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RESPONSE OF VALENCIA ORANGE TREES IN AUSTRALIA TO HEDGING AND TOPPING[1]

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Abstract. **Mature 'Valencia' orange trees on sweet orange rootstock were hedged and topped in spring, early summer, or early autumn at 3 levels of severity. The number and length of shoots developing from the cut branches increased with severity of pruning. Regrowth in early-autumn-pruned trees was delayed until the following spring. Flowering and fruiting of the regrowth in the season following pruning occurred only in trees pruned in spring and early summer. The incidence of fruiting was higher in spring than early-summer-pruned trees, and this was particularly evident with regrowth from severely pruned branches. Flowering and fruiting of regrowth from autumn-pruned trees was delayed until the second season after pruning. The best response to pruning was obtained by pruning predominantly 2-year-old wood in spring or early summer.**

Hedging and topping is now a routine practice in Australian citrus orchards. Current emphasis is on maintaining trees at an optimum size consistent with high productivity and economical orchard management. Previous work has shown that the response to pruning will vary with tree age and health, variety, pruning severity, and time of year (1, 2, 3, 5). Stimulation of excessive vegetative growth at the expense of fruit production is obviously undesirable, as is the development of very weak regrowth incapable of bearing fruit.

The widespread adoption of closer tree spacings has further emphasized the need for proper control of vegetative growth and for a greater understanding of the principles involved. The aim of this experiment was to obtain detailed information on the response of mature 'Valencia' sweet orange trees to hedging and topping at different levels of severity and at different times of the year.

Materials and Methods

The experiment was carried out at the Horticultural Research Station, Dareton located in south-west New South Wales. The climate is characterized by hot summers and mild winters, with an average annual rainfall of 270 mm. The trees were 18-year-old 'Valencia' sweet orange (*Citrus sinensis* (L.) Osb.) on sweet orange rootstock, planted on a deep sand at a spacing of 6.7 X 6.1 m, and irrigated by overhead sprays.

Application of pruning treatments commenced in spring 1977 immediately after harvest and consisted of 3 times of pruning combined with 3 levels of severity. Each tree was mechanically hedged on 2 sides and topped. Times of pruning were October (spring), December (early summer), or March (early autumn). Levels of severity of pruning were very light (1 years growth removed), light (2 years growth removed), and moderate (3 years growth removed). The moderate treatment removed approximately 0.4 m canopy from the top and each side. The largest branches cut had a diameter of 23 mm. Heavier pruning treatments were avoided as previous results had shown that more severe pruning of vigorous rootstock-scion combinations caused a substantial loss of production (1). There were 5 replications of each treatment. Ten pruned branches selected at random were tagged on each tree and used for observations on regrowth. The diameter of each branch was measured with calipers, and the number and length of shoots in each growth flush from the time of pruning until spring 1979 recorded. The number of fruit set on the regrowth and the total yield for each tree was also recorded.

Results and Discussion

Shoot growth. During the observation period most pruned branches on spring- and early-summer-pruned trees produced 3 growth flushes. Five per cent produced 4 flushes. Development of the initial flush occurred immediately after pruning and in most instances was the only flush produced until the following spring. Pruning of 1-year-old wood in spring and early summer usually stimulated the growth of a single shoot, whereas pruning of wood 2 years and older stimulated the growth of 2-6 shoots. Initial flush growth on early-autumn-pruned trees was highly variable and with 53% of pruned branches the initiation of shoot growth was delayed until spring. Where regrowth was delayed some die-back of pruned branches was evident. The length of the initial growth flush increased with the severity of pruning and was greater in spring- and early-summer-pruned trees than in early-autumn-pruned trees (Table 1). Shoot growth in early autumn pruned trees was affected by the onset of cooler weather.

The development of a second flush in the first year was largely confined to trees moderately pruned in spring and was evident on 12% of pruned branches. For most trees the second regrowth flush coincided with the normal spring flush. With spring- and early-summer-pruned trees the mean number of shoots/pruned branch in the second flush ranged from 2.4-7.2, whereas for early-autumn-pruned trees the number ranged from 0.8-1.2. The number of second flush shoots increased with severity of pruning: Shoots on early-autumn-pruned trees developed directly from the pruned branch rather than from initial flush shoots and were entirely vegetative. Shoots on moderately pruned trees were also significantly greater in length (Table 1). Effects of treatment on shoot length carried over to the third regrowth flush. These shoots developed at the usual time for summer flushes. Shoot length was greater on moderately pruned trees (Table 1).

