Abstract. Dwarf Japanese euonymus (Euonymus japonica Thunb. ‘Microphylla’) and ‘Pink Supreme’ azalea (Rhododendron xsp.) grown in containers of three diameters (10.2, 15.2, and 20.3 cm), were given three rates of Osmocote 17N-3P-10K (3.6, 7.1, and 10.7 kg m\(^{-3}\)). Response to container volume and fertility was species-dependent. Top growth of euonymus increased in response to both increased medium volume and fertility and was closely related to foliar levels of N, P, and K. Top growth of azalea increased in response to increasing fertility rates in the smallest pots, and to increasing medium volume at the lowest fertilizer rates. With an increase in both fertilizer rate and medium volume, growth of azalea was reduced. Top growth was inversely related to foliar K, but was unrelated to foliar N and P.

Growth of plants in containers is influenced by physical and chemical characteristics of the container environment, including container volume, shape, and fertility. Studies have shown increased growth with increased volume of growth medium (1, 2, 5, 7–9). In most of these studies, fertilizer was applied on 4 Feb. 1985 at rates of 3.6, 7.1, and 10.7 kg m\(^{-3}\) to containers of each size.

Fig. 1. Top dry weight and soluble salts of euonymus grown in pots of three diameters and fertilized at three rates.
The most recently matured leaves of each species were sampled and analyzed for N, P, and K using the double-acid extraction procedure. After sampling of tissue, plant tops were severed at the soil line, dried at 80°C for 72 hr, and weighed. Data were subjected to statistical analysis using an analysis of variance and regression.

Top dry weight of euonymus increased in response to increasing pot diameter and to increasing fertility rates (Fig. 1) and was closely correlated with foliar N, P, and K (Fig. 2). There were interactions between pot diameter and fertility rates. For instance, with small pots or at low fertility rates, top dry weight response was more pronounced (linear response), whereas in large pots or at high fertility, growth was not affected or was moderated (quadratic response).

Soluble salts in the growth medium increased linearly as fertility rate increased, while pot diameter had no effect (Fig. 1). Positive correlation of growth through a wide range of fertility rates and pot diameters emphasized the tolerance of rapid growing species such as euonymus.

Unlike euonymus, the interaction response of pot diameter and fertility rates with respect to top dry weight of azalea was most notable (Fig. 3). Top growth of azalea increased in response to increasing fertility rates in the smallest pots and also to increasing pot size at the lowest fertilizer rates. Response was opposite in the largest pot and at the highest fertility rate, respectively. Notwithstanding the somewhat variable data for soluble salts in the medium (Fig. 3), this latter response was possibly due to the presence of relatively higher levels of soluble salts in contact with azalea plants unable to use these levels of fertilizers. In fact, the reduction in foliar color at the highest fertility levels and also symptoms of stress (reduced internode length and leaf size) observed in those plants seem to confirm this observation. Unlike euonymus, there appears to be no discernible relationship of foliar N and P (Fig. 4) with top dry weight of azalea (Fig. 3). However, there appears to be an inverse relationship between foliar K (Fig. 4) and top dry weight (Fig. 3).

Euonymus and azalea responded differently to changes in container volume and fertility. Top growth of euonymus increased in response to both increased medium volume and fertility and was closely related to foliar N, P, and K. Canopy growth of azalea increased in response to fertilizer in the smaller volumes and to pot diameter at the lower fertilizer rate. With an increase in both fertilizer and medium volume, growth of azalea was reduced, possibly due to high soluble salts in the medium. Foliar N and P of azalea were not closely related to top growth, whereas foliar K was inversely related to top dry weight. These results suggest that plant response to container volume and fertility is species-dependent. Rapidly growing species benefit most from large media volumes and high rates of fertilizer. These results concur with those of other researchers.
Growth of Dieffenbachia maculata 'Perfection' as Affected by Air and Soil Temperatures and Fertilization

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Additional index words: foliage plant, soil heating

Abstract. Dieffenbachia [Dieffenbachia maculata (Lodd) G. Don 'Perfection'] were grown at 13° or 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 temperature (16), but investments in soil heating systems generally did not provide adequate returns prior to escalation of energy costs. In recent years, researchers have examined root-zone heating of poinsettias (7), roses (14), geraniums (12), Easter lily (18), calceolaria (21), and chrysanthemums (11). Plant quality was often improved and turnover time reduced if root-zone temperatures were not above 28°C. Research on foliage plants has been mainly restricted to Dieffenbachia, because it is known to be responsive to elevated soil temperatures. Henley (6) reported increased root and top growth of Dieffenbachia maculata when soil was heated to 25° compared to no heat and variable air temperature of 18° to 27°. Rooting of Dieffenbachia maculata 'Perfection/Compacta' was improved when bottom heating of 21° was provided vs. cuttings receiving 7.5° to 19° (3). Temperatures of 23° soil and 19° air have been recommended by Moeis (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 Biemberg (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.

### 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>3.3</td>
<td>99.2</td>
<td>9.4</td>
</tr>
</tbody>
</table>

Significance: *P* = highly significant, *NS* = not significant

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).
3Not significant and significant at the 0.05 and 0.01 levels, respectively. L = linear, Q = quadratic.