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Girdling as a Means of Shortening the Juvenile Period of Avocado Seedlings

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Abstract. **Shortening the juvenile period is highly important for fruit tree breeding projects. Four girdling dates were tested in an attempt to shorten the juvenile period in 9 crosses of 3-year-old avocado *(Persea americana* Mill.) seedlings. Early September girdling was more effective than later or no girdling. It increased flowering intensity significantly, increased the percentage of seedlings that set from** 15% **to 66%, and increased 7-fold the number of fruits harvested per seedling as compared with the ungirdled control.**

Fruit tree breeding can be costly due to the long juvenile period. In our avocado breeding project, only about 40% of the seedlings had set fruit after a period of 8 years.

Girdling is effective as a means of increasing productivity in many fruit trees (5) including avocado (3). For 'Fuerte' and 'Nabal' avocado, autumn girdling (mid-October) was found to give higher yields than winter girdling (3). Girdling in the spring was occasionally effective. Autumn girdling frequently advances flowering date, sometimes by 2 or 3 months (4). The effect of girdling is attributed to the accumulation of carbohydrates and to temporary cessation in vegetative growth above the girdle (5). The objective of this study was to evaluate the most suitable time for girdling as a means of shortening the juvenile period.

The present experiment used 281 avocado seedlings of 9 crosses obtained by caging 2 cultivars under a net, using bees as a pollination agent. The number of available seedlings of similar size that had not flowered ranged from 7 to 76 for the different combinations. The seedlings were planted at 4 x 2 x 1-m spacing in Spring 1980. Regular commercial cultivation procedures were followed. Three-and-a-half years later, a 5-mm wide girdle was made on one of the 2 or 3 main branches (the commercial recommendation is never to girdle the whole tree). In all instances the cut reached the cambium and was left bare. Seedlings from each cross were allocated at random to 4

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girdling dates and an ungirdled control: 12 Sept. 1983, 18 Oct. 1983, 22 Nov. 1983, and 5 Jan. 1984. The effect of girdling was compared on the progeny of the following crosses: 'Ettinger' x 'Fuerte'; 'Ettinger' x 'Pinkerton'; 'Ettinger' x 'Rosh Hanikra II; 'Hass' x 'Ettinger'; 'Ettinger' x 'Hass'; 'Rincon' x 'Rincon' (selfed); 'Ettinger' x 'Wurtz'; 'Tova' x 'Irving' and Tova' x 'Regina'. Thus, each progeny population was treated at the 4 girdling dates, and there was an ungirdled control.

Table 1. Effect of girdling date on flowering and fruit set of avocado seedlings.[z]

Date of girdling	No. seedlings	Seedlings flowered (% of total)	Flowering intensity[y]	Seedlings that set fruit (% of total)	Average no. fruit per seedling
12 Sept. 1983	73	99.2 a[x]	2.7 a	65.4 a	9.3 a
18 Oct. 1983	64	93.7 a	2.3 b	54.8 ab	6.3 ab
22 Nov. 1983	43	90.9 ab	2.0 b	42.6 ab	4.7 bc
5 Jan. 1984	27	61.4 b	1.0 c	27.4 bc	1.7 bc
Ungirdled control	74	47.3 b	1.0 c	14.9 c	1.3 c

[z]All values are least-square means.
[x]Within column, means separated by Tukey–Kramer test, $P = 0.05$.
[y]Flowering intensity ranked from 1 = very little to 5 = profuse.

Table 2. Effect of parentage on the flowering and fruit set of avocado seedlings.[z]

Cross	No. seedlings	Seedlings flowered (% of total)	Flowering intensity[y]	Seedlings that set fruit (% of total)	Average no. fruits per seedling
Rincon (selfed)	17	99.9 a[x]	2.9 a	80.1 a	9.0 a
Ettinger x Hass	20	86.9 ab	2.1 b	60.2 ab	8.4 a
Hass x Ettinger	37	79.5 ab	1.8 bc	56.2 ab	7.8 a
Ettinger x Wurtz	27	66.8 bc	1.3 cd	26.6 bc	5.6 ab
Tova x Irving	62	74.2 b	1.5 bc	48.2 abc	5.2 ab
Ettinger x Rosh Hanikra	7	99.9 a	2.3 ab	39.5 abc	2.1 ab
Tova x Regina	76	42.2 c	1.0 d	21.0 c	1.9 b
Ettinger x Pinkerton	25	78.9 ab	1.5 bc	34.6 bc	1.6 b
Ettinger x Fuerte	10	80.3 ab	1.8 bc	5.0 c	0.5 b

[z]All values are least-square means. Crosses are arranged in descending order according to average number of fruits per seedling.
[y]Flowering intensity ranked from 1 = very little to 5 = profuse.
[x]Within column, means separated by Tukey–Kramer test, $P = 0.05$.

Two-way analyses of variance (ANOVA) were carried out for unbalanced data (1) evaluating the effects of dates (Table 1) and seedlings' origin (Table 2) on: a) percentage of seedlings that flowered; b) flowering intensity evaluation rating from 1 = few flowers to 5 = profuse flowering; c) percentage of seedlings that set fruit; and d) average number of fruits (left for harvest) per seedling).

In order to obtain homogeneity of variance within treatments, an arcsin transformation was applied to percentage calculations before the analysis. The interaction between cross and girdling date was not significant for any of the parameters studied. Thus, a new ANOVA was done without an interaction term followed by least-square means calculations for main effects with the Tukey Kramer test (2) to determine for significance between different levels. (Least square means are estimates of the mean values adjusted for the imbalanced number of individuals in the different treatments.)

Girdling improved each of the measured parameters, and the earlier the girdling, the

greater the effect. The earliest (September) girdling increased the proportion of seedlings flowering from 47% to about 100%; nearly tripled the flowering intensity (from rating 1.0 to 2.7); highly increased the proportion of seedlings setting fruit (10.8% vs. 65.4%); and, perhaps most significantly of all, resulted in a 7-fold increase in number of fruits per tree (1.3 vs. 9.3). In breeding evaluation, one fruit is of little or no value, but 9 fruit permit a significant appraisal.

The findings in this experiment agreed with our previous (unpublished data) observations of differences in the length of the juvenile period among various crosses (Table 2). Selfed 'Rincon' seedlings rated highest in all 4 parameters measured. 'Tova' x 'Regina' rated lowest in the flowering comparisons, while 'Ettinger' x 'Fuerte' seedlings rated lowest in number of fruit. No significant interaction was found between seedling origin and girdling date for any of the parameters studied.

Calculation of the correlation coefficients between the different parameters showed significant *r* values between flowering intensity and the 3 following parameters: percentage of seedlings that flowered *(r* = 0.77); percentage of seedlings that set fruit (r = 0.68); and number of fruits per seedling *(r* = 0.53). Significant correlation coefficients also were found between the number of fruits per seedling and the percentage of seedlings that set fruit *(r* = 0.55) or the percentage of seedlings that flowered (*r* = 0.33).

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