these studies indicate that several available herbicides provide effective weed control in caladiums without crop injury or loss of tuber production. Metolachlor is in the same chemical family with alachlor and has a similar spectrum of weed control. It provided excellent control of C. compressus (annual sedge) which is a common, difficultly controlled weed in caladiums. Flumetralin is a relatively new compound, the availability and development of which is unsure at this time. Isoxaben + oryzalin might have some utility in certain situations; however, the current price will limit its use in caladium production. Methyl bromide fumigation should be based on the economics of this practice and the potential returns. This decision probably should be made on an individual field and cultivar basis rather than in consideration of the entire farm.

**Literature Cited**


### COPPER HYDROXIDE-TREATED POTS IMPROVE THE ROOT SYSTEM OF BOUGAINVILLEA CUTTINGS

**Abstract.** The responses of root systems of ‘Barbara Karst’ bougainvillea (Bougainvillea x buttiana (Bougainvillea glabra Choicy x Bougainvillea peruviana Humb. & Bonpl.) ‘Barbara Karst’) cuttings to 100 g Cu(OH)$_2$/liter in latex paint applied to the interior surface of square 66, 120, or 280-ml plastic pots were determined. Cuttings (10 cm long; 3-5 nodes; 2 leaves) were scored on opposite sides and dipped in KIBA at 6000 mg-liter$^{-1}$ for 3 sec on 16 Apr. 1993. Cuttings were placed in treated or untreated pots that contained a medium of 1 Canadian sphagnum peat: 1 coarse perlite (v/v). The pots were completely randomized in a 3X2 factorial design. The cuttings were rooted under intermittent mist 9 sec-5 min$^{-1}$ for 12 hr-day$^{-1}$ in a greenhouse (20% shade). Cuttings rooted in Cu(OH)$_2$-treated containers had no root circling and a more compact, well-branched root system compared to cuttings rooted in untreated containers. However, root fresh weight was reduced by the Cu(OH)$_2$ treatment. Container size affected the number of primary roots as well as root fresh and dry weight.

Bougainvillea are primarily propagated by stem cuttings. The cuttings root well but the root systems are usually composed of long brittle non-fibrous roots which circle the interior of the propagation container. When transplanted some of the roots are often broken.

The results of recent studies have demonstrated the usefulness of chemical root pruning with copper hydroxide (Arnold, 1992; Arnold et al., 1993; Svenson and Broschat, 1992). A relatively new product, Spin Out™, is a water-based latex paint containing copper hydroxide that is applied to the interior surface of square 66, 120, or 280-ml plastic pots that contained a medium of 1 Canadian sphagnum peat: 1 coarse perlite (v/v). The pots were completely randomized in a 3X2 factorial design. The cuttings were rooted under intermittent mist 9 sec-5 min$^{-1}$ for 12 hr-day$^{-1}$ in a greenhouse (20% shade). Cuttings rooted in Cu(OH)$_2$-treated containers had no root circling and a more compact, well-branched root system compared to cuttings rooted in untreated containers. However, root fresh weight was reduced by the Cu(OH)$_2$ treatment. Container size affected the number of primary roots as well as root fresh and dry weight.

