

# The Effect of Girdling on the Productivity of the Avocado<sup>1</sup>

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**ABSTRACT.** Girdled branches of 6 avocado cultivars usually bore an increased subsequent crop. A decrease in productivity of girdled as compared with ungirdled control branches, was recorded for all cultivars except 'Benik', in the second and third years after treatment. Increased yield could be maintained by repeated girdling. The girdle also affected the ungirdled control branch. Girdling sometimes induced a second "on-year" in the alternate-bearing cultivars.

Unsatisfactory bearing has always been a major commercial problem in avocado trees (1, 5, 10). Yields too often bear little relationship to the usually excellent vegetative growth. Thus trees expected to yield several hundred fruits frequently bear only a few fruits. All avocado cultivars grown in Israel, with the exception of 'Hass', suffer from less than adequate productivity. No satisfactory solution to this problem has yet been obtained.

Girdling has been practiced to increase productivity in some deciduous fruit trees (2) and in citrus (8). It commonly induces increased amounts of elaborated plant materials and of growth substances in the branch girdled, and presumably thereby brings about conditions more favorable for fruit set and development (6).

Few statistically reliable analyses have been made of the results of avocado girdling. Girdling experiments performed in California (1, 4, 5) demonstrated an increase in yield in the first year after treatment with a smaller increase in the second season. The data were based on few trees.

In 1965 a study was started in Israel on methods to improve avocado productivity. This study included the effect of girdling on productivity and alternate bearing.

## Methods

Orchards were selected in all parts of Western Galilee, and in 2 coastal plain locations. The number of trees treated varied with cultivar and year (Table 1). Most of the trees girdled were from 4 to 8 years old. Many had previously borne little or no fruit.

Comparisons were made between girdled branches, ungirdled control branches (of the same tree) and ungirdled control trees. The control trees were in the same orchard, of equal age and size. The crop was either weighed or the number of fruits estimated

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<sup>1</sup> Received for publication October 9, 1970. Contribution from the Volcani Institute of Agricultural Research, Bet Dagan, Israel. 1970 Series, No. 1975-E.

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<sup>5</sup> The authors wish to express their appreciation to Professor Ch. Oppenheimer for his advice and help.

<sup>6</sup> Lahav, E., Gefen, B., and Zamet, D. The effect of girdling on fruit quality, phenology and mineral analysis of the avocado tree. Submitted to Yearb. Calif. Avocado Soc.

while still on the tree according to a six-degree (0-5) scale. Estimation is naturally less accurate than actual measurement, but it enables the estimator to take into account variations in tree and branch size, and their yield potential.

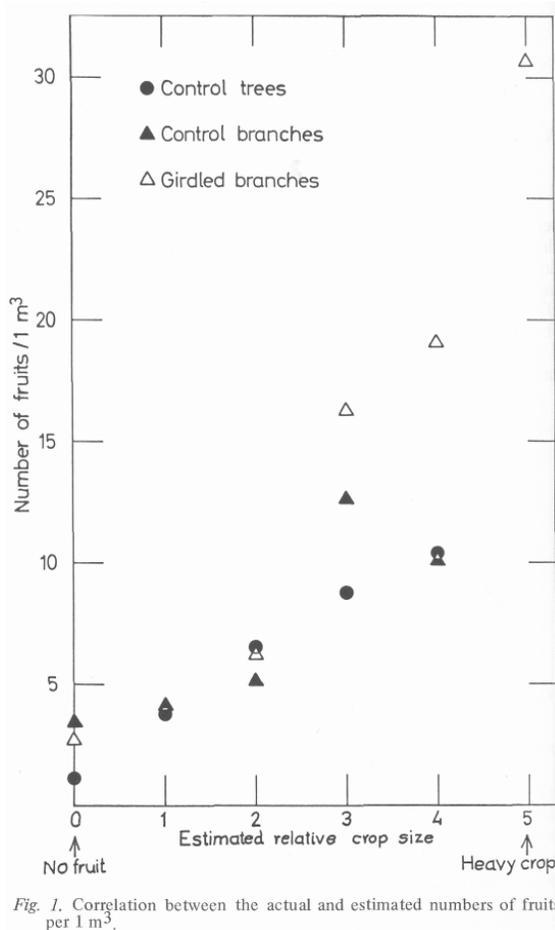


Fig. 1. Correlation between the actual and estimated numbers of fruits per 1 m<sup>3</sup>.

A comparison was made between estimated and weighed yields of 90 trees of the cv. Benik, in order to verify the accuracy of the estimation method. A high correlation was found between the estimated yield and the fruit count per unit tree volume (Fig. 1). Analysis of 9 'Ettinger' trees showed a similar good correlation of estimated with actual yield.

One-third to one-half of the branches were girdled. Branches were girdled in 1 year only, in 2 consecutive years, with one-year rest in between, or in each of 3 consecutive years (Table 1).

