trees were not found to be deficient in boron. However, low levels of boron in acid plots of the Experiment Station would indicate that boron deficiency could develop on rough lemon with a continuous low pH program. Only a comparatively few samples were collected from the East Coast section but a larger number of deficient orchards was found. They were all on sour orange stock but since no study was made of rough lemon stock in this area it cannot be said that boron deficiency only occurs with sour orange stock.

With the trend toward high analysis fertilizer mixes and straight materials programs, less boron is present as an impurity. This is a wide variation between fertilizers and different materials programs. Howboron toxicity is not necessary for good fertilizer practice and much less boron could be safely used.

SUMMARY

Visible symptoms for boron deficiency are not dependable. Boron deficiency was found in orchards on sour orange stock, mainly on the East Coast. Commercial orchards in the central part of the state on rough lemon rootstock, did not show deficient levels of boron in the leaves even though they were selected on the basis of deficiency symptoms.

High levels of boron in grapefruit leaves resulted in only a slight increase in the boron level of the fruit. No relation was found between boron treatment and the percent gummed grapefruit found among the dropped fruit.

A rough estimate has shown that natural sources of boron could be equivalent to more than twice the tree requirement for 1000 pounds of fruit.

The probable need for boron is recognized with the trend toward higher analyses fertilizer mixes and materials programs. However, this study would indicate that too much boron is now being used on many orchards.

**LITERATURE CITED**


**XYLOPOROSIS OF CITRUS**

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XYLOPOROSIS OF CITRUS was first recognized in Palestine about 1928 (9) and was later identified in Brazil and Argentina (6). Recently typical symptoms of this disease were observed in Florida on trees budded on a so-called sweet lemon, the exact classification of which has not been established (4). Now that xyloporosis, or a disease similar to it, is known to be present in Florida, citrus growers of the state should
know its nature, characteristics and importance.

The exact nature of xyloporosis has not yet been determined completely and different ideas have been set forth to explain the disease. Fawcett (5) states that it is probably caused by a virus. Moreira (8) considered the disease to be the result of an incompatibility between cion and stock; Baumgart (1) attributed it to the "disturbed circulation of the sap caused by the mechanical injury of the sweet lime stock at the time of budding"; and Katzprowsky (7) to "a dehydration of the sweet limestock by drying winds." Microorganisms are not the cause of the disease, although in advanced stages they are present in the dead and scaling bark of the stock as secondary invaders. Neither soil nor climate cause xyloporosis, but they might influence the course of the disease. Affected trees are found growing in many different soil types and climates. According to Reichert and Perlberger (9) "the percentage of diseased trees and especially the grade of the disease do seem to be directly affected by the texture of the soil... In orchards of waterlogging soils, the grade and percentage is higher than in more sandy and better drained soils."

**Symptoms and Effects**

The course of xyloporosis sometimes is separated roughly into three stages, but the progress of the disease is so gradual that no sharp separation occurs from one phase to the next. In this discussion the symptoms will be described in reference to the part of the tree affected, and are based in part on the description of xyloporosis given by Reichert and Perlberger (9) for sweet orange on sweet lime and in part on our own observations.

Symptoms usually are not observed in the nursery. On the contrary, trees on sweet lime rootstock produce a vigorous growth. Some of the more susceptible plants, however, may not be quite as thrifty as others at the time they are set out in the grove and, in succeeding years, these are the first to develop symptoms of xyloporosis.

Up to the present, no leaf symptom has been found that is characteristic of xyloporosis only. Symptoms of minor element deficiencies, particularly those of zinc and manganese, and yellowing of the midvein have been observed in affected groves, but these symptoms are not peculiar to xyloporosis. Leaves on diseased trees tend to be smaller than normal. Deficiency symptoms usually are noticed first when affected trees are three to four years old.

Shallow depressions develop in the bark below the bud union and gradually increase in size and merge into large patches and bands. The bark of the stock becomes hard, cracks and dead patches scale off, and at times gum exudes through cracks in the bark. In advanced cases the wood under severely affected patches dies, turns dark and finally decay sets in. Ordinarily these bark symptoms are confined to the stock, but sometimes a scaly patch resembling psorosis extends over the bud union onto the trunk of the cion, Fig. 1. There is often an appreciable overgrowth or swelling of the cion forming a kind of knee at the bud.
union. This type of structure is attributed to the accumulation of carbohydrates (3, 9).

Usually about the third or fourth year, small, round or flattened cone-shaped pits occur in the wood of the trunk below the bud union, into which fit corresponding pegs or protuberances of the bark. The pits and pegs are most numerous just below the bud union and become progressively less numerous below the soil line. Observation of trees on sweet lime stock in Argentina showed that pits and pegs were present on the tap root and upper parts of the crown roots, but not on the secondary and small roots. As the disease progresses and the trees get older the pits and pegs become more numerous giving the wood a perforated or sieve-like appearance. Gum accumulates in the bark of the stock, discoloring the phloem layer brown. This brown gum deposit, which may be seen readily by removing the outer layer of bark carefully is found only in the bark of the sweet lime stock. The presence of pits and pegs and the brown gum layer in the bark are important diagnostic symptoms of xyloporosis.

