Crowded Citrus Orchards

preliminary studies to determine effect of pruning practices in dense groves

S. H. Cameron and R. W. Hodgson

Blocks of large orange trees now producing unsatisfactory crops—running largely to small sizes—are a problem in some of the older citrus growing districts of California.

If the principal factor limiting production is reduction of bearing surface—resulting from shading due to crowding—pruning to reduce tree size and reëstablish the bearing surface seems to be a logical approach to increasing the yield and fruit size.

Studies of the general nature of the responses of bearing citrus trees to pruning to serve as a guide in field experiments to determine whether it is feasible and profitable to rehabilitate orchards of large crowded trees by pruning were begun in 1939.

Temporary trees in a double-set orchard planted in 1929 and 1930 at the Los Angeles Experiment Station were used for these studies. The trees were all on the same sweet orange rootstock. They were large for their age, unusually uniform in size and fruit production, and were beginning to crowd slightly at the time these studies were begun.

The pruning experiments can be divided into three parts.

Twenty-four Valencia orange trees were used to study the effect of time of pruning on the rate of recovery. Two trees were deheaded each month during a 12-month period.

This study revealed that the time of year at which pruning is done is not a very important factor in determining the rate of recovery. Trees pruned in late spring and early summer recovered a little faster, and those pruned in late autumn and early winter, a little more slowly. However, the differences were so small that they might well be ignored in favor of other considerations, such as the harvesting of the crop, injury from sunburn, low temperature or the convenience of the owner.

New Growth

The study of the effect on the rate of growth of new top of the number of new shoots left involved 64 Valencia orange trees which were divided into four groups of 16 trees each and pruned heavily.

Twelve trees of each group were restricted to a definite number—five, 10 or 20—new shoots. The remaining four trees of each group were allowed to develop an unrestricted number of new shoots.

Trees with an unrestricted number of new shoots produced more new growth than those with a limited number of new shoots, but by the end of the second year, many of the young shoots on the unrestricted trees had been shaded out. The remaining branches were still too numerous for a satisfactory permanent tree. On the other hand the trees restricted to 20 new shoots gave appreciably less total new growth.

This experiment suggests that some thinning out and selection of shoots to form a new scaffold branch system during the first year after severe pruning probably would be necesary for best results.

To study the effect of severity of pruning on the rate of top regeneration and resumption of fruiting, nine trees each of Valencia orange, navel orange and grapefruit, and six trees of Eureka lemon were used. Trees of each group were pruned according to one of three methods:

1. Skeletonization—removing all growth less than about one-half inch in diameter and thinning out of the scaffold branches;
2. Deheading—leaving 10 scaffold branches three to four feet long;
3. Severe deheading—leaving only five scaffold branches about 18 inches long.

Each tree was allowed to produce a new top without any restriction of the number of new shoots.

This study showed conclusively that lightly pruned trees recover and resume fruiting more quickly than do heavily pruned trees. All the skeletonized trees produced good crops the second season after pruning. With the exception of the lemon, and to a lesser degree the navel orange, the deheaded trees produced much smaller crops the second year after pruning than did the skeletonized trees.

The behavior of the trees in this experiment indicates that citrus trees in good health, reduced in size by severe pruning, will regenerate new tops and resume fruiting at a rate inversely proportional to the severity of pruning. Whether this response would be rapid enough and the resulting tree sufficiently satisfactory to warrant the deheading of blocks of large, low-yielding trees can only be determined by actual experiments with such trees. The more rapid recovery of lightly pruned trees suggests that if practical, a less drastic procedure than deheading might be preferable.

The lemon is apparently an exception to the general pruning principle of retain-

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Lightly pruned navel orange trees quickly recover. *Left.* Skeletonized navel one year after pruning. *Right.* Two years after pruning.

SAMPLING

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is formed by the drop must be large enough to allow the fruit always to fall through and not bridge over—but no larger. Thus, the size or shape of a fruit has no influence on its being taken in the sample.

