South African Avocado Growers' Association Yearbook 1995. 18:51-53

Girdling Avocado Trees for Improved Production

S.J. Davie, P.J.C. Stassen, M. van der Walt and B. Snijder
Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit,1200, RSA

ABSTRACT

Girdling is examined as a method of improving avocado yield, eliminating biennial bearing and increasing Hass fruit size in particular. Preliminary results indicate that by girdling a number of branches on a Hass tree that had set a good crop at a stage when rapid fruit growth is taking place, an increase of over 35% in fruit mass is possible. It is recommended that only half the branches of the tree be girdled in any one year in order to avoid root starvation.

INTRODUCTION

The term girdling is used to describe a variety of methods used to stop or reduce the flow of sap via the bark or phloem, to the lower parts of the tree and to the roots.

The process generally applied is that of cutting through the bark or phloem, with or without the removal of tissue.

The time required for the healing process, and the re-establishment of sap flow, will depend on the width and severity of the girdle, as well as the condition and phenological stage of the tree.

In fact girdling is more frequently applied as a preliminary step aimed at achieving one final good yield from a tree before it is cut down and removed.

In this paper we use the term girdling in a very broad sense but imply that the break in sap flow is temporary.

Girdling has for centuries been utilised for a variety of purposes, yet despite research reports of benefits derived by girdling trees, it has not generally been adopted as a standard practice in the tropical and subtropical fruit industries.

Girdling seems to come into fashion from time to time and then, after a short while loses its popularity. More often than not when a problem arises, such as new orchards taking too long to come into production, girdling is tried as an instant cure and whether or not it is successful, the process is shelved till the next crisis.

Girdling stops or reduces the flow of sap and causes carbohydrates, and in particular starch, to accumulate above the girdle while the production and translocation of certain plant hormones is also arrested.

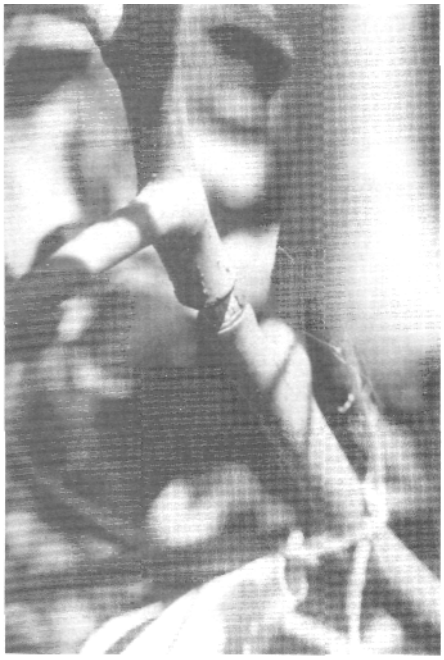

Figure 1
Girdling of avocado branch

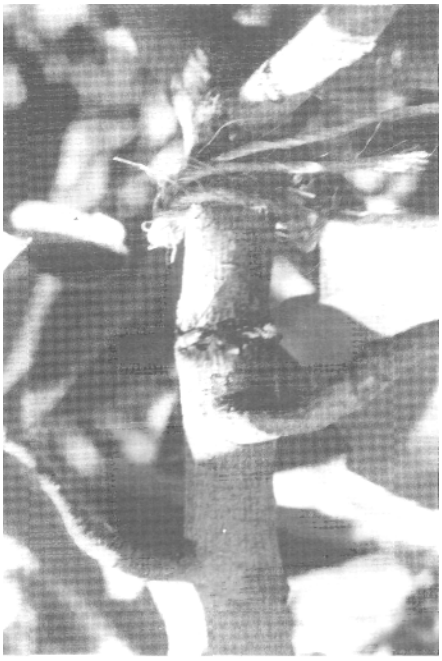

Figure 2
Scoring of avocado branch

APPLICATIONS

Girdling has been applied with varying degrees of success to many different crops for a variety of purposes. Some of these applications include:

- shortening the juvenile phase of seedling and grafted trees by inducing early flowering in apples (Dennis, 1968) and citrus (Furr *et al,* 1947),
- increasing yield in avocados (Köhne, 1992; Lahav *et al,* 1971; Ticho, 1970; Trochoulias & O'Neill, 1976), and litchis (Young, 1977),
- increasing fruit set and fruit retention of mangoes (Oosthuyse, 1991), citrus (Lima & Davies, 1984), and macadamias (Nagao & Sakai, 1990),
- regulating flower production of litchis (Menzel, 1983),
- eliminating or modifying irregular bearing in avocados (Hodgson, 1934; Hodgson & Cameron, 1935, 1937; Ticho, 1936), mangoes (Rath & Das, 1979), and olives (Lavee *et al,* 1983),
- manipulating fruit size of deciduous fruit (Fernandez-Escobar *et al,* 1987), and citrus (Cohen, 1984),
- increasing rooting of cutting material for *Hibiscus* (Stoltz & Hess, 1966),
- easing the effects of drought stress on citrus (Cohen & Goell, 1988), controlling vegetative growth and tree size of apples (Greene & Lord, 1983), and
- Improving fruit quality (Lahav *et al,* 1971).

