially watershoots. In higher potential soils, nutritional management and growth inhibition also plays an important role. Selective pruning (pruning by hand using saws, chain saws, power shears or other tools) is currently the method used by most producers. However, mechanical, tractor driven pruners are also being utilized by some of the larger producers.

Experimental work continues to refine the initial method of pruning, follow-up pruning and growth control management. A number of strategies have, however, been developed.

Pruning practices for mature avocado orchards

Mature and encroached avocado orchards selected for pruning should be harvested as soon as the fruit is physiologically mature. This will ensure that the first pruning operation will be finished before the next season commences.

During the first season of pruning the working rows are opened up in a North-South direction. This will ensure that adequate sunlight can be intercepted by every tree in the orchard. The opening of working rows is done by the removal of overhanging branches, and upright growing branches on the outside of the trees, but keeping the upright leaders. A pyramidal tree shape will ensure that the working rows will allow sunlight to penetrate into the lower branches throughout the year. This opening of the work rows in a slightly encroached situation will concentrate on the tops of the trees and not on the lower sides of the trees. For a mechanical pruning system to operate in severely encroached situations, a working path has to be opened before a tractor operated saw can enter the orchard. After pruning the orchard the following reactions can be expected:

- Buds will break on the bare inner branches and start developing into bearing shoots for the coming season.
- At the bottom of the tree new growth will develop that can be used as replacements for shoots that have died back.

This growth has to be managed throughout the growing season. The reason for this is

1. to develop a complex branching system for next year's crop.
2. to maintain light penetration into the trees, for healthy growth throughout the season.
3. to remove any unwanted and upright growing shoots.

During the second year of pruning continuous shaping of the tree will take place and height control applied. Unwanted and upright growing shoots are regularly removed to

promote sunlight interception in the orchard and penetration into the trees. Unproductive branches at the bottom of the tree are pruned back to new developing shoots to rejuvenate the tree and at the same time continue the shaping and size control of the tree. Height control is done after harvest to 70% of the row width. This will allow maximum sunlight interception by the avocado trees, and ensure optimal productivity in the orchard. Continuous regrowth control throughout the season is necessary to ensure light penetration into the trees. This is important if healthy developing branches are to become reproductive during February-March (normal time for flower initiation according to Robertson, 1969).

During the third and subsequent years, regular maintenance pruning is applied. This ensures height control and tree shape and size is maintained. Winter pruning is undertaken to open up the trees by removing one or two branches in the tops and to remove old and unwanted shoots. This is normally the time for more severe pruning operations. During spring and summer, regrowth control is applied, and this entails light, selective pruning and removal of young developing watershoots. With this light pruning, shoot complexity is accomplished to ensure good yields.

When to prune

The question when to start pruning, and when all the different pruning actions need to be finished, is regularly asked. It depends largely on the situation in the orchard and the cultivar involved.

The time for doing the first pruning will depend on the type of crop expected. If an on-year is expected, the main pruning is done directly after harvest. The first pruning in an on-year will also produce less regrowth in spring as most of the energy flows into the fruit. However, during the summer a strong flush can be expected that has to be controlled (mechanically and/or chemically) as soon as this flush starts to develop. Otherwise this will lead to severe fruit drop. If an off-year is expected, this operation should preferably take place in late spring or early summer (October to December). The regrowth reaction at this stage is more uniform and controllable and less follow-up pruning is needed during the first year. A good crop can be expected during the second year (on-year). Once the pruning system is in place, it is recommended that a strict follow-up programme be employed to ensure good yields of high quality fruit. The follow-up programme is as follows:

After harvest (June-early August) when trees are dormant the major pruning operation is done. This includes the removal of unwanted branches, height control and thinning of the tree tops to single leaders for maximum light penetration. During this process excessive flower buds in an on-year will be removed and this will positively influence fruit size and moderate the alternate bearing pattern. Shaping the tree to keep the tops narrower than the base, and maintaining the open V-shape in the working row must also be done. The pruning in winter can be done mechanically by using inexpensive motorized tools to save time.

