action of the citric acid cycle. The genesis of oxalic acid is similarly linked to the activity of the enzyme aconitase, and its formation would be suppressed under conditions of iron deficiency.

The only other major nutrient cation which can compensate for this loss is potassium, since in most plants sodium and magnesium are taken up in much smaller amounts. Hence, differences in iron nutrition are also shown in the relationships between potassium and calcium, the iron-deficient tissues being characterized by higher ratios of potassium to calcium than the green tissues.

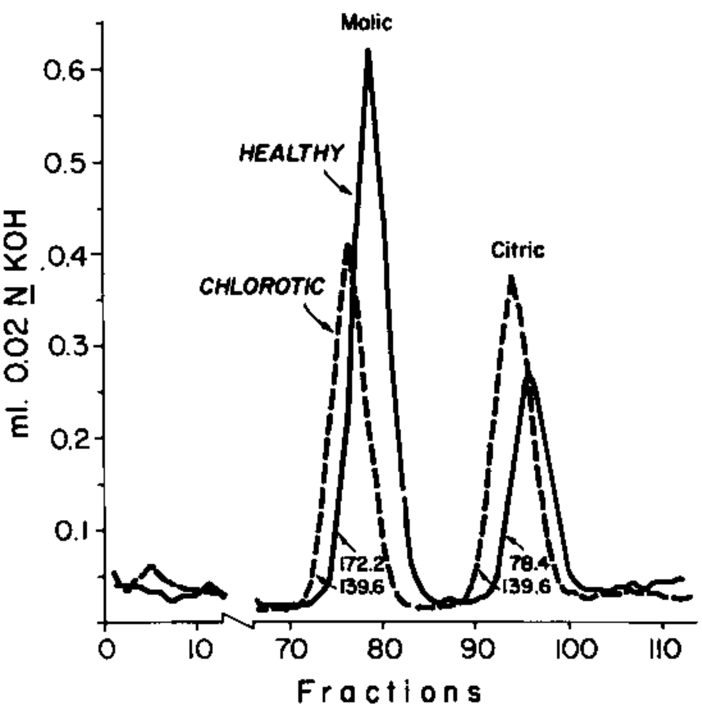
Investigators have repeatedly found that iron-deficient leaf tissues contain as much or more iron than the green tissues, and that so-called absolute iron content is not a valid criterion of iron deficiency. Very often the phosphorus content of such deficient tissues is greater; so it appears that it is really the ratio of phosphorus to iron which determines whether a tissue will appear chlorotic or healthy. Although the exact distribution of iron between the various structures in the cell is not known with certainty, attachment to phosphoproteins such as nucleic acids has been inferred and certain iron proteins containing phosphorus such as phytoferritin have been identified. Hence, addition of excessive amounts of phosphate to plants can be expected to induce a chlorosis which can be corrected by addition of iron—phosphorus toxicity, therefore, becoming equivalent to iron deficiency.

Although such toxicity effects are easily reproduced in the laboratory, they are rarely observed in the field. Such effects were discovered recently, however, in a raspberry plantation in which the new canes showed typical iron deficiency chlorosis. The soil contained abnormally high amounts of phosphate, although other factors were normal. The table shows that the chlorotic leaves contained more phosphorus and less calcium than the green leaves, so that the phosphorus-iron and potassium-calcium ratios were higher in the chlorotic than in the green leaves. Analyses of the organic acids of these leaves showed again that the chlorotic leaves contained greater amounts of citric acid and less malic than the green leaves (see graph), and the citric-malic ratio followed the trend of the phosphorus-iron and potassium-calcium ratios. Hence, excess phosphate in the soil caused changes in leaf composition which are characteristics of iron deficiency.

The amounts of nutrients as well as the relation of those amounts to each other are crucial in plant nutrition, and an excess of one nutrient may cause a deficiency of another. Moreover, such deficiencies or excesses can alter characteristic metabolic patterns.

P. C. DeKock is Visiting Professor of Plant Physiology from the Macaulay Institute for Soil Research, Aberdeen, Scotland; and A. Wallace is Professor of Plant Nutrition, University of California, Los Angeles.

Iron-deficient leaf tissues contain more citric acid and less malic acid than healthy leaf tissues of the Malling Jewel raspberry. (Figures inside graph refer to milliequivalents per kilogram of fresh leaf tissue.)



