Growth of Dieffenbachia maculata 'Perfection' as Affected by Air and Soil Temperatures and Fertilization

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Abstract. Dieffenbachia [Dieffenbachia maculata (Lodd. G. Don 'Perfection')] were grown from 13° to 18.5°C minimum air temperature (AT) with constant soil temperature (ST) of 13.0°, 18.5°, 24.0°, or 29.5° and fertilized (FR) with 1.4, 2.8, or 4.2 g N/m2 per week from a 3N-1P-2K ratio stock solution. Data from experiments conducted during Winter 1981-82 and 1982-83 showed that air and soil temperatures had greater effects on plant growth than fertilizer rate. Interactions of AT and ST were highly significant for plant height, grade, number of basal breaks, and fresh top and root weights with plants produced at 18.5° AT better than 13° plants at low ST, but not at 29.5° ST. Quadratic responses of plants grown at 18.5° AT to increasing ST were similar to data obtained for tissue Ca and Mg, with lowest tissue levels occurring at the extremes of ST.

Most foliage plants have their origins in the tropics and require relatively high night temperatures to sustain rapid growth (17). Increases in costs of fossil fuels during the last decade has influenced producers to attempt energy conservation by lowering night and/ or day temperatures. Problems of reduced growth rate and increased turnover time caused many producers to return to original temperature regimes (2). Producers have been aware of benefits of bottom heating in relation to increased plant growth due to soil temperatures (2). Producers have been aware of benefits of bottom heating in relation to increased plant growth due to soil temperatures (3). Temperatures of 23° soil and 19° air have been recommended by Moes (13). Effects of soil temperature on uptake of nutrients from substrates have been shown to influence plant growth and/or yield (4, 10). In Calceolaria, White and Biembaum (20) found increased levels of N, P, K, Ca, Mg, S, Al, Fe, Zn, and Cu in tissue with an increase in root-zone temperature from 10° to 12° to 20° to 22°. The experiments discussed in this manuscript were designed to determine interactions of soil and air temperatures and fertilization rate on plant growth and tissue elemental levels.

Dieffenbachia maculata 'Perfection' were grown at 13° or 18.5°C minimum air temperature (AT); 13.0°, 18.5°, 24.0°, or 29.5° constant soil temperature (ST); and fertilized (FR) with 1.4, 2.8, or 4.2 g N/m2 per week during Winter 1981-82 and 1982-83. Treatments were in factorial combination in randomized block design with four replications for third-order interactions. The two experiments were duplicates of each other except for starting and ending dates; Expt. 1 was initiated 29 Oct. 1981 and terminated 24 Mar. 1982, while Expt. 2 was initiated 22 Nov. 1982 and terminated 23 Mar. 1983. Liners from 7.5-cm pots were repotted into 15-cm pots in a medium composed of 3 cedgpeatmoss: 1 washed mason sand (v/v) amended with 4 kg dolomite, 1.2 kg CaSO4, and 0.9 kg Micromax (Sierra Chemical Co., Milpitas, Calif.) per cubic meter of mix. Plants were placed into zoned forced-air systems for controlling soil temperature (8), which was maintained ± 1° from set points. Minimum greenhouse temperatures were also

Table 1. Fertilizer rate effects on Dieffenbachia maculata 'Perfection'.

<table>
<thead>
<tr>
<th>Fertilizer rate (g N/m² per wk)</th>
<th>Height (cm)</th>
<th>No. basal shoots</th>
<th>Plant grade</th>
<th>Color grade</th>
<th>Fresh top wt (g)</th>
<th>Fresh root wt (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4</td>
<td>37.2</td>
<td>7.3</td>
<td>3.3</td>
<td>3.6</td>
<td>106.3</td>
<td>13.3</td>
</tr>
<tr>
<td>2.8</td>
<td>38.0</td>
<td>7.2</td>
<td>3.4</td>
<td>3.7</td>
<td>110.5</td>
<td>9.0</td>
</tr>
<tr>
<td>4.2</td>
<td>36.3</td>
<td>6.0</td>
<td>3.3</td>
<td>3.6</td>
<td>99.2</td>
<td>9.4</td>
</tr>
</tbody>
</table>

