

severity relationship for citrus canker could be determined as has been done for numerous other diseases. A citrus type that may have only one lesion per tree might be unfairly ranked by incidence with another variety that had thousands of lesions per tree. However, these incidence-severity relationships vary with season (8), pesticide application (13), location (8), and crop variety (12).

The calculation of epidemic rates for the increase in incidence of citrus canker among scions, rootstocks, and sanitation practices may provide growers with criteria upon which to base management decisions. In Florida, for example, 'Valencia Late' and Navel oranges comprise >35% of the citrus acreage. Rough lemon is the rootstock for ~60% of the trees. If canker should be reintroduced into Florida, rather rapid spread of the disease can be anticipated since susceptible scion types are present and most of the trees are on a rootstock that increases the likelihood of infection.

The removal of infected shoots or entire trees would be expected to slow the disease spread as has occurred with other diseases (1). Such sanitation procedures should be combined with other rate reducing practices to be most effective (1).

We gained much insight into the spread of canker in groves with our epidemiological approach. We encourage future workers to obtain histories of disease progress so that critical analyses of location, cultivar, climatic, and other differences can be performed.

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SUMMER PRUNING OF ORANGE TREES¹

C. K. KIANG AND R. H. BIGGS
University of Florida, IFAS,
Fruit Crops Department,
Gainesville, FL 32611

Abstract. Based on experience in West China, physiological responses to pruning of orange trees are quite different from apples. While winter pruning in suitable but not excessive amounts stimulates the vegetative processes of apples, it enhances the reproductive processes of citrus and summer pruning does the opposite.

As a supplementary practice to winter pruning, summer pruning of oranges at the right time with specific techniques will invigorate neglected and old trees and modify the alternate bearing habit of healthy trees. During the on-year, trees respond to moderate summer pruning by producing moderate amounts of summer flushes which increases the shedding of young fruits. Thus, the on-year crop will be reduced and the next year crop increased. This is "physiological thinning," as compared to chemical or hand thinning. Excessive summer pruning before the time of "June drop" can result in considerable fruit drop.

Growth patterns and endogenous processes of fruit

trees differ during the season and from season to season. Therefore, the responses to pruning practices in different seasons also may differ distinctly. These phenomena have been found in apple orchards, for example, in Germany. Lange (ca. 60's) reported that "Summer pruning (of apples) promotes reproductive development and winter pruning promotes vegetative growth" (Der Sommerschnitt fordert . . . der Fruchtbarkeit; der Winterschnitt fordert . . . die Triebkraft). However, for citrus fruits little work has been done on the relation of pruning to fruiting habit.

According to research in the humid Chungking area of West China it was found that winter pruning of orange trees in moderate amount of cuts can enhance vegetative growth and also improved fruit setting, probably through the improvement of sunlight penetration into the canopy. Whereas, summer pruning just before the appearance of an early summer flush vigorously stimulated vegetative growth and enhanced "June drop." These findings suggest that physiological responses between apples and oranges to pruning, especially summer pruning, appear to be opposite. In other words, summer pruning of mature orange trees promotes vegetative growth while summer pruning of mature apple trees promotes reproductive development.

Materials and Methods

The material and methods for this report are common

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horticultural practices of pruning and observing the effects in commercial orchards of citrus in Western China for over 20 years. Timing and the degree of pruning are most critical and will be mentioned along with the results.

Results

I. Time of Summer Pruning

"The correct timing" is very important for summer pruning of orange trees. First, it is very dependent upon climatic conditions, i.e. temperature, light, rainfall and relative humidity. All these factors must be in optimal condition for luxurious growth or orange trees when such pruning is conducted. In Chungking, West China, the rainy season begins in May and lasts until early July. During this period the temperature range is good for tree growth and the relative humidity is constantly high. Table 1 consisting of some abbreviated climatic records that demonstrates these conditions.

Table 1. Part of the Climatic records of Chungking, West China.^a

Climatic factors	April	May	June	July	August
Avg. temp. °C	18.8	22.2	25.2	28.6	28.4
Avg. rainfall mm	72.3	155.4	165.4	150.7	141.0
Avg. rel. humidity %	75	78.	79	76	74

^aData of local government report in 1978.