ACHIEVEMENTS WITH AVOCADOS

What is of major concern is what can and has thus far been achieved with the girdling of avocados.

A report on girdling avocado trees already appeared in 1920 in California in the U.S.A. and a lot of interest was shown in those early years.

Researchers in California, Israel and Australia were all able to, to a greater or lesser extent, increase fruit yield and managed in some cases to maintain these improved yields for a few years by successive annual girdling (Lahav *et al.,* 1971; Ticho, 1970; Trochoulias & O'Neill, 1976). Three years seemed to be the maximum period this process could be repeated.

Lahav *et al.* (1971) used the girdling method in 1966 in an attempt to reduce the size of Ettinger avocados by increasing yield.

Köhne (1992) reported an increased fruit production of 60% after girdling three year old Hass avocado trees in September prior to their removal in order to thin out the orchard. The increased percentage of small fruit was offset by the total fruit production increase and the higher export fruit yield that resulted.

RESEARCH OBJECTIVES

What we therefore need to establish is firstly, what can in fact be achieved consistently by girdling or scoring avocado trees. Secondly, the optimum phenological timing for girdling needs to be established for each particular purpose, and thirdly, the long term effects on yield, fruit size and quality must be determined.

It is of interest to note that virtually all the trials reported on in the literature dealt with the need to increase yield and to a lesser extent with size reduction in some avocado cultivars.

Our objective however is to use girdling and scoring as methods to improve the fruit size of Hass avocados. A longer term objective is the elimination or modification of biennial bearing in Hass in particular.

TRIALS CONDUCTED

Part of our planned study was hampered by the continuing drought as trees were under severe stress but we were able to conduct some of the preliminary work.

Branches of Hass trees that had been regularly irrigated at Nelspruit, and that had set a good fruit crop were scored and girdled on 8th December 1994 and equivalent branches were labeled for use as controls.

Some physiological studies were conducted where conditions allowed.

RESULTS

Water uptake by the tree has been shown by Kurzmann (1966) to be little affected by girdling.

Nitrogen uptake is apparently restricted but this is attributed to the low carbohydrate levels in the roots and the consequent impairment of metabolism.

Carbohydrates and especially starch accumulates rapidly above the girdle (Figure 3).

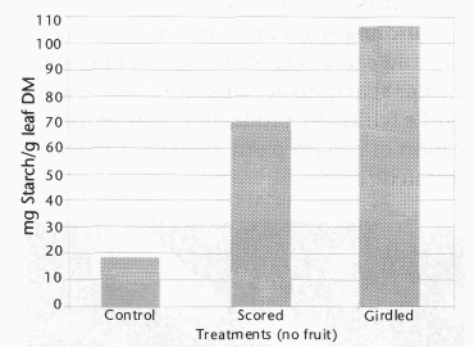

Figure 3
Leaf starch concentration
6 weeks after treatment

Leaf chlorophyll in the girdled samples was reduced to 50% of the levels in control samples i.e. non-girdled branches (Figure 4).

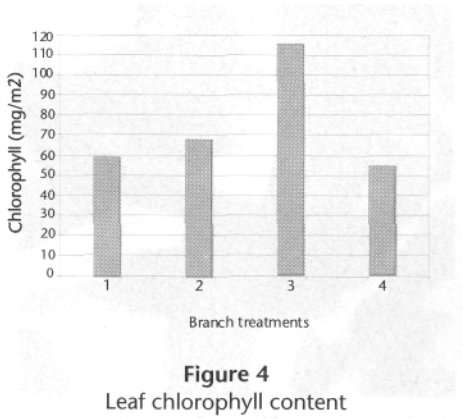

Figure 4
Leaf chlorophyll content
1 = girdled plus fruit; 2 = girdled no fruit;
3 = control no fruit; 4 = scored no fruit

The leaves on scored and girdled branches without fruit showed a decrease in photosynthesis rate within a few days after treatment and had stopped photosynthesizing for much of the day by the 14th day after treatment.

Branches with fruit took longer to show a reduction in photosynthesis (Figure 5). The imbalance of plant growth regulators brought about by girdling stimulated development of basal shoots i.e. shoots below the girdle, while inhibiting shoot development above the girdle.

