Leaf Symptoms of Toxic Biuret

citrus and avocado leaf patterns indicating biuret toxicity different in variety and by concentration

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Nitrogen, in the form of biuret, has a toxic action on citrus—when present in sufficient concentration—as demonstrated in tests with rooted Prior Lisbon lemon cuttings in sand cultures.

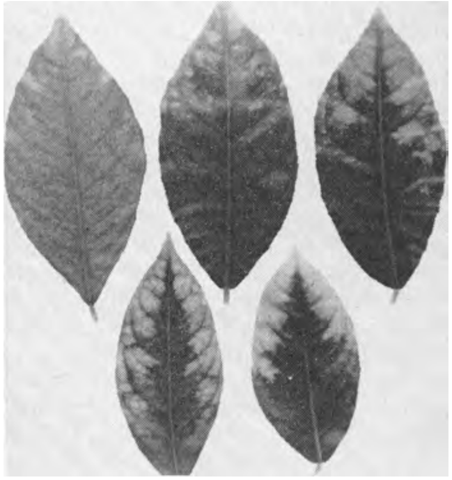
The leaf patterns reflecting toxicity show considerable variation as the concentration of biuret applied to the culture medium is increased.

The effect of low concentrations of biuret is evident first near the leaf tip, and as the concentrations are increased, the injury—chlorosis—extends progressively along the leaf margin. The symptoms bear a resemblance to those of boron excess except for lacking both the gum spots on the underside of the leaf and the golden yellow color of the chlorotic portion. There is also some resemblance to sulfate toxicity patterns. At the higher concentrations of biuret, there is a leaf pattern resemblance to that of calcium or magnesium deficiency in which a green triangle remains along the midrib.

Comparative Tests

To observe whether the leaves of other seedling varieties give essentially the same leaf patterns as those of Prior Lisbon lemon, a large series of three-gallon-capacity, well-drained soil cultures were set up in which were used the seedlings of seven citrus varieties commonly used as rootstocks.

Three seedlings of a given variety were planted in each of six cultures. The cultures were given a uniform treatment of Hoagland's nutrient solution and distilled water until the seedlings were approximately pencil diameter. All of the seedlings were cut back at the same time to encourage the simultaneous production of new growth in each culture. When the growth was well developed and the leaves still immature, biuret was added to one application of nutrient solution to obtain concentrations of biuret in parts per million—ppm—of 0, 50, 100, 150, 200, and 250. Symptoms of toxicity were soon evident in such varieties as rough lemon and Tangelo. The subsequent cycles of growth were practically free of the leaf symptoms of the cycles from which they originated.



Variation in the leaf patterns of Prior Lisbon lemon supplied with nutrient solution containing concentrations of biuret varying from 0 to 150 ppm.

Leaves of the Tangelo seedlings showed a few yellow spots after the one application of nutrient containing 50 ppm biuret. With 100 ppm, there were many small yellow spots. At 150 ppm and 200 ppm, symptoms were pronounced, and at 250 ppm, they were very severe.

One of the earliest varieties of citrus seedlings to show biuret toxicity was the rough lemon. At the 100 ppm concentration, there were numerous small yellow areas in the leaves, whereas at all of the higher concentrations, the leaf symptoms were very severe.

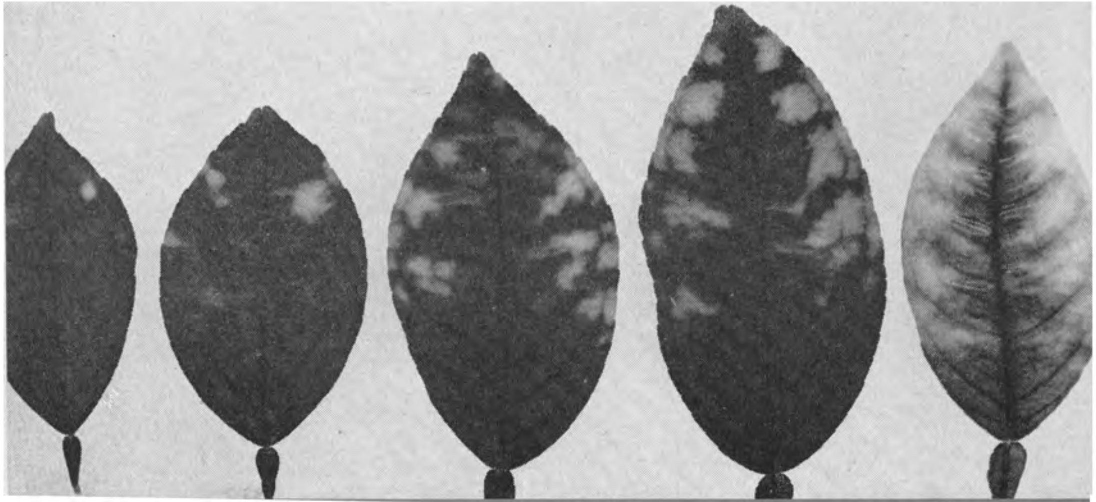
Severely affected leaves of the Tangelo and rough lemon varieties were dipped into a solution of iron tartrate—one gram per liter of distilled water—or into a solution of zinc sulfate—at the rate of six pounds of zinc sulfate, three pounds hydrated lime in 100 gallons of distilled water—with no improvement evident in any case after two or more weeks.