According to the research on summer pruning in Chungking the best time for this practice is near the end of May. It can be done up to mid-June but by July 10th it is too late for summer pruning because the summer drought gradually sets in, with intermittent but sporadic rain showers.

The time of summer pruning of orange trees also depends upon tree growth. Weak, neglected or old trees, around the Chungking area need to be pruned at the end of May. Pruning healthy alternate bearing trees can be postponed until Mid-June. Young trees, if pruned, should be pruned during the first week of July.

Vigor of trees should be taken into consideration. As a rule, the weaker the tree, the earlier the pruning. Overly vigorous trees must not be summer pruned. In apple orchards Lange (ca. 60's) remarked "It is completely wrong to prune strongly vegetative trees in winter and to prune very productive trees in summer." (Es ist daher vollkommen falsch, zu stark treibende Baume im Winter und zu stark fruchtende Baume im Sommer zu schneiden). For orange trees, it seems to be wrong to prune very weak trees in winter and to prune strongly vegetative growing trees in summer because physiological responses of summer or winter pruning of apples and oranges are seemingly opposite.

II. Summer Pruning Practices in West China

A. Neglected Trees. Summer pruning to invigorate neglected trees is more effective than winter pruning because at this period it is not necessary to cut the tree heavily. Good fertilization and irrigation practices, if rainfall is not enough, should be followed.

In West China orange trees are hand pruned with shears, just as it was many years ago in the United States. On the top of canopy, heading back to laterals is made. Both thinning and heading back of certain branches are practiced on the middle part of the tree. Low drooping branches are under cut to provide branch support to keep the fruit off the ground and to aid in cultivation.

B. Alternative Trees. Summer pruning for alternate

bearing orange trees has mainly taken place in "on" years. Pruning at this time, just before the early summer flush appears, will stimulate more summer flushes. Following this, vigorously vegetative growth will appear and the tree will abscise more fruit in period of "June drop." Thus, the "on" year crop will be reduced and the next crop increased. This thinning effect is termed "physiological thinning," as compared with chemical thinning or thinning by hands.

Pruning "on" year orange trees by shears consists of under-cutting weak branches beneath, thinning-out the cross, crowded shoots and removing dead woods or insect and disease infected shoots. Since the stimulus of pruning is more or less localized, the cuts should be distributed over the canopy for best results.

C. Old Trees. Providing old orange trees have sound trunks and good root systems, it is better not to try to invigorate them entirely by summer pruning. The practices used should be much the same as those used for neglected trees. A moderate amount of summer pruning is stressed as old trees are slow to recover. *It is suggested that the practice be spread over two successive years.* Meanwhile, good cultural practices must be maintained.

D. Young Trees. Generally, young trees are not pruned in the summer. However, occasionally either for the purpose of tree trimming, or to remove sporadic fruits of the first crop, light summer pruning has been practiced. Prunings are limited to the removal of the sprouts on the scaffold, undercutting the drooping low shoots and removing crossed, crowded shoots.

Discussion

As far as timing for pruning is concerned, responses to pruning of apple trees and orange trees are quite different. While winter pruning favors vegetative growth of apple trees, in moderate amounts of cuts, it favors the reproductive processes of orange trees. On the other hand, summer pruning favors increased fruiting of apple trees and decreases the fruit load of certain varieties of oranges. It is not uncommon to see that some citrus pruning practices are patterned from deciduous tree cultural practices, particularly apples. This is not a good practice. For good fruiting practices, citrus pruning practices should be established for each cultivar.

Summer pruning of orange trees would be a supplementary practice, not a substitute for pruning during the cool periods. It is more effective to invigorate neglected and old trees at this time than in the winter. Summer pruning can be used to regulate fruit load, so a special interest is on the thinning effect. Also, summer pruning can modify the alternative bearing habits of citrus trees. In this case, we need not thin the fruits directly with chemicals or by hands but by stimulating the early summer-flush so natural thinning is enhanced during the period of "June drop." In fact, as moderate amounts of early summer flush appear, moderate amounts of fruit drop naturally.

