ing detergent solutions reduced the ETU levels to 2.0 ppm or less. The use of sodium hypochlorite in the washing solutions appeared to have little effect on decreasing the ETU residues in canned spinach. Small changes in quality were observed in canned spinach washed with detergent solutions as compared to the water-wash control. Quality changes were mainly in pH and titratable acidity. Panelists detected small differences in liquor and drained spinach color; however, no difference in overall appearance was noted among the washing treatments.

Literature Cited


Production and Storage Factors Influencing Quality of Potted Easter Lilies

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Additional index words. Lilium longiflorum, potted flowering plants, postharvest handling, fertilization

Abstract. Termination of liquid fertilizer application at the visible bud stage or 2 weeks later during production of potted Lilium longiflorum Thunb. ‘Nellie White’ increased foliar chlorosis development relative to fertilization until harvest on plants stored for 3 weeks at 2°C in the dark. Drenches of ancyimidol applied during early production increased poststorage foliar chlorosis and bud abortion. Polyethylene (PE) lining of boxes used for cold storage and simulated shipment of potted lilies reduced water loss but did not affect subsequent floral longevity, but abortion, or foliar chlorosis. Spermidine application before boxed storage did not influence foliar chlorosis.

Termination of fertilizer application before harvest has been found to increase foliar longevity of potted chrysanthemums (Nell and Barrett, 1985) and non-sleeved poinsettias (Prince and Cunningham, 1988) held in postproduction environments. These studies suggest that similar treatments could improve postproduction quality of other potted floral crops. Foliar chlorosis development on potted lilies after retail sale can reduce postproduction life. Ancyimidol application has been shown to enhance foliar chlorosis of potted lilies during production (Jiao et al., 1986) but its further influence on postproduction quality of cold-stored plants is unknown. Application of spermidine and other polyamines has been shown to reduce chlorophyll degradation in Heliotropium spp. (Birecka et al., 1984) and Hordeum vulgare (Srivastava et al., 1983), but tests of application to commercial potted plants to delay chlorosis have not been reported.

Increased postproduction bud abortion and foliar chlorosis, as well as decreased floral longevity, of potted Easter lilies have all been related to increasing durations of cold storage (Prince et al., 1987; Staby and Erwin, 1977). Cold storage in boxes has been reported to be less successful (Staby and Erwin, 1977) than non-boxed storage (Healy et al., 1979; Prince et al., 1987). While exposure to light was not critical (Healy et al., 1979), the non-boxed plants were watered during storage. This difference suggests that reduction of moisture loss during boxed storage could improve subsequent quality.

The present studies examined two production and two postproduction factors that could influence longevity of potted Easter lilies. The first involved ancyimidol application and preharvest fertilizer termination treatments applied to potted plants before cold storage. The second study examined the application of spermidine to reduce chlorosis and the use of PE-box liners to reduce moisture loss from potted lilies during cold storage and simulated shipment.

‘Nellie White’ bulbs were obtained from a commercial supplier, cooled while still in the shipping box, and forced by standard commercial practice (Tayama et al., 1986). Bulbs were planted in 15-cm pots (1.4 liters) of Sunshine Mix No. 1 (Fisons-Western, Vancouver, B.C., Canada) and grown at 19 plants/m2 of bench area with constant liquid feed of 20N–4.4P–16.6K at 250 mg N/liter and Peters Soluble Trace Element Mix (W.R. Grace, Fogelsville, Pa.) at 0.7 mg/liter–1. Regular drenches of methyl[1-[(butylamino)carbonyl]-1H-benzimidazol-2-yl]carbamate [benomyl, 50% wettable powder (WP), 0.6 g/liter–1] and 5-ethoxy-3-trichloromethyl-
Table 1. Medium analysis after termination of fertilizer at three preharvest stages during production of potted 'Nellie White' lilies.2

<table>
<thead>
<tr>
<th>Fertilizer termination stage</th>
<th>pH</th>
<th>Soluble salts (dS-m⁻¹)</th>
<th>Macronutrients (µg g⁻¹ dry wt)</th>
<th>Macronutrients (µg g⁻¹ dry wt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>NO₃</td>
<td>P</td>
</tr>
<tr>
<td>VB</td>
<td>6.5</td>
<td>0.5</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>BV2</td>
<td>6.2</td>
<td>1.1</td>
<td>99</td>
<td>25</td>
</tr>
<tr>
<td>HVST</td>
<td>6.0</td>
<td>3.5</td>
<td>372</td>
<td>47</td>
</tr>
<tr>
<td>F tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Ancymidol effects were ns. Values are means of four replicates from five plants sampled when two to three buds had opened.

1,2,4-thiadiazole (ethazol, 30% WP, 0.6 g liter⁻¹) were applied to control root rot.

Plants were watered as needed during storage, except those stored in boxes, as described later. Plants were evaluated for keeping quality under a simulated home interior environment of 20 ± 0.5C and 60% to 70% RH with 12 hr of light (8–11 µmol s⁻¹ m⁻², photosynthetic active radiation) per day from cool-white fluorescent lamps. Plants were watered with tap water as needed during evaluation.

