



[Environmental Horticulture Program Research Summaries](#)

IR-4 Environmental Horticulture Program

Powdery Mildew Efficacy & Literature Review:

Erysiphe azaleae
Erysiphe cichoracearum
Erysiphe knautiae
Erysiphe lagerstroemia
Erysiphe lonicerae var. *lonicerae*
Erysiphe monardae
Erysiphe polygoni
Erysiphe pulchra
Oidium sp.
Podosphaera pannosa
Podosphaera xanthii

Author: Cristi Palmer

Date: July 10, 2023

Acknowledgements:

Ely Vea
Susan Bierbrunner
Lori Harrison
Karen Sims

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award numbers 2015-34383-23710, 2017-34383-27100, 2019-34383-29973, 2020-34383-32455 and 2021-343830-34848 with substantial cooperation and support from the State Agricultural Experiment Stations and USDA-ARS.

Table of Contents

Table of Contents	2
Table of Tables	4
Abstract	9
Introduction	10
Materials and Methods	11
Results	14
Comparative Efficacy on <i>Erysiphe azaleae</i>	17
Comparative Efficacy on <i>Erysiphe knautiae</i>	17
Comparative Efficacy on <i>Erysiphe lagerstroemia</i>	18
Comparative Efficacy on <i>Erysiphe lonicerae</i>	19
Comparative Efficacy on <i>Erysiphe monardae</i>	21
Comparative Efficacy on <i>Erysiphe polygoni</i>	22
Comparative Efficacy on <i>Erysiphe pulchra</i>	30
Comparative Efficacy on <i>Golovinomyces cichoracearum</i>	40
Comparative Efficacy on <i>Golovinomyces orontii</i>	55
Comparative Efficacy on <i>Oidium</i> sp.	55
Comparative Efficacy on <i>Podosphaera pannosa</i>	69
Comparative Efficacy on <i>Podosphaera xanthii</i>	72
Efficacy Summary by Product/Active Ingredient	77
Azoxystrobin	77
Azoxystrobin + Benzovindiflupyr	77
Chlorothalonil	77
Copper Products	77
Cyflufenamid	77
Fenarimol. Rubigan provided	77
Fluoxastrobin. Disarm provided	77
Fluxapyroxad + Pyraclostrobin	77
Hydrogen dioxide	77
Kresoxym-methyl	77
Lupinus extract	77
Myclobutanil	78
Neem Oil extract	78
Piperalin	78
Potassium bicarbonate	78
Propiconazole	78
Pydiflumetofen	78
Pyraclostrobin	78
Pyraclostrobin + Boscalid	78
Pyriofenone. IKI-309	78
Reynoutria sachalinensis extract	78
Sulfur	79
Tebuconazole	79
Tetraconazole	79
Thiophanate-methyl	79
Triadimefon	79

Trifloxystrobin.....	79
Triflumizole	79
Phytotoxicity	79
Appendix 1: Contributing Researchers.....	86

Table of Tables

Table 1. Guide to taxonomic shifts for select powdery mildew pathogens of environmental horticulture crops	10
Table 2. List of Products and Rates Tested through IR-4 from 1981 to 2021.....	12
Table 3. Overview of IR-4 testing from 1981 to 2021	15
Table 4. *Efficacy on Powdery Mildew (<i>Erysiphe azaleae</i>) on Azalea (<i>Rhododendron daviesi</i>) 'Ghent', Pscheidt, OR, 2000.	17
Table 5. *Efficacy on Powdery Mildew (<i>Erysiphe knautiae</i>) on pincushion flower (<i>Scabiosa columbaria</i>), Nelson, WA, 2005.....	17
Table 6. *Efficacy on Powdery Mildew (<i>Erysiphe lagerstroemia</i>) on Crapemyrtle (<i>Lagerstroemia indica</i>) 'Carolina Beauty', Hagan, AL, 1999.....	18
Table 7. *Efficacy on Powdery Mildew (<i>Erysiphe lagerstroemia</i>) on Crapemyrtle (<i>Lagerstroemia indica</i>), 'Muskogee' and 'Whit III', Baysal-Gurel, TN, 2016.	19
Table 8. Efficacy on Powdery Mildew (<i>Erysiphe lonicerae</i> var. <i>lonicerae</i>), on Lilac (<i>Syringa vulgaris</i>), Freiburger, NJ, 2012.	20
Table 9. Efficacy on Powdery Mildew (<i>Erysiphe lonicerae</i> var. <i>lonicerae</i>), on Lilac (<i>Syringa vulgaris</i>), Freiburger, NJ, 2015.	21
Table 10. *Efficacy on Powdery Mildew (<i>Erysiphe monardae</i>) on Bee Balm (<i>Monarda didyma</i>) 'Cambridge Scarlet', LaMondia, CT, 2000.....	21
Table 11. *Efficacy on Powdery Mildew (<i>Erysiphe monardae</i>) on Bee Balm (<i>Monarda didyma</i>) 'Cambridge Scarlet', LaMondia, CT, 2001.....	22
Table 12. General summary of efficacy for <i>Erysiphe polygoni</i> on various crops.	23
Table 13. *Efficacy on Powdery Mildew (<i>Erysiphe polygoni</i>) on Hydrangea (<i>Hydrangea macrophylla</i>) 'Hobella', Williams-Woodward, GA, 1999.....	24
Table 14. *Efficacy on Powdery Mildew (<i>Erysiphe polygoni</i>) on Hydrangea (<i>Hydrangea macrophylla</i>) 'Nikko Blue', Hagan, AL, 2000, Experiment 1.....	25
Table 15. *Efficacy on Powdery Mildew (<i>Erysiphe polygoni</i>) on Hydrangea (<i>Hydrangea macrophylla</i>) 'Nikko Blue', Hagan, AL, 2000, Experiment 2.....	25
Table 16. *Efficacy on Powdery Mildew (<i>Erysiphe polygoni</i>) on Hydrangea (<i>Hydrangea macrophylla</i>) 'Nikko Blue', Hagan, AL, 2001.	26
Table 17. *Efficacy on Powdery Mildew (<i>Erysiphe polygoni</i>) on Hydrangea (<i>Hydrangea macrophylla</i>) 'Nikko Blue', Hagan, AL, 2003.	27
Table 18. *Efficacy on Powdery Mildew (<i>Erysiphe polygoni</i>) on Hydrangea (<i>Hydrangea macrophylla</i>) 'Hobella', Williams-Woodward. GA, 2003.....	27
Table 19. *Efficacy on Powdery Mildew (<i>Erysiphe polygoni</i>) on Hydrangea (<i>Hydrangea macrophylla</i>) 'Nikko Blue', Hagan, AL, 2005.	28
Table 20. *Efficacy on Powdery Mildew (<i>Erysiphe polygoni</i>) on Hydrangea (<i>Hydrangea macrophylla</i>) 'Dooley', Hagan, AL, 2010.	28
Table 21. *Efficacy on Powdery Mildew (<i>Erysiphe polygoni</i>) on Hydrangea (<i>Hydrangea macrophylla</i>) 'Dooley', Hagan, AL, 2011, Experiment 1.....	29
Table 22. *Efficacy on Powdery Mildew (<i>Erysiphe polygoni</i>) on Hydrangea (<i>Hydrangea macrophylla</i>) 'Dooley', Hagan, AL, 2011, Experiment 2.....	29
Table 23. *Efficacy on Powdery Mildew (<i>Erysiphe polygoni</i>) on Delphinium (<i>Delphinium</i> sp.) 'Belladonna Dark Blue', Wegulo, CA, 2002.	30
Table 24. *Efficacy on Powdery Mildew (<i>Erysiphe polygoni</i>) on Delphinium (<i>Delphinium</i> sp.) 'Belladonna Dark Blue', Wegulo, CA, 2003.	30

Table 25.	General summary of efficacy for <i>Erysiphe pulchra</i> on dogwood.....	31
Table 26.	*Efficacy on Powdery Mildew (<i>Microsphaera pulchra</i>) on Dogwood (<i>Cornus florida</i>) ‘First Lady’, Hagan, AL, 1999.....	32
Table 27.	*Efficacy on Powdery Mildew (<i>Microsphaera pulchra</i>) on Dogwood (<i>Cornus florida</i>) ‘Cloud 9’, Hagan, AL, 2001.....	33
Table 28.	*Efficacy on Powdery Mildew (<i>Microsphaera pulchra</i>) on Dogwood (<i>Cornus florida</i>) ‘Cloud 9’, Hagan, AL, 2001.....	33
Table 29.	*Efficacy on Powdery Mildew (<i>Erysiphe pulchra</i>) on Dogwood (<i>Cornus florida</i>) ‘Rubra’, Hagan, AL, 2002.....	34
Table 30.	*Efficacy on Powdery Mildew (<i>Microsphaera pulchra</i>) on Dogwood (<i>Cornus florida</i>), Smith, CT, 2002.....	34
Table 31.	*Efficacy on Powdery Mildew (<i>Microsphaera pulchra</i>) on Dogwood (<i>Cornus florida</i>), Mulrooney, DE, 2002.....	35
Table 32.	*Efficacy on Powdery Mildew (<i>Erysiphe pulchra</i>) on Dogwood (<i>Cornus florida</i>) ‘Cloud 9’, Hagan, AL, 2003.....	36
Table 33.	*Efficacy on Powdery Mildew (<i>Erysiphe pulchra</i>) on Dogwood (<i>Cornus florida</i>) ‘Budded White’, Hagan, AL, 2003.....	36
Table 34.	*Efficacy on Powdery Mildew (<i>Microsphaera pulchra</i>) on Dogwood (<i>Cornus florida</i>), Mulrooney, DE, 2004.....	37
Table 35.	*Efficacy on Powdery Mildew (<i>Erysiphe pulchra</i>) on Dogwood (<i>Cornus florida</i>) ‘Rubra’, Hagan, AL, 2004.....	37
Table 36.	*Efficacy on Powdery Mildew (<i>Erysiphe pulchra</i>) on Dogwood (<i>Cornus florida</i>) ‘Rubra’, Hagan, AL, 2005.....	38
Table 37.	*Efficacy on Powdery Mildew (<i>Erysiphe pulchra</i>) on Dogwood (<i>Cornus florida</i>) ‘Cloud 9’, Hagan, AL, 2007.....	38
Table 38.	*Efficacy on Powdery Mildew (<i>Erysiphe pulchra</i>) on Dogwood (<i>Cornus florida</i>) ‘Cherokee Princess’, Baysal-Gurel, TN, 2016 - McMinnville.....	39
Table 39.	*Efficacy on Powdery Mildew (<i>Erysiphe pulchra</i>) on Dogwood (<i>Cornus florida</i>) ‘Cherokee Princess’, Baysal-Gurel, TN, 2016 - Smithville.....	39
Table 40.	*Efficacy on Powdery Mildew (<i>Erysiphe pulchra</i>) on Dogwood (<i>Cornus florida</i>) ‘Cherokee Princess’, Baysal-Gurel, TN, 2016.....	40
Table 41.	General summary of non-IR-4 efficacy for <i>Golovinomyces cichoracearum</i> on various crops.....	41
Table 43.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>), on Gerbera Daisy (<i>Gerbera jamesonii</i>), Buck, GA, 2003.....	42
Table 44.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>), on Gerbera Daisy (<i>Gerbera jamesonii</i>), Buck, GA, 2004.....	42
Table 45.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘Jaguar Mix’, Hausbeck, MI, 2004, Experiment 1.....	43
Table 46.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘Dark Eye Cherry’, Hausbeck, MI, 2004, Experiment 2.....	44
Table 47.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘Dark Eye Cherry’, ‘Light Eye Pink,’ ‘Semi Double Orange,’ ‘Dark Eye Golden Yellow’, Hausbeck, MI, 2004, Experiment 3.....	44

Table 48.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘Dark Eye Cherry’, ‘Light Eye Orange,’ ‘Semi Double Yellow’, Hausbeck, MI, 2004, Experiment 4.	45
Table 49.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘Festival Orange’, Hausbeck, MI, 2005, Experiment 1.	45
Table 50.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘Festival Orange’, Hausbeck, MI, 2005, Experiment 2.	46
Table 51.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>), Buck, GA, 2010.	46
Table 52.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Phlox (<i>Phlox paniculata</i>) ‘Miss Universe’, LaMondia, CT, 2000.	47
Table 53.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Phlox (<i>Phlox paniculata</i>) ‘Miss Universe’, LaMondia, CT, 2001.	47
Table 54.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Phlox (<i>Phlox paniculata</i>) ‘Miss Peppers’, J. Robbins, AR, 2001.	48
Table 55.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Zinnia (<i>Zinnia elegans</i>) ‘Dreamland Yellow’, Jacobi, AL, 2003.	48
Table 56.	*Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Zinnia (<i>Zinnia elegans</i>) ‘Dreamland Mix’, Hagan, AL, 2004.	49
Table 57.	Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Zinnia (<i>Zinnia</i> spp.), Freiburger, NJ, 2016.	50
Table 58.	Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Zinnia (<i>Zinnia</i> spp.), Freiburger, NJ, 2017.	51
Table 59.	Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Zinnia (<i>Zinnia</i> spp.), Bodine, NJ, 2020.	51
Table 60.	Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Zinnia (<i>Zinnia</i> spp.), Hausbeck, MI, 2020.	52
Table 61.	Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Zinnia (<i>Zinnia</i> spp.), Bodine, NJ, 2021.	53
Table 62.	Efficacy on Powdery Mildew (<i>Golovinomyces cichoracearum</i>) on Zinnia (<i>Zinnia elegans</i>) ‘Magellan Orange’, Hausbeck, MI, 2021.	54
Table 63.	Efficacy on Powdery Mildew (<i>Golovinomyces orontii</i>) on Hydrangea (<i>Hydrangea macrophylla</i>), Baysal-Gurel, TN, 2018.	55
Table 64.	General summary of efficacy for <i>Oidium</i> sp. on various crops - Part 1.	56
Table 65.	General summary of efficacy for <i>Oidium</i> spp. on various crops - Part 2.	57
Table 66.	*Efficacy on Powdery Mildew (<i>Oidium</i> sp.) on Poinsettia (<i>Euphorbia pulcherrima</i>) ‘Freedom Red’, Hausbeck, MI, 1999, Experiment 1.	58
Table 67.	*Efficacy on Powdery Mildew (<i>Oidium</i> sp.) on Poinsettia (<i>Euphorbia pulcherrima</i>) ‘Freedom Red’, Hausbeck, MI, 1999, Experiment 2.	58
Table 68.	*Efficacy on Powdery Mildew (<i>Oidium</i> sp.) on Poinsettia (<i>Euphorbia pulcherrima</i>) ‘Freedom Red’, Daughtrey, NY, 1999.	59
Table 69.	*Efficacy on Powdery Mildew (<i>Oidium</i> sp.) on Poinsettia (<i>Euphorbia pulcherrima</i>) ‘Freedom Red’, Daughtrey, NY, 2000.	59
Table 70.	*Efficacy on Powdery (<i>Oidium</i> sp.) on Poinsettia (<i>Euphorbia pulcherrima</i>) ‘Freedom Red’, Hausbeck, MI, 2001.	61

Table 71.	*Efficacy on Powdery (<i>Oidium sp.</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘New Mexico Red’, Hausbeck, FL, 2001.	62
Table 72.	*Efficacy on Powdery (<i>Oidium sp.</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘New Mexico Red’, Hausbeck, FL, 2002, Experiment 1.	63
Table 73.	*Efficacy on Powdery (<i>Oidium sp.</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘New Mexico Red’, Hausbeck, FL, 2002, Experiment 2.	63
Table 74.	*Efficacy on Powdery (<i>Oidium sp.</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘Michelle’, Hausbeck, FL, 2002, Experiment 3.	64
Table 75.	*Efficacy on Powdery Mildew (<i>Oidium sp.</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘Revolution Red’, Villavicencio, CA, 2010. Experiment 1.	64
Table 76.	*Efficacy on Powdery Mildew (<i>Oidium sp.</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘Revolution Red’, Villavicencio, CA, 2010. Experiment 2.	65
Table 77.	*Efficacy on Powdery Mildew (<i>Oidium sp.</i>) on Pincushion Flower (<i>Scabiosa columbaria</i>) ‘Pink Mist’, Hausbeck, MI, 2002.	65
Table 78.	*Efficacy on Powdery (<i>Oidium sp.</i>) on Verbena (<i>Verbena x hybrida</i>) ‘Spitfire Rose/White Star’, Hausbeck, MI, 2002, Experiment 1.	66
Table 79.	*Efficacy on Powdery (<i>Oidium sp.</i>) on Verbena (<i>Verbena x hybrida</i>) ‘Sparkler’, Hausbeck, MI, 2002, Experiment 2.	66
Table 80.	*Efficacy on Powdery Mildew (<i>Oidium sp.</i>) on Verbena (<i>Verbena x hybrida</i>) ‘Sparkler Red/White’, Hausbeck, MI, 2003, Experiment 1.	67
Table 81.	*Efficacy on Powdery Mildew (<i>Oidium sp.</i>) on Verbena (<i>Verbena x hybrida</i>) ‘Sparkler Red/White’, Hausbeck, MI, 2003, Experiment 2.	67
Table 82.	*Efficacy on Powdery Mildew (<i>Oidium sp.</i>) on Verbena (<i>Verbena x hybrida</i>) ‘Sparkler Red/White’, Hausbeck, MI, 2004, Experiment 1.	68
Table 83.	*Efficacy on Powdery Mildew (<i>Oidium sp.</i>) on Verbena (<i>Verbena x hybrida</i>) ‘Sparkler Red/White’, Hausbeck, MI, 2004, Experiment 2.	68
Table 84.	*Efficacy on Powdery (<i>Oidium sp.</i>) on Trailing Petunia (<i>Calibrachoa x hybrida</i>) ‘Cabaret Scarlet’, Hausbeck, MI, 2011.	69
Table 85.	*Efficacy on Powdery Mildew (<i>Podosphaera pannosa</i>) on Miniature Rose (<i>Rosa hybrida</i>) ‘Mini Brite’, ‘Sunblazer’, Hausbeck, MI, 1999.	70
Table 86.	*Efficacy on Powdery Mildew (<i>Podosphaera pannosa</i>) on Miniature Rose (<i>Rosa sp.</i>) ‘Pretty Cupido’, Pemberton, TX, 1999.	71
Table 87.	*Efficacy on Powdery Mildew Mildew (<i>Podosphaera pannosa</i>) on Rose (<i>Rosa sp.</i>) ‘Tropicana’, Mulrooney.DE, 2004.	72
Table 88.	*Efficacy on Powdery Mildew Mildew (<i>Podosphaera pannosa</i>) on Rose (<i>Rosa sp.</i>) ‘Tropicana’, Mulrooney.DE, 2008.	72
Table 89.	General summary of efficacy for <i>Podosphaera xanthii</i> on various crops.	73
Table 90.	*Efficacy on Powdery Mildew (<i>Podosphaera xanthii</i>) on Verbena (<i>Verbena x hybrida</i>) ‘Obsession Lilac’, Hausbeck, MI, 2005, Experiment 1.	74
Table 91.	*Efficacy on Powdery Mildew (<i>Podosphaera xanthii</i>) on Verbena (<i>Verbena x hybrida</i>) ‘Obsession Lilac’, Hausbeck, MI, 2005, Experiment 2.	74
Table 92.	*Efficacy on Powdery Mildew (<i>Podosphaera xanthii</i>) on Verbena (<i>Verbena x hybrida</i>) ‘Obsession Lilac’, Hausbeck, MI, 2005, Experiment 3.	75
Table 93.	*Efficacy on Powdery Mildew (<i>Podosphaera xanthii</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘Festival Orange’, Hausbeck, MI, 2008, Experiment 1.	75

Table 94.	*Efficacy on Powdery Mildew (<i>Podosphaera xanthii</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘Festival Orange’, Hausbeck, MI, 2008, Experiment 2.	75
Table 95.	*Efficacy on Powdery Mildew (<i>Podosphaera xanthii</i>) on Gerbera Daisy (<i>Gerbera jamesonii</i>) ‘Royal Dark Eye Deep Orange’, Hausbeck, MI, 2009.	76
Table 96.	*Efficacy on Powdery Mildew (<i>Podosphaera xanthii</i>) on Trailing Petunia (<i>Calibrachoa x hybrida</i>) ‘Cabaret Scarlet’, Hausbeck, MI, 2011.	76
Table 97.	Summary of product efficacy by pathogen and crop.	80

Abstract

Powdery mildew is a highly recognizable disease with pronounced colonies of white on foliage and, for some species, on petals. Due to the high number of spores produced, powdery mildews often develop resistance quickly to fungicides. Starting in 2012, IR-4 initiated a series of regional projects to examine new fungicides and biofungicides for powdery mildew management. In addition, we performed a literature review. Contained in the project summary are outcomes from 96 experiments conducted in greenhouses and/or outdoors. Specific powdery mildew pathogens included: *Erysiphe azaleae*, *Erysiphe knautiae*, *Erysiphe lagerstroemia*, *Erysiphe lonicerae* var. *lonicerae*, *Erysiphe monardae*, *Erysiphe polygona*, *Erysiphe pulchra*, *Golovinomyces cichoracearum*, *Golovinomyces orontii*, *Oidium* spp., *Podosphaera pannosa*, and *Podosphaera xanthii*. Across species, the best performing products and actives included Aveylo, Bayleton, Broadform, Gatten, Heritage. Magus. Mural, NF-149 (cyflufenamid), SP2478, and XDE-659.