Root rot is not a normal symptom accompanying diseased trees, although there are fewer fibrous roots on affected than on healthy trees. Reichert and Perlberger (9) noted that diseased trees growing in heavy soil had more root rot than trees growing in well drained soils. The root rot in such cases was attributed to waterlogging rather than xyloporosis.

Trunks of diseased trees often grow at an angle to the ground and may be curved, Fig. 1. This distortion occurs because the wood is incompletely hardened and the weakened trunks, unable to support the weight of the tops, bend over (9).

Xyloporosis-diseased trees are stunted and tend to be flat-topped. The degree of dwarfing is dependent on the length of time that a tree has been diseased as well as the age of the tree. Not all the trees in a grove are affected equally or at the same time, the more severely affected trees being more stunted than the less affected ones.

Ten xyloporosis diseased trees that were measured averaged 6.5 feet in height, 8 feet in diameter and had a bearing surface of 163 square feet. In comparison, ten apparently healthy trees averaged 11.5 feet in height, 12 feet in diameter and had a bearing surface of 433 square feet. All the trees measured were ten-year-old trees of the same variety in the same grove and had received the same care. Thus, the affected trees had made about half the growth and had only 37 percent of the bearing surface of the unaffected trees.

Small branches and twigs wither and die and dead wood accumulates giving diseased trees a scraggly appearance. Death of branches progresses until only a small cluster of living branches is left in the center of the tree. Depending on the growing conditions, diseased trees do not always die, but may remain dwarfed and continue to produce small quantities of fruit.

The quantity of fruit produced by diseased trees is variable; mildly affected trees produce fair crops of fruit for their size and trees that are about dead bear little, if any, fruit. Reichert and Perlberger (9) noted that the percentage of soluble solids, total sugars, reducing sugars and acidity in fruit from diseased trees was higher than that from healthy trees. The fruit from normal trees was heavier and larger than that from diseased trees.

VARIETIES AND STOCKS AFFECTED

Xyloporosis affects mainly trees budded on the sweet lime rootstock. Sweet oranges on sweet lime are the most susceptible and the following varieties, when budded on sweet lime, so far have been reported affected: Valencia, Lue Gim Gong, Navalencia, Jaffa, Shamouti, Criolla, Azores sweet orange, Mediterranean sweet, Barao, Pera, Hamlin, Parson Brown, Bahia navel and Ruby Blood. Sour lemon, grapefruit and common mandarin are also reported to be susceptible when budded on the sweet lime stock (3). In Florida the following varieties have been observed to be affected when grafted on a so-called sweet lemon: Jaffa, Lue Gim Gong, Hamlin and Temple oranges and Foster Pink grapefruit. Pit and peg symptoms of xyloporosis have been observed in other cion-stock combinations, such as Valencia sweet orange on “Limon sutil (3).” Recent evidence by Childs (2) indicates that xyloporosis and the cachexia disease of tangelos are manifestations of the same disease. Sweet lime seedlings also are susceptible and develop the typical pit and peg symptoms on the trunk.

PREVENTION AND CONTROL

In the light of the present information on xyloporosis, budding trees on sweet lime or other susceptible stocks should be avoided.
Other suggestions which may be beneficial are based on changing the rootstock of susceptible trees where possible by inarching with seedlings of rough lemon, sweet orange, sour orange or any rootstock that will produce a xyloporosis resistant tree. In addition, converting the grafted tree to a seedling by cion rooting may also be done to save a tree. Inarching and cion rooting, to be of value, should be done on young trees before the disease appears. Trees so treated might later develop heart rot. Top-working with some other variety is of doubtful value since the disease is primarily one affecting the rootstock. It is usually more satisfactory to pull affected trees and replant with tolerant or resistant ones than to treat diseased trees. When budding nursery stock, bud wood should be taken from trees that do not harbor xyloporosis as determined by budding tests on sweet lime stock. If the test trees do not develop the disease, it can be assumed that the parent tree is free of xyloporosis.

Xyloporosis probably has been present in Florida for many years, but it became evident only when susceptible cion-stock combinations were grown. Xyloporosis is not a major disease in the Florida citrus industry because the so-called sweet lemon is not a commonly used rootstock. If it were to be generally adopted, which is not likely now, xyloporosis would be a problem.

Changes to new, untried rootstocks entail risks because of possible unsuspected problems that could arise. In this respect an example might be taken from the Argentine citrus industry. In the nineteen twenties a change was made from sweet orange to sour orange stock to avoid foot rot. In 1930-31 tristeza appeared and since then has destroyed over 10,000,000 trees on sour orange roots. To avoid tristeza, many growers made extensive plantings on the Persian sweet lime stock only to find themselves faced with xyloporosis. Many of the new groves set out on sweet lime stock only to find themselves faced with xyloporosis. The finding of xyloporosis in Florida emphasizes the necessity of thoroughly testing new rootstocks for a number of years for pathological and horticultural aspects before they are adopted commercially.

LITERATURE CITED