After fruit set, during the spring flush. Only a light pruning should be carried out to remove watershoots and any other unwanted and upright growing shoots. This pruning action is necessary as strong growth can seriously influence fruit size. Unnecessary branch removal should be avoided as sunburn can damage the fruit. This is therefore a

corrective pruning and not a rejuvenation operation. This pruning has to be done selectively, otherwise fruit damage will occur.

During the summer flush. (December/January) During this period strong summer flushes appear in the tree. These flushes seriously affect fruit drop. Removal of watershoots is essential and the opening of the tree by removing branches that are directly above each other gives better light penetration. This has to be done to ensure healthy, hardened-off branches during February. During this time flower initiation will take place. (Robertson, 1969). Chemical growth control after the summer pruning can help (Renter & Stassen, 1998; Erasmus & Brooks, 1998). This summer pruning can easily be done mechanically, as this is just a light tipping of the new growth for better shoot complexity.

The results obtained with various methods of pruning are encouraging. Even the Fuerte with its informal growth habit, could be pruned to a pyramidal shape and gave good yields. In Table 1 the results with a selectively pruned Hass orchard in the Kiepersol area are shown. This orchard, planted in 1982 was seriously encroached in 1994, and with the coming on-year 1994/95 the decision was made to prune this orchard drastically, as described above, in July 1994 after harvesting.

Table 1: *Yield (t/ha) of Hass avocados in the Kiepersol area (planted 1982) before and after selective pruning*

	Before pruning				After pruning			
Year	1991	1992	1993	1994	1995	1996	1997	1998
Yield (t/ha)	11.9	5.0	15.3	6.4	11.7	11.4	10.0	12.3

From Table 1 it is evident that pruning did not effect the yield adversely with an average yield of 9.7 t/ha before pruning and an average yield of 11.4 t/ha after pruning. It is also clear from this table that with a regular pruning programme alternate bearing can be minimized or eliminated from the orchard. Fruit size was better after pruning with less small fruit at harvesting and orchard management was improved.

Table 2: *Yield (t/ha) of Hass and Fuerte avocados in Levubu (planted 1989) before and after mechanical pruning*

	Before pruning			After pruning
Year	1995	1996	1997	1998
Hass (t/ha)	0.26	0.82	5.37	22.92
Fuerte (t/ha)	0.57	1.20	6.60	17.45

In Table 2 the results with Hass and Fuerte in the Levubu area are shown after being mechanically pruned. These orchards were, in 1994, in a vigorously growing state. After

the 1997 harvest, all the trees were mechanically pruned in a hedgerow system. Height was controlled at 4 m. The trees were approximately eight years old.

CONCLUSION

The current practices applied in the avocado industry lead to uneconomical orchards due to low productivity and massive tree size. High labour costs and low returns per ton of fruit produced, forces the producer to higher levels of productivity. This can only be achieved when the avocado tree is of such dimensions that spraying and picking can be carried out with relative ease. One of the solutions is to prune and shape the trees, and the current research project aims to achieve this objective. Results have shown that tree size can be controlled with either a selective, mechanical or combination of pruning systems. Follow-up pruning to control regrowth is essential to ensure good results continuously. Positive results are obtained and alternate bearing is alleviated. Fruit size, in general, is better after pruning.

It should be kept in mind that each orchard situation differs in terms of the severity of pruning required and the method of pruning, depending on the state of encroachment. The timing of follow-up pruning will be determined by the severity of pruning as well as the crop load on the tree. In an off-year pruning could be started after fruit set, while in an on-year pruning should be finished before flowering to obtain the best results. In spring and summer the regrowth during each flush should be managed in such a way that sunlight can penetrate into the trees, but fruit will not be damaged by sunburn. Watershoots should be removed timeously.

Future research will concentrate mainly on the optimisation of pruning techniques and its timing as well as the use of growth regulators during the pruning process to improve the yields of avocado trees and fruit quality. The reactions of the different cultivars to pruning will also be monitored.