Introduction

In 2012, IR-4 initiated a regional project to determine efficacy of several fungicides on various species causing powdery mildew and obtain data supporting current and future registrations for environmental (ornamental) horticulture crops. At the 2019 Workshop, we added a priority related to screening primarily biopesticides for the management of powdery mildew. In addition, we reviewed available experiments published in the Fungicide & Nematicide Tests and Plant Disease Management Reports (PDMRs) to check efficacy of experimental and registered fungicides on various species. This report is a brief summary of available data from 95 IR-4 and non-IR-4 experiments. Tables containing non-IR-4 PDMRs have an asterisk (*) at the beginning of their titles and the source of report is included under each data table. Eighteen experiments from the IR-4 project are included in this report, including some historical archive reports from prior to 2012.

Fungal nomenclature (the Latin names of fungi) of powdery mildew pathogens has shifted. Historically, fungi were named by both their teleomorph (sexual) and anamorph (asexual) stages because many fungi were only observed in one state or the other naturally. With the advent of genomic technology, it is now possible to determine relatedness through an organism's genetic makeup rather than solely by morphology, growth patterns, and host range. Plus, there is a taxonomic preference to refer to an organism by a single name, not the dual system developed for fungi. This means that familiar Latin names may or may not be changing depending on the powdery mildew pathogen. Below is a short list of historical and current names for powdery mildew pathogens that infect environmental horticulture crops (Table 1).

Table 1. Guide to taxonomic shifts for select powdery mildew pathogens of environmental horticulture crops

Powdery mildew of [Host(s)]:	Old Latin Name(s) Teleomorph	Former Anamorph	Current Latin Name Teleomorph
Alder	<i>Erysiphe aggregata</i>		<i>Erysiphe aggregata</i>
Azalea, Rhododendron	<i>Microsphaera azaleae</i>	<i>Oidium ericinum</i>	<i>Erysiphe azaleae</i>
Bee Balm (Monarda)	<i>Erysiphe monardae</i>		<i>Golovinomyces monardae</i>
Carnation	<i>Erysiphe pisi var buhrii</i>	<i>Oidium dianthi</i>	<i>Erysiphe buhrii</i>
Crape-Myrtle	<i>Erysiphe lagerstroemiae</i>		<i>Uncinula australiana</i>
Cucurbits, Asteraceae (e.g., gerbera daisy, zinnia)	<i>Erysiphe cichoracearum</i>	<i>Oidium lactucae-debilis</i>	<i>Golovinomyces cichoracearum</i>
Cucurbits, Calibrachoa, Verbena, Petunia, Torenia	<i>Erysiphe xanthii</i> , <i>Sphaerotheca xanthii</i> ,	<i>Oidium balsaminae</i> , <i>Oidium santpauliae</i>	<i>Podosphaera xanthii</i>
Dogwood	<i>Microsphaera pulchra</i> , <i>Microsphaera pulchra</i> <i>var. japonica</i>		<i>Erysiphe pulchra</i>
Euonymus	<i>Erysiphe euonymicola</i>	<i>Oidium euonymi-japonici</i>	<i>Erysiphe euonymicola</i>
Gerbera, Pincushion Flower, Poinsettia, Verbena	<i>Erysiphe cichoracearum</i>	<i>Oidium sp.</i>	<i>Golovinomyces cichoracearum</i>
Honeysuckle	<i>Microsphaera lonicerae</i>		<i>Erysiphe lonicerae var lonicerae</i>
Hydrangea	<i>Erysiphe polygoni</i>	<i>Oidium muehlenbeckiae</i>	<i>Erysiphe polygoni</i>
Lilac	<i>Microsphaera alni</i> or <i>M. penicillata</i>		<i>Erysiphe penicillata</i>
Oak	<i>Erysiphe trina</i>		<i>Brasiliomyces trina</i>
Oak, Sorbaria, Wisteria, Mango, Euonymus	<i>Microsphaera alphitoides</i>	<i>Oidium mangiferae</i>	<i>Erysiphe alphitoides</i>

Powdery mildew of [Host(s)]:	Old Latin Name(s) Teleomorph	Former Anamorph	Current Latin Name Teleomorph
Petunia, Begonia, Hydrangea	<i>Erysiphe polyphaga</i>	<i>Oidium begoniae</i>	<i>Golovinomyces orontii</i>
Pincushion Flower	<i>Erysiphe caucasica</i>		<i>Erysiphe knautiae</i>
Rose	<i>Sphaerotheca pannosa</i>		<i>Podosphaera pannosa</i>

Materials and Methods

From 1981 to 2021, 39 products representing 34 active ingredients were tested primarily as foliar applications against 12 species causing powdery mildew on environmental horticulture crops (Table 2). The species tested included: *Erysiphe azaleae*, *Erysiphe knautiae*, *Erysiphe lagerstroemia*, *Erysiphe lonicerae* var. *lonicerae*, *Erysiphe monardae*, *Erysiphe polygoni*, *Erysiphe pulchra*, *Golovinomyces cichoracearum*, *G. orontii*, *Oidium* spp., *Podosphaera pannosa*, and *Podosphaera xanthii*. Treatments were applied either a few days before disease inoculation or immediately after inoculation. A minimum of four plants (replicate treatments) were required with most researchers exceeding this minimum. Disease severity and incidence were recorded at various intervals after initial application. Phytotoxicity was recorded on a scale of 0 to 10 (0 = no phytotoxicity; 10 = complete kill) at each rating date for any treatment exhibiting damage unrelated to disease.

For IR-4 testing, the following protocols were used: 12-020, 13-020, 14-016, 15-016, 16-018, 17-018, 18-006, 20-015, and 21-015. For more detailed materials and methods, including application rates for various products, please visit <https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-researcher-resources/#Protocols> to view and download these protocols.

Products were supplied to researchers (See list of researchers in Appendix 1) by their respective manufacturers.

In addition, Plant Disease Management Reports were reviewed and included below as a supplement for IR-4 research efforts.

For all research data tables, latin names for pathogens were updated based on current naming conventions, product names have been updated where manufacturers have established trade names, and tables have been rearranged by product alphanumeric order. Where both inoculated and non-inoculated checks were included in the experiment, the inoculated check appears last in the table with the non-inoculated check immediately preceding it.

Table 2. List of Products and Rates Tested through IR-4 from 1981 to 2021.

Product	Manufacturer	Active Ingredients	Code Numbers	MOA Class	Application Type	# Experiments
Avelyo Fungicide	BASF Corporation	Mefentrifluconazole	BAS 750 02F	FRAC 3	Foliar	2
Banner MAXX	Syngenta Crop Protection	Propiconazole		FRAC 3	Foliar	2
Bayleton 25WP	Mobay	Triadimefon		FRAC 3	Foliar	5
Bayleton 50WP	Envu (formerly Bayer)	Triadimefon		FRAC 3	Foliar	2
Baytan 25DF	Envu (formerly Bayer)	Triadimenol	KWG 0519	FRAC 3	Foliar	1
Benlate 50WP	Dupont Crop Protection	Benomyl		FRAC 1	Foliar	1
Broadform SC500	Envu (formerly Bayer)	Fluopyram + Trifloxystrobin		FRAC 7 + FRAC 11	Foliar	1
CGA 71818 10W	Ciba-Geigy	Penconazole	CGA 71818 10W	FRAC 3	Foliar	1
Eagle 20 EW	Dow AgroSciences	Myclobutanil		FRAC 3	Foliar	2
EcoSwing	Gowan	Swinglea glutinosa	GWN-10320	FRAC BM01	Foliar	4
F9944	FMC	F9944	F9944		Foliar	1
Funginex (Triforine 18.2)	Syngenta Crop Protection	Triforine		FRAC 3	Foliar	1
Gatten	Landis International	Flutianil		FRAC U13	Foliar	6
Heritage	Syngenta Crop Protection	Azoxystrobin		FRAC 11	Foliar	4
IKF-309	ISK BioSciences Corporation	IKF-309	IKF-309		Foliar	4
Magus	Gowan	Fenazaquin	GWN-1708	IRAC 21A	Foliar	1
MBI 121	Pro Farm Group (formerly Marrone Bio Innovations)	MBI 121	MBI 121		Foliar	4
Mettle	IsaGro-USA	Tetraconazole		FRAC 3	Foliar	4
MilStop	Bioworks	Potassium bicarbonate	BW133	FRAC NC	Foliar	2
Mural WDG	Syngenta Crop Protection	Azoxystrobin + benzovindiflupyr	A18126B, SYN545192, X4206B	FRAC 11 + FRAC 7	Foliar	8
NF-149	Nisso America	Cyflufenamid	NF-149	FRAC U6	Foliar	8
NSTKI-014	TKI	NSTKI-014	NSTKI-014		Foliar	2
Orchestra Intrinsic	BASF Corporation	Fluxapyroxad + pyraclostrobin	BAS703 06F, BAS703 01F	FRAC 7 + FRAC 11	Foliar	4
Problad Verde	FMC	Banda de Lupinus albus doce (BLAD)	F9110-NEW	FRAC BM01	Foliar	2
Regalia O5 (MOI-10605)	Pro Farm Group (formerly Marrone Bio Innovations)	Extract of Reynoutria sachalinensis		FRAC P05	Foliar	2
Regime	FMC	Banda de Lupinus albus doce (BLAD)	F9110, F9110-1	FRAC BM01	Foliar	7
SP2478	SePRO Corporation	SP2478	SP2478		Foliar	3
SP2700 WP	SePRO Corporation	SP2700	SP2700		Foliar	4
SP2770 10WP	SePRO Corporation	SP2770	SP2770 10WP		Foliar	1
Stargus	Pro Farm Group (formerly Marrone Bio Innovations)	Bacillus nakamurai strain F727	MBI 110	IRAC UNF & FRAC BM02	Foliar	2

Product	Manufacturer	Active Ingredients	Code Numbers	MOA Class	Application Type	# Experiments
TDA-NC-1	TDA	TDA			Foliar	4
Tril-21	Kemin Crop Technologies	Thyme oil		FRAC BM01	Foliar	2
TXC2020	Kemin Crop Technologies	Thyme oil	TXC2020	FRAC BM01	Foliar	1
XDE-659	Corteva Agriscience	XDE-659	XDE-659		Foliar	4
XE-779 25 WP	Chevron	Diniconazole	XE-779 25 WP	FRAC 3	Foliar	1
ZeroTol	BioSafe Systems	Hydrogen dioxide		FRAC NC	Foliar	2

Results

Between 1981 and 2021, 18 experiments were conducted through the IR4 program examining new active ingredients and products for activity against five powdery mildew pathogens: *Erysiphe azalea*, *Golovinomyces cichoracearum*, *Golovinomyces orontii*, *Microsphaera lonicerae*, and *Podosphaera pannosa*. Powdery mildew pathogens tend to have a narrow host range with the exception of *G. cichoracearum* (cucurbit powdery mildew) which impacts over 100 plant species in 4 families. In addition to data generated through IR-4, Plant Disease Management Reports were reviewed and included for breadth. Non-IR-4 results are indicated with an asterisk and a notation is included as a foot note.

Between 1982 and 1985, five experiments were conducted for azalea powdery mildew on three different crops. Of the products screened, only Bayleton is currently registered. Both formulations provided good efficacy.

For cucurbit powdery mildew on environmental horticulture crops, eight experiments were conducted between 1982 and 2021. SP2478, Gatten, and XDE-659 provided good to excellent efficacy in at least three experiments.

For powdery mildew on hydrangea a single experiment was conducted, originally planned as a crop safety experiment. In this experiment both Gatten and Mural provided good to excellent reduction of disease.

In four experiments conducted between 1981 and 2015, Bayleton, Orkestra, Benlate, Magus, Mural, NF-149, Banner Maxx, Heritage and Milstop provided good to excellent efficacy in at least one experiment.

In a single experiment conducted in 1981, Bayleton provided great efficacy of rose powdery mildew.

Table 3. Overview of IR-4 testing from 1981 to 2021

Product (Active Ingredients)	MOA	Powdery Mildew, Azalea (<i>Erysiphe azaleae</i>)	Powdery Mildew, Cucurbit (<i>Golovinomyces cichoracearum</i>)	Powdery Mildew (<i>Golovinomyces orontii</i>)	Powdery Mildew, Lilac (<i>Microsphaera lonicerae</i>)	Powdery Mildew, Rose (<i>Podosphaera pannosa</i>)
Avelyo Fungicide (Mefentrifluconazole)	FRAC 3		4.5 (4 - 5) n2 Labeled			
Banner MAXX (Propiconazole)	FRAC 3				3.0 (3 - 3) n1 Labeled	
Bayleton 25WP (Triadimefon)	FRAC 3	3.5 (3 - 4) n2 Labeled	5.0 (5 - 5) n1 Labeled		5.0 (5 - 5) n1 Labeled	4.0 (4 - 4) n1 Labeled
Bayleton 50WP (Triadimefon)	FRAC 3	4.0 (4 - 4) n1	5.0 (5 - 5) n1			
Baytan 25DF (Triadimenol)	FRAC 3	4.0 (4 - 4) n1				
Benlate 50WP (Benomyl)	FRAC 1				5.0 (5 - 5) n1	
Broadform SC500 (Fluopyram + Trifloxystrobin)	FRAC 7 + FRAC 11		5.0 (5 - 5) n1			
CGA 71818 10W (Penconazole)	FRAC 3	5.0 (5 - 5) n1				
Eagle 20 EW (Myclobutanil)	FRAC 3		5.0 (5 - 5) n2			
EcoSwing (Swinglea glutinosa)	FRAC BM01		1.0 (1 - 1) n4 Labeled			
Funginex (Triforine 18.2) (Triforine)	FRAC 3		5.0 (5 - 5) n1			
Gatten (Flutianil)	FRAC U13		4.3 (2 - 5) n4	4.0 (4 - 4) n1		
Heritage (Azoxystrobin)	FRAC 11		3.0 (3 - 3) n1 Labeled		3.0 (3 - 3) n1 Labeled	
IKF-309 (IKF-309)	unknown		3.5 (2 - 5) n2			
Magus (Fenazaquin)	IRAC 21A				5.0 (5 - 5) n1	
MBI 121 (MBI 121)	unknown		2.0 (1 - 3) n4			
Mettle (Tetraconazole)	FRAC 3				2.0 (1 - 3) n2	
Milban 39EC (Dodemorph)	FRAC 5	3.0 (3 - 3) n1 Labeled	5.0 (5 - 5) n1 Labeled			
MilStop (Potassium bicarbonate)	FRAC NC				3.0 (3 - 3) n1 Labeled	
Mural WDG (Azoxystrobin + benzovindiflupyr)	FRAC 11 + FRAC 7		4.0 (3 - 5) n2 Labeled	5.0 (5 - 5) n1 Labeled	4.0 (3 - 5) n2 Labeled	
NF-149 (Cyflufenamid)	FRAC U6		3.0 (3 - 3) n2		3.5 (2 - 5) n2	
NSTKI-014 (NSTKI-014)	unknown		2.5 (2 - 3) n2			

Product (Active Ingredients)	MOA	Powdery Mildew, Azalea (<i>Erysiphe azaleae</i>)	Powdery Mildew, Cucurbit (<i>Golovinomyces cichoracearum</i>)	Powdery Mildew (<i>Golovinomyces orontii</i>)	Powdery Mildew, Lilac (<i>Microsphaera lonicerae</i>)	Powdery Mildew, Rose (<i>Podosphaera pannosa</i>)
Orkestra Intrinsic (Fluxapyroxad + pyraclostrobin)	FRAC 7 + FRAC 11		3.0 (3 - 3) n1 Labeled		5.0 (5 - 5) n1 Labeled	
Problad Verde (Banda de Lupinus albus doce (BLAD))	FRAC BM01		2.0 (2 - 2) n1			
Regalia O5 (MOI-10605) (Extract of Reynoutria sachalinensis)	FRAC P05				1.0 (1 - 1) n1 Labeled	
Regime (Banda de Lupinus albus doce (BLAD))	FRAC BM01		1.0 (1 - 1) n2 Labeled		1.0 (1 - 1) n2 Labeled	
SP2478 (SP2478)	unknown		4.3 (3 - 5) n3			
SP2700 WP (SP2700)	unknown		2.8 (2 - 4) n4			
Stargus (Bacillus nakamurai strain F727)	IRAC UNF & FRAC BM02		1.0 (1 - 1) n1 Labeled			
Tank Mix: MilStop + Cease (potassium bicarbonate + Bacillus subtilis)	FRAC NC + IRAC UNF				1.0 (1 - 1) n1	
TDA-NC-1 (TDA)	unknown		1.5 (1 - 3) n4			
Tilt 3.6E (Propiconazole)	FRAC 3		5.0 (5 - 5) n1			
Tril-21 (Thyme oil)	FRAC BM01		3.0 (1 - 5) n2			
TXC2020 (Thyme oil)	FRAC BM01		1.0 (1 - 1) n1			
XDE-659 (XDE-659)	unknown		3.3 (1 - 5) n4			
XE-779 25 WP (Diniconazole)	FRAC 3	1.0 (1 - 1) n1				
ZeroTol (Hydrogen dioxide)	FRAC NC				1.0 (1 - 1) n1 Labeled	

Average rating on a scale of 1 – 5 with 1 = 0 to about 70% efficacy and 5 = 100 efficacy or equivalent to non-inoculated control; minimum to maximum rating; number of trials. A rating of 2 or lower is considered unacceptable. A rating of 3 or higher is considered commercially acceptable. For pathogen/product combinations that are blank, IR-4 has not screened this combination.

Products that do not have ‘labeled’ may not be registered by EPA. Consult the label and your state officials.

Comparative Efficacy on *Erysiphe azaleae*

In 2000, Pscheidt conducted an experiment to determine efficacy of several fungicides for the control of powdery mildew (*Erysiphe azaleae*) on azalea (*Rhododendron daviesi*) 'Ghent'. All treatments significantly reduced a moderate disease pressure, with Compass and Garden Fungicide having the lowest incidence of powdery mildew (Table 4). The average length of new shoots did not differ significantly among any of the treatments. No phytotoxicity was observed in any treatment, except Garden Fungicide, which had several necrotic or sunburned leaves within a week after the first treatment when record temperatures in the mid 90's F were recorded.

Table 4. *Efficacy on Powdery Mildew (*Erysiphe azaleae*) on Azalea (*Rhododendron daviesi*) 'Ghent', Pscheidt, OR, 2000.

Treatment	Rate Per 100 Gal	% Leaves with Powdery Mildew ^x	Length of New Shoots (cm)
Banner 1.1E (propiconazole)	8 fl oz	6.0 cd	8.1 a
Compass 50DG (trifloxystrobin)	4 oz	4.4 d	8.9 a
Garden Fungicide 0.4% (sulfur)	2 fl oz	4.4 d	8.8 a
Heritage 50W (azoxystrobin)	1 oz	21.3 bc	8.4 a
	2 oz	21.4 bc	9.2 a
	4 oz	20.3 bcd	7.9 a
	8 oz	21.6 bc	10.4 a
Immunox (myclobutanil)	8 fl oz	11.6 cd	9.0 a
Kaligreen (potassium bicarbonate)	5 lb	16.0 cd	8.1 a
Nontreated	-	44.7 a	8.1 a

* Not an IR-4 Experiment: F&N Tests 56:OT2.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05).

Treatments applied on Jun 27 (just after hedging), Jul 11 (new shoots starting to grow), Jul 25 and Aug 8.

Comparative Efficacy on *Erysiphe knautiae*

In 2005, Nelson conducted a field experiment to determine efficacy of several fungicides for the control of powdery mildew (*Erysiphe knautiae*) on pincushion flower (*Scabiosa columbaria*). All treatments significantly reduced a moderate to high powdery mildew pressure (Table 5), with Quintec, Systhane and V-10118 providing excellent control. No phytotoxicity was observed in any treatment.

Table 5. *Efficacy on Powdery Mildew (*Erysiphe knautiae*) on pincushion flower (*Scabiosa columbaria*), Nelson, WA, 2005.

Treatment	Rate Per 100 Gal	Percent Infected Cuttings ^x	
		May 20	Jul 29
JMS Stylet Oil (paraffinic oil)	6 qt	9.1 a	8.0 a
Neudorff's Vegol Oil Insecticide (canola oil)	1 gal	8.0 a	20.4 b
Sythane 40WSP (myclobutanil)	4 oz	0.0 a	1.6 a
V-10118 5% EC	28 fl oz	2.3 a	0.0 a
Nontreated	-	21.6 b	62.2 c

* Not an IR-4 Experiment: F&N Tests Vol 61:OT032. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05).

