attributable to the more inland location of the nursery plots, or an error in the recording thermometer used at the nursery plots, since the instrument used was not a U.S Weather Service approved recording thermometer.

Efficacy data for all 7 species is shown in Table 1. For areca palm, coconut palm, schefflera, and jasmine, there were no significant differences in plant quality grading that were attributable to chemical treatments. In dracaena and ixora, there were differences noted during the first plant quality evaluation on 17 Jan. 1986 but none of these differences persisted to the second evaluation on 20 Feb. 1986. Dracaena treated with either Vapor Gard at the 5% rate or Folicote at the 5% rate had higher quality ratings than the untreated controls at the first evaluation, but there were no significant differences noted at the second evaluation. Ixora treated at the 10% rate had significantly lower quality rating as compared to untreated controls at the first evaluation but there were no differences noted at the second evaluation. This suggests a very short-term activity of certain formulations, or the possibility that the observed changes were due to unknown factors. With ficus, there were no differences in plant quality grading at the first evaluation, but at the second evaluation the quality grade of plants treated with Vapor Gard twice at the 5% rate was significantly lower than the quality grade of plants treated twice with Folicote at the 5% rate and plants treated twice with Envy at the 10% rate. The untreated ficus had quality grade levels that were not significantly different from any of the treatments. The lower quality grades seen in ficus and ixora subjected to some of the Vapor Gard treatments suggest the possibility of phytotoxicity being a factor contributing to the lower quality grading. Phytotoxicity caused by some antitranspirant formulations, including Folicote (but not Vapor Gard), has been quantitated by other researchers (2).

The potential for phytotoxic damage to foliage, coupled with the inability of most formulations tested to improve the plant quality grade of most of the species evaluated during periods of chilling, but not freezing, temperatures suggests the advisability of further development work before these types of materials could be recommended for cold protection in nurseries.

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PRE- AND POSTSTORAGE TREATMENT OF CUT LEATHERLEAF FERN FRONDS WITH FLORAL PRESERVATIVES

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Additional index words: Rumohra adiantiformis, vase life.

Abstract. Five commercial pulsing/conditioning solutions (Chrysal AVB, DVB, LVB, SVB-1, SVB-2), 6-benzylamine (BA), and 8-hydroxyquinoline citrate (8-HQC) solutions were evaluated as prestorage treatments for leatherleaf fern [Rumohra adiantiformis (Forst.) Ching] harvested in June and September. Fronds were stored for 2 weeks at 4°C. In June, only DVB affected vase life (76% reduction). In September, fronds pulsed with 8-HQC for 15 minutes (8-HQC/15) or DVB for 12 hr generally had greater water uptake than those pulsed with other treatments. Fronds pulsed with 8-HQC/15 had the longest vase life. However, DVB and LVB pulsed fronds had reduced vase life compared to the non-pulsed checks. Water uptake was not correlated with vase life. Pulsing solutions containing silver were of no benefit, suggesting that ethylene production/sensitivity is not an important factor influencing vase life of leatherleaf fern. In other experiments, fronds were held in commercial holding/preservative solutions (Floralife, Florever, Chrysal RVB), 1 mM col-

bait chloride, 1% ethanol, 200 ppm 8-HQC, or 0.1 mM phenidone solutions after storage. Fronds held in 8-HQC had the greatest water uptake, but none of the holding solutions increased vase life. Floralife and RVB solutions shortened vase life compared to deionized water at both harvests.

Leatherleaf fern continues to be the dominant crop produced by the cut foliage industry in Florida, and therefore, interest in factors that influence its vase life is considerable. Preharvest factors that reportedly affect cut frond longevity include season (12, 16), frond age (16), frond maturity (11) and precipitation level (13). However, growers have no control over season and since leatherleaf fern is grown under oak trees or shade fabric, they have little control over precipitation level at times when rainfall is plentiful. In addition, growers have little control over the market and no way to determine frond age unless sori are present, so frond age at harvest can vary greatly.