Training or shaping trees for easier harvesting must take into account yield reduction from pruning operations. Reshaping mature Valencia trees by slab pruning resulted in 80% less fruit, according to this report of a two-year trial conducted by the Citrus Research Center and the Agricultural Extension Service.

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J. E. PEHRSON

Valencia orange tree pruned as a 5-ft-thick hedge. The fruit-producing canopy has become a wall. Such a bearing surface offers easy picking. An inexpensive rolling scaffold with fruit-handling system could be utilized for greater harvesting efficiency. This pruning and training was too severe for mature orchards, and yield was reduced 80% over two years. Training young trees with closer spacings appears more feasible.

SLAB PRUNING

mature orange trees

harvesting, reduces yields

C. D. MC CARTY

Valencia orange trees pruned to hedgewall 2½ ft from centerline of trunk. All fruit-bearing zones can be reached from the outside edge. Trees were originally 14 to 16 ft in diameter at base of canopy and 15 ft in height. Branches in right foreground show relationship of unpruned tree size. The cutting operation removed 75 to 80% of the fruit-producing surface. The reduction in yield also amounted to about 80%.

SINCE PICKING represents nearly one-half of the manpower input for production of Valencia oranges in southern California, it has often been suggested that planting trees close together, then pruning and trimming them to form a 5- or 6-ft thick "hedge," might extend a potentially insufficient labor supply by increasing picker efficiency. With such a hedge, pickers could reach in from either side to the center of the tree. The hedge would be topped at 10 or 12 ft, so that one man, riding on a raised platform, could easily harvest the top half of the hedge. The platform or scaffold could incorporate a fruit-handling system so that picking would not involve bags or any other weight load on the picker. This system also would be economical and require little maintenance. However, the feasibility of such a pruning plan depends not only on harvest efficiency, but yield response.

Pruning trials

As a labor shortage appeared imminent, a pruning trial with mature Valencia oranges was initiated in September of 1960 as a cooperative effort of the Citrus Research Center and the Agricultural Extension Service. The test site was at Rancho Los Cerritos in the San Juan Capistrano district of Orange County.

A hedgerow orchard of Valencias, planted in 1943, spaced 12 feet apart in the row and 24 feet between rows was selected for the trial. The trees were 14 to 16 ft in diameter at the base and 15 ft high. Sixteen trees were grouped into four replicates of four trees each. Each replicate had a four-tree check. The trees were cut back to a width of 5 ft and topped to a height of 10 ft in September, 1960. A vigorous flush of new growth 3 to 6 inches long pushed out on the main scaffold branches six weeks following pruning. A fall growth flush is typical of Orange County growing conditions. During the winter, however, this growth was injured by frost; later the spring growth was damaged by aphids. Very little fruit was set on wood less than one season old. Subsequent growth tended to be of vigorous vegetative nature and attained considerable length before setting fruit. The weight on the ends of these long branches caused the limbs to hang out over the original 5-ft width.

Yield results

Average yields from the pruned trees for 1961, 1962, and 1963 were 0.6, 1.3, and 2.2 field boxes. The unpruned check trees during the same crop years produced 3.7, 5.4, and 1.7 boxes, respectively. In this case the pruning appeared to interrupt the alternate bearing cycle associated with this variety. This response has been observed in other trials also, and sometimes pruned trees may become alternately phased with the check trees.

Valencia orange trees in a late-maturity district such as Orange County have at least one crop on the tree at all times. Any pruning or cutting of wood reduces yield. Timing for pruning Valencia oranges is difficult if crop loss is to be minimized.

The average cumulative reduction (80%) of seven field boxes per tree during the first two years of the San Juan Capistrano trials was considered too expensive to offset any increases in picker efficiency. For this reason the trial has been concluded. Emphasis has now shifted to training young trees in varying spacings, so that the variable of greater tree density can be incorporated in new trials.

J. E. Pehrson is Farm Advisor, Orange County; and C. D. McCarty is Extension Horticulture Technologist, Agricultural Extension Service, University of California, Riverside.

Assisting in these trials were L. N. Lewis, Department of Horticultural Science, Citrus Research Center, and R. G. Platt, Agricultural Extension Service, U. C., Riverside. The trees were provided by Rancho Los Cerritos, G. D. McGrath, Manager.