South African Avocado Growers' Association Yearbook 1997. 20:55-58

Avocado Tree Girdling and Fruit Thinning

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ABSTRACT

Avocado trees were girdled in an attempt to improve fruit size and increase yield and fruit retention. In addition trees were girdled at various times throughout the year in order to find ways of preventing alternate bearing of Hass trees in particular.

The starch reserves of the trees were determined to establish the effect of the different treatments on the tree physiology. It was also necessary to compare the results of trees where the main stem was girdled in two successive years with those of control trees which had been girdled only once.

Fruit thinning experiments were conducted to determine the number of fruit a tree is capable of nurturing to maturity and the effect it has on fruit size, yield in the following year and starch reserves.

The results of these investigations are discussed and the short and long term implications for the producer are evaluated

UITTREKSEL

Avokadobome is geringeleer in 'n poging om vruggrootte te verbeter en om opbrengs en vrugretensie te verbeter. Daarmee saam is borne op verskillende tye reg deur die jaar geringeleer om maniere te vind om oorslaan in drag by veral Mass borne te voorkom.

Die stysel reserwes van die borne is bepaal om die uitwerking van verskillende behandelings op boomfisiologie vas te stel. Dit was ook nodig om resultate van borne, waar die hoofstam twee jaar na mekaar geringeleer is, te vergelyk met die van kontrolebome wat net een jaar geringeleer was.

Vruguitdun-proewe is uitgevoer om vas te stel watter rol vrugaantal speel by vruggrootte en opbrengs in die daaropvolgende jaar en hoe dit die stysel reserwes beinvloed.

Die resultate van hierdie ondersoeke word bespreek en die kort-en langtermyn implikasies vir die produsent word evalueer.

INTRODUCTION

Girdling

Girdling is a management tool which is applied in order to direct nutrients to, or concentrate nutrients at the site of greatest need to effect a particular plant process.

It is a specific, environmentally acceptable, selective, quick acting, cost effective and easily applied manipulation technique. As with any other manipulation process, girdling can however affect the tree physiology and phenology for a certain length of time after its application.

For the purpose of this paper the term girdling must be regarded as synonymous with cincturing, which implies a single knife cut around the stem or branch, severing the phloem (bark) but without the removal of any tissue.

The objectives for girdling trees are manifold but for the avocado, we concentrate primarily on its application for promoting flowering and fruit set, improving fruit size and moderating alternate bearing.

Some of the reasons for girdling may appear to be in conflict e.g. girdling for better fruit set could be counter productive to increasing fruit size, as the higher fruit load of the tree will of necessity result in smaller fruit. The timing of the girdling process is the determining factor as regards the final effect on the tree physiology. Numerous applications have to be made throughout the year in order to pinpoint the optimal phenological stage for achieving the result intended.

A biological system, such as a productive fruit tree, is however subject to many external influences, one example being the weather, and in addition the tree itself suffers carry-over effects from previous years during which it either had very few fruit, resulting in good vegetative development and a build up of reserves to tide it over a new production season or it had given a substantial yield, resulting in reserve depletion and a tree almost incapable of meeting its maintenance requirements, let alone set a good fruit load for the coming season. One-off experiments are therefore seldom a true reflection of the value of tree or fruit manipulation. The manipulation process itself has carry-over effects which might in subsequent years totally negate the positive effects achieved with the first application.

With cincturing the wound inflicted would normally heal in a relatively short time and sap flow to the roots or lower parts of the tree would be fully restored but the effect of the temporary cessation of nutrient flow nevertheless changes the plant physiology and phenology to some extent and this change can affect the tree, not only for this year, but probably for a number of seasons.

Fruit Thinning

Fruit thinning is a method of overcoming the severe depletion of carbohydrates in the tree because of carrying a high fruit load. The removal of a portion of the fruit load allows the remaining fruit to benefit from the available photosynthate supply as well as the tree carbohydrate reserves and in this way increase the individual fruit size without overtaxing the tree reserves. The higher carbohydrate reserves in the plant at harvest promote the more rapid recovery of the tree and make it possible for the tree to properly set a new fruit crop for the coming season. The lower fruit numbers result in the tree bearing a reasonable crop every year with the economic advantage of the fruit being larger and more saleable and with a better keeping quality.