Treatments applied on May 7, May 27, Jun 10, Jun 20, Jul 1, Jul 15.

Comparative Efficacy on *Erysiphe lagerstroemia*

In 1999, Hagan conducted a greenhouse experiment to determine efficacy of several fungicides for the control of powdery mildew (*Erysiphe lagerstroemia*) on crapemyrtle (*Lagerstroemia indica*) 'Carolina Beauty'. All treatments significantly reduced a high powdery mildew pressure (Table 6), with Heritage generally as effective or in some cases more effective than the commercial standards Eagle and 3336.

Table 6. *Efficacy on Powdery Mildew (*Erysiphe lagerstroemia*) on Crapemyrtle (*Lagerstroemia indica*) 'Carolina Beauty', Hagan, AL, 1999.

Treatment	Rate Per 100 Gal	Application Interval (wk)	Disease Incidence ^x
3336 4SF (thiophanate-methyl)	20 fl oz	1	3.1 b
Eagle 40W (myclobutanil)	8 oz	2	2.0 bc
Heritage 50W (azoxystrobin)	4 oz	1	1.6 c
		2	2.1 bc
		3	2.0 bc
	8 oz	1	1.9 c
		2	2.1 bc
		3	1.9 c
Nontreated	-	-	8.4 a

* Not an IR-4 Experiment: F&N Tests 55:539.

^x Means within column followed by the same letter are not significantly different (Duncan's Multiple Range Test, P=0.05). Rated on Jun 1 using Horsfall and Barratt rating scale based on the percentage of leaves diseased where 1= no disease, 2 = 0 to 3%, 3 = 3 to 6%, 4 = 6 to 12%, 5 = 12 to 25%, 6 = 25 to 50%, 7 = 50 to 75%, 8 = 75 to 87%, 9 = 87 to 94%, 10 = 94 to 97%, 11 = 97 to 100%, and 12 = 100% of leaves symptomatic or colonized by *E. lagerstroemia*.

Treatments applied at various intervals from Mar 1 to May 24.

In 2016, Baysal-Gurel conducted a greenhouse experiment to determine efficacy of several fungicides for the control of powdery mildew on two cultivars of crapemyrtle: 'Muskogee' and 'Whit III'. All treatments significantly reduced high disease pressures in both cultivars, generally resulting in higher growth rates (Table 7). No phytotoxicity was observed in any treatment.

Table 7. *Efficacy on Powdery Mildew (*Erysiphe lagerstroemia*) on Crapemyrtle (*Lagerstroemia indica*), ‘Muskogee’ and ‘Whit III’, Baysal-Gurel, TN, 2016.

Cultivar	Treatment	Rate Per 100 Gal	Powdery mildew ^x		New growth length (in)
			% Disease Severity	AUDPC	
'Muskogee'	Concert II 4.3SE (chlorothalonil + propiconazole)	22 fl oz	8.1 bc	188.1 b	14.7 cde
		35 fl oz	6.3 bc	155.3 b	16.1 bcd
	Mural 45WG (azoxystrobin + benzovindiflupyr)	6 oz	4.4 c	97.6 b	18.9 ab
	Pageant Intrinsic 38WG (pyraclostrobin + boscalid)	12 oz	11.3 b	229.7 b	17.6 abc
	Picatina Gold 2.5SE (A21461A) (azoxystrobin + propiconazole + pydiflumetofen)	7.0 fl oz	10.6 bc	216.6 b	18.5 ab
		13.7 fl oz	6.9 bc	132.6 b	19.9 a
Nontreated	-	76.3 a	1583.8 a	12.4 e	
'Whit III'	Concert II 4.3SE (chlorothalonil + propiconazole)	22 fl oz	5.6 b	97.1 b	15.9 a
		35 fl oz	2.5 b	60.4 b	16.1 a
	Mural 45WG (azoxystrobin + benzovindiflupyr)	6 oz	3.4 b	72.6 b	16.3 a
	Pageant Intrinsic 38WG (pyraclostrobin + boscalid)	12 oz	9.4 b	184.2 b	14.1 abc
	Picatina Gold 2.5SE (A21461A) (azoxystrobin + propiconazole + pydiflumetofen)	7.0 fl oz	6.3 b	97.6 b	14.8 abc
		13.7 fl oz	2.1 b	39.4 b	15.3 ab
	Nontreated	-	63.8 a	1295.0 a	12.2 c

* Not an IR-4 Experiment: Plant Disease Management Reports 11:OT013.

^x Means within column followed by the same letter are not significantly different (Fisher's LSD Test, P= 0.05).

Disease ratings and area under the disease progress curve (AUDPC) observed weekly from Jun 16 to Jul 14, were based on percentage of foliage area affected.

Treatments applied on Jun 9 and 23.

Comparative Efficacy on *Erysiphe lonicerae*

During 2012 and 2015, Freiburger conducted two field experiments to determine efficacy of several fungicides for the control of powdery mildew (*Erysiphe lonicerae* var. *lonicerae*) on lilac (*Syringa vulgaris*). In the 2012 experiment, all treatments maintained statistically equivalent percentages to the pre-application percentages, with the exception of the Nontreated control plots, Regalia, and ZeroTol, when foliage infection is compared across time for each treatment, (Table 8). In other words, Banner Maxx, F9110, Mettle, Milstop, Milstop + Cease, NF-149, and X4602B stopped or reduced additional powdery mildew development. In the 2015 experiment, no treatment was significantly different from the controls until Sep 28 when BAS 703, Heritage, Magus, Mettle, and Mural significantly reduced powdery mildew. NF-149 applied at 3.4 fl oz at 7 day intervals was significantly better than the water sprayed control plots (Table 9). Both rates of F9110 and NF-149 applied at 3.4 fl oz at 14 day intervals were not significantly different from either no treatment or water sprayed controls.

Table 8. Efficacy on Powdery Mildew (*Erysiphe lonicerae* var. *lonicerae*), on Lilac (*Syringa vulgaris*), Freiberger, NJ, 2012.

Treatment	Rate Per 100 Gal	Spray Interval (day)	Percent Foliage Infection ^x					
			Aug 30	Sep 10	Sep 17	Sep 24	Oct 5	Oct 12
Banner Maxx (propiconazole)	5 fl oz	14	17.7 abc	20.4 b	17.7 abc	22.3 b-e	19.6 bc	20.0 bc
F9110 (<i>Lupinus</i> extract)	20.5 fl oz	10	20.2 bc	24.0 b	25.0 c	31.9 de	31.0 cd	31.7 c
	46 fl oz	10	12.5 abc	14.0 ab	13.8 abc	20.4 b-e	19.8 bc	22.9 bcd
Mettle (tetraconazole)	2.5 fl oz	14	19.6 bc	22.7 b	22.1 bc	30.0 de	27.3 cd	30.8 cd
Milstop (potassium bicarbonate)	4 lb	10	0.6 ab	0.6 a	1.5 a	2.1 a	1.0 a	2.3 a
Milstop + Cease	2 lb + 4 qt	10	4.4 ab	4.4 a	5.0 ab	7.9 abc	8.1 ab	13.1 ab
NF-149 (cyflufenamid)	3.4 fl oz	14	25.3 c	23.8 b	25.4 c	28.3 de	26.0 cd	25.6 b
Regalia (<i>Reynoutria sachalinensis</i> extract)	1 gal	14	13.5 abc	15.2 ab	15.8 abc	27.5 de	29.0 cd *	33.3 cd *
Mural (azoxystrobin + benzovindiflupyr)	4.25 oz	10	17.4 abc	14.6 ab	13.3 abc	16.5 a-d	15.2 abc	17.5 abc
	8.5 oz	10	4.9 ab	4.9 a	3.6 a	5.5 ab	4.0 ab	4.5 a
ZeroTol (hydrogen dioxide)	1 gal	10	11.5 ab	16.9 ab	20.0 bc	29.0 de *	29.4 cd *	32.3 cd *
Water	--	10	25.4 c	27.9 b	30.4 c	36.8 e	36.0 d	38.1 d
Nontreated	--	-	13.8 abc	16.4 ab	19.3 bc	26.9 de *	25.6 cd *	27.4 bcd *

^x Means within column followed by the same letter are not significantly different ((Fisher-Hayter Test, P=0.05). Means within row followed by ‘*’ are significantly different from mean on 8/30/2012 (Fisher-Hayter Test, p=0.05).

Fungicides applied from Aug 31 to Sep 28.

Table 9. Efficacy on Powdery Mildew (*Erysiphe lonicerae* var. *lonicerae*), on Lilac (*Syringa vulgaris*), Freiberger, NJ, 2015.

Treatment	Rate Per 100 Gal	Spray Interval (day)	Disease Rating (0-10) ^x				
			Jul 30	Aug 18	Sep 1	Sep 15	Sep 28
BAS 703 (fluxapyroxad + pyraclostrobin)	8 fl oz	14	0.1 ab	0.0 a	0.0 a	0.0 a	0.0 a
	10 fl oz	14	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
F9110 (<i>Lupinus</i> extract)	20 fl oz	7	0.0 a	0.1 a	0.7 a	1.0 a	2.1 abc
	46 fl oz	7	0.0 a	0.0 a	0.4 a	0.7 a	2.4 abc
Heritage (azoxystrobin)	4 oz	14	0.3 ab	0.0 a	0.1 a	0.2 a	0.7 ab
Magus (fenazaquin)	2.5 fl oz	14	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Mettle (tetraconazole)	2.5 fl oz	7	0.0 a	0.0 a	0.0 a	0.0 a	0.4 ab
Mural (azoxystrobin + benzovindiflupyr)	4.25 oz	7	0.0 a	0.0 a	0.0 a	0.0 a	0.1 a
	4.25oz	14	0.0 a	0.0 a	0.0 a	0.0 a	0.2 a
NF-149 (cyflufenamid)	3.4 fl oz	7	0.7 b	0.2 a	0.3 a	0.3 a	0.7 ab
	3.4 fl oz	14	0.0 a	0.0 a	0.2 a	0.4 a	1.2 abc
No Spray	-	-	0.1 ab	0.1 a	0.8 a	1.3 a	2.4 bc
Water	-	-	0.1 ab	0.0 a	0.6 a	1.3 a	3.2 c

^x Means within column followed by the same letter are not significantly different ((Fisher-Hayter Test, P=0.05). Rating based on how much powdery mildew was present on a scale of 0-10, 0 being no powdery mildew and 10 being 100% of the plant covered with powdery mildew. Fungicides applied from July 30 to Aug 20.

Comparative Efficacy on *Erysiphe monardae*

In 2000 and 2001, LaMondia conducted experiments to determine efficacy of several fungicides for the control of powdery mildew (*Erysiphe monardae*) on container-grown bee balm (*Monarda didyma*) 'Cambridge Scarlet'. In 2000, Domain and Heritage at 2, 4 and 8 oz provided the best control under severe disease pressure (Table 10). In 2001, all treatments except Kumulus resulted in disease control on the leaf surface (Table 11). The best control of defoliation occurred with Heritage, followed by Daconil and Zyban. No phytotoxicity was observed in any treatment in both years.

Table 10. *Efficacy on Powdery Mildew (*Erysiphe monardae*) on Bee Balm (*Monarda didyma*) 'Cambridge Scarlet', LaMondia, CT, 2000.

Treatment	Rate Per 100 Gal	No. Colonies Per Plant ^x		Percent Healthy Leaves			
		Jun 2	Jun 23	Jun 29	Jul 14	Aug 4	Sep 14
Domain FL (thiophanate-methyl)	18.5 fl oz	38.0 a	0.2 b	87.5 b	80.0 b	70.8 c	5.8 a
Heritage 50WG (azoxystrobin)	1.0 oz	23.3 a	1.7 b	77.1 b	81.7 b	40.0 b	2.3 a
	2.0 oz	15.2 a	0.0 b	77.1 b	86.7 b	66.7 c	30.0 b
	4.0 oz	18.0 a	0.2 b	80.4 b	81.3 b	76.7 c	47.5 b
	8.0 oz	21.7 a	0.0 b	84.2 b	84.6 b	88.3 c	65.8 b
Phyton 27 (copper sulfate pentahydrate)	16.0 fl oz	35.0 a	42.7 a	18.3 a	6.3 a	5.0 a	10.8 a
	32.0 fl oz	30.7 a	3.0 b	27.1 a	9.2 a	7.5 a	6.7 a
Nontreated	-	53.0 a	26.2 a	11.7 a	7.1 a	1.3 a	3.7 a

* Not an IR-4 Experiment: F&N Tests Vol 56: OT4.

^x Means within column followed by the same letter are not significantly different (Kruskal-Wallis Multiple Comparison Z-Value Test, P=0.05).

Treatments applied on May 26, Jun 2, Jun 16, Jun 30, Jul 14, and Jul 28.

Table 11. *Efficacy on Powdery Mildew (*Erysiphe monardae*) on Bee Balm (*Monarda didyma*) 'Cambridge Scarlet', LaMondia, CT, 2001.

Treatment	Rate Per 100 Gal	Percent Leaf Surface Mildewed ^x			Percent Defoliation			Shoot Wt. (oz)
		Jul 13	Jul 20	Aug 2	Jul 13	Jul 20	Aug 2	Aug 22
Daconil 82.5WDG (chlorothalonil)	22 oz	5.0 a	1.7 b	0.5 b	10.3 d	8.7 d	30.0 d	2.3 bc
Domain 46.2FL ((thiophanate methyl)	20 fl oz	0.3 b	0.1 b	0.2 b	31.7 b	46.7 b	58.3 b	2.5 bc
Heritage 50WDG (azoxystrobin)	8 oz	0.3 b	0.3 b	0.1 b	8.7 d	8.7 d	19.2 e	2.7 bc
Kumulus 80DF (sulfur)	543 oz	8.5 a	4.5 a	5.2 a	20.0 c	29.2 c	49.2 c	2.2 b
Zyban 79.6WP (thiophanate methyl + mancozeb)	24 oz	5.0 a	0.8 b	0.1 b	12.5 cd	13.3 d	36.7 d	2.8 c
Nontreated	-	5.8 a	5.8 a	5.8 a	65.8 a	74.2 a	84.2 a	1.4 a

* Not an IR-4 Experiment: F&N Tests Vol 57: OT21.

^x Means within column followed by the same letter are not significantly different (Kruskal-Wallis Multiple Comparison Z-Value Test, P=0.05).

Treatments applied on Jun 27, Jul 11, Jul 25, Aug 2, and Aug 9.

Comparative Efficacy on Erysiphe polygoni

From 1999 through 2011, 12 experiments were conducted on *Erysiphe polygoni* on hydrangea (*Hydrangea macrophylla*) and delphinium (*Delphinium* sp.). The Banner MAXX, Eagle, Heritage, Serenade, and Sunspray UltraFine Oil treatments provided the most consistent levels of control across the experiments (Table 12). BAS 500, BW420, Compass, the copper fungicides (Bonide Liquid Copper Fungicide, Phyton 27, Southern Ag Liquid Copper Fungicide), sulfur (Bonide Citrus, Fruit, and Nut Orchard Spray Concentrate), and Triact also provided good to excellent control in one or two experiments. The only product which consistently performed poorly against this pathogen was Rubigan. See the following paragraphs for summaries of each experiment.

Table 12. General summary of efficacy for *Erysiphe polygoni* on various crops.

Product	Hydrangea										Delphinium	
	Williams- Woodward 1999*	Hagan 2000*	Hagan 2000*	Hagan 2001*	Hagan 2003*	Williams- Woodward 2003*	Hagan 2005*	Hagan 2010*	Hagan 2011*	Hagan 2011*	Wegulo 2002*	Wegulo 2003*
Agri-50						+/-						
AQ-10	-											
Banner MAXX	-						++		++	++	++	++
Bonide Citrus, Fruit, and Nut Orchard Spray Concentrate								++	++			
Bonide Liquid Copper Fungicide								++	++			
BW420							++					
Compass						++						
Concert									++			
Daconil					++						+	+/-
Eagle, Systhane	++	++	++	++		++		++	++		+	+
E-RASE											+/-	+/-
Heritage	++	++	++	++		++		+	++	++		
BAS 500						++						
Kaligreen, Milstop					++						+/-	+/-
Palladium									+			
Phyton 27	+											
Rubigan	+/-										+/-	+/-
Serenade		++						++	++			
Southern Ag Liquid Copper Fungicide								++	++			
SunSpray UF Oil		++	++	++								
Triact	-							++	++			

* Not an IR-4-sponsored experiment.

1 Rating Scale: ++ = clearly statistically equivalent or better than Nontreated non-inoculated and/or clearly statistically different than Nontreated inoculated; + = statistically different from Nontreated inoculated and Nontreated non-inoculated; +/- statistically equivalent to both Nontreated inoculated and Nontreated non-inoculated; - = statistically equivalent to Nontreated inoculated. For experiments without non-inoculated check, efficacy determined on author's conclusions, % control or comparisons to standard product(s).

2 Where more than one rate or application type for a product was included in the experiment and each performed statistically different, the better rating is provided in this table.

In 1999, Williams-Woodward conducted an experiment to determine efficacy of several fungicides for the control of powdery mildew (*Erysiphe polygoni*) on container-grown hydrangea (*Hydrangea macrophylla*) ‘Hobella’. Heritage, Systhane and Phyton 27 significantly reduced a severe disease pressure until the end of the season; Banner MAXX and Rubigan provided less residual control, while Triact and AQ-10 were ineffective (Table 13).

Table 13. *Efficacy on Powdery Mildew (*Erysiphe polygoni*) on Hydrangea (*Hydrangea macrophylla*) ‘Hobella’, Williams-Woodward, GA, 1999.

Treatment	Rate Per 100 Gal	Powdery Mildew Rating ^x				
		Jul 14	Jul 22	Aug 16	Sep 3	Sep 22
AQ-10 (<i>Ampelomyces quisqualis</i> strain AQ10)	100 gm	7.2 d	5.6 e	7.4 bc	7.2 c	6.3 cd
Banner MAXX (propiconazole)	5 fl oz	3.3 c	2.5 abc	5.8 b	6.8 bc	7.0 cd
Heritage 50W (azoxystrobin)	2 oz	1.0 a	1.0 a	1.1 a	1.5 a	3.0 a
Phyton 27 (copper sulfate pentahydrate)	15 fl oz	1.5 ab	1.8 ab	2.5 a	2.4 a	5.0 abc
Rubigan AS (fenarimol)	6 fl oz	2.8 bc	1.0 a	6.1 b	4.9 b	5.9 bcd
Sythane 40WSP (myclobutanil)	4 oz	1.1 a	1.0 a	1.2 a	2.3 a	3.8 ab
Triact 70 (neem oil)	1 gal	6.8 d	4.5 de	8.1 c	7.7 c	7.2 cd
Nontreated	-	6.0 d	3.9 cde	8.0 c	7.0 c	7.9 d

* Not an IR-4 Experiment: F&N Tests Vol 56:OT15. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Tukey’s HSD Test, P=0.05).

Rated using a disease severity scale of 1-10 where 1 = 0-10%, 2 = 11- 20%, 3 = 21-30%, 4 = 31-40%, 5 = 41-50%, 6 = 51-60%, 7 = 61-70%, 8 = 71-80%, 9 = 81-90%, and 10 = 91-100% of the leaf area with powdery mildew infection.

Treatments applied on Jun 13 and reapplied at 2-wk intervals except Phyton 27 and AQ-10, which were applied weekly.

During 2000 and 2001, Hagan conducted three greenhouse experiments to determine efficacy of Heritage applied at various rates and application intervals for the control of powdery mildew on hydrangea. In the first experiment in 2000, all treatments provided effective control of a severe disease pressure (Table 14). The flowable formulation of Serenade was somewhat less effective in controlling powdery mildew than the wettable powder formulation. In the second 2000 experiment, Heritage at all rates provided excellent control of severe disease pressure, comparable to the standard Eagle, when applied weekly (Table 15). Only the 4.0 oz rate of Heritage proved as effective as Eagle when applied at 2-wk intervals, and it was ineffective at all rates when applied at 3-wk intervals. In 2001, all treatments provided effective control under severe disease pressure (Table 16). At each application rate of Heritage, no significant differences in the rating for powdery mildew occurred at the 1- and 2-wk application intervals. When applied at 3-wk intervals, all rates of Heritage failed to reduce disease incidence compared to the same rates applied at the shorter spray intervals. No phytotoxicity was observed in any treatment.

Table 14. *Efficacy on Powdery Mildew (*Erysiphe polygoni*) on Hydrangea (*Hydrangea macrophylla*) ‘Nikko Blue’, Hagan, AL, 2000, Experiment 1.

