

GIRDLING, A MEANS TO INCREASE AVOCADO FRUIT PRODUCTION

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The avocado, an erratic producer

Ever since the avocado became a commercial crop in California (since World War I) growers were aware of its poor bearing habits. It is not an alternate bearer in the accepted sense (such as some apple varieties producing alternating heavy and light crops), since a heavy crop may be followed by 2-3 poor crops. Just to show its capability, a bumper crop may be produced once in a dozen years. This situation is particularly worrisome with the Fuerte avocado (both in California and in Israel).

Some of those who studied the behavior of the avocado in its natural habitat in Central America noticed that some avocado seedlings never bloom. A seedling avocado tree, 12 years old growing in a home garden in Westwood, California started flowering and fruiting only after a scaffold branch was ringed in 1934! The remainder of the tree continued with its juvenile habit.

Early ringing trials of avocado trees made no lasting imprint

This subject was studied in the thirties at UCLA. However, the first publication on avocado ringing was by Coit (1920). Hodgson and Cameron (1935) found that ringing Fuerte trees in November and December gave positive results, while ringing in January to March did not increase the yield. Coit (1920) indicated that ringing was advantageous even prior to November. France (1931) declared at a symposium that ringing of avocados gave indifferent results.

Except for a few stalwarts, commercial ringing of avocado trees in California was discontinued. In the thirties the recommended width of the strip of bark to be removed was 1/4 and its physiological influence was very much dependent upon the rate of healing, which was very quick. There were many genetically non-productive Fuerte trees; they are less responsive to ringing or may not respond at all. The persons in charge of this project at UCLA were busy teaching and there were not enough graduate students at that time to follow up these findings. The present upsurge of interest in California is based on the very-positive results obtained in Israel.

Some background information

Before continuing with the subject it may be advisable to recall some principles. The leaves are the main seat of carbohydrate synthesis, which in turn serve as raw material for a long list of compounds found in the plant cell and in the cell wall. Carbohydrates move in form of sugars either to the terminals (growing points), or to the roots. Their path are the sieve tubes in the phloem (bark). The temperature has a bearing on the movement of elaborated materials, 20 to 30 degrees Centigrade being the optimum. The influence of temperature is many fold: it influences the production of carbohydrates

and the mobility of the sap. It moves more by day than at night (especially in herbaceous plants). The sap in the bark is sometimes under pressure and we may notice the sap oozing out upon ringing. Other very important materials, such as hormones, amino-acids etc. move in the bark in the same direction. Minerals—provided that they enter the sap stream in the bark—move also in the same direction. However, in general, bark ringing does not affect significantly the supply of these elements.

A bio-chemical study of avocado tree ringing

The only fairly comprehensive analytical study of avocado bark ringing was done in 1935/36 (M.S. thesis of the author at UCLA), a summary of which was published in the yearbook of 1936. This study was directed by Profs. Hodgson, Cameron and Biale and should substantiate some of their former findings. Obviously, hormones were not included because their study was at that time in its infancy.

Three-year-old Mexican seedlings were ringed on the trunk in October and again in February. Starting from October 1935 till May 1936 a ringed and unringed tree were uprooted every 3 weeks and divided into 13 fractions (small roots, medium roots, trunk below the girdle, trunk above the girdle, leaves, etc.). Each fraction was analyzed for sugar, hemicellulose, cellulose, starch and total nitrogen.

The results may be summarized as follows:

	<i>ringed trees</i>	<i>unringed trees</i>
1. Cambial activity in spring	early	later
2. Root activity in spring	late	early
3. Starch concentration in roots	dwindled (down to 8% of unringed trees)	maintained
4. Starch above the girdle	was high (even in leaves)	less
5. % dry wt. in top of tree	increased until May (end of experiment)	did not increase after March
6. Influence on N content	no significant effect of girdling	

The author ran into difficulties when called upon to report his findings. The ringing changed materially the carbohydrate content, which—in turn—forms most of the dry matter. If carbohydrates are reported as % dry weight, we relate them essentially to themselves—and confuse the issue. By relating them to the fresh weight, we introduce new sources of uncertainty.

Avocado tree ringing in Israel—a resounding success

In the early sixties the Fruit Crops Department in the Ministry of Agriculture (Professional and Extension Services) got a number of growers in several avocado districts interested in the subject.

After a number of years of very satisfactory field trials in growers' plots and at the Agricultural School at Kfar Hayarok, we got our research people (The Volcani Institute for Agricultural Research) interested and both agencies (research and extension) are now cooperating in this many-sided project. There were many doubters until now, but most of us are at present convinced that ringing is the most promising single cultural

practice for increasing avocado production. The 1970/71 avocado crop in Israel is estimated at 15,000,000 lbs.; about 2,500,000 lbs. can be traced to the effect of ringing. Ringing tends not only to increase the yield, but increases also the % of exportable fruit, by decreasing fruit size. There is also a slight delay in the time of ripening.