Fruit Drop

Fruit drop appears to be predetermined at fruit set or earlier and off-years have been directly correlated to low carbohydrate reserves at the end of a high yield season. Previous studies have also shown that avocado trees in an off-year will normally set fruit in reasonable quantity but that these fruit are subsequently abscised even when the tree has recovered its carbohydrate reserve status (Davie & van der Walt, 1994).

Experiment I

In this trial the effect of repeated girdling on yield of Hass avocados was assessed with particular reference to alternate bearing.

Three-year-old Hass trees of which the trunks had been spiral girdled in May 1994, were used. In May 1995 ten of these trees were left ungirdled as controls and ten again had their main stems cinctured. The 1995 yield figures were available for these trees and in May, July and October of 1995 and in January, April and July of 1996 root and xylem samples were collected for analysis.

Table I

Fruit yield of Hass avocado trees over a three year period after cincturing in 1994 and with additional cincturing applied in 1995. The control trees had been cinctured in May 1994 only

Average fruit yield per tree	*Main stem cinctured 1994 & 1995*	*Control cinctured 1994 only*
1995 – kg (SD)	24,8 (2,7)	22,0 (4,4)
1996 – kg (SD)	19,9 (7,2)	11,1 (3,4)
1997 – number (SD)	154 (66)	216 (83)

In figure 1 the effect of cincturing on fruit production is illustrated. In May 1994 the young Hass trees had been stimulated by girdling into a good fruit set (averaging nearly 24 kg per tree). The relatively heavy fruit load for such young trees in the 1994/95 season meant that an off-year was to follow.

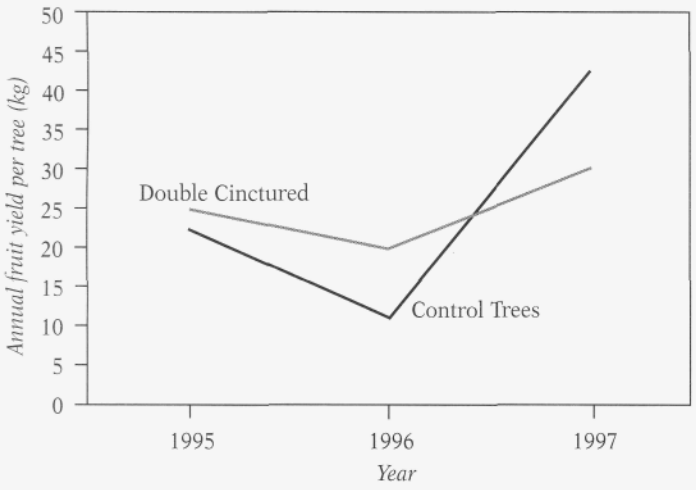

Figure 1
Fruit yield of Hass avocado trees which were cinctured in May 1994 only (control trees) and trees which were cinctured again in May 1995 (twice cinctured)

The 1995/96 yield of the uncinctured control trees dropped to nearly 11 kg per tree. The trees that were cinctured again in May 1995 yielded 20 kg of fruit per tree. The big drop expected in production for 1995/96 had been reduced somewhat by cincturing a second time.

The lower fruit production in 1995/96 therefore meant that a good yield could be expected again in 1996/97 but probably with a negative effect on fruit size.

The results were as predicted and the trees that were twice girdled and where the 1995/96 fruit yield had not been too low, gave a lower yield in 1996/97 than the other treatments.

The figure clearly shows the biennial bearing pattern for the control trees but the main stem cincturing appears to have reduced the fruit load on those trees for 1996/97 showing a tendency to flattening the yield oscillations.

For report purposes the fruit were counted on the trees in February 1997 and the numbers multiplied by a mass factor in order to compare fruit yield figures.

Incorporating these figures, the cumulative yields for the two sets of trees are as follows:

- 77,3 kg for the uncinctured controls, and
- 75,9 kg for the main stem cinctured trees.

Actual harvest data for 1996/97 should bring these totals closer together as the lower yield of fruit should produce larger avocados.

At this early stage it would appear that cincturing a second time did not adversely affect fruit yield. Cincturing the main stem again had the effect of flattening the oscillations of the alternate bearing cycle and the cumulative fruit yield for the treatments shows that the fruit yield for the controls and the trees with the main stem cinctured for a second

time was about the same.

There was however no significant difference in the fruit size for the treatments in 1995/96.