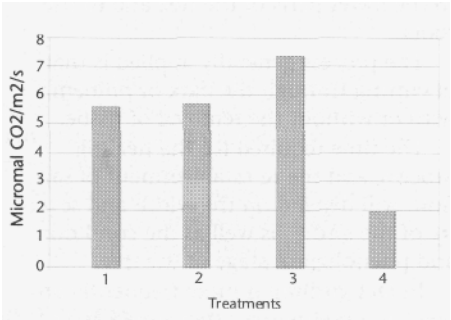

Figure 5
Leaf photosynthesis rates:
scored vs control
1 = control plus fruit; 2 = control no fruit;
3 = scored plus fruit; 4 = scored no fruit

Effect on the tree

The leaves on the girdled branches showed signs of yellowing after three weeks and were clearly chlorotic after 5 weeks. Leaves on branches with fruit took slightly longer.

Girdling one lot of Hass trees that had not been subjected to drought and had already set fruit, on 8 December 1994 resulted in flower bud development on the girdled branches by 27 January 1995, while the non girdled branches were all starting to develop vegetative flushes.

All the girdled and ringed branches flowered while the remaining branches on the trees all developed only vegetative shoots.

The scored branches showed signs of complete wound healing within 4-5 weeks (Figure 6) but the girdled branches had after 12 weeks failed to heal properly.

Figure 6
Healed wound five weeks after scoring.

Effect on the root system

The prevention of carbohydrate flow to the roots results in starvation and root die-back which ultimately reduces water and nutrient uptake to the stage where the tree dies (Noel, 1970). In our trials only a certain number of branches were girdled which would not give rise to root starvation, and starch determinations on the roots of the test trees showed no significant reduction compared to trees that had not been girdled at all.

Effect on the fruit

The most encouraging results were however related to the fruit on the girdled and scored branches when compared to the untreated control branches.

All the fruit from the girdled, scored and control branches were harvested eight weeks after treatment.

The results were that the fruit on the scored and girdled branches showed on average a mass increase of more than 35% over the fruit on the non-treated control branches. The average mass of the fruit on the girdled and scored branches was about 139 grams each while the fruit on the non-treated control branches each averaged 103 grams

(Figure 7).

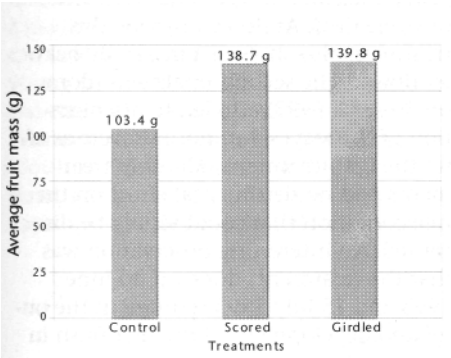

Figure 7
Avocado fruit mass 8 weeks after treatment

Put another way, the equivalent of an improvement in fruit count by a factor 4 was achieved, i.e. count 24 would improve to count 20, 20 to 16, and so on.

It may be too optimistic at this stage to expect this mass increase to be sustained over the rest of the growth period but if only the 36 gram weight advantage obtained in this eight week period could be maintained then the result would still substantially improve the fruit count. A 36 gram additional mass per fruit enlarges count 22 to count 18, and most of count 20 to count 16. Figure 8 shows the fruit count shift which can occur with only a 25-30 % mass increase.

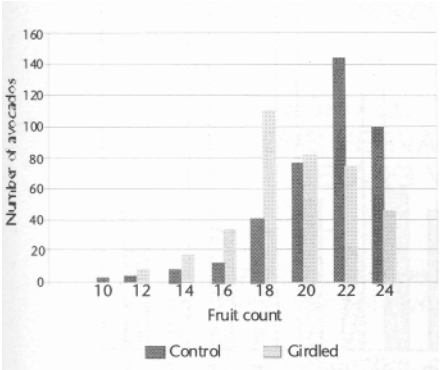

Figure 8
Fruit count shift
with 25–30 % mass increase

RECOMMENDATIONS

It is too early to make firm recommendations but the results indicate that girdling or scoring at the correct time can increase the fruit size in Hass.

Our preliminary recommendation would be to score (not girdle) alternate branches of a

Hass avocado tree that has set a good crop, at the end of November. This would mean that about half the branches would still be supplying nutrients to the roots to prevent root starvation and sufficient root development should still occur.

The cleaning and disinfection of the girdling tools between tree treatments is a high priority to avoid any possible disease transfer.

CONCLUSIONS

Our continued research will be looking at optimum time for treatments and the long term effects of such treatments on tree performance and fruit quality.

