

Principles Involved in Tree Management of Higher Density Avocado Orchards

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INTRODUCTION

Conventional orchard plantings of 100 and 200 avocado trees/ha can under no circumstances be economically justified.

The reasons are the following:

- The long period required for the investment to produce a positive income and the even longer period to produce a commercially paying crop.
- At the stage at which the trees reach their optimal production potential they are unmanageably large, making the harvesting operation hazardous and the spraying programmes ineffective.
- Because the large trees at this stage are encroaching on each other, production declines and drastic measures have to be taken.

Producers have already experienced these problems and this has prompted a move to more intensive plantings of 5 x 5 m or 400 trees/ha. The main problem however is that producers are in this way merely accelerating the encroachment problem. Apparently a stalemate situation has now been reached where the extensive conventional plantings take an unsatisfactory long time to reach their peak while the more intensive plantings reach the encroachment stage too soon.

It would be irresponsible to make recommendations to producers for high density orchards without presenting them with a method of containing the trees within their given space and maintain them productively within the allocated area.

HANDLING HIGHER PLANT DENSITIES

There exist two schools of thought on how to handle the problem, namely:

- Plant trees on a more intensive scale and then remove them according to a prearranged system when encroachment occurs.
- Plant trees according to a realistic and logical spacing and utilise a tree management system to shape and contain the tree within the allocated space.
- Our opposition to the first school of thought stems from the following:
- The removal of tree crops when they are healthy and good producers is counter productive and psychologically unsound. This necessity must be avoided as long

as possible. The solution is temporary and must be repeated within two to three years with a further "tree thinning" action or a tree management system must be adopted.

- The system allows trees to become larger and taller as more space is made available to them thus creating management problems. Side branches and shoots that get longer in the tree top resulted in adjacent trees touching each other high up to form dark tunnels beneath the trees.
- Unproductive surfaces develop within and between trees. The bearing surfaces shift ever higher up in the tree and further from the centre of the tree.

The second approach is conditional on manipulation techniques being developed to maintain a specific plant volume. Do not wait for problems to occur before acting but shape trees according to established plant principles.

BASIC PRINCIPLES

These basic principles must be followed in order to accommodate trees in a more intensive planting for their full commercial life span.

The deciduous fruit industry has over the past 30 years been confronted by the same dilemma as that now facing the avocado industry. Do you allow sufficient space when planting for each tree to grow unfettered to its maximum size with all the associated problems or do you try to get the maximum return in the quickest way by a concerted tree management effort? The deciduous fruit industry went from one extreme to the other. The same arguments were presented as those now given for avocados and the same mistakes were made but they eventually developed systems for each need (Stadler & Stassen 1985a; 1985b; 1985c) including higher density plantings of up to 2000 trees/ha (Stassen 1987 — unpublished bulletin).

We need not follow the same road but should rather apply the knowledge and experience gained. We do not contend that avocado trees can be handled in exactly the same way as deciduous crops. In fact the manipulation techniques for peaches differ from that for apples.

There are however certain basic principles that have to be taken into account and in accordance with which systems are developed, adapted or modified.

The following principles apply:

- Photosynthesis is correlated to the total leaf surface which is effectively exposed to light and this eventually determines total production of energy and dry mass. It is therefore essential that a large leaf surface is attained as soon as possible.
- At least 30% (and for certain plant processes considerably more) of the available sun radiation is required for all the plant processes to function normally.
- Without this there is insufficient growth, die-back of shoots, poor fruit size, and loss of fertility, unsatisfactory flower initiation and poor colour development.

- Crops can only utilise the light intercepted by the leaf canopy. The tree shape and the effective exposure of leaves will determine light interception and penetration to the inner zones.
- The ideal tree shape is conical or pyramidal (that is, the base is wider than the tree top) and the diameter of the base must not be more than about three metres. The narrower the trees the more the side shoots are spirally developed around a central stem so that light penetration can occur.
- A hedgerow planting system should be applied (planting on a rectangular basis) and if normal implements are used the working row between tree rows must not be less than 1.8 metres. The work area must utilise the minimum space while allowing free movement of implements. With crops that are terminal bearers you will have to allow for more work space but not more than about three metres.
- The tree height must not surpass 80% of the width between rows or twice the free working space between rows. If the total row width is 5 metres the tree height may not exceed 4 metres but preferably be held at 3.5 metres.
- The spatial orientation of the ideal trees should be such that optimal light utilisation occurs over the total leaf canopy during the day depending on the sun movement. Normally it will be a North-South orientation but can be adapted according to latitude, siting, occurrence of sunburn and other practical considerations.

What are the reasons for tree manipulation?