Figure 2 clearly illustrates the effect that repeated cincturing has on the root starch cycles for a full year after treatment and the effects will probably carry over into the next year.

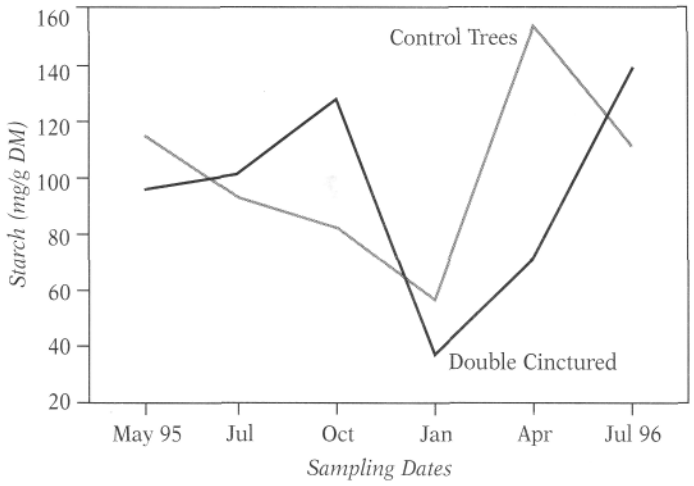

Figure 2
Root starch concentrations of twice cinctured and control trees

Figure 3 shows the starch levels in the xylem or wood of these trees and here the starch accumulation and utilization levels have similar patterns for the control and double cinctured trees.

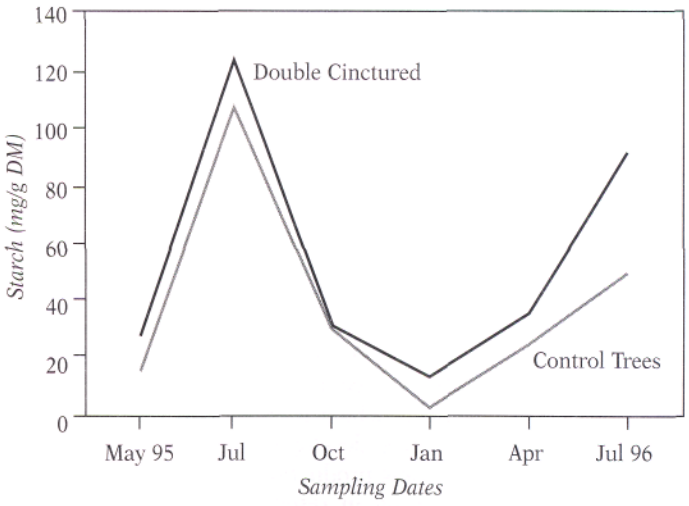

Figure 3
Xylem (wood) starch concentrations of twice cinctured and control trees

Experiment 2

In a second experiment we wanted to determine the best time for girdling six-year-old Hass avocado trees to improve fruit size and influence the alternate bearing pattern. The experiment was similar to that conducted by Davie *et al,* (1995) in the same orchard.

All the trees used in this trial had a nil yield in 1994/95.

Different sets of six-year-old Hass avocado trees which were in an established alternate bearing pattern, were cinctured in October and another group in November 1995.

The grading at harvest showed no improvement in fruit size as a result of the cincturing.

Figure 4 however, shows that the cinctured trees had a significantly higher fruit yield in 1995/96 than the control trees.

Trees cinctured in October 1995	–	59,37 (SD4,34) kg
Trees cinctured in November 1995	–	56,18 (SD5,25) kg
Control trees (uncinctured)	–	40,61 (SD7,80) kg