During 1981 experiments done in West China were repeated at the Horticultural unit of the University of Florida at Gainesville. It was found that when navel orange trees were pruned before "June drop" the shedding of fruitlets was heavy (Fig. 1). When the trees of orlando tangelo were moderately pruned on June 17, a moderate dropping of fruitlets occurred (Fig. 2). The results obtained at the University of Florida supports the observation made in West China. When navel oranges were pruned on July 17 at Gainesville, it stimulated many late summer flushes during the first week of August. Nevertheless, no fruit abscised. (Fig. 3). This indicates that summer pruning of citrus trees



Fig. 1. Numerous abscission of fruitlets before "June drop" in pruned tree.



Fig. 2. Moderate abscission of fruitlets occurred from tree pruned on June 17.

can promote fruit abscission earlier during the so-called "June drop," but can not induce an "August drop."

In Florida, there is a serious problem of an alternative bearing habit with Dancy tangerine. Summer pruning techniques may modify this characteristic.

Of course, up to now our experiments have been with

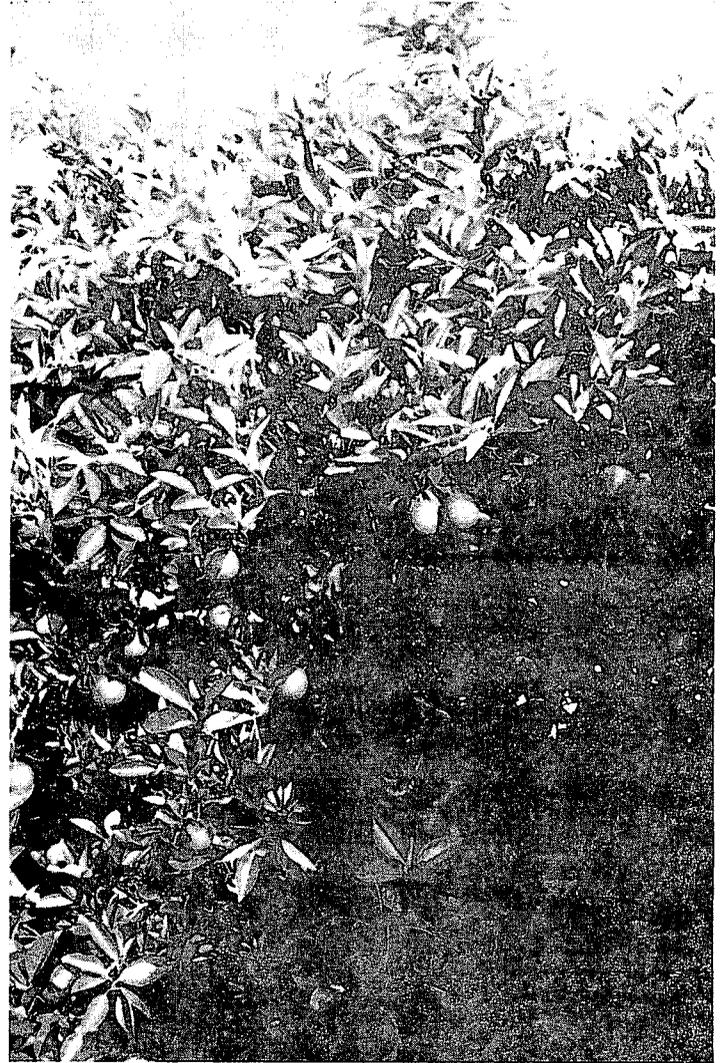


Fig. 3. No fruit abscised from tree pruned after "June drop."

removable by pruning shears. At the Horticultural unit of the University of Florida, it was found that the responses of summer pruning of navel oranges, on July 17 appeared much the same whether pruned by selective cuts (Fig. 3) or by imitative topping with pruning shears. (Fig. 4) It may be possible to use mechanical topping or hedging of Dancy tangerine trees at the "right time" to lessen the alternative-bearing problem in Florida.



Fig. 4. Topping the tree yielded similar results as in Figure 3.