**Materials and Methods**

Softwood stems cuttings were removed from ‘Barbara Karst’ bougainvillea [Bougainvillea x buttiana (Bougainvillea glabra Choicy x Bougainvillea peruviana Humb. & Bonpl.) ‘Barbara Karst’] on 16 Apr. 1993 and submerged in a mixture of insecticidal soap (Safer, Wellsley, Mass.) (19.5 ml-liter$^{-1}$) and dimethyl[(1,2-phenylene)-bis(iminocarbonothioyl)] bis(carbamate) (thiophanate-methyl; Domain FL; OM Scott, Marysville, Ohio) (1.3 ml-liter$^{-1}$). Cuttings (10 cm long; 3-5 nodes; 2 leaves) were scored on two sides and dipped in KIBA at 6000 mg-liter$^{-1}$ for 3 sec. The cuttings were placed in one of three containers treated on the interior with Cu(OH)$_2$/liter (in latex paint; Spin Out™, Griffin Corp., Valdosta, GA) and filled with a medium of 1 Canadian sphagnum peat: 1 coarse perlite (v/v). Container sizes were 66 ml (4.5 cm square top, 4 cm bottom, and 3.7 cm deep), 120 ml (5 cm square top, 4.3 cm bottom, and 6 cm deep), and 280 ml (7 cm square top, 6 cm bottom and 7 cm deep). The containers, with and without Cu(OH)$_2$, were completely randomized in a factorial experiment with 15 replications per treatment per container size. The cuttings were rooted under intermittent mist 9 sec-5 min$^{-1}$ for 12 hr-day$^{-1}$ in a greenhouse (20% shade). The number of primary roots, root fresh and dry weights, and degree of rooting were recorded 15 June. The degree of rooting was rated on a scale of 1= no callusing, 2= only callusing, 3, 4, and 5= light, medium, and heavy rooting, respectively.

Data were subjected to analysis of variance for a significant response to the container size and/or Cu(OH)$_2$ (Eisensmith, 1992). Since there was no interaction between chemical treatment and container size, data were combined.

Results and Discussion

Copper hydroxide treatment. Softwood cuttings of ‘Barbara Karst’ bougainvillea rooted in Cu(OH)$_2$-treated containers had a more compact, well-branched root system than those rooted in untreated containers; furthermore there was no root circling in Cu(OH)$_2$-treated pots (Fig. 1). This could greatly reduce the possibility of damage to the root system of bougainvillea at transplanting. Degree of rooting ratings were similar in Cu(OH)$_2$-treated and untreated containers (4.5 and 4.2, respectively). The only effect Cu(OH)$_2$ had on rooting was a reduction in root fresh weight (Fig. 2). The mean root fresh weight of Cu(OH)$_2$-treated cuttings and untreated cuttings was 2100 mg and 2800 mg, respectively. On a volume basis (mg/ml container space), the values for root fresh weight were 22.7 and 17.4 mg/ml for untreated and Cu(OH)$_2$-treated containers, respectively. There was the expected dark brown root tips resulting from the contact with the Cu(OH)$_2$. However, there was a slight veinal reddening that occurred on the cuttings in the Cu(OH)$_2$-treated containers by 15 June. This occurred only on the leaves present on 16 Apr.; there was no new growth by 15 June. There has been no Cu(OH)$_2$-related veinal reddening reported for tree seedlings (Arnold, 1992), tropical greenhouse crops (Case and Arnold, 1992), or woody landscape species (Appleton and Salzman, 1993; Beeson and Newton, 1992). Veinal reddening is often associated with phosphorus deficiency, but a tissue analysis was not conducted. A subsequent trial in 1994 with another bougainvillea cultivar did not result in veinal reddening (unpublished results).

Container size. The number of primary roots and root fresh and dry weights of the cuttings were affected by container size (Figs. 3, 4, 5, respectively). Cuttings in the smallest container

Figure 1. Root pruning effect on two-month-old ‘Barbara Karst’ bougainvillea cuttings of a formulation of Cu(OH)$_2$ in latex paint (Spin Out™) applied to the interior surface of a 120-ml plastic container (A - Untreated, B - Cu(OH)$_2$-treated).

Figure 2. Influence of Cu(OH)$_2$ applied to the interior surface of plastic containers on the root fresh weight of two-month-old ‘Barbara Karst’ bougainvillea cuttings (LSD$_{0.05} = 137$ mg; n=45).

Figure 3. Influence of container size on number of primary roots of two-month-old ‘Barbara Karst’ bougainvillea cuttings (LSD$_{0.05}$=2.2; n=30).

Figure 4. Influence of container size on root fresh weight of two-month-old ‘Barbara Karst’ bougainvillea cuttings (LSD$_{0.05}$=163 mg; n=30).

