Influence of Foliar Applications of Micronutrients and Fungicides on Foliar Necrosis and Leaf Spot Disease of *Chrysalidocarpus lutescens*

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ABSTRACT

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Chelates of copper, iron, manganese, and zinc and fungicides containing these elements were applied to *Chrysalidocarpus lutescens* (areca palm) as sprays at recommended rates to determine their effects on foliar necrosis and fungal leaf spot incited by *Exserohilum rostratum*. Single applications of all chelated micronutrients caused foliar necrosis under greenhouse conditions, and copper or iron chelate also caused damage under shadehouse conditions. Cupric hydroxide caused symptoms similar to those caused by copper chelate. Fungal leaf spot was controlled by ferbam, mancozeb, or zineb in shadehouse trials and by micronutrient applications in greenhouse trials.

Leaf spot is one of the most serious problems encountered by Florida palm producers. In the past, research has identified several causes of foliar necroses, such as fungi (1) and copper toxicity (6). Control of fungal leaf spot diseases of *Chrysalidocarpus lutescens* H. Wendl. (areca palm) has not always been successful although several fungicides available could control this disease (2). At certain times of the year, growers make weekly applications of these fungicides in production areas. Micronutrient sprays are also applied to improve plant quality (6) because areca palms are subject to several micronutrient deficiencies and imbalances (3–5). The most commonly used fungicides contain some of the same micronutrients. This research was conducted to clarify the influence of some of these micronutrient sprays and fungicides containing micronutrients on growth, foliar necrosis, and fungal leaf spot development of areca palm.

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MATERIALS AND METHODS

Palm seedlings were obtained from commercial growers and planted three per 15-cm plastic pot (about 1.6 L volume) in a steam-sterilized potting medium consisting of Canadian peat, cypress shavings, and pine bark (2:1:1, v/v/v). The medium was amended with 4 kg dolomite and 0.9 kg Micromax (Sierra Chemical Co., Milpitas, CA 95035) per cubic meter. After planting, 2 g per pot of Osmocote (19-6-12, slow-release fertilizer, Sierra Chemical Co.) was added as a topdressing. Palm plants ranged from 5 to 8 mo old at the initiation of treatments. Plants were watered from overhead sprinklers in experiments 3 and 4 and by hand in experiments 1 and 2.

Greenhouse experiments. Fifteen pots per treatment were arranged in a randomized complete block design. Treatments were applied as foliar sprays once a month for 2 mo and plants were checked 1 wk after the first application and evaluated 1 wk after the second application for foliar necrosis and growth parameters (all heights are for the longest frond). Treatments included water control; iron chelate (Fe 330 Sequestrene, 10% a.i., Ciba Geigy Corp., Greensboro, SC 27049) 0.4 g a.i./L; manganese chelate 12% a.i., 0.2 g a.i./L; and zinc chelate, 14.2% a.i., 0.2 g a.i./L.

Plants were artificially inoculated with conidia of *Exserohilum rostratum* (Drechs.) Leonard & Suggs grown on V-8 juice agar (18% V-8 juice cleared with 4.5 g $CaCO_3$ and 15 g agar per liter (V8A) for 2 wk at 26 C and receiving about 25 μE m^{-2} sec^{-1} fluorescent light (12 hr daily). Inoculum was prepared by adding sterile deionized water to culture dishes, counting conidia in the resulting suspension, and adjusting to 1×10^4 conidia per milliliter. Plants were sprayed to runoff and sealed in plastic bags for 72 hr. Disease severity was rated 2 wk later.

This experiment was performed twice under greenhouse conditions (about 200 μE m^{-2} sec^{-1} [natural light] and 15–30 C). Experiments 1 and 2 were conducted between 19 April and 12 July 1982, and 1 February and 4 April 1983, respectively.

