IR-4 Environmental Horticulture Program
Cyflufenamid Crop Safety

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Abstract

Cyflufenamid is an active ingredient for managing foliar diseases including powdery mildew and botrytis. It is not yet registered by EPA for the ornamental horticulture industry. From 2012 to 2014, the IR-4 Project completed 39 trials on 16 ornamental plant genera or species. In these trials, 9 species or genera exhibited minimal or no injury after foliar applications. For the remaining 7 crops, sufficient information has not yet been generated. However, to date all tested crops are not sensitive to foliar applications up to 4X the proposed high label rate.
Introduction
Cyflufenamid is an active ingredient for managing foliar diseases including powdery mildew and botrytis. It is not yet registered by EPA for the ornamental horticulture industry. From 2012 to 2014, the IR-4 Project completed 55 trials on 16 ornamental plant genera or species.

Materials and Methods
Foliar applications of cyflufenamid at 1.7, 3.4, and 6.8 oz per 100 gal were applied 3 times at 14 day intervals. All experiments had an untreated control. A minimum of 10 plants (replicate treatments) were required. Phytotoxicity was planned to be recorded on a scale of 0 to 10 (0 = no phytotoxicity; 10 = complete kill). Phytotoxicity was rated 7 days after each application. For testing, the following protocol were used: 12-010, 13-010 and 14-003. Please visit https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-researcher-resources/#Protocols to view and download these protocols.

Cyflufenamid was supplied to 8 researchers (See list of researchers in Appendix 1) by Cleary Chemical and Nisso America.

Results and Summary
Based on the type and nature of injury seen with pesticide applications, tested plant species were placed into three categories: 1) no significant phytotoxicity or growth differences from the untreated check or any injury was transitory, 2) no or minimal transitory injury seen at the 1X rate, but the 2X and/or 4X rates did cause significant phytotoxicity, 3) significant injury sufficient to recommend growers not utilize cyflufenamid, and 4) more data are needed to make informed recommendations.

Phytotoxicity
Across all plant species tested, cyflufenamid exhibited no or minimal negative impact (Table 1) on 9 plant genera or species fell into this category. No crops exhibited significant injury (Table 3). There are 7 species or genera where less than 3 trials were conducted so there is not enough information available at this time (Table 4).

Please see Table 5 for a summary of the individual trial results.
Table 1.  List of cyflufenamid treated crops with no or minimal transitory injury.

Antirrhinum majus
Calibrachoa sp.
Hydrangea sp.
Osteospermum sp.
Pelargonium sp.
Petunia sp.
Pseudotsuga menziesii
Rosa sp.
Zinnia sp.

Table 2.  List of cyflufenamid treated crops with no injury at 1X but significant injury at 2X or 4X.

None

Table 3.  List of cyflufenamid treated crops with significant injury at 1X.

None

Table 4.  List of cyflufenamid treated crops where more information is needed.

Chrysanthemum/Dendranthemum sp.
Narcissus sp.
Rhododendron sp. (Azalea)
Rhododendron sp. (Rhododendron)
Tulipa sp.
Viola sp.
Table 5  Detailed Summary of Crop Safety Testing with Cyflufenamid

Notes: Table entries are sorted by crop Latin name. Only those trials with research reports received by 8/14/2015 are listed below.

