Biuret, Toxic Form of Nitrogen

soluble nitrogen compounds are not of equal value as fertilizers as shown by tests with citrus and avocado

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Biuret—a compound form of nitrogen obtainable from urea—was recently tested for its toxic effect on the growth of citrus and avocado.

The claim has often been made that similar concentrations of soluble nitrogen are of equal value for the healthy growth of citrus and avocado trees regardless of the nature of the nitrogen-containing fertilizer. One of the forms of nitrogen frequently used in the fertilization of such trees is urea, so tests were designed to determine what effect the use of biuret—derivable from urea—would have on citrus and avocado tree growth.

Prior Lisbon lemon leafy-twig cuttings were obtained from parent trees S1A, R7, T1 in the Citrus Experiment Station orchard at Riverside on February 4, 1954. The cuttings were rooted in propagation chambers. The use of continuous mist—periodically containing a nutrient solution—resulted in 100% of the cuttings taking root. When hardened, a single cutting was planted in each of several three-gallon capacity earthenware jars containing pure silica sand.

The cuttings remained in these jars, with only distilled water added to each of the silica sand cultures, until a new cycle of growth was well under way.

On March 4, 1954, each culture received two liters of Hoagland's nutrient solution made with distilled water and containing the trace elements: boron, manganese, zinc, iron, aluminum, copper, and molybdenum. This solution has given excellent healthy growth in other experiments.

Effect on the leaves of rooted leafy-twig Zutano (Mex.) avocado cuttings grown in soil cultures of a single application of two liters of nutrient solution containing—*Left to right:* 100, 50, and 0 ppm of biuret.

Biuret, at concentrations of 0, 50, 100, or 150 ppm—parts per million—was added to the nutrient in this study. Within a few days the injurious effect of the biuret was observed, even though the Hoagland's nutrient solution contained 718 ppm of nitrate. When the pronounced symptoms produced by the 150 ppm biuret concentration were first becoming evident, the leaf margins of half-grown leaves appeared wilted and ready to show leaf burn. Instead of burning, the margins became increasingly chlorotic—yellow. The original mature leaves of the cuttings—grown before the biuret was added to the solution—showed no effect of the biuret by April 9, 1954, when the photographs on this page were taken. At the 50 ppm biuret concentration, slight chlorosis—yellow spotting—occurred in the new

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The toxic effect of a single application of two liters of Hoagland's nutrient solution containing biuret on the growth of rooted leafy-twig cuttings of Prior Lisbon lemon grown in sand cultures. *Left to right:* 150, 100, 50, and 0 ppm of biuret.

Frequency of Separation Layer Occurrence between Inner and Outer Bark One Year after Inoculation.

Inoculum	Lesions examined No.	Lesions with layer %
Botrytis	**35**	**66**
Diplodia	**29**	**83**
Dothiorella	**6**	**50**
Phomopsis	**31**	**100**

many lesions less than one-fourth of this amount remained alive and even this portion was often gum filled. *Botrytis* killed to the greatest average depth.

The bark of each lesion was examined for the presence of a separation layer or cork cambium in the bark beneath the lesions at distances of 1″, 2″, and 4″ from the inoculation wounds. Separation layers had formed beneath all *Phomopsis* lesions but had also developed in a high percentage of lesions from other fungi. The formation of this separation layer is essential in the development of typical shell bark.

Many natural shell-bark lesions developed on the same trees simultaneously with lesions resulting from wound inoculations. In some cases these occurred in the vertical elliptical pattern common in shell bark. *Pyrenochaeta* and *Alternaria* were the fungi most commonly found, but 38% of the lesions apparently contained neither fungi nor bacteria.

Injury and Shell Bark

In May 1953, numerous small scratches were made on Allen Eureka and Rosenberger Lisbon lemon trees of various ages. The wounds on 4-year-old Rosenberger Lisbon trees healed rapidly. Satisfactory healing occurred on 4-year-old Allen Eureka and 13-year-old Rosenberger Lisbon trees. Extremely variable rates of healing—with considerable death of bark next to some scratches—were observed on 13-year-old and 18-year-old Allen Eureka trees. The poorest healing and the largest areas of dead bark were found on the 18-year-old Allen Eureka trees which had shell-bark lesions on other portions of their trunks at the time the scratches were made.