Shadehouse experiments. Effects of micronutrient-containing fungicides on foliar necrosis and growth and severity of fungal leaf spot of areca palm were tested under shadehouse conditions (600 μE m^{-2} sec^{-1} [natural light] and 15–35 C). The following treatments were included in at least one of two experiments: 1) water control; 2) cupric hydroxide (Kocide 101, 77% a.i.), 0.3 and 0.7 g a.i./L; 3) mancozeb (Manzate 200, 80% a.i.), 1.4 and 2.9 g a.i./L; 4) ferbam (Carbamate 76% a.i.), 1.4 and 2.9 g a.i./L; 5) zineb (Zineb 75% a.i.), 1.4 and 2.9 g a.i./L; 6) soluble trace element mix (S.T.E.M., 40% a.i., R. B. Peters Co., Inc., Allentown, PA 18104), 0.2 g a.i./L; 7) copper chelate (13% a.i.), 0.05 and 0.1 g a.i./L; 8) manganese chelate, 0.2 and 0.4 g a.i./L; 9) iron chelate, 0.2 and 0.4 g a.i./L; and 10) zinc chelate, 0.2 and 0.4 g a.i./L.

All chemicals were applied weekly with the exception of the chelated micronutrients, which were applied monthly. Experiment 3 was conducted between 15 June and 6 October 1982 and experiment 4 between 29 November 1982 and 26 January 1983. Evaluations included foliar necrosis and quality (appearance and salability) and grades, height, and severity of natural infection by *E. rostratum*.

Table 1. Influence of selected micronutrients on growth, quality, and fungal leaf spot severity of areca palms (experiment 1)

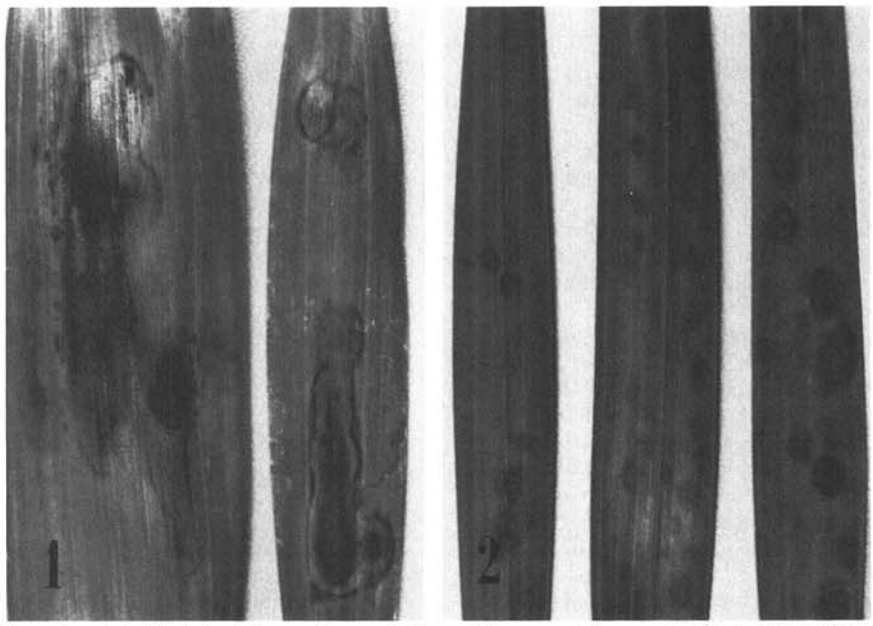
Treatment[w]	Rate (g a.i./L)	Foliar damage rating[x]	Plant height (cm)	Fungal leaf spot severity[y]
Water	···	0.1 a[z]	35.2 c	3.8 b
Iron chelate	0.4	3.1 b	29.8 a	2.6 a
Manganese chelate	0.2	2.2 b	32.4 b	2.7 a
Zinc chelate	0.2	2.6 b	29.4 a	2.5 a

[w] Treatments were applied twice, 1 mo apart, at recommended rates.
[x] Damage rating: 1 = no necrosis, 2 = 1 leaf necrotic, 3 = 2–4 leaves necrotic, 4 = 5–7 leaves necrotic, and 5 = 8 or more leaves necrotic.
[y] Leaf spot caused by *Exserohilum rostratum* rating: 1 = no lesions, 2 = 1–10 lesions, 3 = 11–25 lesions, 4 = 26–75 lesions, and 5 = 76 or more lesions.
[z] Numbers in the same column followed by the same letter were not statistically different ($P = 0.05$) according to Duncan's new multiple range test.