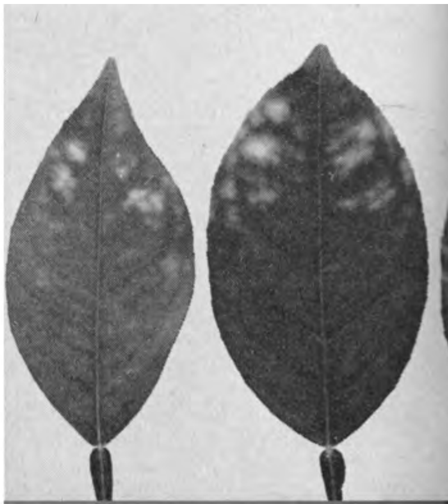
Leaves of the sweet orange seedlings showed many small yellow areas at the 100 ppm and 150 ppm biuret concentration in the one application of nutrient, with severe injury at 200 ppm and very severe injury at 250 ppm.

At the 150 ppm concentration, the leaves of the Cleopatra mandarin seedlings showed very slight symptoms, with only a few yellow areas at 200 ppm but with very severe symptoms at the 250 ppm concentration.

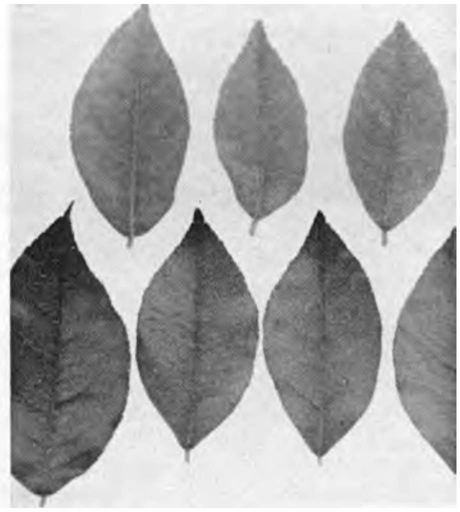
The leaves of grapefruit seedlings

The four illustrations below show—*left to right*—1. The effect of increasing the biuret concentration—50, 100, 150, 200, and 250 ppm in one application of nutrient solution to Tangelo soil cultures. 2. Concentrations of biuret—100 to 250 ppm—in the one application of nutrient solution applied to soil cultures of sweet orange seedlings were accompanied by marked





Lemon trees on sour orange rootstock. Control tree on left. The four trees on right were sprayed out-of-doors with a urea mixture. After spraying, the second and third trees from the left were placed in a whitewashed glasshouse. The two trees on the right were continuously out-of-doors.



Effect of urea spray on the leaves of lemon trees—on sour orange rootstock—grown out-of-doors. *Upper row:* leaves from sprayed cultures continuously out-of-doors. *Lower row:* leaves from sprayed trees placed in whitewashed glasshouse.

showed very few yellow spots at 150 ppm concentration, but at 200 ppm and 250 ppm, the toxic effect was very severe.

Troyer Citrange leaves showed only the slightest trace of toxicity at 150 ppm, small but distinctive symptoms at 200 ppm, and considerable mild symptoms at 250 ppm.

Sour orange seedlings also showed a marked resistance to biuret toxicity, as did those of Troyer Citrange. At 200 ppm, the leaves of sour orange showed definite but mild symptoms, whereas at 250 ppm, the symptoms still were not severe.

Biurea, hydroxylamine hydrochloride, and acetamide were added without success to Hoagland's nutrient solution applied to sand cultures of lemon or rough lemon seedlings in efforts to learn whether their presence in compounds could produce the leaf symptoms induced by biuret.

