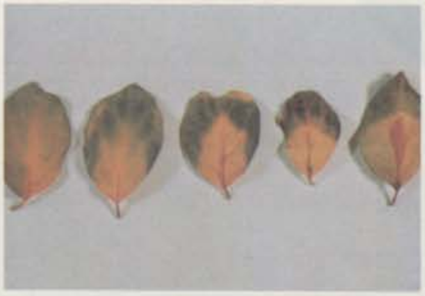
Chlorotic azalea following seven weeks treatment with 5 ppm copper.

Plant on left received .032 ppm copper; the other, 5 ppm copper.

Wilting is a symptom of acute copper injury. Silver hairs were also prominent.



Basal chlorosis of cotoneaster caused by treatment for 10 days with 100 ppm.

Basal necrosis of cotoneaster caused by treatment for 10 days with 10 ppm copper.

Visual Symptoms Of Copper Toxicity On Woody Ornamentals

To aid nurserymen and landscape contractors in identifying copper toxicity on ornamentals, a series of tests were run by T. Davis Sydnor and Larry Kuhns of Ohio State University.

Copper toxicity symptoms have been recorded for a number of fruit and agronomic crops, but not for ornamentals. Ornamentals may also be subjected to high copper levels in several ways. Some factories emit copper-containing smoke. In these areas copper may be deposited on foliage or it may accumulate in the soil.

Repeated applications of fungicides, such as Bordeaux mixture may result in toxic copper levels in the soil. Finally, many woody ornamentals are sold balled and burlapped with copper treated burlap. Several growers have suggested that this treated burlap may be toxic to enclosed plants, for though they have not kept accurate records, they have claimed plants wrapped with copper treated burlap have a higher replacement rate than plants in untreated burlap. A study by the authors suggests this may be true for copper sulfate treated burlap, but not for copper naphthenate treated burlap. In all of these situations copper is especially troublesome because of its immobility in the soil. It is one of the most tightly held cations, so that only in very sandy or very acid soils can it be readily leached.

To aid nurserymen and landscape contractors in identifying copper toxicity on ornamentals, a series of tests were run to obtain visual symptoms of copper toxicity on several woody ornamentals. Spreading cotoneaster common boxwood and azalea were selected as the test plants.

Plants were selected from cuttings rooted in sand, transferred to a medium of acid-washed silica sand, and watered with a standard nutrient solution. Iron was supplied in the chelated form to prevent its precipitation from solution. The copper concentration in the nutrient solution was then adjusted with copper sulfate to vary from 0.032 ppm (control) to 8000 ppm. These copper levels caused two types of injury to the plants. At concentrations of 50 ppm copper and below, chronic injury was induced, resulting in the gradual decline of the plants. At 100 ppm copper and above, acute injury was induced, resulting in the sudden death of all plants.

Chronic injury. Chronic injury is the type injury which would most commonly be found on ornamentals. It was induced in azalea and cotoneaster by copper concentrations between one and 50 ppm, and in boxwood by five to 50 ppm. Generally, chronic symptoms were interveinal chlorosis and stunted growth, except for boxwood which did not become chlorotic but was simply stunted. The location of the chlorosis in azalea and cotoneaster was dependent on the concentration. Between one and five ppm chlorosis began on the new growth, while at 50 ppm bottom leaves became chlorotic first. The higher copper concentrations resulted in faster symptom expression. Chlorosis may have developed at lower copper levels if chelated iron had not been used, as it has been shown to alleviate the effects of high copper concentrations. Surviving cotoneasters were pruned during the experiment, and this seemed to accentuate the problem. New growth was very severely stunted and chlorotic with five ppm causing all but terminal leaves to drop.

Chronic injury of the roots resulted in thicker main roots and fewer lateral roots. Dark stubs were prevalent that apparently were lateral roots which were killed before elongating. Necrotic lesions were common on affected roots which were also darker than healthy roots. At copper concentrations associated with chronic injury, high soluble salts levels were not a problem.