Table 2. Influence of selected micronutrients on growth, quality, and fungal leaf spot severity of areca palms (experiment 2)

Treatment[v]	Rate (g a.i./L)	No. foliar lesions[w]	Plant height (cm)	Chlorosis[x]	Fungal leaf spot severity[y]
Water	···	1.6 a[z]	44.4 a	3.4 b	3.3 a
Iron chelate	0.4	4.1 b	45.2 a	1.8 a	3.3 a
Manganese chelate	0.2	3.7 b	43.5 a	1.3 a	3.4 a
Zinc chelate	0.2	4.6 b	45.2 a	1.6 a	3.1 a

[v] Treatments were applied twice, 1 mo apart, at recommended rates.
[w] Number of lesions per pot (three plants).
[x] Chlorosis rating: 1 = dark green, 2 = medium green, 3 = light green, 4 = slightly yellow, and 5 = very yellow or white.
[y] Leaf spot caused by *Exserohilum rostratum* rating: 1 = no lesions, 2 = 1–10 lesions, 3 = 11–25 lesions, 4 = 26–75 lesions, and 5 = 76 or more lesions.
[z] Numbers in the same column followed by the same letter were not statistically different ($P = 0.05$) according to Duncan's new multiple range test.



Figs. 1 and 2. Phytotoxicity reactions of *Chrysalidocarpus lutescens* to two monthly foliar applications of **(1)** iron chelate at 0.4 g a.i./L and **(2)** copper chelate at 0.4 g a.i./L.

RESULTS AND DISCUSSION

Greenhouse experiments. All micronutrient products applied to palms in the greenhouse caused slight foliar necrosis after one application at the recommended rate but was most apparent after two applications (Tables 1 and 2). In some cases, the shape, color, and size of lesions were similar to those incited by *E. rostratum*. This was especially true of lesions caused by iron chelate (Fig. 1). The heights of micronutrient-treated plants were significantly suppressed compared with those of water-treated control plants in experiment 1 (Table 1) but were not affected in experiment 2 (Table 2). Severity of fungal leaf spot incited through artificial inoculation was suppressed by all micronutrients in one test (Table 1) but was unaffected in other (Table 2). Foliar necrosis was much less severe in the second test, which was performed during the winter and early spring. This difference may relate to the temperature and resulting growth rate of the plants at different times of the year. This was especially apparent in the color (chlorosis) of the control palms during the second test. Although all plants were treated with micronutrients in the potting medium at the initiation of each experiment, plants in each micronutrient treatment had a superior green color compared with the untreated control plants (Table 2). Palms frequently appear chlorotic during cool weather because the micronutrients in the potting medium are not absorbed by their roots as well as under warm conditions.

Shadehouse experiments. Results of experiments 3 and 4 using both chelated micronutrients and fungicides on relatively large areca palms (8 mo old) in a shadehouse were similar to those seen in greenhouse trials using smaller plants (5 mo old). Both copper chelate and cupric hydroxide caused foliar necrosis, which was severe enough to degrade plant quality in the case of copper chelate (Table 3). Symptoms caused by these two compounds were similar (Fig. 2). Iron chelate caused slight foliar necrosis but there was no loss in plant quality. In experiment 4,

Table 3. Influence of micronutrients and fungicides on growth, quality, and fungal leaf spot severity of areca palms (experiment 3)

Treatment[w]	Rate (g a.i./L)	Plant quality[x]	Fungal leaf spot severity[y]
Water	···	3.6 bc[z]	2.4 b
Copper chelate	0.05	2.7 a	2.4 b
Iron chelate	0.4	3.4 ab	2.6 b
Manganese chelate	0.2	3.5 bc	2.4 b
Zinc chelate	0.2	3.7 bc	2.4 b
Soluble trace element mix	0.2	3.3 ab	2.4 b
Cupric hydroxide	0.3	3.0 ab	1.8 a
Ferbam	1.4	3.5 bc	1.3 a
Mancozeb	1.4	3.5 bc	1.2 a
Zineb	1.4	4.0 c	1.4 a