Leaves of rooted Zutano—Mexican variety—avocado cuttings grown in soil cultures revealed considerable sensitivity to biuret toxicity, showing an increasing effect as the biuret concentration—50 ppm to 200 ppm—was increased in the one application of nutrient. The chlorosis pattern sometimes affected the portion on one side of the midrib more than that on the other side, and it usually developed along the leaf margin and toward the midrib.

Tests with Urea

Experiments were carried on with crystalline urea with the objective of learning what effect, if any, a more or less continuous period of sustained high air temperatures, coupled with intense sunlight, may have on the behavior of citrus leaves when sprayed with urea.

Lemon trees on sour orange rootstock were grown with the same nutrient treatment for several years out-of-doors in 12-gallon capacity, well-drained soil cultures. The trees were pruned back and when the new growth had progressed to nearly full size but immature, four of the eight cultures were sprayed out-of-doors on July 9, 1954.

The spray used was a mixture of five pounds of urea, 2.5 pounds of hydrated lime, and 100 gallons of distilled water. Two of the sprayed trees were at once placed in an adjacent glasshouse that had been whitewashed but not provided with any mechanical cooling system.

Within a few days, the leaves of the cultures placed in the glasshouse were somewhat larger and greener than those of the cultures sprayed and left continuously out-of-doors. No leaf damage occurred in any of the sprayed cultures, all of which were much greener than the nonsprayed cultures kept continuously out-of-doors.

The results of the test indicated the desirability of conducting urea spraying during periods of cool or foggy weather in order to obtain the maximum beneficial effect.

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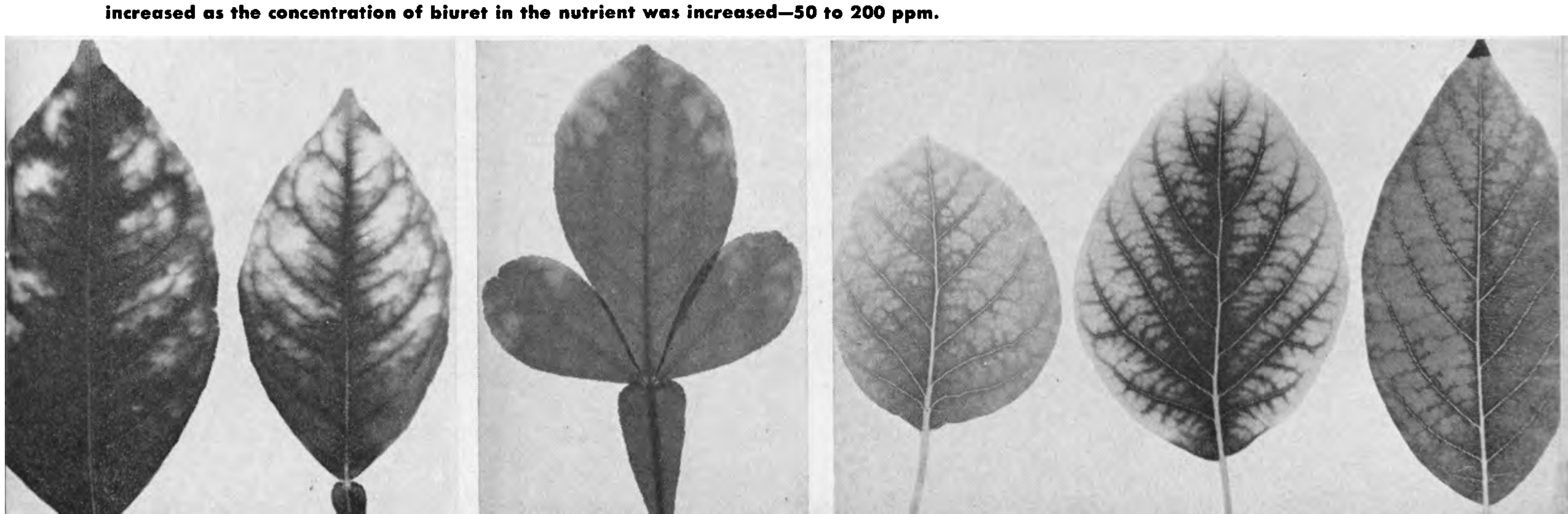
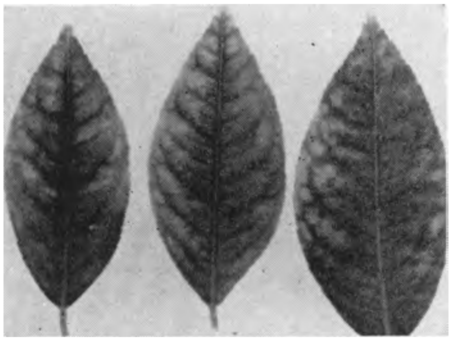
leaf symptoms. 3. Symptoms of biuret toxicity in leaves of Troyer Citrange seedling soil cultures. These effects occurred only at the higher biuret concentrations. 4. Leaves of rooted Zutano—Mexican variety—avocado cuttings grown in soil cultures. The severity of the chlorosis increased as the concentration of biuret in the nutrient was increased—50 to 200 ppm.