- To achieve and maintain the desired tree form for maximum light interception and for the development of fruit within reach.
- To develop a strong and sturdy framework to avoid branch tearing or fruit hanging on the ground while exposing sufficient leaves.
- To develop a suitable and productive bearing surface for the whole tree.
- To balance the roots and above ground parts of the tree.
- To induce fruitfulness.
- To control the relationship between growth and fruit and to achieve the desired ratio of leaves to fruit. To remove excess flowers and/or fruit.
- To maintain a sufficient degree of light penetration into the tree canopy.
- To remove superfluous or dead shoots.
- To restrict tree height and width.
- To avoid ageing of bearing wood and through rejuvenation cuts retain bearing material in close proximity to the frame branches.

Table 1
Recommended planting densities for
avocados

<i>Cultivar</i>	<i>Spacing</i>	<i>Trees/ha</i>
Ryan	5 × 2.5 m	800
Hass	5 × 3 m	667
Fuerte	6 × 3 m	556
Edranol	5 × 2 m	1000
Pinkerton	5 × 2.5 m	800

Pruning cuts that can be used in tree manipulation

Heading

This cut stimulates growth and should be avoided if at all possible. It can however be applied just after planting in order to stimulate lateral shoot growth for creating the tree frame. It must not be applied to frame branches as it gives rise to vigorous growth of mainly water shoots with multiple shoots near the cut ends resulting in a bushy growth in the top of the tree which prevents light penetration and spoils the shape. If the cut is made it has to be followed up with the summer removal of unwanted shoots. It can be used to renew side branches and shoots but will again necessitate summer removal of suckers.

Tipping

This involves the removal of the growth point. The cut may be used to stimulate lateral shoot growth during the growth period especially when shaping the tree to establish side branches in the right places. It may also be used to temporarily retard flushing, for example when the flush is competing with the fruit during the fruit set stage.

Branch thinning

This involves the removal of branches and shoots with a smooth cut at the point of origin. It is used to remove excess foliage and improve light penetration and utilisation.

Suckering

When water shoots or other unwanted growths are removed at an early stage before too much energy is utilised or light penetration is prevented.

Cutting back

This cut will be used throughout the year but especially in the growth season. It is used more specifically to shape the trees and to reduce height and spread. It involves the cutting back of the shoot or branch to a lateral or weaker shoot in order to change the direction or vigour of the original growth.

How must these principles be applied in practice?

- To achieve the maximum leaf area per orchard as rapidly as possible it is important to fill the space allocated to the tree as quickly as possible, i.e. within

the first two or three years.

-Good soil preparation and the removal of soil factors which restrict the yield potential of the crop are a prerequisite.

-The best plant material must be used. It is short sighted to save money by using inferior material. Nurseries must propagate only from mother trees with a known bearing history.

-The trees must be well cared for and fertilised monthly to achieve good growth during the formative years. A tree that is growing well is easily shaped.

There is often an interest in dwarfing rootstocks. A good rootstock should preferably not be too dwarfing, it must induce early fruiting, provide uniformity and improve fruit quality. In particular, rootstocks that are too dwarfing are not recommended for low potential soils. On the other hand vigorous rootstocks that give rise to excessive watershoot-type growth are unsuitable for high potential soils.

Chemical growth retardants are available to control growth. These must however only be applied once the tree starts to fill its allocated space. These materials can serve as tools in tree manipulation. Due to negative connotations caution is necessary in their use especially if you consider exporting.

Judicious nitrogen application can also be utilised as a manipulation tool as is the case with controlled water stress. Nitrogen application during the summer months of three year and older bearing trees must be done with extreme caution, otherwise vigorous watershoot development results. The timing of nitrogen application for bearing trees is very important.

- It is important to adapt the shape of the tree to the natural growth pattern of the crop. Newman (1931) suggested that growers must know what tree shape is required. If you do not shape the tree early in its life, the tree will grow wild and asymmetrical. A further requirement is for the avocado tree to be manipulated early to avoid having to apply drastic steps at a later stage when it could have growth-stimulating results. This manipulation demands vigorous growth in the first two years, but must avoid luxuriant growth of water shoots. Use nitrogen judiciously, preferably often, rather than in excess. Develop the tree's bearing and leaf area during this time without stimulating excessive growth.

The question remains: what is the most suitable shape for the avocado tree. We concur with Newman (1931) who saw the ideal avocado tree as a central leader on which the limbs are properly spaced. Most cultivars such as Hass, Ryan, Edranol and Pinkerton can with small adjustments achieve this shape. Fuerte needs a bit more attention. The secret is to already establish this shape in the nursery (Figures 1 & 2) and then in the orchard early on with small cuts to balance the side shoots relative to the leader. Remove vertical and unnecessary water shoots at an early stage in order to attain a pyramidal tree in the second year that is ready to bear fruit (Figure 3) instead of a spreading tree (Figure 4)



Figure 1

A small tree such as this one from a nursery, must be cut to a single leader or developed as a double leader tree with both leaders upright.