Table 2. Foliar analysis after termination of fertilizer at three preharvest stages during production of 'Nellie White' lilies.6

<table>
<thead>
<tr>
<th>Fertilizer termination stage</th>
<th>Macronutrients (mg g⁻¹ dry wt)</th>
<th>Macronutrients (µg g⁻¹ dry wt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>P</td>
</tr>
<tr>
<td>VB</td>
<td>39.5</td>
<td>7.3</td>
</tr>
<tr>
<td>BV2</td>
<td>47.0</td>
<td>9.9</td>
</tr>
<tr>
<td>HVST</td>
<td>47.9</td>
<td>10.5</td>
</tr>
<tr>
<td>F tests</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Ancymidol effects were ns. Values are means of four replicates of five plants sampled when two to three buds had opened.

Spermidine and box liner study. Plants were grown as described above and selected to be free of root rot symptoms and leaf chlorosis. Half of the plants were sprayed with spermidine [10 mM in phosphate buffer at pH 5.8 with 0.1% (v/v) Tween 20], while the remaining were sprayed with buffer only. Plants were allowed to dry, sprayed with spermidine, and placed upright in boxes with or without a 0.05-mm-thick PE liner. Boxes were placed unclosed in cold storage for 1 day to allow some removal of field heat. Medium temperature declined to 3.5 to 4.0C after 1 day. Liners were then loosely folded over and all boxes sealed with tape. After 3 weeks of cold storage, the boxes were placed in interior conditions for either 2 days or were opened immediately. Two replicate boxes of each liner—warm storage day combination, each containing three spermidine-sprayed and three control plants, were used. Data were analyzed as a split-plot design with spermidine as the subplot and liner and warm storage days as the main plot.

Air samples (3 ml) were withdrawn from all boxes before opening. Ethylene in the boxes (measured by gas chromatography) was
Means of four replicates of three plants each. 

*Significant or significant at P = 0.01 or 0.001. Interactions were nonsignificant.

Table 3. Influence of ancymidol application and fertilizer termination stage on percentage of chlorotic foliage on potted ‘Nellie White’ lilies after 3 weeks of storage at 2°C plus 10 days in simulated interior conditions.2

<table>
<thead>
<tr>
<th>Fertilizer termination stage</th>
<th>No. ancymidol drenches</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Chlorotic foliage (%)</td>
<td></td>
</tr>
<tr>
<td>VB</td>
<td>22</td>
<td>49</td>
</tr>
<tr>
<td>VB2</td>
<td>20</td>
<td>32</td>
</tr>
<tr>
<td>HVST</td>
<td>11</td>
<td>30</td>
</tr>
<tr>
<td>Means</td>
<td>18</td>
<td>37</td>
</tr>
</tbody>
</table>

F tests: Ancymidol vs. untreated, ***; HVST vs. VB and VB2, **; VB vs. VB2, NS

2Plants were in boxes for 0, 2, or 4 days of the interior conditions. Number of days was nonsignificant. Data were averaged over the box effect and are means of six plants. Data analyzed on arcsin-transformed scale.

*VB = visible bud, VB2 = 2 weeks after VB, HVST = harvest.

NS,***Nonsignificant or significant at P = 0.01 or 0.001. Interactions were nonsignificant.

Table 4. Quality of potted ‘Nellie White’ lilies after 3 weeks storage at 2°C in boxes with or without polyethylene (PE) liners and after 2 days of simulated shipment at 20°C.2

<table>
<thead>
<tr>
<th>Box lining</th>
<th>Days at 20°C</th>
<th>Weight loss (%)</th>
<th>Floral longevity (days)</th>
<th>Chlorotic foliage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>0</td>
<td>3.2</td>
<td>9.2</td>
<td>22</td>
</tr>
<tr>
<td>None</td>
<td>0</td>
<td>2.9</td>
<td>9.2</td>
<td>27</td>
</tr>
<tr>
<td>PE</td>
<td>2</td>
<td>10.3</td>
<td>8.6</td>
<td>31</td>
</tr>
</tbody>
</table>

F tests: Liner vs. PE, ***; Days, NS

2Spermidine effects were nonsignificant. Means are averaged over spermidine level and area of four replicates of three plants each.

*Loss from entire plant and soil mass during cold storage and simulated shipment.

*Determined at date of senescence of terminal flower (16-20 days after removal from storage).

NS,***Nonsignificant or significant at P = 0.01 or 0.001, respectively. Interactions were nonsignificant.

Between 10 and 30 nMiter-1 and was not significantly influenced by box lining. Fresh weight loss from the plants and soil during storage and simulated shipment was reduced by the PE liners, but there was no influence on average longevity of individual flowers, foliar chlorosis, or bud abortion (Table 4). Spermidine application had no influence on foliar chlorosis. Its chlorosis-inhibiting effects have been shown to be less effective on mature than on immature leaves (Srivastava et al., 1983). This effect may have prevented a beneficial response from lily foliage.

These studies have shown that preharvest fertilizer termination at the visible bud stage or 2 weeks later is detrimental for Easter lilies that will be cold-stored. Commercial recommendations should therefore be to continue to apply nutrients until harvest. Ancymidol treatment increased storage-induced foliar chlorosis and bud abortion. Possibly, other growth regulators or manipulation of temperature regimes (Erwin et al., 1987) could be used to control plant height without enhancement of chlorosis after storage. PE lining of boxes reduced moisture loss during storage and simulated shipment, but did not enhance foliar or floral quality. Condensation on the inside of the liner resulting from temperature fluctuations during transport could enhance Botrytis growth on the flower buds. Therefore, PE-box liners are not recommended for commercial storage of potted Easter lilies.

Literature Cited


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