Postharvest treatments that would increase frond longevity are, therefore, of potentially greater interest to leatherleaf fern producers. Research has shown that daily recutting of stipes can increase frond vase life (10), however, daily recutting is impractical. Additionally, fronds were not stored in that study as is necessary commercially. In another study that did not include storage, antitranspirant dips were found to increase vase life compared to a water dip, but not compared to an undipped control (15). In addition, some of the antitranspirants left sticky residues on the fronds. Storage temperature has been shown to influence frond vase life with storage at 4.5°C increasing vase life compared to 24°C storage (19). Prestorage benomyl dips can also improve vase life (19). However, there are still occasional problems with postharvest frond longevity, even with the use of benomyl dips and storage at 4.5°C.

Postharvest pulsing of fronds for 10 minutes with 800 ppm 8-hydroxyquinoline citrate (8-HQC) immediately after cutting increased vase life in one study, but vase life of fronds held in 200 ppm 8-HQC, citric acid, or a wetting agent was reduced compared to holding fronds in deionized water (21). Low solution pH can increase frond water uptake and also decrease frond vase life (21). The effects of commercial floral conditioning and holding solutions on vase life of leatherleaf fern have not been studied, but a reduction in vase life of croton and English ivy cuttings due to a floral preservative has been reported (18).

Postharvest decline of leatherleaf fern fronds is characterized by three phenomena, yellowing, desiccation and frond curl syndrome (wilting, rapid desiccation) (17, 14). The cytokinin 6-benzylamino purine (BA) has been shown to retard chlorophyll loss of harvested broccoli (7), brussels sprout leaves (6), and leaves of dieffenbachia plants stored in the dark (2). The beneficial effects of stipe recutting (10) suggest that vascular plugging may be a factor influencing frond curl. Ethanol has been shown to extend the vase life of peach flowers by decreasing xylem plugging; whereas 8-HQC, gibberellic acid, or BA were of no benefit (5). Ethanol has also been shown to inhibit ethylene biosynthesis in carnations (9), as have compounds containing silver (Ag) (4, 8, 22) and cytokinins (4). Phenidone has also been used to delay senescence of cut carnations (1).

The following experiments were conducted to determine the effects of various commercial and noncommercial floral pulsing (conditioning) and holding (preservative) solutions on solution uptake and vase life of cut leatherleaf fern fronds.

Materials and Methods

Pulsing experiments. Leatherleaf fern plants were grown in ground beds of Millhopper fine sand under 73% shade fabric at the Agricultural Research and Education Center in Apopka, FL. Mature, dark green fronds of similar physiological maturity (sori gray-colored) were harvested in June and September with hand clippers between 0800 and 0815 HR from beds. Fronds were immediately transported to a nearby holding room (23°C, 19 μmol-s⁻¹·m⁻² PPFD continuously) where stipes were recut with a razor blade at 20 cm below the proximal pinna. Fronds were placed into parafilm covered Erlenmeyer flasks and pulsed with the following solutions for the indicated time intervals prior to storage: 1) no pulse for 15 min, 2) no pulse for 3 hr, 3) deionized water (DIW, pH 6.3) for 15 min, 4) DIW for 3 hr, 5) 10 ppm 6-benzylamino purine (BA, pH 5.4) for 15 min, 6) 10 ppm BA for 3 hr, 7) 1,000 ppm 8-hydroxyquinoline citrate (8-HQC, pH 4.2) for 15 min, 8) 1,000 ppm 8-HQC for 3 hr, 9) Chrysal AVB (Bendien, Naarden, Holland; pH 5.8) for 3 hr, 10) Chrysal DVB (pH 4.8) for 12 hr, 11) Chrysal LVB (pH 5.4) for 3 hr, 12) Chrysal SVB-1 (pH 5.2) for 3 hr, and 13) Chrysal SVB-2 (pH 4.9) for 3 hr. All solutions were freshly made using deionized water and commercial products were prepared according to their manufacturer’s instructions. Excess pulsing agent was shaken from stipes, leaf blades were dipped briefly in deionized water, and fronds from each treatment were sealed in individual polyethylene bags and bags were placed in waxed corrugated fiberboard cartons for storage. Fronds were stored for 2 weeks at 4.5°C. Upon removal from storage, an additional 2 cm was cut from stipe base and fronds were placed individually in deionized water-filled test tubes in holding rooms under simulated home or office conditions. Temperatures were 22 ± 1°C, relative humidity was 55 ± 10%, and light intensity was 21 μmol-s⁻¹·m⁻² 12 hr/day in the holding rooms. Water uptake uptake was recorded daily for the first 5 days poststorage. Treatments 2, 3, and 4 above were not tested and water uptake was not measured at the June harvest. All other procedures and conditions were the same as outlined above. The experimental design was completely randomized, individual fronds were the experimental units, and there were 10 and 6 replications, respectively, for the June and September harvests.

