Lithium Toxicity in Citrus

recognized on leaves in a grove in Santa Barbara County on the basis of artificially produced symptoms

D. G. Aldrich, Jr., A. P. Vanselow, and G. R. Bradford

Lithium toxicity in citrus was recognized for the first time in the field in Santa Barbara County. The element apparently came from irrigation water.

The symptoms—leaf mottling and defoliation—were recognized from experiments in which lithium toxicity symptoms had been produced artificially, and the presence of lithium in the affected plants was confirmed by a recently developed spectrochemical method.

The lithium-toxicity symptoms shown in the accompanying photograph occurred on sweet orange seedlings grown in pots in the greenhouse about six months after two and five ppm—parts per million—of lithium sulfate were incorporated in the air-dried soil.

Similar leaf symptoms were obtained in the field by applying lithium chloride to three series of 10-year-old Eureka lemon trees, at the rate of one, two, and four ppm.

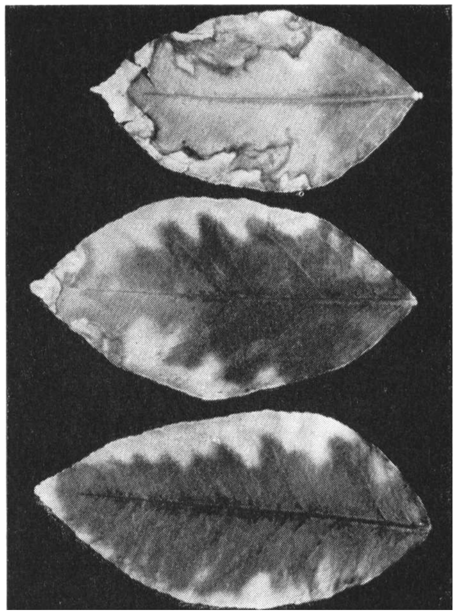
The extent to which the lithium excess patterns occurred and the amount of defoliation that accompanied these symptoms in both greenhouse and field experiments was directly related to the amount of lithium applied.

All the leaves showed symptoms of lithium toxicity. Normally, lithium is not detected in citrus plant ash.

Experiments

The lithium content of the young leaves of the sweet orange seedlings appeared to be related to the amount of lithium applied to the soil. Such relationship did not exist with respect to the other plant parts analyzed—the mature leaves, top bark, top wood, rootbark, and root wood. In each set of samples, less lithium was found in the plants growing in the soil receiving the largest amount of salt. The more rapid and greater defoliation of the plants treated with the larger amounts of lithium may partly account for this condition since defoliation eliminates lithium from the plant. Lithium accumulates in the leaves as they mature—85% of the lithium content of the entire plant is in the leaves—and concentrations of similar magnitude do not develop in other vegetative parts of the plant.

The analytical data likewise show no direct relation between the lithium content of mature leaves of Eureka lemon and the amount of lithium applied to the soil. Inasmuch as lithium-toxicity symptoms were present in all leaf samples, such symptoms may be expected when the amount of lithium found in the leaves is 13.5 ppm or more.



Lithium-toxicity symptoms on sweet orange leaves.

An analysis of lemon fruit taken from trees receiving the highest amount—4 ppm—of lithium reveals that a small amount of lithium moves into the peel, and a barely detectable amount can be found in the juice. Detailed information on the toxicity of lithium to humans is lacking; but any study of the use, by humans, of citrus products obtained from trees irrigated with lithium waters will have to consider the areas of lithium concentration in citrus fruit. Further studies will investigate the effect on animals of plants containing lithium.

Field Evidence

The naturally occurring lithium symptoms discovered in the grove in Santa Barbara County were found in the leaves of lemons, grapefruit, and Valencia and navel oranges. Leaf samples showing typical lithium-toxicity patterns were taken from the several varieties for analysis.

Analyses of these samples showed that the macroelements—elements taken up by the plant in large quantities—were present in relatively normal amounts although calcium was high. Spectrographic examination revealed that the content of all microelements—those taken up by the plant in minute quantities—except lithium was normal. This element was present in amounts comparable to that found in leaves showing artificially produced lithium-toxicity symptoms. The lithium contents in the leaves of lemon were 12 ppm dry matter, in grapefruit 14 ppm, in navel orange 23 ppm and in Valencias 14 ppm.

A survey of the cultural history of the grove and its general vegetative condition from year to year showed that the lithium toxicity patterns apparently became more prevalent when the amount of irrigation water applied to the plantings was increased. Such an increase was made possible by the recent development of new wells on the property.

Samples of water were taken from four wells used as sources of irrigation water. Spectrographic examination revealed lithium contents of 0.075, 0.045, 0.055, and 0.080 ppm. Microelements other than lithium were present in the waters from these four wells in amounts within the range commonly encountered in good irrigation water.

As a lithium determination can not be made on the water source used in previous years to irrigate this grove, it is impossible to say whether the lithium symptoms of the citrus are the result of an accumulation of lithium in the soil over a long period, suddenly accentuated by the increased use of water; or whether these symptoms have been produced in a relatively short period by the small amount of lithium present in the well waters recently developed. Experiments are now being conducted to determine the relative toxicity to citrus and other plants of small amounts of lithium—0.05 to 0.10 ppm—present in irrigation waters.

D. G. Aldrich, Jr. is Associate Chemist, University of California College of Agriculture, Riverside.

A. P. Vanselow is Associate Chemist, University of California College of Agriculture, Riverside.

G. R. Bradford is Assistant Specialist in Soils and Plant Nutrition, University of California College of Agriculture, Riverside.