Some of the findings:

In 1966, 1200 Fuerte avocado trees were ringed on scaffold limbs at the Agric. School Kfar Hayarok (Cohen, Roisman 1968). The trees were girdled at 3 dates. The yield was estimated. The following data are taken from the a/m publication; they illustrate some of the results:

<i>Date of Ringing</i>	<i>No. of trees</i>	<i>yield in lbs./acre</i>	
		<i>ringed</i>	<i>unringed</i>
10 Oct. - 5. Nov.	200	9000+	450
10 Nov. - 30 Nov.	75	3600	450
30 Nov. - 30 Dec.	54	700	700

The results obtained in 1967 and 1968 indicated the same trend. Even ringing the same branch in 2 successive years gave in the 2nd year positive, although less startling, results. If the young fruits (within 4-6 weeks after setting) were protected from hot, dry easterly winds by sprinkling (see publ. by Ticho 1970) — the generally positive results of girdling would be even more pronounced.

A joint publication (Extension and Research), which came out in 1970 is devoted to ringing trials (farmers plots) mainly in Western Galilee. It stresses — among other things — the beneficial effect of ringing on the % exportable fruit.

Variety: Ettinger, season 1966/67, Kibbutz Shomrat
(taken from the a/m publication)

	<i>Ringed</i>	<i>Unringed</i>
% Export fruit	72.4	48.8
% of fruit for the home market	20.5	40.2
% culls	7.1	11.0

The average weight of the fruit on the ringed branches was 277 grams; of the unringed ones: 338 grams (22% difference).

These are just a few examples illustrating the effect of ringing. There were, of course, cases (about 20% of the total) when ringing did not influence the yield.

What are then the objectives of ringing?

Avocado trees are ringed in fall and early in winter in order to increase fruit bud differentiation, hasten flowering and increasing fruit set. This is the standard practice in Israel. Ringing (a narrow girdle of only 1/5 to 1/6") at the beginning of April may increase the rate of growth of the young fruit and may improve its chances of survival. Another, incidental benefit of ringing at any time after the fruit has set — is the increase in fruit size (of value only for varieties which run in small sizes).

Caution

Weak trees or those with light green foliage should not be ringed; nor should trees suffering for any reason, such as those affected by sun-blotch virus. The additional weakening due to ringing may cause the decline of the ringed limb. There is no point in

ringing young non-bearing trees.

Details of the ringing operation in fall

a) *Timing of operation*

Fuerte: from the middle of October to the beginning of November

Nabal: end of December

Ettinger: at the beginning of January

Benik: at the beginning of January

Anaheim: at the beginning of January

b) *Width of girdle*

3/4 to 1" on scaffold branches at least 3" in diameter. The healing is faster in fall due to the higher temperatures than in winter. Therefore, the girdle should be somewhat narrower in midwinter.

c) *What proportion of the tree should be girdled?*

2/3 of the top (i.e. one third of the top is girdled in 2 consecutive years).

d) *Tying and Propping*

Girdled limbs, which have set a heavy crop should be tied or propped; they are otherwise in danger of breaking at the girdle.

General remarks:

Girdling causes a temporary loss of the deep green color of avocado leaves in the girdled branch and may bring about premature shedding of leaves in spring. If the girdle heals in a normal manner this temporary setback may be overcome by mid-summer (July). Therefore, one should not be unduly concerned, if the trees look rather "tired" in spring after having set a heavy crop. On the contrary, if bearing avocado trees have dark green foliage and grow lushly, there is something basically wrong with the balance between growth and reproduction.

The prolific variety Hass is usually not in need of girdling, although it responds very positively to it, so much so that the girdled branch having more fruits than leaves — may decline. With this variety the girdle should — in any case — not be wider than 1/4".

Girdling increases not only the yield of normal fruits, but also of cukes. These cukes (seedless avocados) set *in addition* to the crop of seeded fruit and not *instead*.

Dwarfing stocks — a form of permanent girdle

With all due respect for the achievements obtained by girdling avocado trees, we should not forget that there is a simpler and more lasting type of girdle: by using a dwarfing stock the union of which with the scion may be considered to act as a girdle. There are, of course, thousands of cogent examples in horticulture. We have good grounds to believe that some of the West-Indian stocks produce a slightly smaller canopy and may, possibly, have some beneficial effect on fruiting. Bergh and Whitseil described in 1962 a dwarfing type (a seedling with "spur-type" growth at Riverside.

I have the impression that the dwarf variety Wurtz may possibly serve as a starting point (may be as an interstock). I suspect that this variety may not be a "pure" *Persea americana*, but may — according to some of the seed characteristics be a hybrid with *P. schiedeana*?

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