EFFECT OF TIME OF HEDGING ON SHOOT GROWTH AND FLOWERING IN CITRUS

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Abstract. To assess the effect of pruning at different times of the year 38-year-old Valencia trees were hedged at monthly intervals from September (early spring) to April (autumn), and 17-year-old Ellendale trees were hedged and topped in October and March. Time of pruning affected regrowth vigour and the incidence of flowering on the pruned branches in the following spring. The earlier the time of pruning the greater the number of growth flushes and the greater the shoot length within each flush. Regrowth from trees pruned in autumn was generally delayed until the following spring. When pruning was carried out before midsummer, regrowth on 40-65% of pruned branches produced flowering shoots in the following spring. With trees pruned in late summer-autumn only vegetative shoots were produced. In the Ellendale trial autumn pruning resulted in a greater loss of yield in the first year and in a significant reduction in total yield two years after pruning. With trees pruned in spring the yield loss in the first year was recovered by increased production in the second year. Total yields 2 years after pruning for control and spring pruned trees were not significantly different.

Hedging and topping of citrus to control tree size is becoming an important management practice (2, 7). In addition to tree size control, hedging has been used to rejuvenate old, unthrifty trees (3, 5), to improve fruit quality, and to alleviate the alternate bearing tendency of certain varieties (1, 4, 6). To be effective it is important that hedging does not stimulate shoot growth with excessive vigour or adversely affect yields. Early studies in California indicated that the response to hedging would vary with...
variety, district, time of the year, and severity of pruning (8, 9). However, there is little detailed information on how these factors affect tree response. This paper provides some information on the response of Valencia orange and Ellendale tangor trees to hedging at different times of the year.

Materials and Methods

**Valencia trial.** Thirty-eight-year-old Valencia orange (Citrus sinensis (L.) Osbeck) trees on rough lemon (C. jambhiri Lush) rootstock were hedged at monthly intervals from September 1973 (early spring) to April 1974 (autumn) at the Agricultural Research Centre, Yanco. The trees were hedged on their east and west sides with a commercial hedging machine, which consisted of a row of 3 power-driven 60 cm diameter circular saws on a boom attached to a tractor. Hedging removed approximately 0.3 m of the outer canopy from each side of the tree.

For each time of hedging there were 4 single tree replications. Observations on regrowth were recorded on 8 tagged branches on the east and west side of each tree during the winters of 1974 and 1975. Size of the cut stem, number of shoots, length of each flush, the incidence of flowering and fruit numbers were recorded for each tagged branch.

**Ellendale trial.** Tree response to hedging and topping in spring or autumn was studied in 17-year-old Leng Ellendale (C. reticulata x C. sinensis) on sweet orange (C. sinensis) and Poncirus trifoliata (L.) Raf. rootstocks at the Horticultural Research Station, Dareton. The trees were hedged on their east and west sides, and topped in either October 1976 (spring) or March 1977 (autumn). Pruning was carried out with a machine similar to that described for the Valencia trial. For trees on sweet orange the depth of canopy removed from the top and each side of the tree averaged 0.9 m and 0.4 m respectively. Trees on P. trifoliata were smaller in size and the depth of canopy removed from the top and each side averaged 0.5 m and 0.3 m respectively.

For each time of pruning there were 6 replications (3 replications on each rootstock). To record observations on regrowth a wire frame (area 1 m²) was attached at random to the east and west side of each tree in the spring following hedging. Size of the cut stem, number of shoots, length of each flush, and the incidence of flowering on the regrowth was recorded for all cut stems within the area of the frame. Tree yields were recorded at harvest.

Results and Discussion

Time of hedging affected both the incidence and length of shoot growth on the pruned branches. In the Valencia trial the initial regrowth flush from trees hedged in April did not survive the 1974 winter and the length attained by the initial regrowth flush from trees hedged in March was markedly reduced (Fig. 1). The development of a second growth flush from pruned branches was confined to trees hedged during the period September to December, and the development of a third growth flush to trees hedged in September and October. The earlier the time of hedging the greater were the lengths of the second and third growth flushes.

