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THE EFFECT OF GIRDLING ON FRUIT QUALITY, PHENOLOGY AND MINERAL ANALYSIS OF THE AVOCADO TREE

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Background; Commercial avocado cultivars grown in Israel, except 'Hass', bear fruits which are frequently too large for the consumer's taste. Earlier investigations with avocado tree girdling showed that it increased productivity and advanced bearing (2). The present work is devoted to the study of the effect of girdling on fruit quality (fruit weight and maturity). Other responses of the tree were investigated, such as leaf drop, flowering, chlorosis, small seedless fruit, wound healing, and leaf and bark mineral concentrations.

Materials and methods

Methods of girdling were described in another paper (2). Most girdling was done with a girdling tool, simultaneously cutting and removing the bark strip. The width of the girdle was between 10 and 20 mm, depending on branch size. Very wide girdling—100 mm—was also tested. In other experiments the girdle was the cut of a pruning saw (3 mm wide), which reached the cambium and was left bare. Shallower girdling where care was taken to leave a thin layer of tissue intact above the cambium was tried with the 'Fuerte' cultivar, as was girdling of only half the branch circumference.

Fruit quality. The effect of girdling on fruit weight was determined. The mean fruit weight was estimated in the packing house from the fruit count and the collective weight. The reasons for down-grading of fruit were recorded by visual inspection of each lot.

Oil content of the fruit was used to determine the degree of maturity. Oil analyses were carried out by the Halowax method, measuring the refractive index of firm fruit (1). A comparison was made between fruits of equal size picked on the same date from girdled and ungirdled branches.

Phenological measurements. The effect of girdling on vegetative growth was estimated

by the dates of leaf drop, flowering and the appearance of new flush. The number of seedless fruits on girdled and ungirdled branches was estimated as for normal fruits (2).

To determine the damage of branch-girdling and trunk-girdling to the tree, a visual survey was made of the effects on chlorosis. The 'Hass' cultivar was selected for a more detailed study as it is particularly susceptible to chlorosis.

Wound healing. Relative healing rates of girdling tool and pruning saw methods were compared by estimating the wound area covered by callus at regular intervals.

Mineral analysis. In October, 6-month-old leaves (spring flush) were sampled along with their petioles. Six replications of individual trees were sampled at 1.5 - 2.0 m height. The following were analyzed: 'Ettinger' leaves from trees one and two years after girdling; 'Fuerte' leaves from trees two years after girdling and from repeatedly girdled branches; 'Fuerte' bark samples from above and below the girdle and also from the control branch.

Results and discussion

Fruit quality. The results showed a highly significant decrease in fruit weight of the 'Ettinger' cultivar due to girdling (Table 1); similar findings were obtained with the 'Fuerte' cultivar. Fruit from girdled branches was down-graded due to rub-marks (surface skin wounds), deformation, or sub-standard size; from the control branches, downgrading was due mainly to over-ripeness.

TABLE 1. THE EFFECT OF GIRDLING ON YIELD AND FRUIT WEIGHT OF 'ETTINGER' (1966/67)

	Orchard A (10 replicates of each)		*Orchard B* (60 replicates of each)	
	girdled branch	control branch	girdled tree	control tree
Mean fruit weight (g)	265	326	298	336
Yield per branch or tree (kg)	85.8	40.1	52.0	34.7

Girdled 'Nabal' branches produced twice as much fruit as the un-girdled control. Both branches were not particularly heavy laden. In consequence, the average fruit weight was the same. In both cases fruit was down-graded because of large size and rub-marks. 'Hass', in contrast to other avocado cultivars, shows a tendency to overproduction, resulting in undersized fruit (under 170 grams); girdling is therefore not recommended for this cultivar.

1. Differences in rate of maturity of 'Fuerte' fruit. Later maturity of girdled branch (left) in comparison with control branch (right).

The greater amount of fruit and the lower individual fruit weight on the girdled branch caused a delay in fruit maturation (Figure 1). The delay in maturity was also reflected by the oil content. The fruit from the girdled branches contained less oil than that from control branches (Table 2). Thus a valuable advantage to be derived from girdling may be prolongation of the picking season.

TABLE 2. EFFECT OF GIRDLING ON THE OIL CONTENT (%) OF FIRM AVOCADO FRUIT (1968)[1]

Cultivar	*Girdling year*	*Oil content*
Fuerte	1967	14.4 a
	control	16.8 b
	1967	14.1 a
	1966	15.4 b
	control	16.4 c
Hass	1967	12.7 a
	control	14.3 b

1) Each value is a mean of six individual determinations. Mean values followed by different letters differ significantly at the 1% level.

Phenological measurements. Earlier leaf drop was noted on the girdled branch in all cultivars, and particularly in 'Nabal' (Figure 2). The effect of the pruning saw girdling on leaf drop was smaller than that of the girdling tool. In shallow girdling, early leaf drop occurred to a lesser extent. Girdling to the cambium, half way around the branch, had no effect on leaf drop. New flush on the girdled branch appeared about a month earlier than on the control. There was a reduction in the rate of vegetative growth following girdling in all cultivars. This might prove an advantage with vigorously growing cultivars, and may postpone the time for orchard thinning.