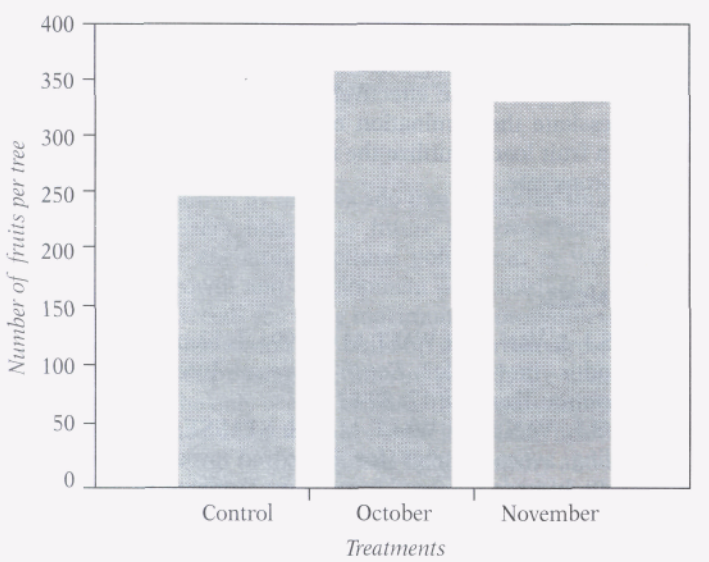

Figure 4
Fruit yield of Hass avocado trees cinctured in October and November compared with uncinctured control trees

Although the girdling could not have influenced fruit set it might have had an effect on fruit retention thus resulting in the higher fruit yield. This will have to be re-examined.

Experiment 3

A further trial was designed to determine the effect of fruit thinning on fruit size and the resultant effect on alternate bearing.

Six-year-old Hass trees with an established alternate bearing pattern were used. In November 1995 three trees were stripped of all fruit, three had half the fruit removed and three were left with all their fruit. Fruit were counted on the trees before and after treatments.

Measurements were made of tree height and canopy radius of the trial trees in order to determine the effect of fruit thinning on tree development.

Fruit yield figures and fruit size measurements were made after May 1996 when the fruit were harvested.

In figure 5 the effect of fruit thinning on yield is illustrated. The first bar in each group represents the fruit yields in 1995/96 after fruit thinning in November 1995.

The second bar represents the fruit yield for the same trees in 1996/97 (fruit were counted on the trees in February 1997). Yield figures for 1995/96 were:

- no fruit for the 100% removal column (first bar),
- an average of 174 fruit per tree where 50% of the fruit were removed and
- 360 fruit per tree where no fruit were removed.

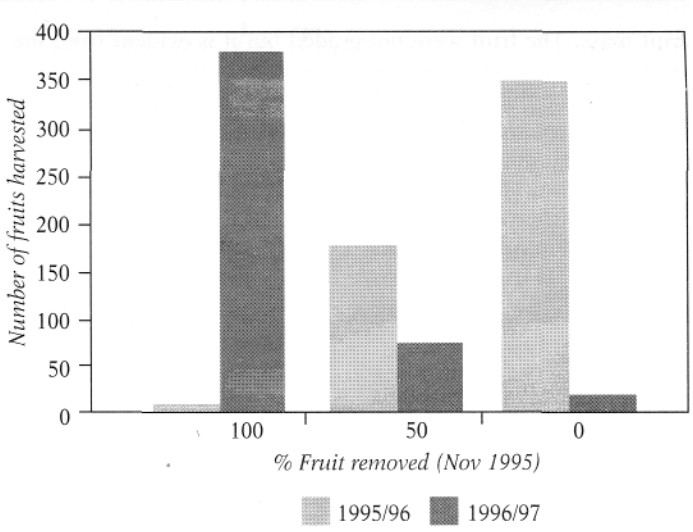

Figure 5
The effect of fruit thinning on future yield of Hass avocados

In the following year 1996/97, as expected, there was a complete reversal of yield figures with 378 fruit per tree, 63 fruit per tree and 12 fruit per tree respectively for the 100, 50 and 0% fruit removal groups. It can be seen that there was no carry-over effect of the fruit load that was removed in November 1995 as the same trees again went into an 'on' year with good yields in 1996/97.

We expected a better yield in the 50% removal group to smooth the alternate bearing cycle but we will have to look at a variety of thinning out procedures and at the times of

application to achieve optimum results.

A positive effect was however evident in 1995/96 (figure 6) in the size of the fruit from the 50% thinned out trees as opposed to the fruit from the unthinned trees.

Average fruit mass of 228g for the thinned-out trees as opposed to 157 g per fruit for the unthinned control trees.

This meant that although there was a loss of 52% of the fruit number by thinning, there was in fact only a loss of 30% in total fruit mass. The fruit were not graded but it is evident from the fruit mass details that there would have been more export grade fruit from the thinned trees, further reducing the economic difference. There would most probably also have been a positive effect on fruit quality.