Treatment	Rate Per 100 Gal	Application Interval (days)	Powdery Mildew Rating ^x
Eagle 40W (myclobutanil)	8 oz	14	1.0 d
Heritage 50WP (azoxystrobin)	8 oz	14	1.0 d
Serenade WP (Bacillus subtilis QST 713 strain)	4 lb	7	1.7 cd
	8 lb	7	1.0 d
Serenade ASO (Bacillus subtilis QST 713 strain)	1 gal	7	3.7 b
	3 gal	7	2.2 c
Sunspray Ultrafine Oil (paraffinic oil)	1 gal	7	1.0 d
Nontreated	-	-	11.2 a

* Not an IR-4 Experiment: F&N Tests Vol 56: OT13.

^x Means within column followed by the same letter are not significantly different (Duncan's Multiple Range Test, P=0.05). Rated on Feb 8 using Horsfall and Barratt rating scale where 1 = no disease, 2 = 0 to 3%, 3 = 3 to 6%, 4 = 6 to 12%, 5 = 12 to 25%, 6 = 25 to 50%, 7 = 50 to 75%, 8 = 75 to 87%, 9 = 87 to 94%, 10 = 94 to 97%, 11 = 97 to 100% and 12 = 100% of the leaves colonized by *E. polygoni*.

Treatments applied from Nov 29 1999 to Feb 2, 2000.

Table 15. *Efficacy on Powdery Mildew (*Erysiphe polygoni*) on Hydrangea (*Hydrangea macrophylla*) ‘Nikko Blue’, Hagan, AL, 2000, Experiment 2.

Treatment	Rate Per 100 Gal	Application Interval (wk)	Powdery Mildew Rating ^x
Eagle 40W (myclobutanil)	8.0 oz	2	1.1 d
Heritage 50W (azoxystrobin)	1.0 oz	1	1.0 d
	1.0 oz	2	2.5 c
	1.0 oz	3	5.5 b
Heritage 50W (azoxystrobin)	2.0 oz	1	1.6 d
	2.0 oz	2	2.6 c
	2.0 oz	3	4.9 b
Heritage 50W (azoxystrobin)	4.0 oz	1	1.4 d
	4.0 oz	2	1.5 d
	4.0 oz	3	5.1 b
SunSpray Ultrafine Oil (paraffinic oil)	1 gal	1	3.1 c
Nontreated	-	-	11.5 a

* Not an IR-4 Experiment: F&N Tests Vol 57: OT15.

^x Means within column followed by the same letter are not significantly different (Duncan's Multiple Range Test, P=0.05). Rated on Jan 5, 2001 using Horsfall and Barratt rating scale where 1 = no disease, 2 = 0 to 3%, 3 = 3 to 6%, 4 = 6 to 12%, 5 = 12 to 25%, 6 = 25 to 50%, 7 = 50 to 75%, 8 = 75 to 87%, 9 = 87 to 94%, 10 = 94 to 97%, 11 = 97 to 100% and 12 = 100% of the leaves colonized by *E. polygoni*.

Treatments applied from Sep 22 to Nov 11, 2000.

Table 16. *Efficacy on Powdery Mildew (*Erysiphe polygoni*) on Hydrangea (*Hydrangea macrophylla*) ‘Nikko Blue’, Hagan, AL, 2001.

Treatment	Rate Per 100 Gal	Application Interval (wk)	Powdery Mildew Rating ^x
Eagle 40W (myclobutanil)	8 oz	2	1.9
Heritage 50W (azoxystrobin)	1.0 oz	1	2.8
	1.0 oz	2	2.6
	1.0 oz	3	5.5
Heritage 50W (azoxystrobin)	2.0 oz	1	2.0
	2.0 oz	2	1.6
	2.0 oz	3	6.6
Heritage 50W (azoxystrobin)	4.0 oz	1	2.0
	4.0 oz	2	2.3
	4.0 oz	3	5.3
Sunspray Ultrafine Oil (paraffinic oil)	1 gal	1	2.4
Nontreated	-	-	8.3
LSD (<i>P</i> =0.05)		0.7	

* Not an IR-4 Experiment: F&N Tests Vol 58:OT039.

^x Mean separation in column was according to Fisher's LSD test. Rated on Dec 18, 2001 using Barratt and Horsfall rating scale where 1 = no disease, 2 = 0 to 3%, 3 = 3 to 6%, 4 = 6 to 12%, 5 = 12 to 25%, 6 = 25 to 50%, 7 = 50 to 75%, 8 = 75 to 87%, 9 = 87 to 94%, 10 = 94 to 97%, 11 = 97 to 100% and 12 = 100% of the leaves colonized by *E. polygoni*.

Treatments applied from Nov 1, 2001 to Jan 3, 2002.

In 2003, Hagan conducted an experiment to determine efficacy of Milstop applied at various rates and application intervals for the control of powdery mildew on hydrangea. At all application rates, MilStop consistently gave better control of powdery mildew when applied on a 1- week than on a 2-week schedule (Table 17). When applied weekly, all but the lowest rate of MilStop greatly reduced the incidence of powdery mildew and proved nearly as effective as the standard Daconil Ultrex. Overall, weekly applications of the 2.5-lb rate of MilStop resulted in the production of attractive bigleaf hydrangea plants that were relatively free of powdery mildew. Higher rates of this fungicide were extremely phytotoxic to bigleaf hydrangea.

Table 17. *Efficacy on Powdery Mildew (*Erysiphe polygoni*) on Hydrangea (*Hydrangea macrophylla*) ‘Nikko Blue’, Hagan, AL, 2003.

Treatment	Rate Per 100 Gal	Application Interval (wk)	Powdery Mildew Rating ^x	Plant Quality
Daconil Ultrex 82.5WDG (chlorothalonil)	1.4 lb	1	1.0 e	4.3 a
	1.4 lb	2	1.8 de	4.5 a
MilStop 85W (potassium bicarbonate)	1.25 lb	1	4.0 c	4.1 ab
	1.25 lb	2	5.5 b	3.9 b
MilStop 85W (potassium bicarbonate)	2.5 lb	1	2.3 d	4.5 a
	2.5 lb	2	5.5 b	4.1 ab
MilStop 85W (potassium bicarbonate)	5.0 lb	1	1.5 de	3.3 cd
	5.0 lb	2	4.0 c	3.4 c
MilStop 85W (potassium bicarbonate)	10.0 lb	1	1.0 e	2.1 e
	10.0 lb	2	2.4 d	2.9 d
Nontreated	-	--	7.3 a	3.4 c

* Not an IR-4 Experiment: F&N Tests Vol 59:OT036.

^x Means within column followed by the same letter are not significantly different (Duncan's Multiple Range Test, P=0.05). Rated on Apr 28 using Barratt and Horsfall rating scale where 1 = no disease, 2 = 0 to 3%, 3 = 3 to 6%, 4 = 6 to 12%, 5 = 12 to 25%, 6 = 25 to 50%, 7 = 50 to 75%, 8 = 75 to 87%, 9 = 87 to 94%, 10 = 94 to 97%, 11 = 97 to 100% and 12 = 100% of the leaves colonized by *E. polygoni*.

^y Plant quality was rated on Apr 28 on a scale of 1 to 5 where 1 = severe stunting and leaf damage to 5 = a quality plant with attractive foliage.

Treatments applied from Mar 10 to Apr 28.

In 2003, Williams-Woodward conducted an experiment to determine efficacy of several fungicides applied as foliar sprays for the control of powdery mildew on container-grown hydrangea. All treatments significantly reduced severe disease pressure with BAS 500, Heritage, and Compass providing the best control with less than 10% of the leaf area affected (Table 18). Agri-50 was the only treatment that provided control that would be unacceptable for most nurseries.

Table 18. *Efficacy on Powdery Mildew (*Erysiphe polygoni*) on Hydrangea (*Hydrangea macrophylla*) ‘Hobella’, Williams-Woodward. GA, 2003.

Treatment	Rate Per 100 Gal	Application Interval (days)	Powdery Mildew Rating ^x
Agri-50 (propylene glycol alginate)	64 oz	14	3.8 d
BAS 500 F (pyraclostrobin)	4 oz	14	0.4 a
	8 oz	14	0.5 a
Compass 50WDG (trifloxystrobin)	2 oz	7	0.9 ab
Eagle 40 WSP (myclobutanil)	4 oz	14	1.3 bc
Heritage 50W (azoxystrobin)	4 oz	14	1.0 ab
Nontreated	-	-	8.3 e

* Not an IR-4 Experiment: F&N Tests Vol 60:OT032. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05). Rated on Jan 5, 2004 using a disease severity scale of 0-10 where 0 = no disease, 1 = 1-10%, 2 = 11-20%, 3 = 21-30%, 4 = 31-40%, 5 = 41-50%, 6 = 51-60%, 7 = 61-70%, 8 = 71-80%, 9 = 81-90%, and 10 = 91-100% of the leaf area with powdery mildew infection.

Treatments applied from Oct 29 to Dec 19, 2003. Nu-Film included with Heritage sprays.

In 2005, Hagan conducted an experiment to determine efficacy of BW420 for the control of powdery mildew on container-grown hydrangea. All treatments provided effective control under severe disease

pressure (Table 19). At both rating dates, the 0.4% rate of BW420 was less effective than the higher rate of the same fungicide, as well as other treatments. The higher rate of BW420 was as effective as the BW420 tank mix combinations and Banner MAXX on Oct 8 but was slightly less effective than the latter fungicide treatments on the Nov 4 rating date. BW420 did not enhance the activity of Banner MAXX against powdery mildew. Some puckering and stunting of the juvenile leaves was noted on Oct 8 on the hydrangea treated with the high rate of BW420.

Table 19. *Efficacy on Powdery Mildew (*Erysiphe polygoni*) on Hydrangea (*Hydrangea macrophylla*) ‘Nikko Blue’, Hagan, AL, 2005.

Treatment	Rate Per 100 Gal	No. Infection Sites ^x	Powdery Mildew Incidence ^y	
			Oct 8	Nov 4
Banner MAXX (propiconazole)	5 fl oz	2.8 b	0.1 c	0.1 d
BW420 / Tricon (sodium tetraborohydrate decahydrate)	0.4%	8.8 b	1.7 b	2.4 b
	0.8%	1.1 b	0.6 c	1.1 c
BW420 0.4% + MilStop	0.4% + 2.5 lb	1.0 b	0.2 c	0.9 cd
BW420 + Banner MAXX	0.4% + 5 fl oz	1.6 b	0.2 c	0.2 d
Nontreated	-	25.0 a	3.1 a	6.4 a

* Not an IR-4 Experiment: F&N Tests Vol 61:OT007.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05).

^y Powdery mildew incidence was visually rated on 8 Oct and 4 Nov on a 0 to 10 scale where 0 = no disease, 1 = 1 to 10%, 2 = 11 to 20% up to 10 = 100% of the leaves colonized by *E. polygoni*.

During 2010 and 2011, Hagan conducted two experiments to determine efficacy of organic and biorational fungicides for the control of powdery mildew on container-grown hydrangea. Heritage and Milstop were included as standards. In 2010, all treatments, except Heritage and MilStop, provided 100% control (Table 20). In 2011, all treatments, except MilStop and Serenade, provided 100% control under severe disease pressure (Table 21). In both years, Southern Ag Liquid Copper Fungicide and, to a lesser extent, Bonide Liquid Copper Fungicide caused unacceptably phytotoxicity to hydrangea.

Table 20. *Efficacy on Powdery Mildew (*Erysiphe polygoni*) on Hydrangea (*Hydrangea macrophylla*) ‘Dooley’, Hagan, AL, 2010.

Treatment	Rate Per 100 Gal	Application Interval (wk)	Powdery Mildew Rating ^x
Bonide Liquid Copper Fungicide (copper octanoate)	1.5 gal	1	0 c
Bonide Citrus, Fruit, and Nut Orchard Spray Concentrate (sulfur)	2 gal	1	0 c
Green Light Neem Concentrate (neem oil)	0.8 gal	1	0 c
Heritage 50WDG (azoxystrobin)	4 oz	3	12 b
Immunox 1.55% (myclobutanol)	0.8 gal	2	0 c
MilStop 85W (potassium bicarbonate)	1.5 lb	1	19 b
Serenade Disease Control RTU (<i>Bacillus subtilis</i> strain QST 713)	RTU	1	0 c
Southern Ag Liquid Copper Fungicide (copper hydroxide)	1.1 qt	1	0 c
Nontreated	-	-	94 a

* Not an IR-4 Experiment: Plant Disease Management Reports 5:OT006.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05). Rated on Nov 11 using a 0 to 11 Horsfall and Barratt rating scale. Values are transformed to percentages for presentation.

Treatments applied from Jul 8 to Oct 29.

Table 21. *Efficacy on Powdery Mildew (*Erysiphe polygoni*) on Hydrangea (*Hydrangea macrophylla*) ‘Dooley’, Hagan, AL, 2011, Experiment 1.

Treatment	Rate Per 100 Gal	Application Interval (wk)	Powdery Mildew Rating ^x
Bonide Liquid Copper Fungicide (copper octanoate)	1.5 gal	1	0 d
Bonide Citrus, Fruit, and Nut Orchard Spray Concentrate (sulfur)	2 gal	1	0 d
Green Light Neem Concentrate (neem oil)	0.8 gal	1	0 d
Heritage 50WDG (azoxystrobin)	4 oz	3	0 d
Immunox 1.55% (myclobutanol)	0.8 gal	2	0 d
MilStop 85W (potassium bicarbonate)	1.5 lb	1	31 b
Serenade Disease Control RTU (<i>Bacillus subtilis</i> strain QST 713)	RTU	1	5 c
Southern Ag Liquid Copper Fungicide (copper hydroxide)	1.1 qt	1	0 d
Nontreated	-	-	85 a

* Not an IR-4 Experiment: Plant Disease Management Reports 6:OT003.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05). Rated on Oct 5 using a 0 to 11 Horsfall and Barratt rating scale. Values are transformed to percentages for presentation.

Treatments applied from Jul 7 to Oct 29.

In 2011, Hagan conducted a second experiment to determine efficacy of fungicides for the control of powdery mildew on container-grown hydrangea. All fungicides, except Palladium, provided 100% control with severe disease pressure (Table 22). Heritage alone or tank mixed with CapSil NIS gave equally effective powdery mildew control.

Table 22. *Efficacy on Powdery Mildew (*Erysiphe polygoni*) on Hydrangea (*Hydrangea macrophylla*) ‘Dooley’, Hagan, AL, 2011, Experiment 2.

Treatment	Rate Per 100 Gal	Application Interval (wk)	Powdery Mildew Rating ^x
Banner MAXX 1.3MEC (propiconazole)	8 fl oz	2	0.0 e
Concert II (chlorothalonil + propiconazole)	35 fl oz	2	0.0 e
Heritage 50WDG (azoxystrobin)	4 oz	2	0.0 e
Heritage 50WDG (azoxystrobin) + CapSil	4 oz + 4 fl oz	2	0.0 e
	4 oz + 4 fl oz	3	0.0 e
Palladium 62.5WDG (cyprodinil + fludioxonil) + CapSil	6 oz + 4 fl oz	2	19 c
	6 oz + 4 fl oz	3	48.4 b
Nontreated	-	-	88 a

* Not an IR-4 Experiment: Plant Disease Management Reports 6:OT022. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05). Rated on Oct 18 using a 0 to 11 Horsfall and Barratt rating scale. Values are transformed to percentages for presentation.

Treatments applied from Jul 6 to Oct 27.

During 2002 and 2003, Wegulo conducted two field experiments to determine efficacy of several fungicides applied as foliar sprays for the control of powdery mildew (*Erysiphe polygoni*) on delphinium (*Delphinium* sp.) ‘Belladonna Dark Blue’ with treatments duplicated for plants transplanted in single and double rows. In 2002, Banner MAXX, Daconil Ultrex, Eagle, Kaligreen, and E-RASE significantly reduced a severe disease pressure in single rows (Table 23). In double rows, all treatments significantly lowered disease severity. In 2003, all treatments significantly reduced a severe disease pressure in both

single and double rows (Table 24). In both years, Banner MAXX was the best treatment. No phytotoxicity was observed in any treatment.

Table 23. *Efficacy on Powdery Mildew (*Erysiphe polygoni*) on Delphinium (*Delphinium* sp.) ‘Belladonna Dark Blue’, Wegulo, CA, 2002.

Treatment	Rate Per 100 Gal	Application Interval (days)	Powdery Mildew Rating ^x	
			Single row	Double Row
Banner MAXX 14.3% (propiconazole)	8 fl oz	14	0.5 e	0.5 d
Daconil Ultrex 82.5 WDG (chlorothalonil)	1.4 lb	14	1.5 d	1.8 c
Eagle 40 WSP (myclobutanil)	3 oz	14	1.6 d	1.9 c
E-RASE (jojoba oil)	64 fl oz	7	2.6 bc	1.9 c
Kaligreen (potassium bicarbonate)	3 lb	7	2.3 cd	2.1 bc
Rubigan AS (fenarimol)	5 fl oz	14	3.0 a-c	2.9 b
Nontreated	-	-	3.8 a	3.9 a

* Not an IR-4 Experiment: F&N Tests Vol 61:OT024. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (LSD Test, P=0.05). Disease severity rated on Dec 24 on a 0 to 5 scale where 0 = no powdery mildew and 5 = 80 to 100% of the plant surface covered with powdery mildew.

Treatments applied from Oct 29 to Dec 24.

Table 24. *Efficacy on Powdery Mildew (*Erysiphe polygoni*) on Delphinium (*Delphinium* sp.) ‘Belladonna Dark Blue’, Wegulo, CA, 2003.

Treatment	Rate Per 100 Gal	Application Interval (days)	Powdery Mildew Rating ^x	
			Single row	Double Row
Banner MAXX 14.3% (propiconazole)	8 fl oz	10	1.6 f	0.4 g
Daconil Ultrex 82.5 WDG (chlorothalonil)	1.4 lb	10	4.0 d	2.8 de
Eagle 40 WSP (myclobutanil)	3 oz	10	3.1 e	1.8 f
E-RASE (jojoba oil)	64 fl oz	7	3.9 d	3.4 cd
Kaligreen (potassium bicarbonate)	3 lb	7	4.3 b-d	2.9 de
Rubigan AS (fenarimol)	5 fl oz	10	4.3 b-d	3.8 bc
Nontreated	-	-	5.0 a	4.8 a

* Not an IR-4 Experiment: F&N Tests Vol 61:OT025. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (LSD Test, P=0.05). Disease severity rated on Mar 17 on a 0 to 5 scale where 0 = no powdery mildew and 5 = 80 to 100% of the plant surface covered with powdery mildew.

Treatments applied from Jan 28 to Mar 3.

Comparative Efficacy on *Erysiphe pulchra*

From 1999 through 2016, 15 experiments were conducted on *Erysiphe pulchra* on dogwood (*Cornus florida*). The 3336 / Domain, Banner MAXX, Compass, Concert II, Eagle / Immunox, Heritage, Pageant, Phyton 27, Sunspray UltraFine Oil and Triact treatments provided the most consistent levels of control across the experiments (Table 25). Bayer Disease Control and Bravo / Daconil, provided good or excellent control in one or two experiments. The relatively new products F9110, Mural, Picatina, and Picatina Flora, also provided good or excellent control in one or two experiments. See the following paragraphs for summaries of each experiment.

Table 25. General summary of efficacy for *Erysiphe pulchra* on dogwood.

Product	Hagan 1999*	Hagan 2001*	Hagan 2001*	Hagan 2002*	Smith 2002*	Mulrooney 2002*	Hagan 2003*	Hagan 2003*	Mulrooney 2004*	Hagan 2004*	Hagan 2005*	Hagan 2007*	Baysal-Gurel 2016	Baysal-Gurel 2016	Baysal-Gurel 2016
3336			+	++				+/-		++	++	++			
Banner MAXX, Ferti-Lome, Infuse	++		++	++				++	++	++	++	++			
Bayer Disease Control									++						
Bayleton			+	+				+/-							
Bravo					++										
Compass	++	++					++								
Concert II													++	+	+
Daconil												++			
Domain			+	++											
Eagle	++	++	++	++		++	++	++	++	++	++				
F9110						+									
Heritage	++		++	++				++				+			
Immunox			++	++				+/-	++	++	++				
Instrata												++			
Medallion												+			
Mural															+
Pageant													+	+	+
Phyton 27			+	++	++			++							
Picatina													++	+	
Picatina Flora													++	++	
Rhapsody										+	-				
SunSpray UF Oil			+		++			+	+	+	-				
Triact, Neem Concentrate						++			+	++	-				

* Not an IR-4-sponsored experiment.

1 Rating Scale: ++ = clearly statistically equivalent or better than Nontreated non-inoculated and/or clearly statistically different than Nontreated inoculated; + = statistically different from Nontreated inoculated and Nontreated non-inoculated; +/- statistically equivalent to both Nontreated inoculated and Nontreated non-inoculated; - = statistically equivalent to Nontreated inoculated. For experiments without non-inoculated check, efficacy determined on author's conclusions, % control or comparisons to standard product(s).

