A CHLOROSIS OF CITRUS PRODUCED BY BIURET AS AN IMPURITY IN UREA

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Urea, as a nutritional additive in insecticidal and fungicidal sprays for citrus, has been used in Florida by some growers and by research personnel since 1947. This organic compound, which contains 46.6% nitrogen, can be applied as foliage sprays and will be absorbed directly into the leaves. Thus it can be used to supplement regular soil applications of nitrogen. Prior to 1953, a urea product conditioned against caking had been used commercially with the only deleterious effects being a burning of the leaf tips and margins and occasionally leaf drop. This damage was usually the result of using a concentration higher than 10 to 12 pounds per 100 gallons in the spray mixture. In 1953, the application of a new form of conditioned urea caused a new type of chlorosis not previously observed in Florida. As the evidence given below indicates, this chlorosis is produced by biuret, an impurity in the conditioned urea.

Biuret chlorosis begins at the tip of the leaf and spreads down over the distal half of the leaf, forming a yellow mottling under mild chlorosis (Fig. 1). Under severe conditions, these chlorotic areas may coalesce so that the distal half of the leaf is completely chlorotic. This chlorosis is entirely different from the concentration type of damage mentioned above. Concentrations as low as five pounds of urea in 100 gallons of water have produced this chlorosis on grove trees. The chlorosis appeared on both the East and West Coasts, as well as in the Central part of the State, and was reported on most varieties of citrus. California workers (1) have recently reported that a granular form of urea has been causing a similar chlorosis. This form of urea has also been used in Florida, but has not produced symptoms as it has in California. This material has since been found to produce a chlorosis on trees at the Station at Lake Alfred.

Biuret chlorosis could be confused with boron toxicity or perchlorate toxicity. In all three types of chlorosis, the yellowing begins at the tip of the leaf and spreads downward. The yellow color of the chlorotic areas produced by biuret and boron toxicity is the same, but the gumming that usually occurs with boron toxicity is absent from the undersides of the leaves having biuret chlorosis. The orange-colored chlorosis produced by perchlorate toxicity is distinctly different from the yellow color of biuret chlorosis, and the green areas separating the chlorotic areas of perchloate toxicity are more narrow than those produced by biuret chlorosis.

Table 1. Chlorosis produced on the leaves of young Pineapple orange trees sprayed with different sources of urea

Urea source	Biuret Content %	Month of spray application											
		S.	O.	N.	D.	J.	F.	M.	A.	M.	J.	J.	A.
Commercial													
1.	2.7	C	C	C	C	C	C	C	C	C	C	C	C
2.	2.0	C	C	C	C	C	C	C	C	C	C	C	C
3.	0.6	C	C	C	-	C	-	C	C	C	C	C	C
4.	0.3	C*	-	-	-	-	-	C*	-	-	-	-	-
Chemical													
5.	0.1	-	-	-	-	-	-	-	-	-	-	-	-
6.	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Days between spraying and observation of chlorosis		45	32	90	107	72	52	18	22	20	18	19	22

C Chlorosis patterns developed
C* " " " but disappeared
- No chlorosis appeared as a result of spraying

Methods

Experiment 1. The first experiment performed was a comparison of six different urea sources. The sources consisted of four commercially available urea materials and two chemical sources, one of which was C.P. grade. Starting in September 1953, six different one-year-old Pineapple orange trees were sprayed each month with the above mentioned materials at a concentration of 12 pounds per 100 gallons. These sprays were applied for 12 consecutive months.

Experiment 2. Three Pineapple orange seedlings were dipped into the following solutions for a few seconds to insure complete coverage of the leaves: (1) 1% commercial urea, (2) 1% crystalline urea, (3) 1% crystalline urea and 0.02% biuret, (4) 1% crystalline urea and 0.04% biuret, and (5) 0.04% biuret.

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After the plants were dipped and the solution allowed to dry on the leaves, the plants were placed in an outdoor vermiculite bed for observation.

Experiment 3. Young flushes of two-year-old Pineapple orange trees were sprayed with the following solutions: (1) 1% crystalline urea, (2) 1% crystalline urea and 0.01% biuret, (3) 1% crystalline urea and 0.03% biuret, (4) 1% commercial urea, (5) 0.03% biuret, and (6) 0.10% biuret. Each solution was applied to three different flushes on February 20 with a hand atomizer.

Experiment 4. Soil applications of 20, 40, 60, and 80 grams of a commercial urea and crystalline urea were dissolved in a liter of water and poured around the base of one-year-old Pineapple orange trees during November 1953.

Experiment 5. On March 2, 1954, various concentrations of biuret in crystalline urea were dissolved in a liter of water and applied to the soil around the base of two-year-old Pineapple orange trees. Biuret was added to 100 grams of crystalline urea to make urea mixtures having biuret concentrations of 0, 0.5, 1.0, 2.0, and 4.0%. In addition, four grams of biuret were added alone. Each treatment was applied to two trees.

Results and Discussion

Experiment 1. Table 1 shows the effect of these sources on the production of chlorosis and the time necessary for chlorosis to appear. The first two commercial sources of urea consistently produced considerable chlorosis. The third source produced a little chlorosis after sprays applied every month of the year except after the December and February sprays. The other commercial source produced chlorosis only after the sprays which were applied during September and March, but this chlorosis disappeared within six to eight weeks. The two chemical sources of urea did not produce chlorosis at any time.