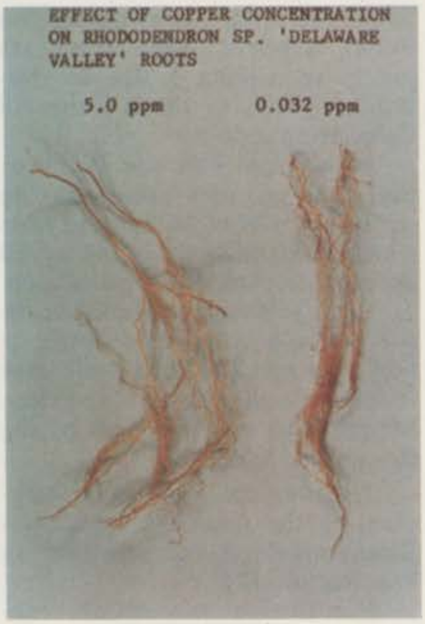
Acute injury. Copper concentrations of 100 ppm and above caused acute injury, but far exceed the amount of copper normally available to a plant. General symptoms of acute injury were wilting, dessication and death of all affected plants. The youngest leaves were affected last, but newly expanded leaves remained small and poorly developed. Other symptoms were species related.

Azaleas showed a gray discoloration of new leaves; and as the wilting occurred, the hairs on the new growth became very prominent and appeared silver. On cotoneaster and boxwood there occurred either a brown discoloration or chlorosis beginning at the base of the leaf and spreading outward until the leaves abscised. With copper toxicity, as opposed to water relations problems, the leaf margin is affected last. Lower leaves curled upward toward the stem, especially on boxwood, and some rosetting of terminal growth was evident. With boxwood only, leaf veins turned charcoal gray, beginning with the midvein and proceeding toward the margins. At copper concentrations of 1,000 ppm and above this occurred while the leaves were still dark green; at concentrations between 100 and 1,000 ppm the leaves and stems became chlorotic first.

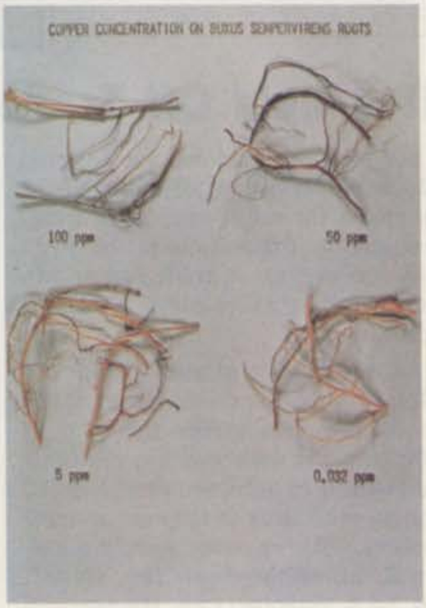
Acute injury was hard to define on the roots because the plants declined so quickly. However, darkened root tips, necrotic lesions, and some dessication were apparent when the plant roots were washed. Some of the described injury may have been due to root cell plasmolysis resulting from the high soluble salts level in the nutrient solutions containing high concentrations of copper sulfate. Root cell plasmolysis would lead to wilting, dessication, and death of plants, but it would not account for the translocation of copper to leaves, the gray discoloration of stems and leaves, or the basal leaf discoloration. It is believed copper toxicity and high soluble salts were both involved in the acute injury to roots.

Summary. Copper toxicity symptoms are very hard to distinguish from other nutrient, and some physiological disorders. Soil tests are generally unsatisfactory in determining a copper toxicity problem, as interpretation of the results depends on the analysis method and soil characteristics. Copper is toxic at much lower levels in a light sandy soil than in a soil high in organic matter or clay. High copper levels resulting from copper treated burlap are confined to the area around the burlap and would probably be missed by a soil test. Tissue analysis seems to be the only sure way to identify a copper toxicity problem, and it is complicated by the fact that a foliar sample is not accurate when looking for copper toxicity. Roots are the only tissue which accumulate enough copper to be satisfactory indicators of copper toxicity. Root copper levels of 30-150 ppm are normal, while anything above 200 may be considered toxic.

Finally, there are at least three means of overcoming copper toxicities of a chronic nature: Keep growing conditions for the plant as close to optimum as possible to eliminate environmental stress, fertilize with chelated iron, or increase the soil pH to precipitate excessive copper. □



Effect of copper concentration on azalea roots. Lateral branching is reduced by chronic copper levels.



Comparison of chronic and acute levels of copper on boxwood roots.

Chronic copper toxicity injury on boxwood roots. Necrotic lesions and undeveloped laterals are characteristic.