2 Where more than one rate or application type for a product was included in the experiment and each performed statistically different, the better rating is provided in this table.

In 1999, Hagan conducted an experiment to determine efficacy of Compass and standard fungicides for the control of powdery mildew (*Microsphaera pulchra*) on container-grown dogwood (*Cornus florida*) ‘First Lady’. All treatments significantly reduced disease incidence and severity under heavy infection pressure, generally resulting in increased tree growth (Table 26). Compass at 0.5 oz applied weekly provided effective control comparable to the standard fungicides Banner MAXX, Eagle, and Heritage. Generally, the height and the caliper of the dogwood treated with the all rates of Compass were similar to those recorded for the fungicide standards.

Table 26. *Efficacy on Powdery Mildew (*Microsphaera pulchra*) on Dogwood (*Cornus florida*) ‘First Lady’, Hagan, AL, 1999.

Treatment	Rate Per 100 Gal	Spray Interval (days)	Powdery Mildew ^x		Tree	
			Incidence	Severity	Height (cm)	Caliper (cm)
Banner MAXX (propiconazole)	5 fl oz	21	2.1 cd	1.9 bc	149.0 ab	20.1 abc
Compass SOWP (trifloxystrobin)	0.5 oz	7	1.8 d	1.8 bc	141.1 bc	19.0 c
	1.0 oz	14	4.3 b	2.4 b	157.9 a	19.8 abc
	2.0 oz	14	3.0 c	2.0 bc	162.0 a	21.2 ab
Eagle 40W (myclobutanil)	8 oz	14	1.6 d	1.6 bc	156.0 ab	21.4 a
Heritage 50W (azoxystrobin)	8 oz	14	1.4 d	1.4 c	153.0 ab	19.2 bc
Nontreated	-	-	12.0 a	7.7 a	133.1 c	14.8 d

* Not an IR-4 Experiment: F&N Tests 55:540.

^x Means within column followed by the same letter are not significantly different (Duncan's Multiple Range Test, P=0.05).. Rated on Jul 7 using Horsfall and Barratt rating scale where 1 = no disease, 2 = 0 to 3%, 3 = 3 to 6%, 4 = 6 to 12%, 5 = 12 to 25%, 6 = 25 to 50%, 7 = 50 to 75%, 8 = 75 to 87%, 9 = 87 to 94%, 10 = 94 to 97%, 11 = 97 to 100% and 12 = 100% of the leaves colonized by *E. pulchra*.

Treatments applied from Apr 12 to Oct 6.

In 2001, Hagan conducted an experiment to determine efficacy of Compass applied at various rates and spray intervals for the control of powdery mildew (*Microsphaera pulchra*) on container-grown dogwood. All treatments significantly reduced a severe disease pressure (Table 27). With the exception of the two lower rates applied monthly, Compass was as effective at controlling powdery mildew as the standard Eagle. No phytotoxicity was observed in any treatment.

Table 27. *Efficacy on Powdery Mildew (*Microsphaera pulchra*) on Dogwood (*Cornus florida*) ‘Cloud 9’, Hagan, AL, 2001.

Treatment	Rate Per 100 Gal	Application Interval (wk)	Powdery Mildew Severity ^x	Growth Index (cm)
Compass 50W (trifloxystrobin)	1 oz	1	2.2 d	105 a
	1 oz	2	2.5 d	97 a
	1 oz	4	4.8 b	104 a
Compass 50W (trifloxystrobin)	2 oz	1	1.7 d	104 a
	2 oz	2	2.0 d	95 a
	2 oz	4	4.2 bc	103 a
Compass 50W (trifloxystrobin)	4 oz	1	1.5 d	100 a
	4 oz	2	2.5 d	108 a
	4 oz	4	2.8 cd	96 a
Eagle 40W (myclobutanil)	8 oz	2	1.8 d	92 a
Nontreated		-	6.7 a	106 a

* Not an IR-4 Experiment: F&N Tests Vol 57:OT09.

^x Means within column followed by the same letter are not significantly different (Duncan's Multiple Range Test, P=0.05). Disease incidence rated on May 29, Jul 10, Aug 8, and Aug 24 using the 1 to 12 Horsfall and Barratt rating scale. Data collected on Jul 10 are presented in the table.

Treatments applied from May 2 to Jul 24.

In 2001 and 2002, Hagan conducted two experiments to determine efficacy of registered fungicides for the control of powdery mildew (*Microsphaera pulchra*) on two different cultivars of container-grown dogwood. In 2001, all treatments significantly reduced a moderate disease pressure, with Banner MAXX, Immunox, and Heritage providing the best control (Table 28). No phytotoxicity was observed in any treatment. In 2002, all treatments significantly reduced a moderate disease pressure (Table 29). The severity rating was higher on the Bayleton T/O-treated dogwoods than on those sprayed with Banner Maxx or Domain 50W. Slight stunting was observed with Banner Maxx and SunSpray Ultra-Fine Oil.

Table 28. *Efficacy on Powdery Mildew (*Microsphaera pulchra*) on Dogwood (*Cornus florida*) ‘Cloud 9’, Hagan, AL, 2001.

Treatment	Rate Per 100 Gal	Powdery Mildew Severity ^x	Growth Index ^y
3336 4.5F (thiophanate methyl)	20 fl oz	3.8 bc	108 ab
Banner MAXX 14.3%E (propiconazole)	6 fl oz	2.0 e	99 ab
Bayleton T/O 50W (triadimefon)	4 oz	4.2 bc	116 a
Domain 50W (thiophanate methyl)	1 lb	5.0 b	115 a
Eagle 40W (myclobutanil)	8 oz	3.2 cde	115 a
Heritage 50W (azoxystrobin)	4 oz	2.3 de	110 ab
Immunox 1.55%E (myclobutanil)	100 fl oz	2.2 e	113 a
Phyton 27 (copper sulfate pentahydrate)	40 fl oz	3.5 cd	96 b
Sunspray Ultrafine Oil (paraffinic oil)	1 gal	3.8 bc	111 ab
Nontreated	-	7.8 a	99 ab

* Not an IR-4 Experiment: F&N Tests Vol 57:OT08.

^x Means within column followed by the same letter are not significantly different (Duncan's Multiple Range Test, P=0.05). Disease incidence rated on May 29, Jul 10, Aug 8, and Aug 24 using the 1 to 12 Horsfall and Barratt rating scale. Data collected on Jul 10 are presented in the table.

^y Growth Index was calculated by adding height + width 1 + width 2 and dividing by 3.

Treatments applied from May 2 to Jul 24 at 2-wk intervals. Domain, Eagle, and Bayleton were tank-mixed with a non-ionic surfactant (0.06% v/v).

Table 29. *Efficacy on Powdery Mildew (*Erysiphe pulchra*) on Dogwood (*Cornus florida*) ‘Rubra’, Hagan, AL, 2002.

Treatment	Rate Per 100 Gal	Powdery Mildew Rating ^x	Tree Height (cm)
3336 4.5F (thiophanate methyl)	20 fl oz	2.2	89.2
Banner MAXX 14.3%E (propiconazole)	6 fl oz	1.0	78.2
Bayleton T/O 50W (triadimefon)	4 oz	2.5	84.8
Domain 50W (thiophanate methyl)	1 lb	1.0	91.8
Eagle 40W (myclobutanil)	8 oz	1.2	85.8
Heritage 50W (azoxystrobin)	4 oz	1.2	85.2
Immunox 1.55%E (myclobutanil)	100 fl oz	1.3	89.8
Phyton 27 (copper sulfate pentahydrate)	40 fl oz	2.2	84.2
Sunspray Ultrafine Oil (paraffinic oil)	1 gal	1.8	78.0
Nontreated	-	5.5	89.8
LSD ($P=0.05$)		1.4	10.3

* Not an IR-4 Experiment: F&N Tests Vol 58:OT038.

^x Mean separation in each column was according to Fisher's LSD test. Rated on Sep 9 using the 1-12 Horsfall and Barratt rating scale.

Treatments applied from May 24 to Aug 14 at 2-wk intervals.

In 2002, Smith conducted a field experiment to determine efficacy of Phyton 27 and Bravo for the control of powdery mildew (*Microsphaera pulchra*) on dogwood. Both products provided excellent control with severe disease pressure (Table 30). Phytotoxicity was observed at both rates of Phyton 27.

Table 30. *Efficacy on Powdery Mildew (*Microsphaera pulchra*) on Dogwood (*Cornus florida*), Smith, CT, 2002.

Treatment	Rate Per 100 Gal	Powdery Mildew Rating ^x	Phytotoxicity
Bravo 90 WDG	5 oz	0.0 b	0 b
Phyton 27 (copper sulfate pentahydrate)	25 fl oz	0.0 b	3 a
	35 fl oz	0.1 b	8 a
Nontreated	-	4.5 a	0 b

* Not an IR-4 Experiment: F&N Tests Vol 58:OT036.

^x Means within column followed by the same letter are not significantly different (Kruskal-Wallis one-way analysis of variance, $P=0.05$). Disease incidence rated on Sep 30 using a modified Horsfall-Barratt rating scale where 1 = < 10 %, 2 = 11-25 %, 3 = 26 -50 %, 4 = 51-75 %, and 5 = > 76 %.

In 2002, Mulrooney conducted a field experiment to determine efficacy of biorational fungicides for the control of powdery mildew (*Microsphaera pulchra*) on dogwood. All treatments provided significant control of a severe disease pressure at levels that would be acceptable in the landscape (Table 31). Triact 70 at the 14-day interval was as effective as Eagle 40 WP applied at 21- or 28-day intervals on Jul 16. No phytotoxicity was observed in any treatment.

Table 31. *Efficacy on Powdery Mildew (*Microsphaera pulchra*) on Dogwood (*Cornus florida*), Mulrooney, DE, 2002.

Treatment	Rate Per 100 Gal	Application Interval (days)	Powdery Mildew Rating ^x		Aesthetic Rating ^z
			Jul 16 ^w	Sep 16 ^y	Sep 16
Eagle 40WP (myclobutanil)	6.0 oz	21	1.3 a	1.5 a	1.8 a
	6.0 oz	28	1.6 ab	2.0 ab	2.5 ab
FirstStep 85WP (potassium bicarbonate)	3.0 lb	14	4.0 de	2.8 bc	2.3 ab
	3.0 lb	21	5.3 e	3.8 c	3.0 b
Sunspray UF Oil (paraffinic oil)	1 gal	14	2.8 bcd	2.0 ab	1.8 a
	1 gal	21	3.3 cd	2.8 bc	3.0 b
Triact 70%EC (neem oil)	1 gal	14	2.3 abc	2.6 abc	2.3 ab
	1 gal	21	3.8 d	3.0 bc	2.8 b
Nontreated	-	-	8.0 f	5.0 d	4.5 c

* Not an IR-4 Experiment: F&N Tests Vol 58:OT034.

^x Means within column followed by the same letter are not significantly different (Duncan-Waller *k*-ratio *t* test, *k*=100, *P*=0.05).

^w Powdery mildew rating was based on the Horsfall-Barratt scale: 1=0%, 2=0-3%, 3=3-6%, 4=6-12%, 5=12-25%, 6=25-50%, 7=50-75%, 8=75-87%, 9=87-94%, 10=94-97%, 11=97-100%, 12=100% of leaves with powdery mildew.

^y Powdery mildew rating: 1-6; 1= no mildew, 6= 100% of foliage affected.

^z Aesthetic rating, overall appearance of plants: 1= excellent, 5=poor.

Treatments applied from May 21 to Aug 3. Eagle was tank-mixed with Latron B-1956 (3.3 fl oz/100 gal).

In 2003, Hagan conducted another experiment to determine efficacy of Compass applied at various rates and spray intervals for the control of powdery mildew (*Erysiphe pulchra*) on container-grown dogwood. All treatments significantly reduced a severe disease pressure (Table 32). On Aug 6, disease incidence increased as the treatment interval for all rates of Compass was lengthened from 1 to 4 wk. When applied at 1- and 2-wk intervals, all rates of Compass gave similar level of powdery mildew control. When applied every 2 wk, the two higher rates of Compass were as effective as the standard Eagle applied on the same schedule.

Table 32. *Efficacy on Powdery Mildew (*Erysiphe pulchra*) on Dogwood (*Cornus florida*) ‘Cloud 9’, Hagan, AL, 2003.

Treatment	Rate Per 100 Gal	Application Interval (wk)	Disease Incidence ^x	
Compass 50W (trifloxystrobin)	1 oz	1	2.0 c	1.7 f
	1 oz	2	2.3 c	2.7 cd
	1 oz	4	3.3 b	3.7 b
Compass 50W (trifloxystrobin)	2 oz	1	2.2 c	2.0 def
	2 oz	2	2.0 c	2.0 def
	2 oz	4	2.3 c	3.3 bc
Compass 50W (trifloxystrobin)	4 oz	1	2.0 c	1.7 f
	4 oz	2	2.3 c	2.0 def
	4 oz	4	2.3 c	2.5 de
Eagle 40W (myclobutanil)	8 oz	2	2.3 c	1.8 ef
Nontreated		-	7.5 a	6.7 a

* Not an IR-4 Experiment: F&N Tests Vol 60:OT027.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05). Disease incidence rated on Jun 18 and Aug 6 using the 1 to 12 Horsfall and Barratt rating scale. Treatments applied from May 7 to Jul 29.

In 2003, Hagan conducted another experiment to determine efficacy of registered fungicides tested in 2001 and 2002 for the control of powdery mildew (*Microsphaera pulchra*) on container-grown dogwood. Similar to results from previous years, all treatments significantly reduced a severe disease pressure (Table 33). Eagle and Heritage provided the best control, followed by Banner MAXX, Phyton 27 and SunSpray Ultra Fine Oil; 3336 and Domain, as well as Bayleton and Immunox, were the least effective products. No phytotoxicity was observed in any treatment.

Table 33. *Efficacy on Powdery Mildew (*Erysiphe pulchra*) on Dogwood (*Cornus florida*) ‘Budded White’, Hagan, AL, 2003.

Treatment	Rate Per 100 Gal	Powdery Mildew Rating ^x
3336 4.5F (thiophanate methyl)	20 fl oz	6.3 bc
Banner MAXX 14.3%E (propiconazole)	6 fl oz	2.6 ef
Bayleton T/O 50W (triadimefon)	4 oz	5.6 cd
Domain 50W ((thiophanate methyl)	1 lb	6.6 b
Eagle 40W (myclobutanil)	8 oz	2.2 fg
Heritage 50W (azoxystrobin)	4 oz	1.6 g
Immunox 1.55%E (myclobutanil)	100 fl oz	5.0 d
Phyton 27 (copper sulfate pentahydrate)	40 fl oz	3.0 e
Sunspray Ultrafine Oil (paraffinic oil)	1 gal	3.3 e
Nontreated	-	7.6 a

* Not an IR-4 Experiment: F&N Tests Vol 59:OT039.

^x Means within column followed by the same letter are not significantly different (Fisher's LSD Test, P=0.05). Disease incidence rated on Jun 12, Jul 10 and Aug 6 using the 1 to 12 Horsfall and Barratt rating scale. Data from Jul 10 is displayed in the table. Treatments applied from Apr 17 to Jul 24 at 2-wk intervals.

In 2004, Mulrooney conducted a field experiment to determine efficacy of currently available fungicides that would be available for homeowner use for the control of powdery mildew (*Microsphaera pulchra*) on dogwood. All treatments provided significant control of a severe disease pressure (Table 34). Eagle,

Infuse, Bayer Disease Control and Immunox provided good control, while the biorational products Remedy, Sunspray UF Oil and Triact were not as effective. No phytotoxicity was observed in any treatment.

Table 34. *Efficacy on Powdery Mildew (*Microsphaera pulchra*) on Dogwood (*Cornus florida*), Mulrooney, DE, 2004.

Treatment	Rate Per 100 Gal	Powdery Mildew Rating ^x		Aesthetic Rating ^y
		Jun 9	Jul 26	Sep 14
Bayer Disease Control 2.9% (tebuconazole)	75 fl oz	1.8 b	2.8 ab	1.8 a
Eagle 40W (myclobutanol)	6.0 oz	1.0 a	2.0 a	1.5 a
Immunox 1.55%E (myclobutanol)	100 fl oz	1.8 b	3.5 bc	1.6 a
Infuse 1.55% (propiconazole)	50 fl oz	1.5 ab	2.3 ab	1.6 a
Sunspray Ultrafine Oil (paraffinic oil)	1 gal	1.8 b	4.3 cd	2.8 b
Triact 70%EC (neem oil)	1 gal	1.8 b	4.8 cd	2.6 b
Nontreated	-	6.5 c	9.0 e	4.3 c

* Not an IR-4 Experiment: F&N Tests Vol 60:OT016. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Duncan-Waller *k*-ratio *t* test, *k*=100, *P*=0.05). Powdery mildew rating was based on the 1 to 12 Horsfall-Barratt scale.

^y Aesthetic rating, overall appearance of plants: 1= excellent, 5=poor.

Treatments applied every 3 weeks from May 17 to Aug 6. Eagle was tank-mixed with Latron B-1956 (3.3 fl oz/100 gal).

During 2004 and 2005, Hagan conducted two experiments to determine efficacy of several fungicides for the control of powdery mildew (*Erysiphe pulchra*) on container-grown dogwood. In 2004, all treatments significantly reduced a moderate disease pressure (Table 35). Very little powdery mildew was seen on trees treated with Immunox, Eagle, Ferti-Lome Liquid Systemic Fungicide, and CL 3336, as well as those treated weekly with Neem Concentrate and Rhapsody. In 2005, all fungicides significantly reduced a severe disease pressure, with Immunox, Eagle, Cleary's 3336, and Systemic Fungicide were much more effective in controlling powdery mildew than Neem Concentrate, SunSpray Ultra Fine Oil and Rhapsody (Table 36). No phytotoxicity was observed in any treatment, except SunSpray Ultra Fine Oil which caused a yellowish and green mosaic pattern, as well as interveinal chlorosis, in 2004.

Table 35. *Efficacy on Powdery Mildew (*Erysiphe pulchra*) on Dogwood (*Cornus florida*) 'Rubra', Hagan, AL, 2004.

Treatment	Rate Per 100 Gal	Application Interval (wk)	Powdery Mildew Rating ^x
3336 50W ((thiophanate methyl)	1 lb	2	1.8 de
Eagle 40W (myclobutanol)	8 oz	2	1.0 e
Ferti-Lome Liquid Systemic Fungicide (propiconazole)	0.4 gal	2	1.0 e
Immunox (myclobutanol)	100 fl oz	2	1.0 e
Neem Concentrate (neem oil)	0.8 gal	1	1.8 de
	0.8 gal	2	3.5 bcd
Rhapsody (<i>Bacillus subtilis</i>)	3 gal	1	2.7 cde
Sunspray Ultrafine Oil (paraffinic oil)	0.8 gal	1	3.7 bc
	0.8 gal	2	4.6 b
Nontreated	-	-	6.2 a

* Not IR-4 Experiments: Plant Disease Management Reports 6:OT003.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, *P*=0.05). Rated on Jun 16 in 2004, and on July 22 in 2005, using the 1 to 12 Horsfall and Barratt rating scale.

Treatments applied from from Apr 7 to Jun 30 in 2003, from Apr 7 to Jun 30 in 2004, dates not provided for 2005.

Table 36. *Efficacy on Powdery Mildew (*Erysiphe pulchra*) on Dogwood (*Cornus florida*) ‘Rubra’, Hagan, AL, 2005.

Treatment	Rate Per 100 Gal	Application Interval (wk)	Powdery Mildew Rating ^x
3336 50W ((thiophanate methyl)	1 lb	2	3.3 c
Eagle 40W (myclobutanil)	8 oz	2	1.3 c
Ferti-Lome Liquid Systemic Fungicide (propiconazole)	0.4 gal	2	1.5 c
Immunox (myclobutanil)	100 fl oz	2	1.8 c
Neem Concentrate (neem oil)	0.8 gal	1	7.5 b
	0.8 gal	2	11.0 a
Rhapsody (<i>Bacillus subtilis</i>)	3 gal	1	7.2 b
Sunspray Ultrafine Oil (paraffinic oil)	0.8 gal	1	7.3 b
	0.8 gal	2	9.8 a
Nontreated	-	-	11.3 a

* Not IR-4 Experiments: F&N Tests Vol 61:OT006.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05). Rated on Jun 16 in 2004, and on July 22 in 2005, using the 1 to 12 Horsfall and Barratt rating scale. Treatments applied from from Apr 7 to Jun 30 in 2003, from Apr 7 to Jun 30 in 2004, dates not provided for 2005.

In 2007, Hagan conducted an experiment to determine efficacy of several fungicides for the control of powdery mildew (*Erysiphe pulchra*) on container-grown dogwood. All treatments significantly reduced a severe disease pressure, with Banner MAXX, Daconil Ultrex and Instrata providing the best control (Table 37). No phytotoxicity was observed in any treatment.