The results following treatment were recorded each year during the 3-year period.

The possible effect of girdling on alternate bearing of 'Benik' and 'Nabal' trees was investigated. The yield of girdled and control trees was evaluated in regard to the preceding year's yield.

Girdling was done each month from October until May; i.e., from well before the flowering period until after fruit set, to determine the most

advantageous time.

Most of the girdling was done with a girdling tool, which simultaneously cuts and removes the bark strip. The width of the girdle was between 10 and 20 mm, depending on branch size. In other experiments the girdle was the cut of a pruning saw (3-mm wide). In all cases the cut reached the cambium and was left bare.

Table 1. Number of branches girdled according to cultivar and year.

Cultivar	Single girdling			Repeated girdlings			1965, 66, 67
	1965	1966	1967	1965, 66	1965, 67	1966, 67	
Ettinger <sup>a</sup>	182	759	878	41	133	189	26
Fuerte	51	549	1000	-	34	157	12
Scotland <sup>a</sup>	6	33	313	-	-	27	-
Nabal	100	504	604	36	-	40	-
Benik	24	31	226	5	4	23	-
Hass	-	39	798	-	-	15	-
Total	363	1927	4307	82	171	451	38

<sup>a</sup>Cultivar selected in Israel.

## Results

Fruitfulness of 'Ettinger' and 'Fuerte' was much improved by girdling (Table 2). It declined below that of the control branches in the second or third year after

treatment. This decline could be partially prevented by repeated girdling. The positive effect of girdling on 'Hass', 'Nabal', and 'Benik' cultivars continued in the second and third years (Table 3), although the increase in yield was not significant. Five- and 6-year-old trees of the 'Scotland' cultivar failed to respond to girdling. Seven-year-old trees responded strongly, with an estimated yield of 2.4 for the girdled branch vs. 0.7 for the control.

Table 2. Estimated yield of girdled and control 'Ettinger' branches<sup>a</sup>

Treatment	Year of harvest	1966/67		1967/68		1968/69	
	Year of girdling	girdled control		girdled control		girdled control	
Single girdling	1965	3.7	** 1.9	1.5	* 2.1	2.5	N.S. 2.7
	1966			2.6	** 1.2	2.0	* 1.0
	1967					1.8	** 1.2
Repeated girdlings	1965, 66			1.6	** 1.1	2.3	N.S. 2.1
	1965, 67					2.9	** 1.7
	1966, 67					2.4	** 0.9
	1965, 66, 67					3.2	** 1.7
Non-girdled control trees		2.4		1.9		2.9	

<sup>a</sup>The estimation was made on a scale of six grades, where 0 = no fruit and 5 = heavy crop. N.S. Differences between the means are not significant.

\* Significant at the 5% level.

\*\* Significant at the 1% level.

Table 3. Estimated yield of girdled and control 'Benik' branches.<sup>a</sup>

Treatment	Year of harvest	1966/67		1967/68		1968/69	
	Year of girdling	girdled control		girdled control		girdled control	
Single girdling	1965	3.3	** 0.8	1.3	N.S. 0.7	0.6	N.S. 0.3
	1966			3.4	** 0.8	0.7	N.S. 0.5
	1967					2.1	** 1.5
Repeated girdlings	1965, 66			2.4	** 0.9	1.0	N.S. 0.8
	1965, 67					1.0	** 0.1
	1966, 67					1.9	** 0.6
Non-girdled control trees		1.4		1.9		1.9	

<sup>a</sup>See footnotes to Table 2.

Table 4. The effect of girdling one branch on estimated yield of the ungirdled control branch of the same tree in 'Ettinger'.<sup>a</sup>

Year of harvest	1966/67	1967/68	1968/69
Year of girdling			
1965	1.9 **	2.1*	2.7 N.S.
1966		1.1**	2.1 **
1967			1.7 **
Non-girdled control trees	2.4	1.7	3.1

In 'Ettinger' orchards where girdling was carried out in each of the 3 years, analysis of variance showed that control branches on trees that had been girdled bore significantly less fruit in the first year after girdling than did branches on ungirdled control trees. In the second year, yield was affected by biennial bearing;

it was higher than that of the ungirdled trees in the "off year" (1967/68), and lower than in the "on year" (1968/69). By the third season the yield almost equalled that of the control trees (Table 4). In 'Nabal' the girdle induced an increase in the yield of control branches only in those instances where such branches were due for an "off-year" (Table 5)

The 'Nabal' cultivar showed that girdled branches could produce 2 successive high yields (rating of '3' or '4'). Girdling failed to give a second "on year" to trees which had exceptionally high yields (rating of '5') in 1967/68 (Table 5). Only a non-significant rise in yield over the controls (branches or trees) was recorded. When carried out before

an "on-year," girdling failed to produce a significant increase in yield, but was significantly higher than the control trees after a medium yield.