<table>
<thead>
<tr>
<th>PR #</th>
<th>Crop</th>
<th>Production Site</th>
<th>Researcher</th>
<th>State</th>
<th>Year</th>
<th>Application Type</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>30675</td>
<td>Snapdragon (Antirrhinum majus) A. majus 'Rocket'</td>
<td>Greenhouse</td>
<td>Grunwald</td>
<td>OR</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times; all plants saleable.</td>
</tr>
<tr>
<td>30675</td>
<td>Snapdragon (Antirrhinum majus) 'Montego Mix'</td>
<td>Greenhouse</td>
<td>Grunwald</td>
<td>OR</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times; all plants marketable.</td>
</tr>
<tr>
<td>30675</td>
<td>Snapdragon (Antirrhinum majus) 'Montego Rose'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30675</td>
<td>Snapdragon (Antirrhinum majus) 'Purple'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30675</td>
<td>Snapdragon (Antirrhinum majus) 'Rocket Mix'</td>
<td>Greenhouse</td>
<td>Gu (TX A&amp;M)</td>
<td>TX</td>
<td>2013</td>
<td>Foliar</td>
<td>No leaf injury, very minor flower tip burn, and no growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30679</td>
<td>Calibrachoa (Calibrachoa sp.) 'Cabaret Purple'</td>
<td>Greenhouse</td>
<td>Williams-Woodward</td>
<td>GA</td>
<td>2013</td>
<td>Foliar</td>
<td>No significant injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30679</td>
<td>Calibrachoa (Calibrachoa sp.) 'Mini-famous Orange'</td>
<td>Greenhouse</td>
<td>Grunwald</td>
<td>OR</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times; all plants marketable.</td>
</tr>
<tr>
<td>30679</td>
<td>Calibrachoa (Calibrachoa sp.) 'Mini-famous Red'</td>
<td>Greenhouse</td>
<td>Grunwald</td>
<td>OR</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times; all plants saleable.</td>
</tr>
<tr>
<td>31626</td>
<td>Chrysanthemum, Garden (Chrysanthemum/Dendranthema sp.)</td>
<td>Field</td>
<td>Harvey</td>
<td>WA</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30683</td>
<td>Hydrangea (Hydrangea sp.) H. arborescens 'Annabelle'</td>
<td>Greenhouse</td>
<td>Grunwald</td>
<td>OR</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times; all plants marketable.</td>
</tr>
<tr>
<td>30683</td>
<td>Hydrangea (Hydrangea sp.) H. macrophylla 'Endless Summer'</td>
<td>Greenhouse</td>
<td>DeFrancesco</td>
<td>OR</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30683</td>
<td>Hydrangea (Hydrangea sp.) H. paniculata 'Little Lamb'</td>
<td>Greenhouse</td>
<td>Brazee</td>
<td>MA</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30684</td>
<td>Daffodil (Narcissus sp.) 'Tete-a-Tete'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2013</td>
<td>Foliar</td>
<td>Slight injury after the final application with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times; slight growth reduction.</td>
</tr>
<tr>
<td>30685</td>
<td>African Daisy (Osteospermum sp.) 'Copper Purple'</td>
<td>Greenhouse</td>
<td>Grunwald</td>
<td>OR</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times; all plants saleable.</td>
</tr>
<tr>
<td>30685</td>
<td>African Daisy (Osteospermum sp.) 'Margarita White'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30685</td>
<td>African Daisy (Osteospermum sp.) O. ecklonis 'Summertime Blueberry'</td>
<td>Greenhouse</td>
<td>DeFrancesco</td>
<td>OR</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>31629</td>
<td>Geranium (Pelargonium sp.)</td>
<td>Field</td>
<td>Harvey</td>
<td>WA</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30686</td>
<td>Geranium (Pelargonium sp.) 'Pink Elite'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30686</td>
<td>Geranium (Pelargonium sp.) 'Pink Elite'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2014</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>PR #</td>
<td>Crop</td>
<td>Production Site</td>
<td>Researcher</td>
<td>State</td>
<td>Year</td>
<td>Application Type</td>
<td>Results</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------</td>
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<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>30686</td>
<td>Geranium (Pelargonium sp.) 'Scarlet'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>31630</td>
<td>Petunia (Petunia sp.)</td>
<td>Field Container</td>
<td>Harvey</td>
<td>WA</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30692</td>
<td>Petunia (Petunia sp.) 'Dream Neon Rose'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2014</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30692</td>
<td>Petunia (Petunia sp.) 'Dream Rose'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30692</td>
<td>Petunia (Petunia sp.) 'Purple'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30693</td>
<td>Fir, Douglas (Pseudotsuga menziesii)</td>
<td>Greenhouse</td>
<td>DeFrancesco</td>
<td>OR</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30693</td>
<td>Fir, Douglas (Pseudotsuga menziesii)</td>
<td>Greenhouse</td>
<td>Grunwald</td>
<td>OR</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times; all plants saleable.</td>
</tr>
<tr>
<td>30693</td>
<td>Fir, Douglas (Pseudotsuga menziesii)</td>
<td>Greenhouse</td>
<td>Grunwald</td>
<td>OR</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times; all plants marketable.</td>
</tr>
<tr>
<td>30694</td>
<td>Azalea (Rhododendron sp.)</td>
<td>Greenhouse</td>
<td>DeFrancesco</td>
<td>OR</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30695</td>
<td>Rhododendron (Rhododendron sp.)</td>
<td>Greenhouse</td>
<td>DeFrancesco</td>
<td>OR</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>31631</td>
<td>Rose (Rosa sp.)</td>
<td>Field Container</td>
<td>Harvey</td>
<td>WA</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30696</td>
<td>Rose (Rosa sp.) R. nutkana</td>
<td>Greenhouse</td>
<td>Grunwald</td>
<td>OR</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times; all plants saleable.</td>
</tr>
<tr>
<td>30696</td>
<td>Rose (Rosa sp.) R. rugosa</td>
<td>Greenhouse</td>
<td>Brazee</td>
<td>MA</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30696</td>
<td>Rose (Rosa sp.) 'Radrazz'</td>
<td>Greenhouse</td>
<td>DeFrancesco</td>
<td>OR</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30697</td>
<td>Tulip (Tulipa sp.) 'Oxford'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2013</td>
<td>Foliar</td>
<td>Virtually no injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30698</td>
<td>Pansy (Viola sp.) 'Golden Yellow'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30698</td>
<td>Pansy (Viola sp.) 'Lavender Blue'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2012</td>
<td>Foliar</td>
<td>Virtually no injury with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times; very minor stunting.</td>
</tr>
<tr>
<td>30699</td>
<td>Zinnia (Zinnia sp.) 'Elegans Envy'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30699</td>
<td>Zinnia (Zinnia sp.) 'Thumbelina'</td>
<td>Greenhouse</td>
<td>Freiberger</td>
<td>NJ</td>
<td>2012</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times.</td>
</tr>
<tr>
<td>30699</td>
<td>Zinnia (Zinnia sp.) Z. elegans 'Zinnita Mix'</td>
<td>Greenhouse</td>
<td>Grunwald</td>
<td>OR</td>
<td>2013</td>
<td>Foliar</td>
<td>No injury or growth reduction with 1.7, 3.4 and 6.8 fl oz per 100 gal applied 3 times; all plants marketable.</td>
</tr>
</tbody>
</table>
Label Suggestions
In this report, 9 species exhibited minimal or no injury after foliar sprays of cyflufenamid.

*Antirrhinum majus*
*Calibrachoa sp.*
*Hydrangea sp.*
*Osteospermum sp.*
*Pelargonium sp.*
*Petunia sp.*
*Pseudotsuga menziesii*
*Rosa sp.*
*Zinnia sp.*

More research is needed to understand crop safety among a wider range of crops.
Appendix 1: Contributing Researchers

Dr. Nick Brazee
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