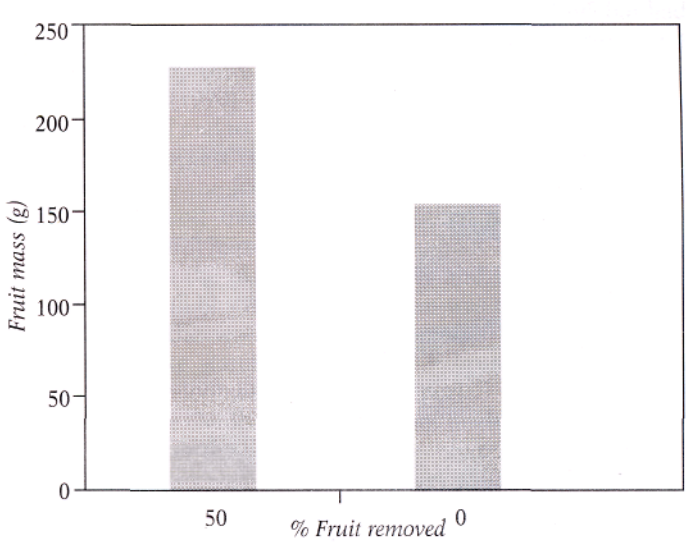

Figure 6
The effect of fruit thinning of Hass avocado trees on fruit size

Tree measurements (figure 7) show that with no fruit on, the tree volume increased in a year by 68% while with 50% fruit left on the tree the volume increased by 36% and where the tree was left with all its fruit, it increased by only 12% in volume.

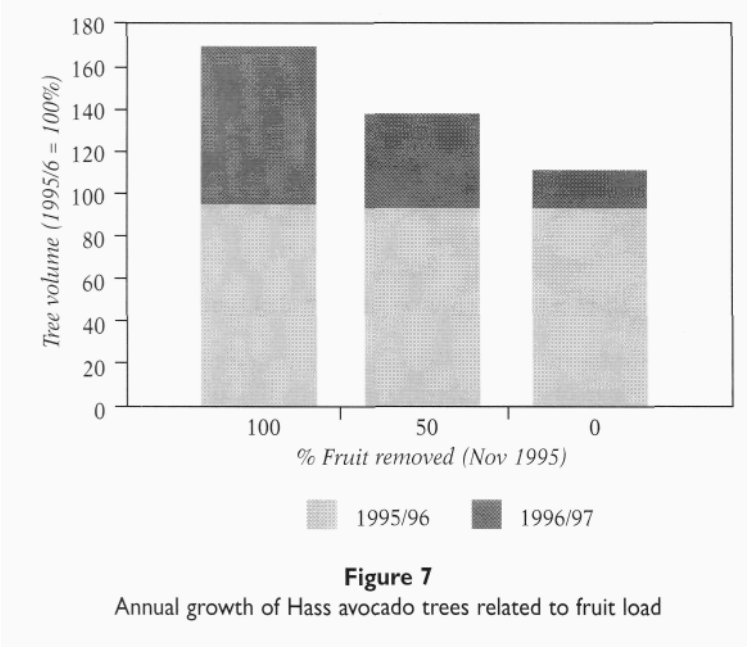

Figure 7
Annual growth of Hass avocado trees related to fruit load

This is a factor to be considered when dealing with high density orchards. In fact any tree manipulation without the tree having a full fruit load seems doomed to excessive vegetative regrowth.

Controlling alternate bearing will have to form part of the programme for controlling excessive tree growth.

CONCLUSIONS

Cincturing trees at the correct time (probably before flowering) may be the way to eliminate or at least, moderate alternate bearing in avocado trees.

Cincturing the same tree before flowering for two successive years did not have an adverse effect on production thus far and cincturing trees before flowering did not adversely affect cumulative yields.

Analytical results showed that cincturing trees before flowering affected the starch reserve cycles in the roots and possibly other tissues as well for a year and probably longer.

The cincturing of trees in October or November may have a positive effect on fruit retention.

The 50% fruit thinning trial reported on was not successful in giving a satisfactory yield in the year after thinning. It only confirmed the effect fruit load has on alternate bearing and showed that fruit thinning increased fruit size.

Controlling tree size effectively in higher density orchards will necessitate the elimination of alternate bearing as a tree without a fruit load to utilize the nutrient supply will grow at a very vigorous rate.

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