Table 5. The effect of the girdle on alternate bearing of 'Nabal'. Estimated yield per branch (1968/69) in relation to the yield in the preceding year.<sup>a</sup>

Yield 1967/68	1968/69	Girdled branch	Control branch	Avg. both branches	Control trees	
0	2.8	N.S.	2.4	2.6	N.S.	2.9
1	3.4	N.S.	3.0	3.2	N.S.	2.5
2	3.4	N.S.	3.0	3.2	N.S.	2.6
3	3.7	N.S.	3.1	3.4	**	1.9
4	3.7	N.S.	2.8	3.2	**	1.6
5	2.1	N.S.	1.7	1.9	N.S.	1.0
Average	3.2	N.S.	2.7	2.9	**	2.1

<sup>a</sup>See footnotes to Table 2.

Table 6. Effect of girdling date on additional yield of girdled branches as compared with ungirdled branches.

Date	Cultivar	Ettinger	Fuerte	Nabal
		%	%	%
1966 October-December		21	150	260
1967 January-February		69	62	22
March-May		94	118	60

The effect of the girdle on alternate bearing of 'Benik' trees was reflected in the yield of girdled trees, which was higher than that of the control trees in all cases, without regard to the preceding year's yield. This was found true for both fruit no. and crop wt. And was most marked when the preceding year's yield had been intermediate.

'Fuerte' and 'Nabal' girdling performed in the middle of the October-May period resulted in a reduced response (Table 6). In 'Ettinger' a rise in response from autumn to spring girdling was recorded.

Girdling with a pruning saw, 3-mm wide, produced a 30% less increase in yield, compared with the 10-20 mm girdling.

## Discussion

Three years of investigation have shown that girdling is an effective means of increasing avocado yields, in a manner similar to that of other fruit trees (2, 8).

A general increase in yield of the girdled branch was found in the first season after girdling. The cultivars least affected by the girdle ('Hass', 'Ettinger' and 'Nabal') have normally higher yields than the other 3 commercial cultivars studied (3, 7). The response to girdling of the medium to low yielding cultivars 'Fuerte' and 'Benik' was considerable. Some previous failures in girdling experiments with 'Fuerte' (1, 5, 10) may have resulted from the use of trees of very low productivity, which may have been environmentally limited. Such trees likewise showed no response to girdling in our study. The outstanding response of 'Scotland' trees may be due to the girdle having advanced their normally late bearing.

Following the first year's decrease in yield in the ungirdled control branches as compared with the ungirdled control trees, there was a gradual rise with smaller annual yield fluctuations. The total yield of the partly girdled tree was well above that of the control tree, in spite of the fact that ungirdled branches yielded less than the ungirdled control tree. Calculations showed an increase in yield of 2.0 - 5.2 tons/acre due to girdling.

Occasionally, yields of the girdled branches were reduced as compared with the rest of the tree, in the second and third years after girdling. Repeated girdling increased yields in girdled branches as compared with branches left ungirdled or girdled only once, but not when compared with ungirdled control trees. It appears that to ensure continuing response, girdling should be practiced annually, as noted for citrus (9).

Girdling of biennial-bearing trees induced a low to medium crop in the "off-year," and also in the following "on-year." Under such conditions the girdle results in larger fruits, which in 'Nabal' and 'Benik' cultivars are difficult to market. In conformance with the results obtained in California with 'Fuerte' (4), no increase in yield was obtained by girdling before an "on-year." Yields of 'Nabal' and 'Benik' in an "on-year" were below those of the control trees, but in an "off-year" the girdle increased yields of the girdled as well as the ungirdled control branches. This increase in yield of the ungirdled control branches was not found in 'Ettinger', probably because of the smaller tendency to biennial bearing.

Two periods suitable for 'Fuerte' girdling were noted in California, with a better response in the autumn. This is in agreement with the present findings. The advantages derived from spring girdling seem to be (a) no increase in the number of small seedless fruits, as early flowering is not induced<sup>6</sup>, and (b) quicker healing of the girdle due to higher temperatures after girdling. The good results which have been obtained from girdling after fruit set seem to indicate that girdling, in addition to inducing fruit set, may prevent fruit abscission. More work is needed to clarify the relationship between girdling time and productivity.

The quicker healing of the narrower pruning-saw wound may be responsible for the slightly lower yield, but it undoubtedly protects the health of the tree. Another possible reason for this lower yield may be insufficient depth of the girdle, which prevented its taking full effect<sup>6</sup>.

Girdling effects from the fourth year onwards are still under investigation. There have been a few cases where a tree was seriously weakened or even killed after the main trunk had been girdled. Therefore, only strong healthy trees of low productivity should be girdled, and on the branches only. No more than one-half to 2-thirds of the tree should be treated in any one year.

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