Effect of excessive concentrations of urea spray mixtures on leaves of lemon trees on sour orange rootstock grown in soil cultures resembles the patterns induced by biuret.

BIURET

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To explore excessive spray applications of such urea mixtures, these same four cultures on July 22, 1954, were again sprayed out-of-doors, but this time with a mixture three times as concentrated as previously. The two cultures formerly in the glasshouse were again placed in the glasshouse following the second spraying. Leaf burn was soon evident in all four sprayed cultures. The test was continued until August 4, 1954, when the sprayed trees—continuously left out-of-doors—were considerably greener than nonsprayed control trees but were not nearly as green as the trees moved into the glasshouse after each spraying.

After August 4, 1954, all cultures were kept out-of-doors. Within three weeks the cultures formerly in the glasshouse showed considerable new growth whereas those continually out-of-doors showed none.

Following the double spraying, some of the leaves of the sprayed trees—kept continuously out-of-doors—had symptoms with patterns suggestive of biuret. The marked change to continuously high air temperatures, together with the high concentrations of the urea spray, were possibly responsible for the appearance of leaf patterns having some resemblance to those produced by biuret.

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DEFECT

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the bean. The affected beans are usually at the blossom end of the pod—at the end away from the place of attachment of the pod to the plant. Sometimes all the beans in a pod are affected, but most frequently only one or two.

Half-grown beans show this defect less frequently than beans that are at the mature green stage for freezing.

In laboratory tests, thin sections from affected beans were stained and examined microscopically to determine precisely the region of the seed covering which becomes discolored. The dark tissue showing injury—except where the whole seed covering is split—is confined to the inner surface of the covering. The exact nature of the affected layer cannot be determined without study of younger seeds, but it appears to be the remains of a nutritive tissue known as endosperm. It is this layer and not the testa or the cotyledons that disorganizes, cracks, and discolors.

Fertilizer experiments in Santa Clara County did not indicate any important relationships to soil nutrients. The experiments included three irrigation treatments—normal and with one and two irrigations omitted late in the season. In all cases, the omission of two irrigations increased the percentage of wrinkled beans. However, on the lightest soil, even the normal irrigation gave 3.4% wrinkled beans, whereas when two irrigations were omitted, 8.8% of the beans were affected. These data indicate a relationship between the relative amount of this defect and irrigation treatment.

There are two sources of economic loss from wrinkled beans: the added cost of extra help to sort the defective beans at the processing plant—as well as the loss due to lower grades with lower sales value—and the abandoning of fields or sections of a field.

Because most of the difficulty with wrinkled beans has been with Concentrated Fordhook, it might be desirable to use the U. S. 242 variety—in less favorable climates and on marginal soils low in water-holding capacity—although it does not always give as high yields and the plant is larger.

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FUMIGATION

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does not seem practical because of the damage done to them.

In the greenhouse fumigation experiment at Riverside, methyl bromide, chloropicrin, vancide 51, and dithane D-14 were tested. Cultures of the fungus were inserted in wire mesh traps on strings of wire and placed in large cans of sterilized soils. Results showed that all four fumigants and fungicides were effective in killing the fungus, but methyl bromide and chloropicrin were the fastest acting and gave the most complete destruction.

Although treating diseased trees in place does not seem practical because of the damage done to them, methyl bromide can be effective in sterilizing potting soil prior to its use for growing avocado seedlings. It is possible that methyl bromide could also be used as a chemical barrier to isolate infected areas in an orchard, but further work needs to be done on the uses of methyl bromide.

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Test plot at the University of California, Los Angeles, involved three diseased trees. Three 10' × 10' areas, with a diseased tree in the center of each, were fumigated with methyl bromide, ½ pound per 100 square feet.