Soil Temperature and Copper Application Rate Affect Growth and Copper Deficiency of *Aglaonema commutatum* 'Fransher'[1]

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Abstract

Fransher aglaonema (*Aglaonema commutatum* Schott. 'Fransher') were used during the winter and spring in two duplicate 4 × 3 factorial randomized block design experiments with four continuous soil temperatures [13.0, 18.5, 24.0 and 29.5° ± 1°C (55, 65, 75, and 85°F ± 1.8°F)] and three copper levels [0, 0.05, and 0.1 g/15 cm pot (0, 0.0017 and 0.0035 oz/6 in pot(] from Cu Sequestrene. Plants were placed into zoned forced-air systems for soil temperature control in a glass greenhouse with an average maximum light intensity of 13 klx (1200 ft-c) and minimum and maximum air temperatures of 16 and 30°C (60 and 86°F), resp. Plant grade, color grade, number of breaks, root fresh weights, and elemental tissue content of Ca, Mg, and Cu increased linearly with increased soil temperature, while elemental tissue content of K decreased linearly with increased soil temperature. As copper application rate increased, plant grade, color grade, and elemental tissue content of Cu increased linearly and elemental tissue content of K, Ca, Mg, Mn, and B decreased linearly. Interactions of increased soil temperature and Cu application rate resulted in increased top fresh weights, elimination of Cu deficiency symptoms, and decreased leaf elemental P content.

Index words: foliage plant

Species used in this study: 'Fransher' aglaonema [*Aglaonema commutatum* Schott. 'Fransher']

Significance to the Nursery Industry

Increased production of aglaonema cultivars as a result of increased popularity has been accompanied by an increase in observation of Cu deficiency symptoms. Results of these experiments demonstrate that copper deficiency symptoms can be alleviated and that growth and quality of *Aglaonema* 'Fransher' can be improved by applying copper to the growing medium and maintaining a soil temperature above 13°C (55°F). Producers can use this information to provide the marketplace with a high quality crop.

Introduction

Increased popularity of aglaonema cultivars for interior plantings has resulted in large increases in production (2). Producers, however, have experienced serious physiological problems, including copper deficiency (6), during growth of aglaonema. Copper deficiency symptoms include slight chlorosis in its mildest form, to distorted, dwarfed, incomplete leaves when the deficiency is severe (2, 6). The appearance of copper deficiency seems to occur more often during cold weather, but this relationship has not been substantiated. Additionally, root initiation and growth of some plants have been observed to be more responsive to soil temperature than air temperature (1, 3). The experiments discussed in this manuscript were designed to determine the effects of soil temperature and copper application rate on copper deficiency symptoms of aglaonema.

Materials and Methods

Fransher aglaonema (*Aglaonema commutatum* Schott. 'Fransher') were grown at continuous soil temperatures of 13.0, 18.5, 24.0, and 29.5°C (55, 65, 75, and 85°F) and treated with 0, 0.05, or 0.1 g Cu/15 cm pot (0, 0.0017, or 0.0035 oz/6 in pot) from Cu Sequestrene during two consecutive winters. Treatments were in factorial combination in randomized block design with four replications. The experiments were duplicates of each other except Experiment 1 was initiated December 21, 1986 and terminated April 27, 1987 while Experiment 2 was initiated November 19, 1987 and terminated May 11, 1988. Fransher aglaonema cuttings for use in these experiments were harvested from Cu-deficient stock plants, rooted in 7.5 cm (3 in) pots containing unamended sedge peat moss and then repotted into 15 cm (6 in) pots in a medium composed of 3 parts sedge peat moss and 1 part washed mason sand (v/v) amended with 4 kg (7 lb) dolomite, 1.2 kg $CaSO_4$ (2 lb) and 0.9 kg (1.5 lb) Micromax without Cu/m^3 (yd^3). Plants were placed into zoned forced-air systems for controlling soil temperatures (5) which maintained temperatures ± 1°C (1.8°F) from set points. Minimum greenhouse air temperatures were maintained at 16 ± 1°C (60 ± 1.8°F) and ventilation occurred at 30°C (86°F). Tissue samples were taken at the termination of the experiment from the youngest, fully matured leaves and were analyzed by W.R. Grace & Co. The SAS General Linear Model procedure was used to analyze data. The two experiments produced similar data thus, only data from Experiment 2 have been selected for discussion.

Results and Discussion

Large linear increases in plant and color grades, number of basal breaks and root fresh weight occurred as soil temperatures increased (Table 1). However, as Cu application

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Table 1. Growth of *Aglaonema* 'Fransher' as influenced by soil temperature and copper application rate.

Treatment	Plant grade[z]	Color grade[y]	# Basal breaks	Root fresh weight (g)
Soil temperature (°C)				
13.0	1.8	2.6	2.8	62.3
18.5	2.0	2.8	4.4	85.4
24.0	3.4	3.9	6.0	143.1
29.5	4.2	3.9	6.4	140.8
Significance[x]				
Linear	**	**	**	**
Cu (g/15 cm pot)				
0.0	2.2	2.4	5.5	106.4
0.05	3.2	3.8	4.6	115.7
0.10	3.1	3.7	4.6	101.6
Significance				
Linear	**	**	NS	NS
Quadratic	**	**	NS	NS

[z] 1 = dead; 2 = poor quality, not salable; 3 = fair quality, salable; 4 = good quality, salable; 5 = excellent quality
[y] (new leaves) 1 = yellow; 2 = yellow-green; 3 = pale green; 4 = green; 5 = excellent dark green color
[x] NS or ** = not significant or significant at the .01 level, resp.

rate increased, plant and color grades were quadratic with best plants produced at the 0.05 g Cu/15 cm pot and no effect of Cu rate was observed on number of basal breaks or root fresh weight. Soil temperature data are consistent with observations previously made on dieffenbachia where much improved growth was observed at higher temperatures, 29.5 versus 13°C (3).