Holding experiments. Fronds were harvested, stored, and handled as stated above except pulsing solutions were not used. Holding solutions were 1) deionized water (pH 6.3), 2) 1.0 mM cobalt chloride (pH 5.2), 3) 200 ppm 8-HQC (pH, 3.9), 4) 1% ethanol (pH 4.6), 5) 0.1 mM phenidone (4.2), 6) 1% Floreator (Smithers-Oasis, Kent, OH; pH 2.8), 7) 1% Floralife (Floralife, Hinsdale, IL; pH 3.1), and 8) Chrysal RVB (pH 3.7). Treatments were replicated 10 times at each harvest with each frond an experimental unit in these randomized design experiments.

Results and Discussion

Pulsing treatments had no effect on vase life of fronds harvested in June, except for a reduction in vase life of DVB pulsed fronds (Table 1). Eighty-eight percent of the

fronds were terminated due to yellowing, 12% due to desiccation and only one frond exhibited curl. Vase lives were generally reduced at the September compared to the June harvest, as would be expected from previous research (12, 16). Again, only one frond exhibited curl, but 26% of the fronds were terminated due to desiccation. As was found in the first experiment, DVB treatments reduced vase life compared to not pulsing. LVB also reduced vase life, but the 15 min pulse with 8-HQC increased vase life compared to the unpulsed check. All pulsing treatments except LVB and 8-HQC for 180 min increased water uptake of fronds the first day poststorage. By day 3 poststorage, only fronds treated with 8-HQC for 15 min or DVB had uptake greater than the unpulsed check. Only DVB pulsed fronds had uptake different (greater) than the unpulsed check by day 5. As has been found previously (21), water uptake was not correlated with vase life (0.97>P>0.21) and high rates of solution uptake do not appear to be an important factor in extending vase life. Similar results have also been reported for rose (3) and peach flowers (5). In addition, the example of DVB’s increasing uptake while reducing vase life is consistent with a previous report where postharvest water uptake was negatively correlated with vase life (20). However, in these experiments the reason for termination of the DVB pulsed fronds was yellowing and not desiccation, suggesting that phytotoxicity rather than an inability to control water loss was the problem.

None of the pulsing solutions containing silver (AVB, DVB, LVB, SVB-2) increased vase life. This finding is in agreement with previous research using silver thiosulfate (21) and suggests that leatherleaf fern is not sensitive to ethylene. Unpublished research where frond vase life was unaffected by exposure to high ethylene concentrations (F. J. Marousky, Univ. of Florida, personal communication) also supports this supposition. This is the second report of leatherleaf fern frond vase life improvement using short term (10-15 min) pulsing with high (800-1,000 ppm) concentrations of 8-HQC.

Phenidone, Floralife, and RVB holding solutions reduced vase life of fronds harvested in June (Table 2). The latter two treatments also reduced vase life of September harvested fronds. Even though solution uptake was increased by several treatments, there was no increase in vase life. For example, from day 2 to day 5 solution uptake was 3 times greater for 8-HQC than DIW but the vase life of fronds held in 8-HQC averaged 10 days versus 11.5 days for those in DIW. These results and those of previous work using holding solutions (18, 21) indicate a need for growers to include the holding solutions their customers use in grower evaluations of frond vase life. Additionally, the use of holding/preservative solutions that do not decrease leatherleaf fern vase life should be encouraged.