Significance: Q*, **NS

1Plant grade was rated on a scale from 1 (poor, unsalable) to 5 (excellent, highly salable).
2Color grade was rated on a scale from 1 (poor, chlorotic) to 5 (excellent, superior color definition).
3NS*: **Not significant and significant at the 0.05 and 0.01 levels, respectively. L = linear, Q = quadratic.
maintained within ±1°C of set points and were ventilated at 29.5°C. Fertilizer rates were obtained with weekly applications of a 3N-1P-2K ratio stock solution derived from KN03, NH4NO3, and H3PO4. Plants were irrigated as required to keep soil moist, which ranged from one to three times per week. Data collected at termination of experiments included plant height, plant grade (1 = poor; 3 = good, salable; and 5 = excellent, highly salable), leaf color grade (1 = poor, little yellow-green contrast; 3 = good, average contrast; and 5 = excellent, brilliant bright yellow-green contrast), number of basal breaks and top and root fresh weights. Recently matured foliage was selected for tissue analyses.

Data from both experiments were subjected to analyses of variance and found to be similar, including the AT × ST interactions, which were significant on 10 measurements in 1981–82 and on nine in 1982–83. The 1981–82 data are presented for discussion. The AT × ST interaction was significant on all growth, quality, and weight measurements (Fig. 1). In each instance there was a linear increase in growth or quality at 13°C AT as ST increased, whereas at 18.5°C AT the response was quadratic with maximum grade or growth generally occurring at 18.5°C to 24°C ST. The r² values for the curves ranged from 0.70 to 0.96. Increasing AT from 10°C to 15°C or 20°C on Dieffenbachia maculata ‘Camille’ (2) increased growth rate and quality and was consistent with previous work on Dieffenbachia by the authors (17). This response also was observed in this research when the ST was between 13°C and 24°C but, at an ST of 29.5°C, plants grown AT of 13°C were equal or better than those grown at 18.5°C AT. Elevations of ST have been shown to increase the number of flowering stems on Calceolaria (7) and number of auxiliary shoots on poinsettia (21). In this work, increase in number of breaks was linear for all STs at 13°C AT, but was quadratic for 18.5°C AT with number of breaks at ST of 29.5°C (Fig. 1 right center) lower than number of breaks at 13°C AT. Curves for fresh top and root weight (Figures 1 left lower and right) were similar to those for number of breaks and indicate similar growth responses for these variables. Most published information details the relationships of Q10 (temperature coefficient) to growth of tops or roots or accumulation of carbohydrates (9, 15, 19). Root fresh weight increases at 18.5°C AT and 13°C to 29.5°C ST were similar to responses reported by Went and Sheps (19) with detached tomato roots between 10°C and 30°C; they did not report comparisons for different ATs. One review of published research indicates different optimum temperatures for top and root growth (11). Root growth of rose was maximized at 18°C, poinsettia at 26°C; however, a range of 7°C to 21°C had no effect on carnation. All these data were generated in experiments using only one AT and cannot be directly compared with this research. Results obtained in this research appear to be due to a temperature-dependent reaction, which becomes limiting when high AT and ST are combined, whereas high ST is not limiting at the lower AT.

Increasing FR to the highest level of 4.2 g N/m² per week had no effect on plant grade or color (Table 1), but generally reduced height, number of basal shoots, and fresh root and top weights. Similar results had been observed with Dieffenbachia previously (17). Lack of significant FR interactions with AT or ST precludes an effect on growth due to applied N, P, and K. However, tissue analyses data (Fig. 2) show the same AT × ST interactions for Ca, Mg, Fe, and Zn as were obtained for growth data, with Ca and Mg interactions being most similar to growth interactions. These data indicate a reduced capacity of roots to absorb or translocate Ca and Mg at 29.5°C ST when grown at 18.5°C AT but not at 13°C AT. Calcium tissue levels were near the deficiency level at both the lowest and highest STs, which could reduce fresh top and root weights and reduce systematic activity in basal breaks thereby reducing their number. Downs and Hellmers (5) reported effects of low temperature on uptake of nutrients. Rice root respiration in N uptake at 13°C or below, but reported little information on the capacity of plants to absorb and translocate other elements when temperatures varied.

The data indicate that an AT near 18.5°C is much better than 13°C when STs are below 24°C for Dieffenbachia growth. However, at
STs of 24° to 29.5°, growth was sometimes maximized at the lower AT and highest ST. In general, most growth measurements were maximized at an AT of 18.5° and ST of 18.5° to 24°. Reducing AT to 13° does not appear to be a satisfactory production technique unless STs near 29.5° are provided.

Literature Cited