Table 37. *Efficacy on Powdery Mildew (*Erysiphe pulchra*) on Dogwood (*Cornus florida*) ‘Cloud 9’, Hagan, AL, 2007.

Treatment	Rate Per 100 Gal	Disease Incidence ^x		
		Jun 15	Jul 17	Aug 13
3336 4.5F ((thiophanate methyl)	20 fl oz	2.2	2.0	2.8
Banner MAXX 14.3%E (propiconazole)	8 fl oz	2.0	1.2	1.0
Daconil Ultrex (chlorothalonil)	1.4 lb	3.4	2.0	1.2
Heritage 50W (azoxystrobin)	4 oz	2.8	3.4	3.8
Instrata 3.61SE (chlorothalonil + propiconazole + fludioxonil)	16 fl oz	2.4	1.0	1.0
	22 fl oz	1.8	1.0	1.0
	33fl oz	2.8	1.2	1.0
Medallion 50W (fludioxonil)	2 oz	5.0	3.6	3.8
Nontreated	-	5.8	7.0	8.4
LSD (P=0.05)		1.0	1.1	0.7

* Not an IR-4 Experiment: Plant Disease Management Reports 2:OT010.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05). Disease incidence rated using the 1 to 12 Horsfall and Barratt rating scale. Treatments applied at approximately 2-wk intervals from May 8 to Sep 4.

In 2016, Baysal-Gurel conducted two greenhouse experiments to determine efficacy of several fungicides for the control of powdery mildew (*Erysiphe pulchra*) on dogwood in 2 locations (McMinnville and Smithville, TN). All treatments significantly reduced a high disease pressure in McMinnville (Table 38), and a moderate disease pressure in Smithville, resulting in higher growth rates (Table 39Table 38). Both rates of Picatina and Picatina Flora, as well as Concert II, generally provided more effective control than Pageant Intrinsic. No phytotoxicity was observed in any treatment in both locations.

Table 38. *Efficacy on Powdery Mildew (*Erysiphe pulchra*) on Dogwood (*Cornus florida*) ‘Cherokee Princess’, Baysal-Gurel, TN, 2016 - McMinnville.

An experiment No. / Location	Treatment	Rate Per 100 Gal	Powdery mildew ^x		Plant Height (in)
			% Disease Severity	AUDPC	
Experiment A / McMinnville, TN	Concert II 4.3SE (chlorothalonil + propiconazole)	35 fl oz	4.4 cd	145.5 c	15.4 a
	Pageant Intrinsic 38WG (pyraclostrobin + boscalid)	12 oz	10.0 b	340.0 b	12.3 b
	Picatina A19649B (pydiflumetophen)	7 fl oz	4.4 cd	143.3 c	12.0 b
		13.8 fl oz	3.0 d	81.4 c	13.7 ab
	Picatina Flora (fludioxonil+pydiflumetophen)	14 fl oz	5.6 c	154.1 c	12.8 ab
		20 fl oz	3.8 cd	110.6 c	12.6 ab
Nontreated	-	93.8 a	2749.4 a	8.9 c	

* Not IR-4 Experiments: Plant Disease Management Reports 11:OT007.

^x Means within column followed by the same letter are not significantly different (Fisher's LSD Test, P=0.05).

Disease ratings and area under the disease progress curve (AUDPC), observed weekly from Jun 16 to Jul 22 for experiment 1 and from Jun 16 to Jul 14 for experiment 2, were based on percentage of foliage area affected. % Disease Severity presented in table observed on July 22 for An experiment 1 and on Jul 14 for experiment 2.

Treatments applied on a 14-day interval from Jun 9 to Jul 7 for both experiments.

Table 39. *Efficacy on Powdery Mildew (*Erysiphe pulchra*) on Dogwood (*Cornus florida*) ‘Cherokee Princess’, Baysal-Gurel, TN, 2016 - Smithville.

An experiment No. / Location	Treatment	Rate Per 100 Gal	Powdery mildew ^x		Plant Height (in)
			% Disease Severity	AUDPC	
Experiment B / Smithville, TN	Concert II 4.3SE (chlorothalonil + propiconazole)	35 fl oz	5.0 bc	129.9 b	64.5 b
	Pageant Intrinsic 38WG (pyraclostrobin + boscalid)	12 oz	8.8 b	150.0 b	65.7 b
	Picatina A19649B (pydiflumetophen)	7 fl oz	5.0 bc	103.3 b	66.5 b
		13.8 fl oz	4.4 bc	106.7 b	70.5 a
	Picatina Flora (fludioxonil+pydiflumetophen)	14 fl oz	3.8 bc	95.7 b	65.5 b
		20 fl oz	2.5 c	65.7 b	71.2 a
Nontreated	-	51.3 a	900.9 a	61.5 c	

* Not IR-4 Experiments: Plant Disease Management Reports 11:OT015.

^x Means within column followed by the same letter are not significantly different (Fisher's LSD Test, P=0.05).

Disease ratings and area under the disease progress curve (AUDPC), observed weekly from Jun 16 to Jul 22 for An experiment 1 and from Jun 16 to Jul 14 for An experiment 2, were based on percentage of foliage area affected. % Disease Severity presented in table observed on July 22 for An experiment 1 and on Jul 14 for An experiment 2.

Treatments applied on a 14-day interval from Jun 9 to Jul 7 for both experiments.

In 2016, Baysal-Gurel conducted another greenhouse experiment to determine efficacy of several fungicides for the control of powdery mildew (*Erysiphe pulchra*) on dogwood. All treatments significantly reduced a moderate disease pressure, resulting in higher growth rates (Table 40). Mural at the higher rate was the most effective treatment. No phytotoxicity was observed in any treatment.

Table 40. *Efficacy on Powdery Mildew (*Erysiphe pulchra*) on Dogwood (*Cornus florida*) ‘Cherokee Princess’, Baysal-Gurel, TN, 2016.

Treatment	Rate Per 100 Gal	Powdery mildew ^x		Plant Height (in)
		% Disease Severity (7/14)	AUDPC	
Concert II 4.3SE (chlorothalonil + propiconazole)	35 fl oz	6.3 b	147.1 b	65.7 b
Mural 45WG (azoxystrobin + benzovindiflupyr)	5 oz	5.0 b	140.0 bc	67.0 b
	7 oz	5.0 b	87.8 c	70.7 a
Pageant Intrinsic 38WG (pyraclostrobin + boscalid)	18 oz	6.9 b	190.3 b	67.5 b
Nontreated	-	58.8 a	1016.9 a	61.8 c

* Not an IR-4 Experiment: Plant Disease Management Reports 11:OT014.

^x Means within column followed by the same letter are not significantly different (Fisher's LSD Test, P= 0.05). Disease ratings and area under the disease progress curve (AUDPC), observed weekly from Jun 16 to Jul 14, were based on percentage of foliage area affected. Treatments applied on a 14-day interval from Jun 9 to Jul 7.

Comparative Efficacy on *Golovinomyces cichoracearum*

From 2000 through 2004, 14 experiments were conducted on *Golovinomyces cichoracearum* on three different crops: gerbera daisy (*Gerbera jamesonii*), phlox (*Phlox paniculata*), and zinnia (*Zinnia elegans* and *Zinnia angustifolia*). Starting in 2016, IR-4 sponsored 5 experiments for *G. cichoracearum* management on Zinnia. The Banner MAXX, Compass, Eagle, Heritage, and Terraguard treatments generally provided good to excellent control across the non-IR-4 experiments (Table 41). Bayer Disease Control, Domain, EcoSmart, Milstop, Pipron, Strike, ZeroTol, and Zyban provided good or excellent control in single experiments. The products Mural, IKF-309, NF-149, and Orkestra also provided good or excellent control in single experiments. F9110 provided mediocre control in one experiment. For cucurbit powdery mildew on environmental horticulture crops, SP2478, Gatten, and XDE-659 provided good to excellent efficacy in at least three experiments. See the following paragraphs for summaries of each experiment.

Table 41. General summary of non-IR-4 efficacy for *Golovinomyces cichoracearum* on various crops.

Product	Gerbera Daisy						Phlox			Zinnia				
	Buck 2003*	Buck 2004*	Jacobi 2003*	Jacobi 2003*	Jacobi 2003*	Hausbeck 2004*	Hausbeck 2005*	Hausbeck 2005*	Buck 2010*	LaMondia 2000*	LaMondia 2001*	Robbins 2001*	Jacobi 2003*	Hagan 2004*
Armicarb												+/-		
Banner MAXX, Ferti-lome		+	+/-	+/-	+/-							++	+/-	
BAS 510, Endura								++						
Bayer Disease Control														++
Biophos	+													
Camelot												+/-		
Compass						++								
Cygnus							-							
Daconil			-	-	-						+	++	-	++
Domain										++	+			
Eagle, Immunox							++	++				++		++
EcoSmart									++					
Fungo												++		
Heritage	++	+	+/-	+/-	+/-	++				+	++	+/-	+/-	++
Junction												-		
Kocide														++
Kumulus											+			
Phyton 27											-			
Pipron	++													
PlantShield												+/-		
Shultz Fungicide			-	-	-								-	
Strike									++					
SunSpray UF Oil														++
Terraguard							++					++		
Zyban											++			

* Not an IR-4-sponsored experiment.

1 Rating Scale: ++ = clearly statistically equivalent or better than Nontreated non-inoculated and/or clearly statistically different than Nontreated inoculated; + = statistically different from Nontreated inoculated and Nontreated non-inoculated; +/- statistically equivalent to both Nontreated inoculated and Nontreated non-inoculated; - = statistically equivalent to Nontreated inoculated. For experiments without non-inoculated check, efficacy determined on author's conclusions, % control or comparisons to standard product(s).

2 Where more than one rate or application type for a product was included in the experiment and each performed statistically different, the better rating is provided in this table.

During 2003 and 2004, Buck conducted two greenhouse experiments to determine efficacy of several fungicides for the control of powdery mildew (*Golovinomyces cichoracearum*) on gerbera daisy (*Gerbera jamesonii*). In 2003, all treatments provided good to excellent control of a severe powdery mildew pressure, with Heritage and Pipron significantly better than BioPhos (Table 42). In 2004, all treatments significantly reduced AUDPC (area under the disease progress curve) after 6 weeks (Table 43). Lowest AUDPC values were observed with Banner MAXX at 7.0 and 10.5 fl oz, CGA-64250 at 4.7 and 9.3 oz, and Heritage at 7.5 oz. No evidence of phytotoxicity was observed in any treatment in both years.

Table 42. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*), on Gerbera Daisy (*Gerbera jamesonii*), Buck, GA, 2003.

Treatment	Rate Per 100 Gal	Percent Powdery Mildew ^x					
		Apr 18	Apr 25	May 2	May 9	May 16	May 23
Biophos 4.7L (dipotassium phosphonate+dipotassium phosphate)	2560 fl oz	10.0 ab	14.1 b	13.5 b	14.7 c	8.9 c	7.2 c
	1280 fl oz	6.9 bc	10.3 b	11.0 bc	8.8 d	5.8 cd	7.4 c
Heritage 50WG (azoxystrobin)	2 oz	6.8 bc	6.3 c	6.0 cd	3.8 de	1.5 e	1.7 d
Pipron 8LC (piperalin)	8 fl oz	5.2 c	5.3 c	2.4 d	3.0 e	1.3 e	1.2 d
Nontreated	-	12.3 a	18.5 a	29.4 a	40.3 a	55.2 a	72.6 a

* Not an IR-4 Experiment: F&N Tests Vol 59:OT033. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05).

Fungicides applied on Apr 11, Apr 25 and May 9.

Table 43. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*), on Gerbera Daisy (*Gerbera jamesonii*), Buck, GA, 2004.

Treatment	Rate Per 100 Gal	Spray Interval (day)	AUDPC ^x
Banner MAXX 1.3 ME (propiconazole)	3.5 fl oz	14	32.8 b
	7.0 fl oz	14	29.2 cd
	10.5 fl oz	14	29.4 cd
CGA-64250 32.4WG (propiconazole)	2.3 oz	14	32.6 b
	4.7 oz	14	26.9 d
	9.3 oz	14	28.2 cd
Heritage 50WG (azoxystrobin)	7.5 oz	7	30.4 bc
Heritage TL (azoxystrobin)	7.5 fl oz	7	28.9 cd
Nontreated	-	-	51.7 a

* Not an IR-4 Experiment: Plant Disease Management Reports 3:OT020.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05). The progression of powdery mildew resulting from natural infection on each plant was estimated weekly using the Horsfall-Barratt scale (1 = no disease, 2 = 0- 3%, 3 = 3-6%, 4 = 6-12%, 5 = 12-25%, 6 = 25-50%, 7 = 50-75%, 8 = 57-87%, 9 = 87-94%, 10 = 94-97%, 11 = 97-100%, 12 = 100% of leaves with lesions) and the ratings were converted to percent midpoint values for analysis.

Treatments applied starting May 18 and were reapplied at 7 or 14-day intervals.

In 2004, Hausbeck conducted four greenhouse experiments to determine efficacy of several fungicides for the control of powdery mildew on gerbera daisy (*Gerbera jamesonii*). In the first experiment, all treatments significantly decreased a severe powdery mildew foliar infection, with Endura providing 100% control (Table 44). Compass, Eagle, Heritage, Milstop, and Pristine had low levels of infection, while Rhapsody, Insignia, ZeroTol, and PlantShield had high levels. In the second experiment, all

treatments significantly decreased a severe powdery mildew foliar infection, with Compass providing 100% control (Table 45). In the third experiment, four cultivars were used, and as there were no significant differences among cultivars, data was pooled across cultivars (Table 46). All treatments significantly decreased a severe powdery mildew foliar infection, with Heritage having the least foliar infection. In the fourth experiment, 3 cultivars were used, and as there were no significant differences among cultivars, data was pooled across cultivars (Table 47). All treatments significantly decreased a severe powdery mildew foliar infection, with Heritage at 0.5 oz providing less efficacy than other treatments. No phytotoxicity was observed in any treatment in all experiments.

Table 44. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Gerbera Daisy (*Gerbera jamesonii*) ‘Jaguar Mix’, Hausbeck, MI, 2004, Experiment 1.

Treatment	Rate Per 100 Gal	Final foliar infection (%) ^x	Final flower infection (%)	AUDPC ^z		
				Foliar infection	Foliar severity ^y	Flower infection
Compass O 50WDG (trifloxystrobin)	4 oz	0.0 b	0.0 a	7.0 b	9.6 b	0.0 a
Eagle 20EW (myclobutanil)	12 fl oz	0.0 b	0.0 a	6.7 b	9.6 b	0.0 a
Endura 70WG (boscalid)	11 oz	0.0 b	0.0 a	0.0 b	0.0 b	0.0 a
Heritage 50WG (azoxystrobin)	4 oz	0.0 b	0.0 a	25.5 b	28.9 b	0.0 a
Insignia 20WG (pyraclostrobin)	3 oz	9.6 b	0.0 a	172.9 b	123.8 b	0.0 a
Milstop (Potassium bicarbonate)	8 oz	0.0 b	0.0 a	11.3 b	9.6 b	0.0 a
PlantShield (<i>Trichoderma harzanium</i> T22)	50 oz	15.5 b	0.0 a	356.7 b	96.2 b	0.0 a
Pristine WG (pyraclostrobin+ boscalid)	23 oz	0.0 b	0.0 a	26.3 b	28.9 b	0.0 a
Rhapsody 1.34% AS (<i>Bacillus subtilis</i>)	128 fl oz	20.4 b	0.0 a	246.8 b	136.1 b	175.0 a
ZeroTol (hydrogen dioxide)	50 fl oz	13.6 b	0.0 a	307.2 b	114.2 b	0.0 a
Nontreated	-	69.7 a	37.5 a	1573.6 a	1564.5 a	262.5 a

* Not an IR-4 Experiment: F&N Tests Vol 60:OT001. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls test, P=0.05).

^y Based on a visual estimation of percentage of foliage infected and rated on a scale of 1 to 10, where 1=no disease, 2=trace to 10% infection, 3=10 to 20%, 4=20 to 30%, 5=30 to 40%, 6=40 to 50%, 7=50 to 60%, 8=60 to 70%, 9=70 to 80%, and 10=80 to 100% infected. Midpoint of each disease range (percentage) used in statistical analysis.

^z Foliar disease severity and flower and foliar infection ratings were assessed weekly from Jul 14, to Sep 16 and used to calculate area under the disease progress curve (AUDPC) values.

Treatments applied from Jul 1 to Sep 30 at 7-day intervals.

Table 45. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Gerbera Daisy (*Gerbera jamesonii*) ‘Dark Eye Cherry’, Hausbeck, MI, 2004, Experiment 2.

Treatment	Rate Per 100 Gal	Final foliar infection (%) ^x	Final flower infection (%)	AUDPC ^y		
				Foliar infection	Foliar severity	Flower infection
Compass O 50WDG (trifloxystrobin)	4 oz	0.0 b	0.0 a	0.0 c	0.0e	0.0 a
Eagle 20EW (myclobutanil)	4 fl oz	25.0 b	0.0 a	87.5 c	0.0 e	0.0 a
EXP 710-145f 0.14% w/v (<i>Bacillus licheniformis</i>)	50 fl oz	100.0 a	0.0 a	5295.6 b	4571.9 b	0.0 a
	75 fl oz	100.0 a	0.0 a	5221.3 b	4235.0 c	0.0 a
	100 fl oz	100.0 a	0.0 a	5062.1 b	3959.4 d	0.0 a
Heritage 50WG (azoxystrobin)	4 oz	0.0 b	0.0 a	29.7 c	62.6 e	0.0 a
Nontreated	-	100.0 a	12.5 a	5654.8 a	5401.4 a	43.7 a

* Not an IR-4 Experiment: F&N Tests Vol 60:OT002. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls test, P=0.05).

^y Foliar disease severity and flower and foliar infection ratings were assessed weekly from Mar 25, to July 6 and used to calculate area under the disease progress curve (AUDPC) values. Treatments applied from Mar 19 to July 2 at 7-day intervals.

Table 46. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Gerbera Daisy (*Gerbera jamesonii*) ‘Dark Eye Cherry’, ‘Light Eye Pink,’ ‘Semi Double Orange,’ ‘Dark Eye Golden Yellow’, Hausbeck, MI, 2004, Experiment 3.

Treatment	Rate Per 100 Gal	Final foliar infection (%) ^x	Final flower infection (%)	AUDPC ^z		
				Foliar infection	Foliar severity ^y	Flower infection
Banner MAXX 1.3EC (propiconazole)	1 fl oz	21.9 b	0.0 b	962.9 a	524.6 a	0.0 a
	2 fl oz	22.4 b	0.0 b	735.8 a	519.9 a	72.9 a
	4 fl oz	24.9 b	0.0 b	592.6 a	477.2 a	0.0 a
Heritage 50WG (azoxystrobin)	2 oz	14.9 b	0.0 b	432.7 a	294.3 a	0.0 a
Nontreated	-	97.2 a	29.2 a	3435.7 b	2889.8 c	539.6 a

* Not an IR-4 Experiment: F&N Tests Vol 60:OT003. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls test, P=0.05).

^y Based on a visual estimation of percentage of foliage infected and rated on a scale of 1 to 10, where 1=no disease, 2=trace to 10% infection, 3=10 to 20%, 4=20 to 30%, 5=30 to 40%, 6=40 to 50%, 7=50 to 60%, 8=60 to 70%, 9=70 to 80%, and 10=80 to 100% infected. Midpoint of each disease range (percentage) used in statistical analysis.

^z Foliar disease severity and flower and foliar infection ratings were assessed weekly from May 17, to Sep 6 and used to calculate area under the disease progress curve (AUDPC) values. Treatments applied from Jun 1 to Aug 25 at 3-week intervals.

Table 47. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Gerbera Daisy (*Gerbera jamesonii*) ‘Dark Eye Cherry’, ‘Light Eye Orange,’ ‘Semi Double Yellow’, Hausbeck, MI, 2004, Experiment 4.

Treatment	Rate Per 100 Gal	Final foliar infection (%) ^x	Final flower infection (%)	AUDPC ^z		
				Foliar infection	Foliar severity ^y	Flower infection
Compass 50WG (trifloxystrobin)	1 oz	1.2 c	0.0 a	47.0 a	69.6 a	0.0 a
Heritage 50WG (azoxystrobin)	0.5 oz	32.0 b	0.0 a	779.1 b	551.2 b	0.0 a
	1.0 oz	9.5 c	0.0 a	299.8 a	185.9 a	0.0 a
	2.0oz	8.6 c	0.0 a	334.8 a	231.4 a	0.0 a
Nontreated	-	100 a	0.0 a	4855.2 c	4049.5 c	0.0 a

* Not an IR-4 Experiment: F&N Tests Vol 60:OT004. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls test, P=0.05).