It is nevertheless still our main objective to find ways of eliminating alternate bearing in avocado trees as we are convinced that the small fruit problem with Hass is a symptom of its biennial bearing tendencies.

If, with early girdling we could induce a tree to set fruit even after a bumper crop and in this way break the alternate bearing cycle or stop the tree from over producing in its on-year we might still further increase fruit size.

REFERENCES

COHEN, A. 1984. Citrus fruit enlargement by means of summer girdling. *J. Hort. Sci.* 59: 119 - 125.

COHEN, A. & GOELL, A. 1988. Fruit growth and dry matter accumulation in grapefruit during periods of water withholding and after reirrigation. *Aust. J. Plant Physiol.* 15: 633 - 639.

DENNIS, F.G. Jr. 1968. Growth and flowering responses of apple and pear seedlings to growth retardants and scoring. *Proc. Amer. Soc. Hort. Sci.* 93: 53 - 61.

FERNANDEZ-ESCOBAR, R., MARTIN, R., LOPEZ-RIVARES, P. & PAZ, SUAREZ, M. 1987. Girdling as a means of increasing fruit size and earliness in peach and nectarine cultivare. *J. Hort. Sci.* 62(4): 463 - 468.

FURR, J.R., COOPER, W.C. & REECE, P.C. 1947. An investigation of flower formation in adult and juvenile citrus trees. *Amer. J. Bot.* 34(1): 1 - 8.

GREENE, D.W. & LORD, W.J. 1983. Effects of dormant pruning, scoring and growth regulators on growth, yield and fruit quality of 'Delicious' and 'Cortland' apple trees. *J. Amer. Soc. Hort. Sci.* 108: 590 - 595.

HODGSON, R.W. 1934. How to overcome the alternate bearing of avocados. *Cal. Avo. Assoc. Yrb.* 92-98.

HODGSON, R.W. & CAMERON, S.H. 1935. Studies on the bearing behavior of the Fuerte avocado variety. *Cal. Avo. Assoc. Yrb.* 156 - 165.

HODGSON, R.W. & CAMERON, S.H. 1937. Girdling to induce bearing in the Fuerte avacado. *Cal. Avo. Assoc. Yrb.* 149 - 153.

KÖHNE, J.S. 1992. Increased yield through girdling of young Hass trees prior to thinning. *South African Avocado Growers' Association Yearbook* 15: 68.

KURTZMAN, R.H. Jnr. 1966. Xylem sap flow as affected by metabolic inhibitors and girdling. *Plant Physiol.* 41: 641 - 646.

LAHAV, E., GEFEN, B. & ZAMET, D. 1971. The effect of girdling on fruit quality,

phenology and mineral analysis of the avocado tree. *California Avocado Society Yearbook,* XX: 162 - 168.

LAVEE, S., HASKAL, A. & BEN TAL, Y. 1983. Girdling olive trees, a partial solution to biennial bearing. I. Methods, timing and direct tree response. *J. Hort. Science,* 58: 209 - 218.

LIMA, J.E.O. & DAVIES, F.S. 1984. Ethylene, cellulase, 2,4-D, and summer fruit drop of Navel orange in Florida. *J. Amer. Soc. Hort Sci.* 109(1): 100 - 104.

MENZEL, C.M. 1983. The control of floral initiation in Lychee: a review. *Scientia Hort.* 21: 201 - 215.

NAGAO, M.A. & SAKAI, W.S. 1990. Effects of gibberellic acid, ethephon or girdling on the production of racemes in Macadamia integrifolia. *Scientia Hort. 42: 47 - 54.*

NOEL, A.R.A. 1970. The girdled tree. *Bot. Rev.* 36: 162 - 195.

OOSTHUYSE, S.A. 1991. Effect of trunk girdling on the number of fruit retained by bearing Haden mango trees. *SAMOA Yrb. 11: 55 - 56.*

RATH, S. & DAS, G.G. 1979. Effect of ringing and growth retardants on growth and flowering of mango. *Scientia Hort.* 10: 101 - 104.

STOLTZ, L.P. & HESS, C.E. 1966. The effect of girdling upon root initiation: Carbohydrates and amino acids. *Proc. Amer. Soc. Hort. Sci.* 89: 734 - 743.

TICHO, R.J. 1970. Girdling, a means to increase avocado fruit production. *Calif. Avo. Soc. Yrbk.* 90 - 94.

TROCHOULIAS, T. & O'NEILL, G.H. 1976. Girdling of Fuerte avocado in subtropical Australia. *Scientia Hort.* 5: 239 - 242.

YOUNG, T.W. 1977. Effect of branch girdling on yield of severely pruned 'Brewster' lychee trees. *Proc. Fla. State Hort. Soc.* 90:251 - 253.