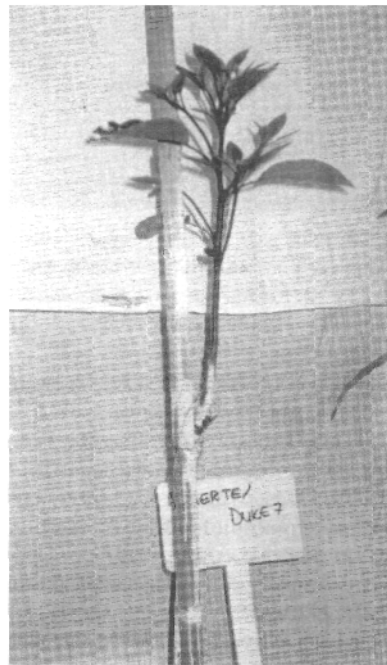


Figure 2

- a) Fuerte on Duke 7 rootstock cut back in the nursery to the strongest and straightest shoot to channel all the growth into the central leader.
- b) If the tree is well cared for it will develop into a dominant central leader with well balanced side shoots.



Figure 3
A two year old Hass tree trained as a central leader for higher density orchards.



Figure 4
Should a young tree be allowed to develop unrestrained it will mainly grow broader at the top and this will in a few years lead to encroachment.

- Plant distances must be logically established as they are determined by the following:

- The inputs the farm management is prepared to make. If no inputs are going to be made then you must revert to the old conventional methods.

In most instances semi high-density plantings of between 556 (6 X 3) and 1000 (5 X 2) trees/ha will be considered. High density plantings of more than 1000 to 2000 trees/ha will not be considered at this stage.

- Soil potential. High potential soils will result in better growth of the trees and semi high-density plantings will fill the allocated space as rapidly as high density plantings under other circumstances. The same will apply in climatic conditions which stimulate vigorous growth.

- Cultivar growth habits will have a determining effect on plant distances. Provisional recommendations on medium potential soils are presented in Table 1.

On high potential soils which will result in vigorous growth, plant distances of 6 x 3 m to a maximum of 7 x 3.5 m would be recommended. In any event it is necessary that small shaping cuts be made at specific times.

- Tree rows will eventually be continuous, with free working space between rows to accommodate the implements. Implements are generally about two metres in width. If a tree diameter of 3 metres is desired the planting distances would be 3 metres in the rows and 3 + 2 metres between rows. The space between rows is there for the implements but especially to expose the whole tree to the sunlight. If the rows are too narrow the base of the trees will be overshadowed by the top of other rows and the same effect will result if the tree grows too tall. This is the reason why planting in a square is undesirable for tree crops. The row where implement movement will take place must be covered with a recommended cover crop.
- Continuous tree management that consists of less drastic cuts during specific phenological periods in the winter and in the summer. The removal of vigorously growing water shoots, upright shoots and excess shoots require constant attention. Branches that tend to grow vertically and threaten the tree light penetration must be cut back to lateral growth or bent more horizontally. The tops of the trees must not be allowed to become dense. Shoots must be timeously thinned out and cut back so that under no circumstances the lower bearing units become overshadowed as shown in Figure 5.



Figure 5

A sixteen year old Hass tree of which the top has been cut back and thinned out in order that the inner area and base of the tree receive some light for new bearers to develop. Note how the trees in the different rows do not overshadow each other.

Research is presently undertaken to further develop manipulation techniques so that more practical and commercially acceptable recommendations will be possible within the next season or two. It is however already clear that control of semi high density plantings, with only minimal low to medium inputs during the year, is attainable.

CONCLUSIONS

Avocado trees can very successfully be shaped to a conical tree form. This will enable one to effectively manage high density plantings.

The result will be:

- Commercially acceptable yields per unit area will be achieved sooner
- More effective use of ground, leaf and tree area
- Smaller, more labour friendly trees
- Easier flower, fruit and bearing-shoot manipulation (more consistent yield of better fruit size every year)

It is however necessary to make small management inputs at the correct time especially during the early years.

SUMMARY

Planting less than 500 trees/ha is unproductive especially in the initial years. Very wide spacings lead to very large trees.

More intensive plantings can be done. This needs the application of certain principles and implies that certain inputs must be made.

Several research projects are presently engaged in refining manipulation techniques for more practical applications.

REFERENCES

- NEWMAN, C.V. 1931. Pruning the avocado. *California Avocado Association Yearbook* 2: 59 - 68
- STADLER, J.D. & STASSEN, P.J.C. 1985a. Pruning and training deciduous fruit trees. Lighting, plant densities and pruning procedures *FFTRI Information Bulletin no 531*, Stellenbosch, South Africa
- STADLER, J.D. & STASSEN, P.J.C. 1985b. Pruning and training deciduous fruit trees. Training to free-standing trees. *FFTRI Information Bulletin no 532*, Stellenbosch, South Africa
- STADLER, J.D. & STASSEN, P.J.C. 1985c. Pruning and training deciduous fruit trees. Training trellis systems. *FFTRI Information Bulletin no 533*, Stellenbosch, South Africa.