Girdling in October-November (i.e., before onset of flowering) caused earlier flowering, especially with 'Fuerte': by 60 days in the first season and by 85 days in the second season. Girdling at a later date affected the start of flowering only in the following year. Girdling of shaded branches, which are usually late to flower, caused earlier flowering.

2. Girdled 'Nabal' branch with earlier-than-normal leaf drop.

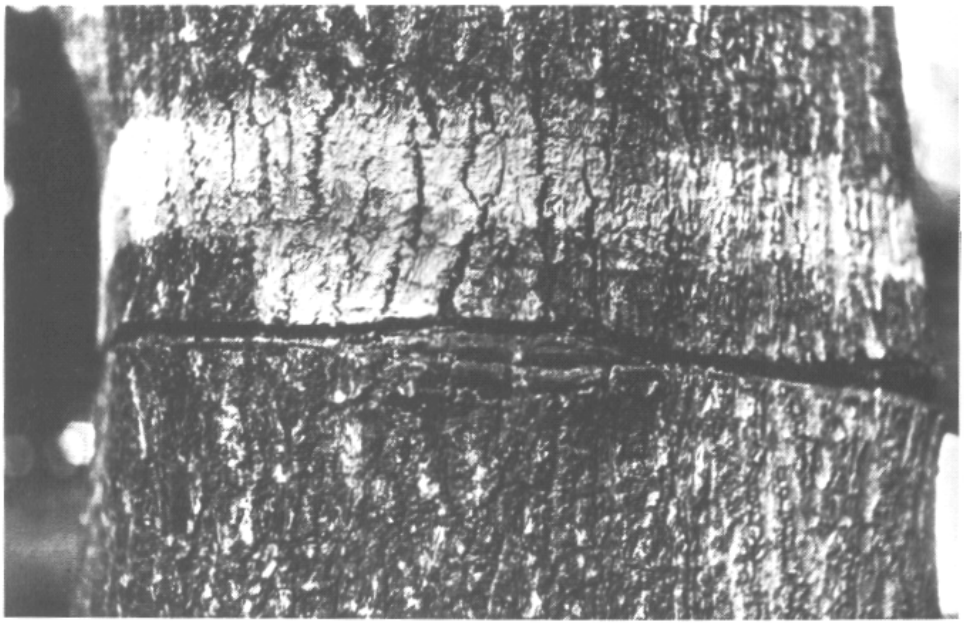
3. Girdled 'Ettinger' branch with numerous small seedless fruits.

Seedless fruits. Early-season flowers usually do not set normal fruit (due to low temperatures), and may set seedless fruit (3). More seedless fruits than normal were

produced, in addition to the normal crop, on the girdled branches of 'Ettinger' and 'Fuerte' cultivars. 'Ettinger' trees, which had a tendency to bear such fruit, responded strongly to girdling (Figure 3), with a girdled branch sometimes bearing thousands of such small fruits. Two years after girdling the number of seedless fruits diminished and in the third year it equaled that of the ungirdled branch. The set of seedless fruit thus resembles other behaviour patterns affected by the girdle, in that the effect soon wears off. No connection was found between the number of normal and seedless fruits.

Wound healing. When girdling was carried out in November, 85% of the area of pruning-saw wounds had healed within three months, but only about 5% of the area of girdling-tool wounds. In the autumn, earlier girdling resulted in more rapid healing. Wounds from spring girdling healed in 75 days and those from autumn girdling in 150 days. Branches girdled to 100 mm width had not healed after three years.

Girdling to the cambium produced a conspicuous swelling (Figure 4). Many instances of insufficiently deep girdling have been found, especially where pruning-saw girdling was practiced on thick-barked trees. For the girdle to be effective, the bark must be severed completely, down to the xylem.



4. Superficial girdling with a pruning saw. Above, in the middle section the girdle reached the cambium and caused callus growth. Below, the same section after bark removal, with the swelling of the xylem visible.