In the Ellendale trial hedging in March reduced the number of shoots and shoot length in the initial regrowth flush (Table 1). For trees hedged in March shoot growth before winter was evident on only 15% of pruned branches (regrowth generally being delayed until the following spring), whereas for trees hedged in October shoot growth was evident on 96% of pruned branches. A second growth flush developed on 17% of the initial growth flush shoots of trees hedged in October.

Time of hedging also affected the incidence of flowering on the pruned branches in the following spring. In the Valencia trial flowering shoots were evident on the regrowth of trees hedged during the period September to January. The % of shoots bearing fruit in the season following hedging is shown in Fig. 2. There were no significant differences in % of shoots bearing fruit between trees hedged during the period September to December, but the level recorded on trees hedged in January was significantly (P<0.05) lower than the level recorded on trees hedged in September, October, and November. With trees hedged in February, March, and April only vegetative shoots were produced on the pruned branches.

In the Ellendale trial hedging was evident on 65% of pruned branches of trees hedged in October. The mean number of inflorescences is shown in Table 1. With trees hedged in March only vegetative shoots were produced.

The effect of the pruning treatments on yield is shown in Table 2. Hedging and topping in October 1976 and March 1977 caused a significant reduction in the crop harvested in September 1977. The reduction in yield was...
Fig. 2. Effect of time of hedging on cropping of regrowth of Valencia orange trees in the season after pruning. The percentages of shoots bearing fruits were determined in June 1975.

greater with the March pruning treatment. For control and October pruned trees the total yield after 2 years was not significantly different. Higher production from October pruned trees in the second year was sufficient to compensate Table 2. Effect of time of pruning on the yield of Ellendale tangor trees.

<table>
<thead>
<tr>
<th>Time of pruning</th>
<th>Yield 1977</th>
<th>Yield 1978</th>
<th>Yield 1977-78</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>192 c</td>
<td>122 a</td>
<td>314 b</td>
</tr>
<tr>
<td>October 1976</td>
<td>140 b</td>
<td>159 a</td>
<td>299 b</td>
</tr>
<tr>
<td>March 1977</td>
<td>104 a</td>
<td>110 a</td>
<td>214 a</td>
</tr>
</tbody>
</table>

*Means within columns followed by the same letter are not significantly different at P>0.05.

for the yield loss in the first year. Pruning in March resulted in a significant reduction in the total 2-year yield. With young grapefruit trees in Texas, Fucik (4) also found that hedging or topping early in the season reduced the post-pruning yield loss, and resulted in the highest 3-year average yields.

In the Ellendale trial both pruning treatments reduced the seasonal variation in yields. Similar effects have been observed in Valencia orange and grapefruit trees (1, 4, 6).

Where pruning was carried out before midsummer regrowth from 40-65% of the pruned branches flowered in the following spring. Part of the reason why the incidence of flowering was not higher may have been due to the severity of pruning. Hedging and topping are nonselective forms of pruning and in any pruning operation branches of various sizes are cut. In both the Valencia and Ellendale trials the length of the initial regrowth flush was significantly correlated with the size of the cut branch. The larger the branch the more vigorous was the regrowth. Moss (8) in trials with orange cuttings observed that flowering was suppressed for some time on the regrowth from the more severely pruned plants but not in the lightly pruned plants where the regrowth was not as vigorous.

The results reported here show that time of pruning is an important factor in determining tree response. If the objective of the pruning program is to rejuvenate unthrifty trees then pruning as early as possible would be desirable. This would allow maximum time for canopy recovery in the season of pruning. Where control of tree size is important delaying pruning until early summer would have the advantage of reducing both the number of growth flushes and shoot length, without adversely affecting cropping on the regrowth relative to earlier times of pruning. Nothing is gained by pruning in late summer-autumn. The crop loss in the first year is likely to be greater, and cropping on the regrowth is delayed until the second season after pruning.

**Literature Cited**