Interactions between soil temperature and Cu application rate occurred on top fresh weight and Cu deficiency grade (Tables 2 & 3). Change in top fresh weight was small from increased Cu application at 13 or 18.5°C, but at 24 and 29.5°C, increasing Cu application rate resulted in a large weight increase (Table 2). Interaction of soil temperature and Cu application rate on appearance of Cu deficiency symptoms (characterized as chlorosis and some necrosis on older leaves, and small, curved leaves on new shoots) showed that when no Cu was added, no benefit was derived from increased temperature; but when Cu was added at 13°C, there was some improvement, and with Cu added and temperature increased to only 18.5°C, all Cu deficiency symptoms disappeared (Table 3).

Increasing soil temperature had no effect on tissue N, Fe, Mn, Zn or B, but was linear on K and Ca (Table 4). Magnesium (Mg) and Cu were both quadratic, with highest tissue levels occurring at 29.5°C. In general, these responses were similar to soil temperature research on dieffenbachia (3) which also showed elevated Ca and Mg, and decreased K with increased temperature. Although the increase in Cu was not as strong as expected, it was adequate to alleviate apparent deficiency. Since the experiment was started with cuttings from Cu-deficient stock, elemental Cu content may be very slow to change or the excess N and Ca may actually be interfering with copper availability (4). All other elemental tissue content of leaves were in the optimal range for each element (7).

Increase in Cu application rate decreased tissue levels of K, Ca, Mg, Mn and B while having no effect on N, Fe or Zn (Table 4). These data were also quadratic, with the greatest reductions of tissue element levels occurring between 0 and 0.05 Cu application rate. Increasing Cu application resulted in a strong linear increase in tissue levels of Cu, explaining the effects of copper on improving plant and color grades.

An interaction occurred on tissue P levels; a consistent decrease in tissue P occurred at 13, 18.5, and 29.5°C as Cu increased (Table 5) while the response at 24°C was variable. As temperature increased at any Cu application rate, so did P tissue level until maximized at 24°C above which P tissue level decreased. One likely explanation for these results is that 24°C is optimal for the plant.

In general, addition of copper to the growing medium should, by itself, reduce or even prevent Cu deficiency symptoms in aglaonemas, especially when the medium temperature is maintained above 13°C.

Table 2. Interaction of soil temperature and copper application rate on top fresh weight (g) of *Aglaonema* 'Fransher'. Significance at P = 0.05.

Soil Temperature	Copper Application Rate (g/15 cm pot)		
°C	0	.05	0.10
13.0	55.2	69.1	69.6
18.5	79.9	73.6	75.3
24.0	94.3	153.0	127.8
29.5	137.2	175.4	179.8

Table 3. Interaction of soil temperature and copper application rate on copper deficiency symptoms (1 = none, 5 = severe) of new leaves of *Aglaonema* 'Fransher'. Significance at P = 0.01.

Soil Temperature	Copper Application Rate (g/15 cm pot)		
°C	0	.05	0.10
13.0	2.5	1.5	1.2
18.5	2.5	1.0	1.0
24.0	4.0	1.0	1.0
29.5	2.5	1.0	1.0

Table 4. Elemental tissue content of newly matured leaves of *Aglaonema* 'Fransher' as affected by soil temperature and copper application rate.

Treatment	Percent				ppm				
	N	K	Ca	Mg	Fe	Mn	Cu	Zn	B
Soil temperature (°C)									
13.0	4.8	3.0	2.4	0.39	60.5	131	5.8	47	58
18.5	5.0	2.9	2.6	0.44	83.3	126	6.1	38	49
24.0	4.7	2.6	3.6	0.70	74.5	105	6.3	41	54
29.5	5.4	2.5	3.8	0.85	88.0	110	7.9	42	53
Significance[z]									
Linear	NS	**	**	**	NS	NS	*	NS	NS
Quadratic	NS	NS	NS	**	NS	NS	**	NS	NS
Cu (g/15 cm pot)									
0.0	4.9	3.1	3.8	0.62	82.4	142	4.8	49	67
0.05	4.8	2.5	2.9	0.59	66.7	102	6.2	38	48
0.10	5.2	2.6	2.6	0.56	80.8	110	8.5	39	45
Significance									
Linear	NS	**	**	**	NS	**	**	NS	**
Quadratic	NS	**	**	NS	NS	**	NS	NS	*

[z]NS, * or ** = not significant, significant at the .05 or .01 level, resp.

Table 5. Interaction of soil temperature and copper application rate on elemental P content (%) of *Aglaonema* 'Fransher'. Significance at P = 0.01.

Soil Temperature °C	Copper Application Rate (g/15 cm pot)		
	0	.05	0.10
13.0	.48	.37	.32
18.5	.62	.42	.35
24.0	1.03	.47	.61
29.5	.77	.50	.42

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