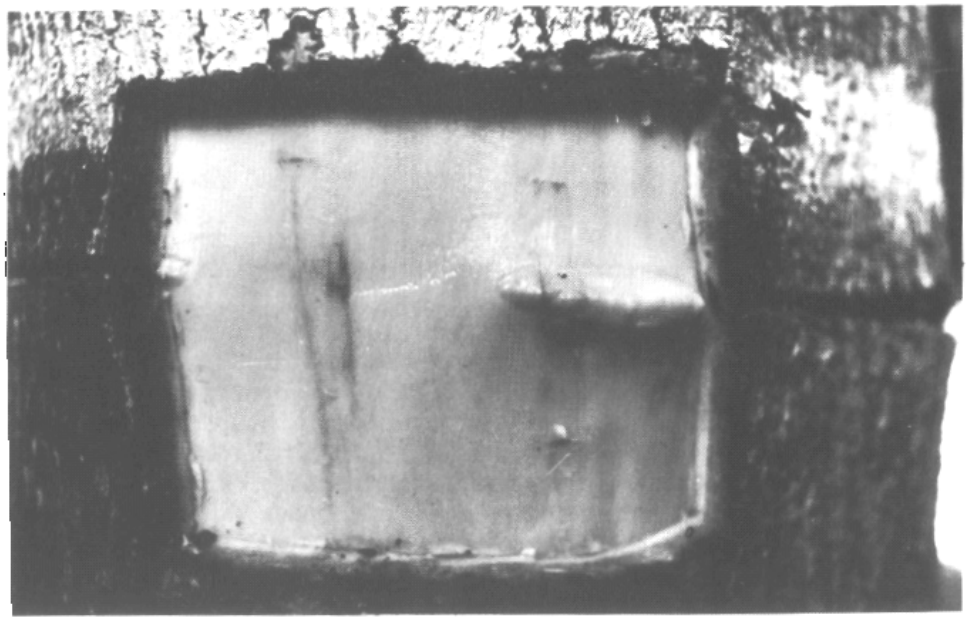


TABLE 3. INCIDENCE OF CHLOROSIS (%) FOLLOWING GIRDLING IN DIFFERENT AVOCADO CULTIVARS

Cultivar	*Ettinger*	*Fuerte*	*Nabal*	*Benik*	*Hass*
Years after girdling					
1	14.1	15.8	2.0	1.0	20.4
2	1.5	1.4	0	0	17.1
3	1.2	0	0	0	–

TABLE 4. INCIDENCE OF CHLOROSIS IN GIRDLED 'HASS' TREES

Treatment		*Number of trees*	*Chlorotic trees*	
			Number	*%*
Partially girdled trees:	girdled branch	407	9	2.2
	control branch		1	0.2
	entire tree		70	17.2
Entire tree girdled		172	61	35.5
Ungirdled control trees		101	15	14.9

Chlorosis. Highly productive trees, girdled or ungirdled, are frequently chlorotic, especially in the high-yielding 'Hass' cultivar. Girdled branches of all cultivars had paler leaves in the first summer after girdling. Chlorosis diminished with each ensuing year after girdling (Table 3). The number of chlorotic 'Hass' trees was twice as high in the case of trunk-girdled trees as in single-branch-girdled trees (Table 4).

Mineral analysis. Increased chlorosis of girdled branches coincided with deviations from normal leaf composition (Table 5). One and two years after girdling, 'Ettinger' branches were comparatively low in ash, nitrogen, calcium, magnesium and manganese. Similar results were obtained two years after girdling, even when the leaves showed no chlorosis. Leaves from branches of 'Ettinger' and 'Fuerte' girdled in two consecutive years showed a further decrease in manganese concentration compared with a single girdle.

The bark of the girdled branch had a lower amount of ash and lower concentrations of magnesium, zinc and manganese than that of the control branch. Ash amount and calcium concentrations above the girdle were found to be low and potassium tobe high.

It seems reasonable to assume that chlorosis and low mineral content in the leaves of girdled branches result from depletion caused by higher yields and from the disruption in translocation caused by the girdle.

One must distinguish between girdled and ungirdled branches in leaf sampling for fertilization recommendations.

TABLE 5. COMPOSITION OF LEAVES AND BARK OF GIRDLED AND CONTROL BRANCHES

Cultivar and tissue	*Sampling year*	*Girdling year*	*in % d.w.* Ash	N	K	Ca	Mg	*in ppm d.w.* Mn	Zn
Ettinger, leaves	1967	1965	4.85a	1.69a	0.83a	0.91a	0.40a	76a	17a
		1966	5.58b	1.68a	0.73b	1.21b	0.43a	81a	16a
		control	5.76b	1.79b	0.79ab	1.27b	0.48b	81a	21b
Ettinger, leaves	1968	1966	7.03ab	1.95ab	0.68a	1.76a	0.53b	120a	27a
		1966, 67	6.68a	1.75a	0.66a	1.68b	0.49a	83b	27a
		control	7.25b	2.15b	0.82b	1.81a	0.55b	163c	25a
Fuerte, leaves	1968	1966	6.43a	1.87a	1.31a	1.19a	0.43a	163a	45a
		1966, 67	6.71b	1.74b	1.15b	1.30b	0.41a	139b	48a
		control	6.82b	1.92a	1.22ab	1.32b	0.46b	149b	47a
Fuerte, bark	1968	1967	4.39a	0.69a	0.84ab	0.96a	0.13a	42a	38a
above girdle		1967	5.57b	0.65a	0.73a	1.44b	0.14a	44a	40a
below girdle		control	6.65c	0.65a	0.99b	1.66b	0.16b	54b	48b

[1] Each value is a mean of six individual determinations. Mean values followed by different letters differ significantly at the 5% level.

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