The greater stimulation of vegetative growth with increasing severity of pruning is clearly evident in the data for total shoot growth (Table 1). The greater amount of shoot growth observed in moderately pruned trees reflects the greater length attained by each flush and the increased number of shoots in each flush. An effect of time of pruning is also apparent. Early-autumn-pruned trees showed substantially less total growth, reflecting the poor growth of the initial flush and the low number of shoots in the spring flush.

Production. Flowering was observed on the regrowth from spring- and early-summer-pruned trees in spring 1978,

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Table 1. Effect of time and severity of pruning on shoot growth and yield of 'Valencia' sweet orange trees.

Time	Severity	Diameter pruned branches (mm)	Shoot length (cm) Initial flush	Spring flush 1978	Summer flush 1979	Total	Yield 1978-79 (kg/tree)	No. fruit set/pruned branch 1978
Spring	Very light	3.7	8.3cd[z]	5.6b	8.4c	31.7c	365	0.3
	Light	5.0	12.7bc	7.0b	8.9c	69.5bc	325	1.1
	Moderate	8.8	17.4ab	7.1b	10.8abc	115.6ab	282	1.2
Early summer	Very light	4.8	12.0bc	5.9b	9.6bc	42.2bc	347	0.5
	Light	6.6	16.5ab	7.9b	12.7abc	81.1abc	363	0.7
	Moderate	8.6	19.9a	9.2ab	16.5a	149.8a	286	0.9
Early autumn	Very light	4.0	4.3d	6.4b	9.5bc	20.1c	343	0
	Light	5.3	5.7cd	8.5b	12.4abc	30.8c	305	0
	Moderate	8.2	6.6cd	12.9a	14.7ab	56.3bc	284	0

[z]Mean separation within columns by Duncan's multiple range test, 5% level.

12 and 10 months after pruning, respectively. In spring-pruned trees 24%, 44%, and 56% of pruned branches in the very light, light, and moderate pruning treatments, respectively, subsequently set fruit on the regrowth. In early-summer-pruned trees 32%, 36%, and 38% of pruned branches in the very light, light, and moderate pruning treatments, respectively, set fruit. No flowering was observed on the regrowth from early-autumn-pruned trees. The flowering response of spring- and summer-pruned trees is in contrast to the suggestion that several cycles of shoot growth are necessary before flowering can occur on the regrowth (4).

Total yields for 1978 and 1979 are shown in Table 1. Differences between treatments were not statistically significant ($P>0.05$). Although there is no consistent effect of time of pruning, there appears to be an effect of pruning severity as moderately pruned trees consistently yielded less than very lightly pruned trees. Significant reductions in yield following moderate pruning of 'Valencia' orange trees have been observed in other trials (1).

Pruning in the first year generally reduces yields in direct proportion to pruning severity. With light pruning the loss in production in the first year is compensated by increased production in the second year (1). The reduced yields from moderately pruned trees can be explained in part by the greater proportion of the canopy removed and by the relatively low fruitfulness of the regrowth. In spring- and early-summer-pruned trees there were no significant differences in the number of fruit set/pruned branch (Table 1), which means that in relation to the amount of vegetative growth, the fruitfulness of the regrowth from moderately pruned trees compared to the lightly pruned trees was considerably less. In autumn-pruned trees the regrowth did not set fruit until the second year after pruning.

The results suggest that very light pruning may be carried out at any time of the year without adverse effects on yield. Removal of up to 2 years growth in spring or early summer is also possible without affecting yield. Pruning of this severity does not stimulate excessive vegetative regrowth and the regrowth is capable of setting fruit the year after pruning. Heavier pruning stimulates excessive vegetative regrowth of relatively low fruitfulness. If heavier pruning is necessary it may be best carried out early in the season, as the incidence of fruiting on the regrowth was higher in spring than in early-summer-pruned trees. Pruning in early autumn was unsatisfactory and should be avoided. Regrowth was sparse and did not set fruit until the second year after pruning, which increases the risk of long-term adverse effects on yield. The trial emphasizes the point that in carrying out a pruning program do not remove more growth than necessary to achieve the objectives of the program. Pruning should always be as light as possible.

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