Second, the drops—apparently scattered over the conveyor—are in lines. By means of controls under the conveyor any one line or any combination of lines can be opened. Thus anywhere from one to 15 drops can be operated. In percentage terms, anywhere from 0.5% of the lot to 8% can be obtained in steps of approximately ½%. Any combination of percentages that might be wanted by an organization can be built into the machines. A remarkably high and uniform degree of accuracy can thus be obtained in the sample.

Research Method

The development of the machine represents an example of coöperation in research. The Division of Agricultural Economics, in coöperation with Ventura County packing houses, worked out the requirements for such a machine. The initial design, construction, and tests were carried out by the Division of Agricultural Engineering in its shops at Davis.

Recently a Ventura County citrus growers committee contracted with a commercial machinery company to construct a pilot model under the supervision of the Division of Agricultural Engineering.

It is believed that an important step has been made in sampling and immediate installation is being planned by a number of lemon packing houses.

The investigation thus far has been limited to lemons but the ideas suggested appear to be equally applicable to many other products such as oranges, apples and tomatoes. In consequence it is hoped that marketing and processing companies will be able to offer their growers a more exact equity than in the past and yet achieve large-scale efficiency in their operations.

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SEEDLINGS

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method saves the labor of transplanting from a seed flat, eliminates the hazard of spreading virus diseases by handling during transplanting, and the seedlings do not sustain the usual 10- to 14-day setback from root injury.

Growing and Hardening of Plants

Because of freedom from disease, the seedlings may be grown safely in greenhouses at high humidity and temperatures of 80° F, and with high levels of soil moisture and fertility. Probably constant-level watering or subirrigation could be used with still greater reduction of labor. About 50 days are required from seeding to hardening off, compared to about 80 days for the usual method.

The flats are moved outdoors for two to three weeks to harden the plants, during which time most of the leaves are shed and the stems become tough and wiry.

The plants are pulled from the flats by hand and, after the soil is shaken from the roots, placed in celery crates for delivery to the field. Experience indicates that such plants are suitable for machine planting, that they start rapidly, and that the root systems are at least as good as those of seedlings pricked out of seed flats.

Healthy Plants Produced

The total effect is to produce healthier plants more dependably and quickly, with less labor and expense. Because the plants are free of virus diseases and such organisms as root-knot nematode and the Rhizoctonia, Pythium, Phytophthora, or Sclerotinia fungi which cause root, stem, and fruit decay, and of Verticillium which causes wilt, the hazard of introducing them to uninfested fields is eliminated. Because of the savings effected by these improved methods, it is probable that the plants can now dependably be grown in greenhouses as cheaply as they can with uncertainty in outdoor seedbeds.

It cannot be too strongly emphasized that the success of this method depends on using soil and seed freed of pathogens, and on rigorous sanitation, and that without these conditions losses actually may be increased.

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ORCHARDS

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ing as many of the old scaffold branches as possible to reëstablish a satisfactory framework branch system. Because of the vigorous growth of its new shoots a skeletonized lemon tree soon becomes top-heavy.

The deheaded lemon trees studied were the most desirable from a commercial standpoint because of their structure and because they produced almost as much fruit as the skeletonized trees. More extensive studies of the response of lemon trees to severe pruning are now in progress.

Recommendations Premature

This report is not intended to advocate severe pruning of crowded trees, since it is unlikely that trees which are unproductive because of other limiting conditions would respond in the same manner as would trees which are limited merely by crowding.

While field experiments now underway with crowded old trees already have given promising results, much more work will be necessary before definite recommendations can be made regarding a rehabilitation program.

Pruning experiments are also in progress to determine whether trees can be prevented from getting too large and at the same time continue to produce profitable crops of high-quality fruit.

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Right. **Skeletonized lemon, photographed two years after pruning. Note the undesirable two-stage effect.** ***Left.*** **A deheaded lemon tree two years after pruning.**