^y Based on a visual estimation of percentage of foliage infected and rated on a scale of 1 to 10, where 1=no disease, 2=trace to 10% infection, 3=10 to 20%, 4=20 to 30%, 5=30 to 40%, 6=40 to 50%, 7=50 to 60%, 8=60 to 70%, 9=70 to 80%, and 10=80 to 100% infected. Midpoint of each disease range (percentage) used in statistical analysis.

^z Foliar disease severity and flower and foliar infection ratings were assessed weekly from May 17, to Sep 6 and used to calculate area under the disease progress curve (AUDPC) values.

Treatments applied from May 25 to Sep 1 at 2-week intervals.

In 2005, Hausbeck conducted two greenhouse experiments to determine efficacy of several fungicides applied as preventive or curative foliar sprays for the control of powdery mildew on gerbera daisy (*Gerbera jamesonii*). In the first experiment, Eagle and Terraguard applied as curative treatments reduced infection similar to that of the preventive applications by the end of the an experiment (Table 48). Cygnus was ineffective applied as either preventive or curative treatment. In the second experiment, Eagle and BAS 510 applied as preventive or curative significantly decreased a severe powdery mildew foliar infection (Table 49). No phytotoxicity was observed in any treatment in both experiments.

Table 48. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Gerbera Daisy (*Gerbera jamesonii*) ‘Festival Orange’, Hausbeck, MI, 2005, Experiment 1.

Treatment	Rate Per 100 Gal	Application Timing ^y	Disease Severity Rating ^x			
			May 26	Jun 3	Jun 13	Jun 20
Cygnus 50WG (kresoxym-methyl)	3.2 oz	preventive	1.8 a	2.8 a	6.0 bc	7.5 cd
	3.2 oz	curative	2.0 a	3.0 a	8.2 c	9.2 d
Eagle 20EW (myclobutanil)	8 fl oz	preventive	2.0 a	1.2 a	1.2 a	1.3 a
	8 fl oz	curative	2.0 a	2.7 a	1.3 a	1.5 a
Terraguard 50W (triflumizole)	8.0 oz	preventive	1.7 a	1.7 a	1.0 a	0.8 a
	8.0 oz	curative	2.3 a	1.2 a	1.2 a	1.3 a
Nontreated control	-	-	2.8 a	3.7 a	7.7 bc	8.7 cd

* Not an IR-4 Experiment: F&N Tests Vol 61:OT010.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls test, P=0.05). Disease severity rating scale of 0-10; 0=no infection, 1=1-10% foliage infected, 2=11-20%, 3=21-30%, 4=31-40%, 5=41-50%, 6=51-60%, 7=61-70%, 8=71-80%, 9=81-90%, 10=91-100% foliage infected.

^y Preventive treatments applied May 24 prior to disease development and then every 7 days until Jun 14. Plants previously infected were selected for the curative treatments.

Table 49. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Gerbera Daisy (*Gerbera jamesonii*) ‘Festival Orange’, Hausbeck, MI, 2005, Experiment 2.

Treatment	Rate Per 100 Gal	Application Timing ^y	Disease Severity Rating ^x		
			Jun 3	Jun 13	Jun 20
BAS 510 70WG / Endura (boscalid)	11 oz	7-day	1.0 a	1.5 a	1.7 a
	11 oz	14-day	1.8 a	2.8 a	1.8 a
	11 oz	21-day	1.5 a	2.2 a	2.0 a
	11 oz	curative	2.3 a	3.0 a	2.7 a
Eagle 20EW (myclobutanil)	8 fl oz	7-day	1.0 a	1.3 a	1.5 a
	8 fl oz	14-day	0.8 a	1.3 a	1.2 a
	8 fl oz	21-day	2.0 a	2.2 a	2.0 a
	8 fl oz	curative	1.3 a	1.5 a	1.7 a
Nontreated	-	-	8.0 b	9.0 b	9.8 b

* Not an IR-4 Experiment: F&N Tests Vol 61:OT011.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls test, P=0.05). Disease severity rating scale of 0-10; 0=no infection, 1=1-10% foliage infected, 2=11-20%, 3=21-30%, 4=31-40%, 5=41-50%, 6=51-60%, 7=61-70%, 8=71-80%, 9=81-90%, 10=91-100% foliage infected.

^y Preventive treatments applied May 24 prior to disease development and then every 7, 14, or 21 days until Jun 14. Plants previously infected were selected for the curative treatments.

In 2010, Buck conducted a greenhouse experiment to determine efficacy of three ready-to-use (RTU) EcoSmart formulations for the control of powdery mildew on gerbera daisy (*Gerbera jamesonii*). All fungicide treatments significantly reduced powdery mildew development (Table 50). No significant differences were observed between the three Ecosmart formulations and Strike fungicide. No phytotoxicity was observed in any treatment.

Table 50. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Gerbera Daisy (*Gerbera jamesonii*), Buck, GA, 2010.

Treatment	Rate	Percent Powdery Mildew ^x	
		Aug 18	Aug 27
EcoSmart 203-1 2% RTU (rosemary oil + thyme oil)	RTU	0.6 b	0.0 b
EcoSmart 203-2 2% RTU (rosemary oil + thyme oil)	RTU	1.8 b	0.0 b
EcoSmart E203-3 2% RTU. (rosemary oil + thyme oil)	RTU	0.0 b	1.2 b
Strike 50 WDG (triadimefon)	4 oz per 100 gal	3.0 b	1.2 b
Nontreated	-	22.3 a	30.9 a

* Not an IR-4 Experiment: Plant Disease Management Reports 8:OT001.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05). Powdery mildew on each plant was estimated one day and 10 days after the final fungicide application using the Horsfall-Barratt scale (1 = no disease, 2 = 0-3%, 3 = 3-6%, 4 = 6-12%, 5 = 12-25%, 6 = 25-50%, 7 = 50-75%, 8 = 75-87%, 9 = 87-94%, 10 = 94-97%, 11 = 97-100%, 12 = 100% of leaves with lesions) and the ratings were converted to percent midpoint values.

Treatments applied 3 times on a 14-day interval from Jul to Aug.

During 2000 and 2001, LaMondia conducted experiments to determine efficacy of several fungicides for the control of powdery mildew (*Golovinomyces cichoracearum*) on container-grown phlox (*Phlox paniculata*) 'Miss Universe'. In 2000, Domain and Heritage at 4 and 8 oz provided the best control of severe disease pressure (Table 51). In 2001, Heritage, Domain, and Kumulus provided the best control of severe disease pressure (Table 52). However, defoliation was high for plants treated with Domain. Leaf loss was least with Heritage, Zyban and Kumulus. No phytotoxicity was observed in any treatment in both years.

Table 51. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Phlox (*Phlox paniculata*) 'Miss Universe', LaMondia, CT, 2000.

Treatment	Rate Per 100 Gal	No. Colonies Per Plant ^x		Percent Healthy Leaves			
		Jun 2	Jun 23	Jun 29	Jul 14	Aug 4	Sep 14
Domain FL	18.5 fl oz	10.3	1.7 c	82.9 c	76.7 c	91.7 c	35.8 b
Heritage 50WG (azoxystrobin)	1.0 oz	8.2	197.8 b	61.2 bc	18.3 b	14.2 ab	0.5 a
	2.0 oz	3.0	255.4 b	53.3 b	21.3 b	10.0 ab	0.2 a
	4.0 oz	37.5	266.0 b	51.3 b	23.8 bc	17.5 bc	1.0 a
	8.0 oz	33.3	159.3 b	65.0 bc	33.8 bc	17.5 bc	5.8 b
Phyton 27 (Copper sulfate pentahydrate)	16.0 fl oz	46.2	367.8 a	16.7 a	13.3 a	10.8 ab	0.3 a
	32.0 fl oz	4.5	112.8 b	32.5 a	16.7 a	14.2 ab	0.2 a
Nontreated		33.6	1199.5 a	22.5 a	7.5 a	3.3 a	0.7 a

* Not an IR-4 Experiment: F&N Tests Vol 56: OT4.

^x Means within column followed by the same letter are not significantly different (Kruskal-Wallis Multiple Comparison Z-Value Test, P=0.05).

Treatments applied on May 26, Jun 2, Jun 16, Jun 30, Jul 14, and Jul 28.

Table 52. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Phlox (*Phlox paniculata*) 'Miss Universe', LaMondia, CT, 2001.

Treatment	Rate Per 100 Gal	Percent Leaf Surface Mildewed ^x			Percent Defoliation			Shoot Wt. (oz)
		Jul 13	Jul 20	Aug 2	Jul 13	Jul 20	Aug 2	Aug 22
Daconil 82.5WDG (chlorothalonil)	22 oz	20.0 bc	15.0 b	19.2 b	11.7 b	30.0 c	36.7 c	3.7 b
Domain 46.2FL	20 fl oz	20.8 b	3.8 c	5.2 d	15.0 b	40.0 b	42.5 b	3.7 b
Heritage 50WDG (azoxystrobin)	8 oz	4.0 d	4.8 c	5.5 d	6.2 b	11.7 d	23.3 d	3.9 b
Kumulus 80DF (sulfur)	543 oz	15.0 bc	8.0 c	9.2 cd	10.8 b	25.0 c	30.0 cd	4.1 b
Zyban 79.6WP (thiophanate methyl + mancozeb)	24 oz	12.5 c	7.8 c	10.8 c	7.5 b	13.3 d	22.5 d	4.1 b
Nontreated	-	32.5 a	43.3 a	51.7 a	25.0 a	56.7 a	64.2 a	2.4 a

* Not an IR-4 Experiment: F&N Tests Vol 57: OT21.

^x Means within column followed by the same letter are not significantly different (Kruskal-Wallis Multiple Comparison Z-Value Test, P=0.05).

Treatments applied on Jun 27, Jul 11, Jul 25, Aug 2, and Aug 9.

In 2001, Robbins conducted an experiment to determine efficacy of several fungicides for the control of powdery mildew on container-grown phlox. All treatments except Junction significantly reduced powdery mildew (Table 53). Eagle, Banner, Daconil, and Fungo reduced powdery mildew to 0 - 6% during the an experiment. Armicarb, Heritage, Camelot, and Plant Shield reduced powdery mildew, but this level of control would not be considered acceptable to many phlox growers. No phytotoxicity was observed in any treatment.

Table 53. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Phlox (*Phlox paniculata*) 'Miss Peppers', J. Robbins, AR, 2001.

Treatment	Rate Per 100 Gal	Percent Leaf Area Affected ^x		
		Sep 27	Oct 11	Oct 25
Armicarb 85WP (potassium bicarbonate)	2.5 lb	1 c	4 bc	13 cde
	5 lb	7 b	12 bc	18 cde
Banner MAXX 1.3EC (propiconazole)	6 fl oz	0 c	0 c	1 e
Camelot 58% FL (copper octanoate)	48 fl oz	4 bc	11 bc	28 c
Daconil Ultrex 82.5WDG (chlorothalonil)	10 oz	0 c	1 c	1 e
Eagle 20EW (myclobutanil)	4.5 fl oz	0 c	0 c	0 e
Eagle 40WSP	6 oz	0 c	0 c	0 e
Fungo 50WSB (thiophanate methyl)	8 oz	0 c	1 c	4 e
Heritage 50WDG (azoxystrobin)	2 oz	2 c	10 bc	19 cde
Junction 60DF (copper hydroxide+mancozeb)	1.5 lb	13 a	32 a	58 a
PlantShield 1.15% (<i>Trichoderma harzianum</i> Rifai strain T-22*)	4 oz	2 c	10 bc	25 cd
Terraguard 50WP (triflumizole)	5 oz	0 c	2 c	6 e
Nontreated	-	15 a	33 a	45 b

* Not an IR-4 Experiment: F&N Tests Vol 59:OT031. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls test, P=0.05).

Treatments applied from Sep 13 to Oct 18 at 7-day intervals, except Fungo and Heritage (14 days) and Banner MAXX (21).

In 2003, Jacobi conducted a field experiment to determine efficacy of several fungicides for the control of powdery mildew on zinnia (*Zinnia elegans*) 'Dreamland Yellow'. All treatments provided significant control of a severe powdery mildew pressure, with Heritage and Ferti-lome significantly better than either Daconil or Schulz Fungicide 3 (Table 54). No phytotoxicity was observed in any treatment.

Table 54. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Zinnia (*Zinnia elegans*) 'Dreamland Yellow', Jacobi, AL, 2003.

Treatment	Rate Per 100 Gal	Percent Powdery Mildew ^x	
		Sep 18	Oct 3
Ferti-lome 1.55% EC (propiconazole)	50 fl oz	36.7 d	53.0 cd
Heritage 50WG (azoxystrobin)	1 oz	48.3 cd	50.8 d
Ortho Daconil 29.5% SC (chlorothalonil)	37 fl oz	67.5 b	75.0 b
Shultz Fungicide 3 70% EC (neem oil)	100 fl oz	58.3 bc	66.7 bc
Nontreated	-	92.5 a	98.3 a

* Not an IR-4 Experiment: F&N Tests Vol 59:OT045.

^x Means within column followed by the same letter are not significantly different (LSD Test, P=0.05).

Treatments applied on a 7-day interval from Jul 11 to Sep 25.

In 2004, Hagan conducted a field experiment to determine efficacy of several fungicides for the control of powdery mildew on zinnia (*Zinnia elegans*) 'Dreamland Mix'. All treatments, except Heritage provided excellent control of a moderate powdery mildew pressure (Table 55). Little if any colonization of the leaves by the powdery mildew fungus was noted on the Kocide 101, Immunox, Daconil Weather Stik, SunSpray Ultra Fine Oil, and Bayer Disease Control treatments. No phytotoxicity was observed in any treatment, except a severe marginal leaf burn was noted on the Kocide 101.

Table 55. *Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Zinnia (*Zinnia elegans*) 'Dreamland Mix', Hagan, AL, 2004.

Treatment	Rate Per 100 Gal	Disease Incidence ^x
Bayer Disease Control (tebuconazole)	0.4 gal	1.0 c
Daconil Weather Stik 6F (chlorothalonil)	1.3 pt	1.8 c
Heritage 50W (azoxystrobin)	4 oz	4.7 ab
Immunox (myclobutanil)	100 fl oz	1.0 c
Kocide 101 (copper hydroxide)	1.5 lb	1.3 c
SunSpray Ultra Fine Oil (paraffinic oil)	0.8 gal	1.8 c
Nontreated	-	6.0 a

* Not an IR-4 Experiment: F&N Tests Vol 60:OT023. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05). Disease incidence was rated on Sep 20 where 1 = no disease, 2 = 0 to 3%, 3 = 3 to 6%, 4 = 6 to 12%, 5 = 12 to 25%, 6 = 25 to 50%, 7 = 50 to 75%, 8 = 75 to 87%, 9 = 87 to 94%, 10 = 94 to 97%, 11 = 97 to 100%, and 12 = 100% of the leaves colonized or damaged.

Treatments applied at 2-wk intervals from May 14 to Sep 10.

In 2016, Freiberger conducted a greenhouse experiment to determine efficacy of several fungicides for the control of powdery mildew on zinnia (*Zinnia* spp.). Of the two cultivars included in this experiment, *Zinnia angustifolia* 'Star Gold' did not exhibit any powdery mildew disease while *Zinnia elegans* 'Magellan Yellow' did show signs of powdery mildew starting on Sep 13, approximately 1 month after the last application date (Table 56). On this date, all treatments had significantly less disease than the water sprayed control plants. NF-149, Orkestra, Heritage and Mural continued to demonstrate lower disease until the last rating on Sep28. Disease ratings for F9110 and IKF-309 started to increase on Sep 21; however, this was 6 weeks after the last application.

During 2017, Freiberger conducted a hoophouse experiment utilizing two cultivars: 'Profusion Cherry' and 'Lime Green'. At the start of the experiment in late July, low levels of powdery mildew were present on 'Lime Green' (Table 57). However, 'Profusion Cherry' was not affected throughout the experiment (data not shown). By the end of the experiment (two weeks after the last application date), all rates of IKF-309, Mural, and NF-149 had the lowest disease incidence. Regime and Stargus suppressed disease development.

In 2020, Bodine conducted an outdoor field container experiment examining 7 different actives for efficacy against zinnia powdery mildew. No powdery mildew was observed at the first application date of 8/7. Foliar applications varied from every 3 to 4 days to one a month depending on active ingredient, as specified by the prospective registrants. The last applications were made 9/24. Disease severity was collected on 8/10/2020 and then every week through 10/27/2020. The most efficacious material through the end of the experiment was Gatten, but control was beginning to break at 5 weeks after last application (Table 58). XDE-659 reduces disease incident through week 9, but by week 10 – 5 weeks after last application – control started to decline. Injury was observed with SP2700 and TXC2020.

In 2021, Hausbeck implemented the IR-4 2020 protocol screening 8 products for efficacy against powdery mildew on greenhouse-grown zinnias. Initial applications occurred prior to inoculation. Pressure was heavy with the average number of powdery mildew colonies at 45.4 in the nontreated 3 weeks after first application (1 week after last application) and then increasing to 74.8 at 5 weeks (3 weeks after last application). Broadform, Eagle, SP2478, SP2700 (high rate), and XDE-659 provided excellent prevention of disease development throughout the experiment (Table 59). The high rate of MBI-121 and the low rate SP2700, provided excellent efficacy through 4 weeks after first applications and then efficacy started to

decline by the end of the experiment. EcoSwing and the low rate of MBI-121 suppressed disease development.

In 2021, Bodine screened 10 actives for activity on zinnia powdery mildew. Foliar applications began after symptoms were observed. All treatments reduced powdery mildew severity in comparison to the water sprayed control, starting the second week after application. Over time the best reduction of powdery mildew occurs with Avelyo, Gatten, SP2478, and XDE-659 (Table 60). SP2700 WP also greatly reduced powdery mildew severity throughout most of the rating dates. No injury was observed (data not shown).

During 2022, Hausbeck implemented the 2021 protocol examining 11 fungicides and bio fungicides for prevention of powdery mildew on zinnia. For number of foliar colonies, foliar incidence and floral incidence, Avelyo, Eagle, Gatten, and XDE-659 provided excellent efficacy through 2 weeks after last application. SP2478 and Tril-21 provided excellent efficacy up to 1 week after last application, but they were effective 2 weeks after last application. EcoSwing, MBI-121, NSTKI, SP2700 WP, and TDA-NC-1 initially exhibited good prevention of powdery mildew on flowers, but only limited suppression of disease development occurred on foliage.

Table 56. Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Zinnia (*Zinnia* spp.), Freiberger, NJ, 2016.

Cultivar	Treatment	Rate Per 100 Gal	Disease Rating (0-10 scale) ^x				AUDPC
			Sep 6	Sep 13	Sep 21	Sep 28	
<i>Zinnia angustifolia</i> 'Star Gold'	Regime (<i>Banda de Lupinus albus doce</i>)	20 fl oz	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
		46 fl oz	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
	Heritage (azoxystrobin)	4 oz	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
	IKF-309 (pyriofenone)	3.84 fl oz	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
		5.76 fl oz	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
		11.52 fl oz	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
	Mural (azoxystrobin + benzovindiflupyr)	4.25 oz	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
	NF-149 (cyflufenamid)	3.4 fl oz	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
	Orkestra (fluxapyroxad + pyraclostrobin)	6 fl oz	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Nontreated	-	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	
<i>Zinnia elegans</i> 'Magellan Yellow'	Regime (<i>Banda de Lupinus albus doce</i>)	20 fl oz	0.0 a	1.2 a	3.8 cd	4.3 de	9.2 de
		46 fl oz	0.0 a	1.0 a	3.1 bcd	3.8 cde	7.8 cde
	Heritage (azoxystrobin)	4 oz	0.0 a	0.0 a	1.2 ab	1.9 a-d	3.1 abc
	IKF-309 (pyriofenone)	3.84 fl oz	0.0 a	0.9 a	2.9 bcd	3.8 cde	7.7 cde
		5.76 fl oz	0.0 a	0.8 a	2.3 abc	3.1 b-e	6.1 bcd
		11.52 fl oz	0.0 a	0.5 a	1.8abc	2.5 a-e	4.8 a-d
	Mural (azoxystrobin + benzovindiflupyr)	4.25 oz	0.0 a	0.2 a	0.9 ab	2.2 a-e	3.1 abc
	NF-149 (cyflufenamid)	3.4 fl oz	0.0 a	0.1 a	0.4 a	1.0 ab	1.5 ab
	Orkestra (fluxapyroxad + pyraclostrobin)	6 fl oz	0.0 a	0.2 a	1.1 ab	1.5 abc	2.8 abc
Nontreated	-	0.0 a	3.1 b	4.8 d	4.8 e	12.6 e	

^x Means within column followed by the same letter are not significantly different (Scheffe's post hoc, P=0.05). Treatments applied from Jul 20 to Aug 17. F9110 and IKF-309 were applied at 7-day intervals, all other treatments applied at 14-day intervals.