Studies of small shell-bark lesions indicated that no fungi were present at first but that the dead bark was soon invaded by one or more fungus species. The bark reacts to these fungi by gum formation, tissue death, and wound tissue formation. Unless the outer bark completely walls off a wound or fungus invasion, a barrier develops in the bark beneath the dead tissue and extends almost parallel to the surface of the bark as the dead area increases in size. Cracking and sloughing of the dead outer bark then produce typical shell bark, often called dry bark in severe cases.

The control of fungus activities within shell-bark lesions is theoretically possible although it has never been achieved on a commercial basis. Various experimental fungicidal treatments during the past forty years have failed to give practical control, although *Avenarius Carbolineum* has, in some experiments, apparently delayed or retarded lesion spread.

A large-scale experiment aimed at developing fungicidal treatments for delaying and reducing the severity of shell bark was started recently in Ventura County.

Resistance

Damage from shell bark can be virtually eliminated by planting lemon selections with an inherently high degree of resistance, which seems to involve the maintenance of a good wound-healing potential by the outer bark.

Comparison* of Cultures Obtained from Small Shell Bark Lesions with Those Grown from Dead Areas Adjacent to Small Scratches on Trees with Shell Bark.

Organism	New S.B. lesions %	Dead spots by scratches %
No growth	**38**	**12**
Bacteria	**26**	**0**
Pyrenochaeta	**25**	**12**
Alternaria	**9**	**29**
Diplodiella	**7**	**0**
Cladosporium	**5**	**47**
Colletotrichum	**5**	**0**
Dothiorella	**3**	**0**
Phomopsis	**1**	**0**
Other fungi	**3**	**6**

*** Total samplings: 76 shell bark lesions, 34 dead spots near scratches.**

All old-line true Eureka selections are moderately to extremely susceptible to shell bark. Most open-type Lisbons are no better. Carefully chosen seedling-line—nucellar—selections from Eureka lemons are somewhat more resistant to shell bark than old-line Eurekas and should be used when Eureka lemons are propagated. Certain vigorous Lisbon or Lisbon-type trees—especially Monroe and Prior—have very high resistance to shell bark. Propagation stock should be carefully chosen from virus-free sources.

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The above progress report is based on Research Project No. 1381.

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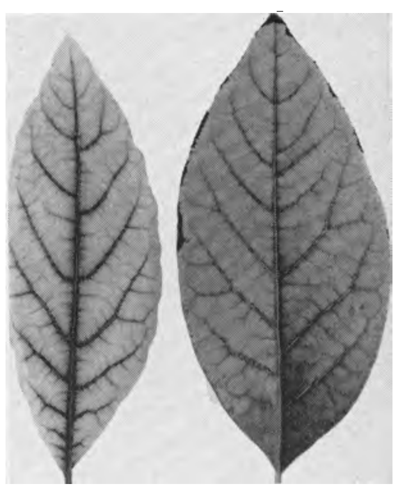
leaves, and at higher concentrations the chlorosis increased.

The toxicity of biuret was also tested on the growth of rooted leafy-twig Zutano — Mexican — avocado cuttings grown in two-gallon-capacity soil cultures. These cultures received Hoagland's complete nutrient solution from time to time and on March 9, 1954, each culture received two liters of the nutrient containing: 0, 50, 100, 150, or 200 ppm of biuret. Within a few days, wherever immature leaves occurred, the symptoms of biuret toxicity were present, mature leaves requiring a somewhat longer period in which to show the symptoms.

On April 9, 1954, the effects were severe, and a few of the cultures were photographed. Many of the immature affected leaves, even at the 50 ppm concentration, were shed. The initial effects were practically all confined to the immature leaves of the culture with biuret.



Chlorosis of immature leaves of large and previously healthy avocado seedlings brought about within a few days by the addition of 50 ppm of biuret in a single application of two liters of nutrient to the soil cultures.

The toxic effect of biuret on the leaves of avocado seedlings was also very pronounced. Hass—Guatemalan—avocado seedlings were grown in soil cultures with Hoagland's complete nutrient solution until they were several feet high and possessed cycles of immature leaf growth.

A few days after a single application of the nutrient solution containing 50 ppm of biuret, the partially mature leaves became markedly chlorotic.

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The above progress report is based on Research Project No. 1086.