SUMMARY

Encroached orchards are currently a common occurrence in the South African avocado industry. With the correct pruning system and tree management programme in place this situation can be alleviated. The pruning of mature trees involves the following strategy:

- **The first year of pruning:**
 - a. Select three to four upright growing branches as leaders
 - b. Remove watershoots and other upright growing branches on the outside of the tree
 - c. Remove overhanging branches
 - d. Open the working row to a V-shape in a North-South direction
 - e. Continuously control regrowth
- **The second year of pruning:**
 - a. Continue with tree shaping
 - b. Remove watershoots

- c. Control height to 70% of row width
- d. Continuously control regrowth
- **The third and subsequent years of pruning:**
 - a. Continue with shaping and height control
 - b. Remove watershoots
 - c. Continuously control regrowth
 - d. Renew branches by pruning back to new growth
 - e. Remove unwanted branches to open up the tree to sunlight

Application of plant growth regulators during the spring and summer flush will reduce growth vigour in fertile soils. A well balanced nutritional programme will also ensure less vigorous growth.

Mechanical, selective or a combination of pruning systems can be used in avocado orchards.

Timing of the operation is important to control regrowth. Winter pruning is done to ensure sunlight penetration into the trees. Spring pruning is applied to control excessive vigour and should be done selectively, while summer pruning is done to open up the tree and to induce shoot complexity.

The first pruning can be applied directly after harvest when an on-year is expected; otherwise pruning can be delayed until late spring for more uniform and controllable regrowth.

The results obtained with pruning of avocados showed good results. Alternate bearing was reduced in pruned orchards and yields were not adversely affected. Productivity was increased and fruit size was more acceptable.

It is concluded that pruning of mature orchards to maintain size and optimise yield can be applied successfully.

REFERENCES

- ERASMUS, H.D., BROOKS, W.H., 1998. Foliar application of uniconazole (Sunny) to avocado trees to improve fruit size and yield and to change fruit shape. *South African Avocado Growers' Association Yearbook* 21:52-53.
- FRANCIS, H.L. 1994. What to do with tall, crowding trees in orchards previously thinned. *California Avocado Society Yearbook* 78:147-153.
- ROBERTSON, B.L. The morphogenesis of the flower and fruit of the Fuerte avocado (*Persea americana* Mill x *P. drymifolia* Cham. Schlecht.) M.Sc. (Agric) thesis, Univ. of Pretoria, Pretoria.
- HOMSKY, S. 1995. The avocado industry in Israel - an overview. *Alan Hanotha*, 49:477-488.

- PENTER, M.G., & STASSEN, P.J.C. 1998. The effect of growth inhibitors on vegetative growth, fruit size and fruit set in Hass avocado trees; a preliminary report. *South African Avocado Growers' Association Yearbook* 21:54-57.
- SNIJDER, B. & STASSEN, P.J.C. 1995. Strategies for renewal of unproductive older avocado orchards with severe encroachment problems. *South African Avocado Growers' Association Yearbook* 18:56-58.
- SNIJDER, B. & STASSEN, P.J.C. 1998. Manipulation of avocado trees to control tree size - a four year progress report. *South African Avocado Growers' Association Yearbook* 21:58-62.
- STASSEN, P.J.C. & SNIJDER, B. 1996. Manipulation of avocado trees - Pruning. *South African Avocado Growers' Association Yearbook* 19:73-76.
- STASSEN, P.J.C., DAVIE, S.J. & SNIJDER, B. 1995. Principles involved in tree management of higher density orchards. *South African Avocado Growers' Association Yearbook* 18: 47-50.
- TOERIEN, J.C. & BASSON, A.M. 1979. An investigation into thinning of an avocado orchard. *South African Avocado Growers' Association Yearbook* 3:59.
- WHILEY, A.W. & SHAFFER, B. 1994. Avocado. In Schaffer, B., & Anderson, P.S. (eds) *Handbook of Environmental Physiology of Fruit Crops II Subtropical and Tropical Crops*. CRC Press (Boca Raton), pp 3-35.