The time interval between application and the manifestation of chlorosis varied with the season. During the summer, chlorosis appeared about three weeks after the spray application, but during the winter chlorosis did not appear for as long as 15 weeks after the application of the spray. The youngest leaves on the tree at the time of spraying appeared to be the most susceptible. The biuret was not translocated in sufficient quantities to produce chlorosis on leaves that developed after the biuret was applied to the trees. Analysis of the above mentioned materials showed biuret concentrations from a trace to 2.7% on a dry weight basis. A recent paper by Sanford et al., (2) included an analysis of one urea source that contained as much as six percent biuret.

Experiment 2. As a result of dipping Pineapple seedlings, chlorosis appeared on all seedlings that had received an application of biuret or commercial urea. Crystalline urea did not produce chlorosis.

Experiment 3. When the solutions were sprayed on young flushes of Pineapple orange trees, the solutions that contained biuret or commercial urea produced chlorosis, whereas the crystalline urea did not. Fig. 2 shows a representative leaf from the sprayed flushes. Leaves that were sprayed with a solution containing as little as 0.01% biuret became chlorotic. Biuret alone was able to produce

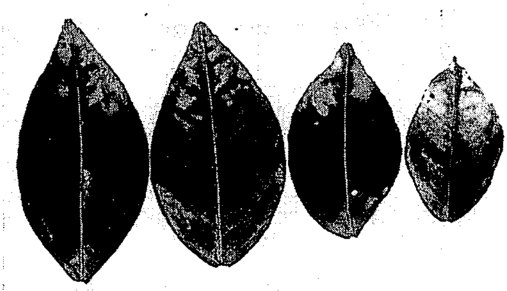

Fig. 1. Chlorosis resulting from the application of a commercial source of urea.

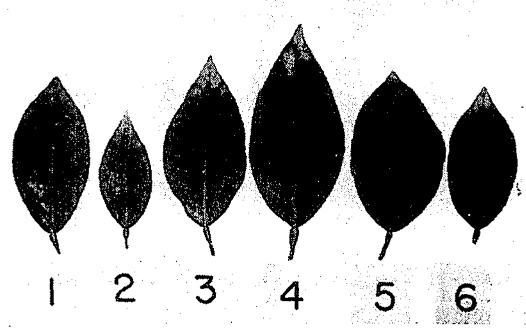

Fig. 2. Chlorosis that develop on Pineapple orange leaves 44 days after being sprayed with a solution of (1) 1% crystalline urea, (2) 1% crystalline urea and 0.01% biuret, (3) 1% crystalline urea and 0.03% biuret, (4) 1% commercial urea, (5) 0.03% biuret, and (6) 0.10% biuret.

Fig. 3. Flushes of Pineapple orange trees 124 days after the application of 100 grams of A. crystalline urea with 0.5% biuret, B. 100 grams of crystalline urea with 2% biuret, C. 100 grams of crystalline urea with 4% biuret, and D. 4 grams of biuret.

chlorosis, but the addition of urea to the solution appeared to enhance the effect of the biuret.

Experiment 4. When different amounts of commercial urea and crystalline urea were applied to the soil, 10 weeks were necessary for the chlorosis to appear on the trees which had received 60 and 80 grams of the commercial urea. No chlorosis resulted from the crystalline urea.

Experiment 5. As a result of the application of different concentrations of biuret, chlorosis began to appear six weeks after the application of the material. Solutions that contained biuret alone, or a urea combination containing as little as one-half percent biuret, produced chlorosis. A urea-biuret mixture with four percent biuret produced very severe leaf patterns and leaf drop. Fig. 3 shows chlorotic flushes taken from some of the treated trees.

SUMMARY

Biuret, an impurity of commercially available urea, caused chlorosis on citrus when applied as a foliage spray or applied to the soil. The time necessary for the chlorotic pattern to develop on the leaves after a spray application varied with the time of the year that it was applied. Chlorosis appeared within three weeks after a summer application, but after a winter application the onset of chlorosis was delayed as long as 15 weeks. The youngest leaves on the tree at the time of spraying were more susceptible to this chlorosis, but leaves that developed subsequent to the spray application of biuret did not become affected. Although the commercially available urea does contain some biuret and may cause chlorosis, urea that will not produce this chlorosis can be manufactured. If the manufacturer can supply a commercial urea with low biuret content, urea will be a safe material to apply to citrus.

LITERATURE CITED

1. Jones, W. W. and M. L. Steinacker. Leaf sprays of urea as a source of nitrogen in fruit trees. Calif. Citrog. 38: 84, 107. 1953.

2. Sanford, W. G., D. P. Gowing, H. Y. Young, and R. W. Leeper. Toxicity to pineapple plants of biuret found in urea fertilizers from different sources. Science. 120: 349-350. 1954.

BORON DEFICIENCY IN FLORIDA CITRUS GROVES

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Boron deficiency in field grown citrus was first described in South Africa by Morris (5) in 1936, but Haas (1) had previously found that several varieties of young citrus plants required boron for normal growth in sand culture. Gumming of the peel and "lumpy-fruit" are of common occurrence in Florida grapefruit as a result of spraying the trees with lead arsenate to hasten maturity. It has been standard practice for a number of years to apply boron to such trees to offset this undesirable effect of arsenic. Boron deficiency