Fluorine Toxicity in Citrus

growth retardation and leaf tip-burn accompanied increased fluorine concentrations in experimental laboratory cultures

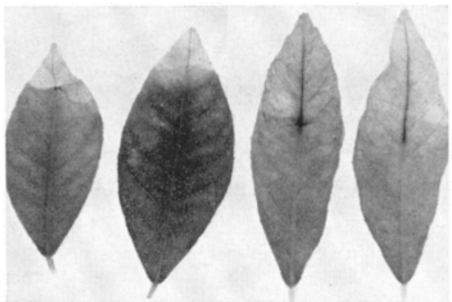
A. R. C. Haas and J. N. Brusca

Foliage injury in certain fruit tree varieties has been reported as being quite serious when the leaves were subject to hydrogen fluoride or fluorine deposits. Leaf tip-burn resulted in gladiolus plants when exposure was made to various concentrations of fluorine gas. Leaves of citrus trees located in close proximity to gaseous sources of fluorine are reported as containing an increased content of fluorine. Fluorides are known to occur in certain crude phosphate materials, the very sources from which fertilizers are prepared.

The present study was designed to show the effect on rooted leafy-twig lemon cuttings of various concentrations of fluorine in the form of sodium or potassium fluoride when added to the nutrient solution applied to silica sand cultures grown in the glasshouse. The tests were repeated several times and always with the same results.

A single cutting was grown in each three-gallon capacity silica sand culture provided with drainage. Hoagland's nutrient solution was used and contained as the minor elements: boron, manganese, zinc, iron, aluminum, copper, and molybdenum. Distilled water was used

Fluorine effect on the growth of rooted leafy-twig cuttings of Prior Lisbon lemon when sodium fluoride is added to the nutrient solution applied to silica sand cultures. *Above, left to right:* 0, 25, and 50. *Below, left to right:* 100, 200, and 400 ppm fluorine. *Lower, extreme right:* no sodium fluoride but instead, 485 ppm sodium added as the nitrate.

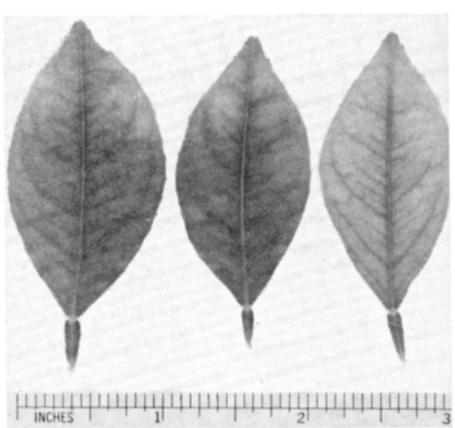


Small or narrow leaves of a Prior Lisbon lemon cutting grown in a silica sand culture, with the nutrient solution containing 400 ppm fluoride added as either sodium or potassium fluoride. The two leaves to the left were taken from the highest fluorine cultures and show a loss in green color between the lateral veins. The second leaf from the left shows a few extremely small burned spots. The two leaves on the right are from the highest fluorine cultures and show severe tip burn. The extent of the burn is evident in the darkening of the upper half of the midribs; the leaves are narrow and pale green.

at all times. To the nutrient solution was added various concentrations of sodium or potassium fluoride. Hoagland's nutrient solution used in the control culture contained 7 ppm—parts per million—sodium and 185 ppm potassium.

The concentrations of fluorine added as sodium fluoride—ppm—were: 0, 25, 50, 100, 200, and 400. At the highest fluorine, a concentration of 485 ppm of sodium accompanied the added fluorine, and the sodium might be considered as contributing to the retardation of growth and injury in the cuttings. An additional

Leaves of sweet orange seedlings grown in silica sand cultures supplied with nutrient solution containing 400 ppm of fluorine as sodium or potassium fluoride. Note the loss of chlorophyll near the leaf tip. New leaves are of reduced size.



culture in which the nutrient solution contained 485 ppm of sodium as the nitrate, instead of as the fluoride, indicated that the concentration of fluorine rather than that of sodium was the injurious agent. The illustrations in the first column show the beginning of growth retardation at the 100 ppm concentration of fluorine and the reduced leaf size. They also show the excellent growth when the highest sodium used was supplied as the nitrate instead of as the fluoride.

Several tests were made with cultures such as these, except that various concentrations of fluorine as potassium fluoride were added to the nutrient solution, in ppm: 0, 25, 50, 100, 200, and 400. At the highest fluorine concentration, the added potassium was 820 ppm. An additional culture was set up in which 820 ppm of potassium was added to the nutrient as the nitrate instead of as the fluoride, and the results indicated that fluoride rather than excessive potassium was the injurious factor.

The pictures in the third column show the effect of the fluorine added as

Concluded on next page

Growth of rooted leafy-twig cuttings of Prior Lisbon lemon in silica sand cultures supplied with Hoagland's nutrient solution containing various concentrations of fluorine added as potassium fluoride. *Above, left to right:* 0, 25, and 50. *Below, left to right:* 100, 200, and 400 ppm fluorine. Lower, extreme right: no potassium fluoride but instead, 820 ppm potassium added as the nitrate.

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FLUORINE

Continued from preceding page

potassium fluoride to the nutrient solution. At the 50 ppm concentration of fluorine, the effects on leaf size and plant growth were apparent.

Whether the fluorine was added to the nutrient solution as the fluoride of sodium or potassium, a concentration of 400 ppm of fluorine in the culture solution was accompanied by severe leaf injury and defoliation. Under ordinary inspection, fluorine tip-burn could easily be confused with the symptoms of chlorine tip-burn.

Numerous silica sand cultures with large sweet orange seedlings have shown when the nutrient solution contained 400 ppm of fluorine supplied as sodium or potassium fluoride that a loss of chlorophyll soon becomes evident near the leaf tip and that the new leaves are of reduced size.

A. R. C. Haas is Plant Physiologist, University of California, Riverside.

Joseph N. Brusca is Principal Laboratory Technician, University of California, Riverside.

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