**Table 1. Effects of pulsing solutions on water uptake and vase life of cut leatherleaf fern fronds.**

<table>
<thead>
<tr>
<th>Pulse solution and concentration</th>
<th>27 June</th>
<th>Harvest date</th>
<th>25 Sept.</th>
<th>Water uptake (ml-cm⁻²·10⁻⁴)</th>
<th>Vase life (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vase life (days)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No pulse</td>
<td>15.3 a</td>
<td></td>
<td>5.3 d</td>
<td>1.2 cd</td>
<td>1.0 bc</td>
</tr>
<tr>
<td>Deionized water</td>
<td>18.6 a</td>
<td></td>
<td>NT⁷</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td>BA (10 ppm)</td>
<td>17.6 a</td>
<td></td>
<td>NT</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td>8-HQC (1,000 ppm)</td>
<td>15.7 a</td>
<td></td>
<td>10.4 a</td>
<td>1.9 b</td>
<td>1.3 ab</td>
</tr>
<tr>
<td>AVB</td>
<td>17.1 a</td>
<td></td>
<td>7.0 dc</td>
<td>1.2 d</td>
<td>0.7 c</td>
</tr>
<tr>
<td>DVB</td>
<td>3.9 b</td>
<td></td>
<td>8.5 ab</td>
<td>1.6 bcd</td>
<td>1.1 bc</td>
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<td>LVB</td>
<td>14.8 a</td>
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</tr>
<tr>
<td>SVB1</td>
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<td>7.0 cd</td>
<td>1.3 cd</td>
<td>0.8 c</td>
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<tr>
<td>SVB2</td>
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<td></td>
<td>8.3 ab</td>
<td>1.4 bcd</td>
<td>0.9 bc</td>
</tr>
</tbody>
</table>

*Mean separation in columns by Duncan’s multiple range test, 5% level.

¹NT = not tested.

**Table 2. Effects of holding solutions on water uptake and vase life of cut leatherleaf fern fronds.**

<table>
<thead>
<tr>
<th>Holding solution and concentration</th>
<th>27 June</th>
<th>Harvest date</th>
<th>25 Sept.</th>
<th>Solution uptake (ml-cm⁻²·10⁻⁴)</th>
<th>Vase life (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vase life (days)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deionized water</td>
<td>9.7 a</td>
<td></td>
<td>5.5 cd</td>
<td>1.3 e</td>
<td>1.0 de</td>
</tr>
<tr>
<td>Cobalt chloride (1.0 mM)</td>
<td>8.6 ab</td>
<td></td>
<td>6.5 bc</td>
<td>2.1 cd</td>
<td>1.9 b</td>
</tr>
<tr>
<td>8-hydroxquinoline citrate (200 ppm)</td>
<td>7.5 abc</td>
<td></td>
<td>8.2 a</td>
<td>4.4 a</td>
<td>3.5 a</td>
</tr>
<tr>
<td>Ethanol (1%)</td>
<td>8.6 ab</td>
<td></td>
<td>7.2 ab</td>
<td>1.2 e</td>
<td>0.8 de</td>
</tr>
<tr>
<td>Phenidone (0.1 mM)</td>
<td>5.5 bc</td>
<td></td>
<td>7.9 a</td>
<td>2.9 b</td>
<td>1.7 bc</td>
</tr>
<tr>
<td>Floralife (1%)</td>
<td>7.5 abc</td>
<td></td>
<td>4.2 dc</td>
<td>2.6 bc</td>
<td>1.7 bc</td>
</tr>
<tr>
<td>RVB</td>
<td>6.3 bc</td>
<td></td>
<td>3.4 e</td>
<td>1.7 de</td>
<td>1.1 cd</td>
</tr>
</tbody>
</table>

*Mean separation in columns by Duncan’s multiple range test, 5% level.

**Literature Cited**


Efficacy of Fertilizer-Insecticide Spikes in Foliage Plant Production

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Additional index words. Cordyline terminalis, Dieffenbachia maculata, Ficus benjamina.

Abstract. Three experiments were established to evaluate three insecticides, carbofuran, disulfoton, and aldoxycarb, incorporated at a 1% concentration in fertilizer spikes with fertilizer analysis of 12-4-8 and 15-14-4 N-P₂O₅-K₂O. Fertilizer-insecticide spikes were evaluated for efficacy, phytotoxicity, and growth ratings on three foliage plants, Ficus retusa L. 'Nitida' infested with Cuban laurel thrips (Gynaikothrips ficorum Marchal), Dieffenbachia maculata (Lodd.) G. Don 'Exotica Perfection' infested with longtailed mealybugs (Pseudococcus longispinus Targoni), and Cordyline terminalis (L.) Kunth 'Baby Doll' infested with longtailed mealybugs. The results of these experiments showed mealybugs were controlled on Dieffenbachia 'Exotica Perfection' by disulfoton and aldoxycarb, while on Cordyline terminalis, mealybug infestations were eliminated by all three insecticides if the applica-

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