Figure 5. Influence of container size on root dry weight of two-month-old ‘Barbara Karst’ bougainvillea cuttings (LSD$_{0.05}$=15 mg; n=30).
size (66 ml) had the most primary roots (26.6) but the lowest root fresh weight (1843 mg) and root dry weight (169 mg). Cuttings in the 120 ml container had only 16.9 primary roots but had significantly heavier root fresh weights (2711 mg) and root dry weights (246 mg) compared to those in the 66 ml pot but nearly identical to those in the 280 ml container (2726 and 246 mg, respectively). Cuttings in the largest container had 20.5 primary roots. There was no effect of container size on degree of rooting.

Analysis of the data on a volume basis provided a different perspective. The number of primary roots and root fresh and dry weights decreased with increasing container volume (Table 1). There were about three and six times more roots per unit volume in the 66 ml container compared to the 120 and 280 ml containers, respectively. The root fresh and dry weights of cuttings in the 66 ml container were also greater on a mg/ml basis then either of the other containers.

The effect of container size on rooting offers potential advantages for propagators of 'Barbara Karst' bougainvillea. More cuttings per area of bench space could be produced in the smallest cups (about 20 cm²) than in the medium (25 cm²) or large (49 cm²) cups. Using the smallest cups would reduce costs for the medium and possibly shipping costs. Also, the greater number of roots produced on cuttings in the smallest cups might result in reduced transplant shock. The primary disadvantage of using the smallest cups would be that the cuttings would be more susceptible to drought stress.

In summary, softwood cuttings of 'Barbara Karst' bougainvillea rooted in Spin Out™-treated plastic containers had more compact, well-branched root systems compared to those in untreated containers. However, further studies are needed to evaluate the growth of cuttings once they are transplanted into larger containers.

**Table 1. Number of primary roots and fresh and dry weights of two-month-old 'Barbara Karst' bougainvillea cuttings per ml of container volume.**

<table>
<thead>
<tr>
<th>Container size (ml)</th>
<th>No. primary roots/ml</th>
<th>Fresh wt. (mg/ml)</th>
<th>Dry wt. (mg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>66</td>
<td>0.40</td>
<td>27.9</td>
<td>2.6</td>
</tr>
<tr>
<td>120</td>
<td>0.14</td>
<td>22.6</td>
<td>2.1</td>
</tr>
<tr>
<td>280</td>
<td>0.07</td>
<td>9.7</td>
<td>0.9</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>0.05</td>
<td>1.6</td>
<td>0.2</td>
</tr>
</tbody>
</table>

**Additional index words:** lettuce, zinnia, endive, pepper, strawberry, gerbera, dieffenbachia

**Abstract.** The effect of a commercial mycorrhizal inoculant containing *Glomus intraradix* was evaluated on the initial growth stages of seven horticultural crops in a soilless substrate. Mycorrhizal root colonization was evaluated on lettuce, strawberry, zinnia, pepper and endive. All species exhibited colonization after 6 weeks growth with significant increase between the sixth and eighth week of growth. Evaluations were made of shoot and root dry weight for lettuce and zinnia, flower production for gerbera, plant height and number of shoots for dieffenbachia. Shoot dry weight of lettuce, flower buds of zinnia, and flower diameter of gerbera were significantly increased by inoculation. A significant percentage increase in height was detected for inoculated dieffenbachia plants. Fertilization level affected flower production for gerbera and plant height increase for dieffenbachia.

The symbiotic association of arbuscular mycorrhizal (AM) fungi with roots strongly affects the plant's physiology. The symbiosis provides beneficial plant growth effects such as improved uptake of phosphorus and other macro- and micro-nutrients, and increased stress tolerance (Sylvia and Williams, 1992). Plants colonized by AM fungi have demonstrated increased tolerance to plant disease (Linderman, 1994). Several studies have investigated the effect of inoculation with AM fungi on horticultural crops (Safir, 1994). Mycorrhizal colonization of plants obtained by micropropagation produced an


**ROOT COLONIZATION BY *GLOMUS INTRARADIX* (AM FUNGI) ON HORTICULTURAL SPECIES**

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**Literature Cited**


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