[w] Treatments were applied weekly for 3 mo, with the exception of chelates, which were applied once each month.
[x] Appearance or salability rating: 1 = poor, not salable; 2 = slightly better, not salable; 3 = medium, salable; 4 = good, salable; and 5 = excellent, salable.
[y] Leaf spot caused by *Exserohilum rostratum* rating: 1 = no lesions, 2 = 1–10 lesions, 3 = 11–25 lesions, 4 = 26–75 lesions, and 5 = 76 or more lesions.
[z] Numbers in the same column followed by the same letter were not statistically different ($P = 0.05$) according to Duncan's new multiple range test.

Table 4. Influence of micronutrients and fungicides on quality and fungal leaf spot severity of areca palms (experiment 4)

Treatment[v]	Rate (g a.i./L)	Foliar damage severity[w]	Plant quality[x]	Fungal leaf spot severity[y]
Water	···	1.0 a[z]	2.6 c	3.0 d
Copper chelate	0.1	3.9 e	1.6 a	1.9 ab
Iron chelate	0.8	2.8 d	2.3 b	2.1 b
Manganese chelate	0.4	1.0 a	2.7 c	2.9 d
Zinc chelate	0.4	1.4 b	2.3 b	2.1 b
Cupric hydroxide	0.7	1.1 ab	2.2 b	1.8 a
Ferbam	2.8	1.1 ab	2.6 c	2.1 b
Mancozeb	2.8	1.0 a	2.7 c	1.8 a
Zineb	2.8	1.9 c	2.2 b	2.5 c

[v] Treatments were applied weekly for 8 wk with the exception of micronutrients, which were applied twice, 1 mo apart.
[w] Damage severity rating: 1 = no damage, 2 = 1–2 leaves damaged at plant base, 3 = all older leaves damaged, 4 = older leaves and 1-2 new leaves damaged, and 5 = all leaves damaged.
[x] Appearance or salability rating: 1 = poor, not salable; 2 = slightly better, not salable; 3 = medium, salable; 4 = good, salable; and 5 = excellent, salable.
[y] Leaf spot caused by *Exserohilum rostratum* rating: 1 = no lesions, 2 = 1–10 lesions, 3 = 11–25 lesions, 4 = 26–75 lesions, and 5 = 76 or more lesions.
[z] Numbers in the same column followed by the same letter were not statistically different ($P = 0.05$) according to Duncan's new multiple range test.

all applications of micronutrients (except manganese chelate) and the fungicide zineb resulted in foliar necrosis, with only the copper chelate treatment causing significant loss in plant quality (Table 4). There were no significant effects on plant height in either experiment.

Disease severity ratings for the two experiments were variable, with micronutrients providing no protection in the first experiment and good protection (except manganese chelate) in the second. All fungicide treatments controlled *E. rostratum* in both trials (Tables 3 and 4).

These experiments demonstrated that chelated micronutrient products can cause foliar necrosis of relatively young (5- to 8-mo-old) shade-grown areca palms, even when applied at recommended rates. In one experiment (not reported) a spreader-sticker added to copper chelate, cupric hydroxide, or iron chelate did not influence phytotoxicity.

Lesions incited by micronutrients are indistinguishable from those caused by *E. rostratum* unless the fungus can be cultured from the tissue. Because culture of the pathogen is not always easily accomplished (1), distinguishing between phytotoxicity and disease remains difficult. Applying micronutrients in the form of either chelated products or fungicides may have little net effect in decreasing foliar lesions and indeed may be responsible for reports of ineffective disease control. Applications of certain fungicides (such as cupric hydroxide) containing the same micronutrients as the chelated products were shown to cause similar toxicity symptoms in these experiments as well as others (7). Therefore, we do not recommend copper-containing compounds for use on areca palms. Also, inasmuch as the other chelated products tested also caused phytoxicity under some conditions, their effects should be carefully monitored. Our results do show the benefit of applications of some chelated products on growth of areca palm, especially during the cooler winter months, when palm roots extract micronutrients from potting media less effectively than during warmer months. Further research is needed on benefits and phytotoxicity of reduced rates of chelated micronutrients.

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