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Differential Foliar Uptake of Copper by Two Azalea Cultivars Following Copper Hydroxide Fungicide Applications[1]

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Abstract

Copper hydroxide [$Cu(OH)_2$] (Kocide 101®) used as a fungicide initially increased leaf copper (Cu) in 'Hinodegiri' and 'Massasoit' azaleas (Kurume type). There was a direct relationship between $Cu(OH)_2$ rates and leaf Cu of 'Massasoit' up to 4 times the commercial rate of 3.58 grams ai/liter (3.08 lb/100 gal). Leaf Cu of 'Hinodegiri' was initially directly related to $Cu(OH)_2$. At rates greater than 0.47 grams ai/liter (0.77 lb/100 gal), leaf Cu became inversely related to the rate of $Cu(OH)_2$. No visual phytotoxic symptoms were observed at 4 times the commercial rate. Erroneous interpretation of leaf analysis could occur if the interpreter was not aware of recent $Cu(OH)_2$ fungicide applications. Growers should not eliminate Cu fertilization based on $Cu(OH)_2$ sprayed plants.

Index words: *Rhododendron,* tissue analysis.

Introduction

Pest management is an important tool in the production of container-grown nursery plants in the South. Herbicides, insecticides and fungicides are often used individually or in various combinations by growers. Recently, pesticide application has been related to changes in nutritional status of plants. Significant reduction in total N and protein N in mature tomato foliage following application of some herbicides was reported by Glaze and Gaines (3), but an increase in protein N and nitrate N of several other species was noted by Eastin (2).

Application of nutrient sprays with fungicidal activity modified the effect of Sclerotinia blight disease in peanuts (4). Nitrogen fertilizer affected the susceptibility of *Juglans nigra* to anthracnose organisms (7) and application rates were indirectly correlated with disease severity. Ammonium fertilizer apparently increased the development rate of blossom-end rot of tomato as well as reducing tissue levels of calcium and magnesium (12). Effects of pesticides on nontarget organisms also have been noted (8). Pest management is considered essential for maximum production in the nursery industry because container-grown plants are a predominant cultural method of the South. This cultural method of production predisposes these crops to fungal infection due to frequent irrigation which serves to spread and enhance fungal infections. Therefore, many nurserymen make repeated fungicide applications on a prophylactic basis. Disease severity is often related to the nutritional level of the plant and fungicide sprays may alter nutrient content through foliar absorption. However, little in-

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formation is available to correlate fungicide application with plant nutrition. Since nurserymen routinely apply fungicides, knowledge of the contribution of fungicide application to plant nutrition would aid growers in evaluating fertilizer programs.

Leaf Cu requirements for 'Gloria' azaleas have been determined to be 5 ppm with 3 ppm leaf Cu being a marginal leaf content to prevent Cu deficiency (11). The objective of this study was to examine the relationship between copper hydroxide applications and the leaf copper content of 2 azalea cultivars.

Materials and Methods

'Hinodegiri' and 'Massasoit' azaleas were grown from April to November 1979 in pine bark:peat moss: sand (1:1:1) amended with dolomite, gypsum, trace elements, and NPK fertilizer. There were 4 plants per replicate and 4 replicates per treatment. Treatments consisted of $Cu(OH)_2$ at 0.47, 0.92, and 3.58 grams ai/liter (0.06, 0.12, 0.48 oz/gal) and a control. The fungicide was applied 4 times as a spray in May, June, July and August. Forty of the most recently matured leaves from each replicate (10 from each plant) were collected in November, washed in detergent, tap water, 1% HCl, rinsed 3 times in demineralized distilled water, then dried and analyzed by atomic absorption spectroscopy for Cu (5,9,10). The data were analyzed by analysis of variance ($P = 0.05$).

Results and Discussion

No visual toxicity symptoms or yield losses were observed. $Cu(OH)_2$ application significantly affected leaf Cu content of azalea plants (Fig. 1). Leaf Cu was significantly increased for both cultivars when $Cu(OH)_2$ was applied at 0.47 grams ai/liter (0.12 oz/gal). Application of $Cu(OH)_2$ at 0.92 and 3.58 grams ai/liter (0.12 and 0.48 oz/gal) caused an increase in leaf Cu in 'Massasoit' azalea but caused a decline in leaf Cu in 'Hinodegiri.' Leaf Cu between cultivars became significantly different at $Cu(OH)_2$ application rates of 0.92 and 3.58 grams ai/liter (0.12 and 0.48 oz/gal). Because all leaf samples were washed and otherwise similarly treated alike, the decline in leaf Cu of 'Hinodegiri' at the 2 high rates suggests that Cu levels recorded were due to internal rather than external Cu residue. Leaf Cu in both cultivars increased (above the control) at low fungicide rates, but higher rates of $Cu(OH)_2$ caused a decline in leaf Cu content of 'Hinodegiri.'

Movement of Cu from old leaves to new leaves depends largely on the growth rate of the plant. Wheat plants which were growing vigorously retained most of their Cu in their older leaves and demonstrated Cu deficiency symptoms in new leaves (1). Copper sprayed trees seemed to move Cu from older leaves to younger leaves and fruit (6). However, Cu translocation in azaleas has not been demonstrated; and if Cu is not translocated from older azalea leaves to new leaves, Cu deficiency might develop in these rapidly growing plants. Further investigations into the relationship between fungicide application and the plant nutrient status are needed to properly evaluate this phenomenon. These data indicate that serious interpretation errors in leaf analysis could occur if fungicide treatment is disregarded.

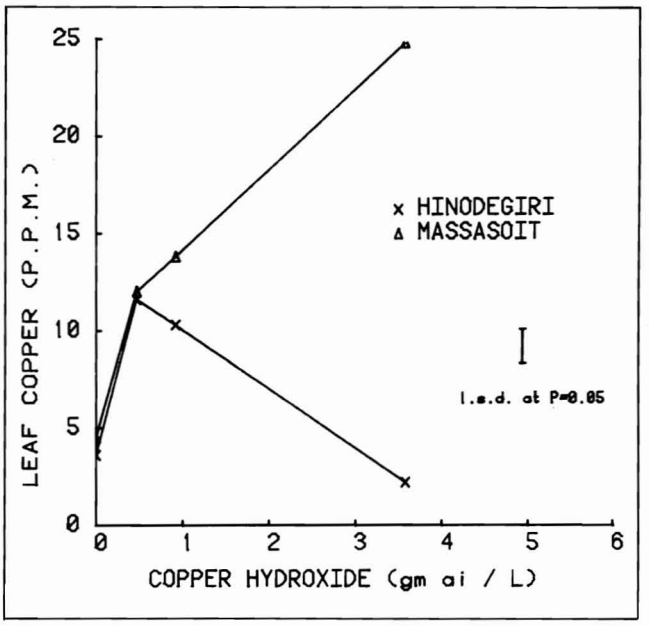

Fig. 1. Influence of copper hydroxide fungicide sprays on leaf copper content of 2 azalea cultivars.

Significance to the Nursery Industry

This research indicated that azalea cultivars respond differently to Kocide 101 sprays. Data indicated that azaleas are not injured by 4 times the recommended rate, and erroneous interpretation of leaf analysis could occur if the fungicide program is disregarded. Erroneous interpretation of tissue analysis could occur if fungicide application is not considered since the data show sufficient Cu in the sampled leaves. However, growers should not discontinue Cu fertilization practices and depend on the fungicide to supply Cu because only those leaves actually sprayed will contain sufficient Cu. New growth cycles (flushes) will probably require supportive Cu fertilization for normal growth.

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