Table 57. Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on *Zinnia* (*Zinnia* spp.), Freiberger, NJ, 2017.

Product	Rate (per 100 gal)	Disease Rating in <i>Zinnia</i> Lime Green						
		7/24/2017	7/31/2017	8/8/2017	8/15/2017	8/22/2017	8/29/2017	9/5/2017
F9110-9	20 fl oz	2.1±0.2 b	2.4±0.3 b	1.5±0.2 ab	1.5±0.2 ab	1.9±0.2 abc	1.8±0.2 abc	3.1±0.3 bcd
	46 fl oz	0.9±0.2 ab	0.4±0.2 ab	0±0.2 a	0.2±0.2 a	0.9±0.2 ab	1.2±0.2 ab	3.1±0.3 bcd
IKF-309	3.84 fl oz	0.1±0.2 a	0.2±0.2 a	0±0.2 a	0±0.2 a	0.2±0.2 a	0.3±0.2 a	0.9±0.3 ab
	5.76 fl oz	1±0.2 ab	0.8±0.2 ab	0.2±0.2 ab	0.1±0.2 a	0±0.2 a	0.1±0.2 a	1±0.3 ab
	11.52 fl oz	0.9±0.2 ab	0.6±0.2 ab	0.5±0.2 ab	0.2±0.2 a	0±0.2 a	0.1±0.2 a	0.5±0.3 a
Mural	6 fl oz	0.4±0.2 ab	0.3±0.2 a	0.1±0.2 ab	0±0.2 a	0.2±0.2 a	0.1±0.2 a	0.1±0.3 a
NF-149	3.4 fl oz	0.4±0.2 ab	0.4±0.2 ab	0.5±0.2 ab	0.2±0.2 a	1.1±0.2 abc	0.9±0.2 ab	1.9±0.3 abc
Regime	20 fl oz	0.3±0.2 ab	0.5±0.2 ab	0.5±0.2 ab	1.3±0.2 ab	2.9±0.2 cd	3.6±0.2 cd	6±0.3 ef
	46 fl oz	1.5±0.2 ab	1.6±0.3 ab	1.8±0.2 b	2.3±0.2 b	2.6±0.2 bcd	3.9±0.2 de	3.9±0.3 cde
Stargus	64 fl oz	0.6±0.2 ab	1±0.3 ab	1.8±0.2 b	2.6±0.2 b	4.3±0.2 d	5.9±0.2 ef	7.7±0.3 f
	128 fl oz	0.5±0.2 ab	0.7±0.3 ab	1.1±0.2 ab	1.4±0.2 ab	2.4±0.2 bcd	2.7±0.2 bcd	4.7±0.3 de
Water	-	0.8±0.2 ab	1.7±0.2 ab	3.8±0.2 c	4.6±0.2 c	6.5±0.2 c	7.9±0.2 f	8.3±0.3 f

^x Means within column followed by the same letter are not significantly different (Scheffe's post hoc, P=0.05).

Disease rating was on a scale of 0 to 10 with 0 being no observation of powdery mildew and 10 being at least 95% of a plant's foliage was covered.

Table 58. Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on *Zinnia* (*Zinnia* spp.), Bodine, NJ, 2020.

Product (rate per 100 gal)	Disease Rating (0 to 10 scale)									
	Week 8		Week 9		Week 10		Week 11		Week 12	
EcoSwing 32 oz	0.6	AB	1.1	CD	2.3	BCD	4.2	BCDE	7.1	E
Gatten 12.8 fl oz	0.0	A	0.0	A	0.1	A	1.2	A	2.6	AB
Gatten 25.4 oz	0.0	A	0.0	A	0.0	A	0.9	A	1.5	A
MBI-121 128 fl oz	0.3	AB	0.6	ABCD	1.3	AB	3.3	BCD	4.9	CDE
MBI-121 96 fl oz	0.4	AB	0.7	ABCD	1.9	BC	3.2	BCD	4.3	BCD
Nontreated Water Spray	0.8	BC	1.3	DE	2.0	BC	3.9	BCDE	6.0	CDE
SP2700	0.1	A	0.1	AB	1.3	AB	3.0	BC	4.6	BCD
SP2700 22 oz	0.1	A	0.3	ABC	1.3	AB	2.8	B	4.3	BCD
TDA-NC-1 570 g 3 Apps	1.4	C	2.3	E	3.4	D	4.8	E	7.0	E
TDA-NC-1 570 g 6 Apps	0.8	BC	1.3	D	3.0	CD	4.6	DE	6.0	CDE
TXC2020 64 fl oz 3 Apps	0.5	AB	0.9	BCD	1.6	B	3.3	BCD	4.2	BC
TXC2020 64 fl oz 4 Apps	0.6	AB	1.3	D	2.2	BCD	4.0	BCDE	5.6	CDE
XDE-659 20.6 fl oz	0.6	AB	1.0	BCD	2.3	BCD	4.3	CDE	6.5	DE
XDE-659 34.3 fl oz	0.6	AB	1.0	BCD	1.3	AB	3.5	BCDE	4.1	BC

^x Means within column followed by the same letter are not significantly different (Scheffe's post hoc, P=0.05).

Disease rating was on a scale of 0 to 10 with 0 being no observation of powdery mildew and 10 being at least 95% of a plant's foliage was covered.

Table 59. Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Zinnia (*Zinnia* spp.), Hausbeck, MI, 2020.

Treatment and rate/100 gal; application dates	Avg. # of powdery mildew colonies per plant					
	12 Oct		21 Oct		28 Oct	
Untreated control	45.4	c*	63.4	c	74.8	bc
MBI-121 96 fl oz; 17, 27 Sep & 4 Oct	4.6	a	8.0	a	23.4	a
MBI-121 128 fl oz; 17, 27 Sep & 4 Oct	0.8	a	2.0	a	4.8	a
SP2700 11 oz; 17, 24 Sep & 30 Sep	0.0	a	0.2	a	6.4	a
SP2700 22 oz; 17, 24 Sep & 30 Sep	0.0	a	0.0	a	0.0	a
TDA-NC-1 570 g + NIS 0.125%; 17, 20, 24, 27, and 30 Sep	27.8	bc	61.2	bc	91.8	c
TDA-NC-1 570 g + NIS 0.125%; 17, 24, and 30 Sep	39.6	c	65.6	c	83.0	bc
SP2478 1.6 fl oz; 20, 27 Sep and 4 Oct	0.0	a	0.0	a	0.0	a
SP2478 3.1 fl oz; 20, 27 Sep and 4 Oct	0.0	a	0.0	a	0.2	a
Gatten 6.4 fl oz; 20, 27 Sep and 4 Oct	0.2	a	0.4	a	0.2	a
Gatten 25.4 fl oz; 20, 27 Sep and 4 Oct	0.0	a	0.0	a	0.0	a
EcoSwing 32 fl oz; 17, 27 Sep & 4 Oct	12.6	ab	27.8	ab	43.6	ab
Eagle 20EW; 20 Sep & 4 Oct	0.0	a	0.0	a	0.0	a
XDE-659 20.6 fl oz; 20, 27 Sep and 4 Oct	0.0	a	0.0	a	0.0	a
Broadform SC 4 fl oz; 20 Sep & 4 Oct	0.8	a	0.8	a	0.8	a

Table 60. Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Zinnia (*Zinnia* spp.), Bodine, NJ, 2021.

Treatment	Rate (per 100 gal)	Powdery Mildew Severity Rating (0 – 10 scale)						
		Week 0 8/17	Week 1 8/24	Week 2 8/31	Week 3 9/7	Week 4 9/14	Week 5 9/21	Week 6 9/28
Avelyo	6 fl oz	3.6 a	3.4 ab	2.1 a	1.8 a	1.1 a	1.4 a	0.4 a
EcoSwing	32 fl oz	4.1 a	5.3 cd	5.2 e	6.1 e	6.2 f	7.5 hi	5.4 cd
Gatten	6.4 fl oz	3.4 a	4.1 abc	2.6 abc	2.1 ab	1.9 a	2.1 abc	0.8 a
MBI 121	64 fl oz	4.2 a	4.5 abc	3.9 cde	3.4 bc	3.6 bc	4.8 def	5.3 cd
	128 fl oz	4.4 ab	3.5 ab	2.6 abc	2.4 ab	2.5 ab	3.5 cde	3.3 b
NSTKI-014	5 lbs	3.9 a	3.6 ab	2.4 ab	2.1 ab	1.7 a	3.3 bcd	4.1 bc
SP2478	3.1 fl oz	4.2 a	4.4 abc	2.6 abc	1.9 a	1.4 a	1.5 a	0.5 a
SP2700 WP	22 oz	4.4 ab	3.2 a	2.1 a	1.7 a	1.6 a	1.9 ab	3.4 b
TDA-NC-1	570 g Applications every 3-4 days	4.4 ab	4.6 abc	3.5 bcd	3.8 cd	4.1 cde	5.1 ef	5.3 cd
	570 g Applications every 7 days	4.6 ab	4.8 abc	4.5 de	5.0 de	5.5 ef	6.7 gh	6.2 de
Tril-21	64 fl oz Applications every 7 days	4.4 a	6.7 de	5.1 e	4.6 cd	5.2 def	5.6 fg	4.9 cd
	64 fl oz Applications every 11 days	3.3 a	4.9 bc	3.9 cde	3.7 cd	3.7 bcd	4.8 def	4.0 bc
XDE-659	34.3 fl oz	4.8 ab	3.6 ab	2.5 ab	3.3 bc	3.8 bcd	3.1 bc	1.8 a
Water		6.1 b	7.9 e	8.1 f	7.8 f	7.8 g	8.3 i	7.0 e

Disease rating was on a scale of 0 to 10 with 0 being no observation of powdery mildew and 10 being at least 95% of a plant's foliage was covered.

Table 61. Efficacy on Powdery Mildew (*Golovinomyces cichoracearum*) on Zinnia (*Zinnia elegans* ‘Magellan Orange’), Hausbeck, MI, 2021.

Treatment and rate/100 gal	Application dates	Avg. # powdery mildew colonies		Foliage powdery mildew incidence (%) [*]				Flower powdery mildew incidence (%)					
		20 Jun		27 Jun		4 Jul		20 Jun		27 Jun		4 Jul	
Avelyo 12.8 fl oz	6, 13, 20 Jun	0.0	a	0.0	a	0.0	a	0.0	a	0.0	a	0.0	a
EcoSwing 32 oz	3, 13, 20 Jun	44.0	de	38.8	d	63.8	c	10.0	bc	30.5	c	42.5	ef
Eagle EW 8 fl oz	6, 20 Jun	0.0	a	0.0	a	0.0	a	0.0	a	0.0	a	0.0	a
Gatten 12.8 fl oz	6, 13, 20 Jun	0.0	a	0.0	a	0.5	a	0.0	a	0.0	a	0.0	a
MBI-121 128 fl oz	3, 13, 20 Jun	26.5	bcd	19.3	bc	52.5	bc	0.0	a	12.0	ab	19.5	abcd
MBI-121 96 fl oz	3, 13, 20 Jun	10.3	ab	12.0	ab	32.5	b	0.0	a	9.3	ab	32.5	def
NSTKI-014 5 lb	6, 13, 20 Jun	14.3	abc	7.0	ab	42.5	bc	2.5	ab	4.4	a	23.0	bcde
SP2478 3.1 fl oz	6, 13, 20 Jun	0.0	a	0.0	a	2.0	a	0.0	a	0.0	a	0.0	a
SP2700 WP 22 oz	3, 13, 16 Jun	0.0	a	6.5	ab	33.0	b	0.0	a	13.3	ab	27.5	cdef
TDA-NC-1 570 g	3, 9, 16 Jun	11.5	ab	9.5	ab	49.3	bc	2.5	ab	23.0	bc	33.8	def
	3, 6, 9, 13, 16, 20 Jun	29.8	cd	32.5	cd	62.0	c	2.5	ab	0.0	a	48.8	f
Tril-21 64 fl oz	3, 6, 9, 20 Jun	0.0	a	0.0	a	7.5	a	0.0	a	0.0	a	3.0	ab
	6, 13, 20 Jun	0.0	a	1.3	a	4.5	a	0.0	a	0.0	a	10.0	abc
XDE-659 20.6 fl oz	6 Jun	0.0	a	0.0	a	0.0	a	0.0	a	0.0	a	0.0	a
Nontreated	--	49.8	e ^{**}	41.3	d	58.8	c	16.3	c	31.3	c	37.5	def

Comparative Efficacy on *Golovinomyces orontii*

As part of a crop safety screening trial for Gatten, Baysal-Gurell observed powdery mildew developing on *Hydrangea macrophylla* ‘Nikko Blue’ in the greenhouse. Disease severity was recorded throughout the experiment. All three rates of Gatten reduced severity as did the standard, Mural (Table 62).

Table 62. Efficacy on Powdery Mildew (*Golovinomyces orontii*) on *Hydrangea* (*Hydrangea macrophylla*), Baysal-Gurell, TN, 2018.

Treatment	Rate	Powdery mildew severity (%)	AUDPC
Gatten (Flutianil)	6.4 fl oz/100 gal	8.5 b*	199.5 b
	12.8 fl oz/100 gal	4.7 bc	129.2 bc
	25.4 fl oz/100 gal	4.7 bc	142.6 bc
Mural 45WG	7 oz/100 gal	1.5 c	40.6 c
Non-treated control	-	50.5 a	955.5 a
<i>P</i> value		<.0001	<.0001

Comparative Efficacy on *Oidium* sp.

From 1999 through 2011, 19 experiments were conducted on *Oidium* sp. on poinsettia (*Euphorbia pulcherrima*), gerbera daisy (*Gerbera jamesonii*), pincushion flower (*Scabiosa columbaria*), verbena (*Verbena x hybrida*) and trailing petunia (*Calibrachoa x hybrida*). The Compass, Bayleton / Strike, Cygnus, Eagle / Systhane, and Terraguard treatments provided the most consistent levels of control across the experiments (Table 63, Table 64). Banner MAXX, Pipron, Regalia, Regalia MAXX, Rubigan, Triact, Trinity, and Zyban also provided good or excellent control in one or two experiments. Heritage and Insignia provided mixed efficacy (poor to excellent) on this pathogen across experiments. Camelot and Milsana performed poorly against this pathogen. See the following paragraphs for summaries of each experiment.

Table 63. General summary of efficacy for *Oidium* sp. on various crops - Part 1.

Product	Poinsettia					Gerbera Daisy					
	Hausbeck 1999*	Hausbeck 1999*	Daughtrey 1999*	Daughtrey 2000*	Hausbeck 2001*	Hausbeck 2001*	Hausbeck 2002*	Hausbeck 2002*	Hausbeck 2002*	Villavicencio 2010*	Villavicencio 2010*
3336		-			+/-						
710-145f											
AQ-10 Biofungicide					-						
Banner MAXX										+	
BAS 500, Insignia			++			++		+/-	+/-		
Bayleton											
Camelot							-	-			
Compass	+	+			+	++	++	+	+	+	
Cygnus	++	++			+						
Decree				++			-				
Eagle, Systhane	++	++			++	++	+	+	+		
FirstStep							-				
Heritage		+		++	-	++		+	+/-		
Milsana					-	+/-	-				
Phyton 27							-				
Pipron	++			++							
Regalia										++	++
Regalia MAXX											++
Rubigan						+					
Serenade					+/-						
Spectro								-			
STBX-013											
Strike						+/-					
Terraguard			++			++	+/-		+		
Triact			++								
Trinity											
ZeroTol											
Zyban											

* Not an IR-4-sponsored experiment.

1 Rating Scale: ++ = clearly statistically equivalent or better than Nontreated non-inoculated and/or clearly statistically different than Nontreated inoculated; + = statistically different from Nontreated inoculated and Nontreated non-inoculated; +/- statistically equivalent to both Nontreated inoculated and Nontreated non-inoculated; - = statistically equivalent to Nontreated inoculated. For experiments without non-inoculated check, efficacy determined on author's conclusions, % control or comparisons to standard product(s).

2 Where more than one rate or application type for a product was included in the experiment and each performed statistically different, the better rating is provided in this table.

Table 64. General summary of efficacy for *Oidium* spp. on various crops - Part 2.

Product	Pincushion Flower	Verbena						Trailing Petunia
	Hausbeck 2002*	Hausbeck 2002*	Hausbeck 2002*	Hausbeck 2003*	Hausbeck 2003*	Hausbeck 2004*	Hausbeck 2004*	Hausbeck 2011*
3336								
710-145f				-			-	
AQ-10 Biofungicide								
Banner MAXX					++			
BAS 500, Insignia	++							
Bayleton		+						
Camelot			-					
Compass	++		++	++	+/-		+/-	
Cygnus								
Decree								
Eagle, Systhane	++	++	++	++	++	++	++	
FirstStep								
Heritage	++				-		-	
Milsana								
Phyton 27								
Pipron								
Regalia								
Regalia MAXX								
Rubigan								
Serenade								
Spectro			-					
STBX-013						-		
Strike	++	+	++					
Terraguard	++		++					++
Triact								
Trinity								+
ZeroTol						-		
Zyban					+			

* Not an IR-4-sponsored experiment.

1 Rating Scale: ++ = clearly statistically equivalent or better than Nontreated non-inoculated and/or clearly statistically different than Nontreated inoculated; + = statistically different from Nontreated inoculated and Nontreated non-inoculated; +/- statistically equivalent to both Nontreated inoculated and Nontreated non-inoculated; - = statistically equivalent to Nontreated inoculated. For experiments without non-inoculated check, efficacy determined on author's conclusions, % control or comparisons to standard product(s).

2 Where more than one rate or application type for a product was included in the experiment and each performed statistically different, the better rating is provided in this table.

In 1999, Hausbeck conducted two greenhouse experiments to determine efficacy of several fungicides for the control of powdery mildew (*Oidium* sp.) on poinsettia (*Euphorbia pulcherrima*) 'Freedom Red'. In

the first experiment, all treatments significantly reduced a moderate disease pressure (Table 65). The most effective treatments limited disease to fewer than three leaves/plant and included the following treatments: Pipron (8 fl oz), Systhane and Cygnus. In the second experiment, all products, except Cleary's 3336 F, significantly reduced disease pressure (Table 66). Systhane completely prevented powdery mildew development even 60 days after the last fungicide application.

Table 65. *Efficacy on Powdery Mildew (*Oidium sp.*) on Poinsettia (*Euphorbia pulcherrima*) 'Freedom Red', Hausbeck, MI, 1999, Experiment 1.

Treatment	Rate Per 100 Gal	Spray Interval (days)	Number of Infected Leaves ^x				Disease Severity ^y
			Nov 5	Nov 10	Nov 17	Nov 22	Nov 22
Compass 50WDG (trifloxystrobin)	0.5 oz	7	1.3 a	4.3 abc	6.3 ab	5.8 ab	1.8 abc
	1.0 oz	14	2.3 ab	3.8 abc	10.5 abc	9.0 abc	1.9 abc
Cygnus 50WG (kresoxim-methyl)	1.6 oz	7	1.0 a	2.0 abc	3.8 a	2.5 a	1.4 ab
Pipron 2EC (piperalin)	4.0 fl oz	7	0.5 a	1.3 abc	3.5 a	5.0 ab	1.4 ab
	8.0 fl oz	7	0.0 a	0.0 a	1.8 a	1.5 a	1.4 ab
Systhane 40WSP (myclobutanil)	4.0 oz	14	0.0 a	0.0 a	0.3 a	0.3 a	1.1 a
Nontreated inoculated	-	-	18.8 c	27.3 d	22.3 d	24.0 d	3.3 d

* Not an IR-4 Experiment: F&N Tests Vol 58:OT014. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P=0.05).

^y Rated on a scale of 1 to 5 where 1=no lesions, 2=trace to 10% of infected leaves covered with fungus, 3=10 to 25% of infected leaves covered with fungus, 4=25 to 50% of infected leaves covered with fungus, 5=>50% of infected leaves covered with fungus

Treatments applied on Oct 14, 21 and 28, and Nov 4, 11 and 18.

Table 66. *Efficacy on Powdery Mildew (*Oidium sp.*) on Poinsettia (*Euphorbia pulcherrima*) 'Freedom Red', Hausbeck, MI, 1999, Experiment 2.

Treatment	Rate Per 100 Gal	Spray Interval (days)	No. Colonies Per Marked Bract ^x	AUDPC ^y	Residue ^z 1/8
Cleary's 3336 4F (thiophanate-methyl) + Latron B-1956	12 fl oz + 2 fl oz	7	23.8 a-e	94.5 ab	2.6
Compass 50WDG (trifloxystrobin)	0.5 oz	14	24.9 a-e	27.8 cd	2.3
	1.0 oz	14	9.9 def	3.7 d	2.4
	2.0 oz	14	6.6 ef	11.3 cd	2.1
Cygnus 50WG (kresoxim-methyl)	1.6 oz	7	13.0 b-f	46.9 bcd	2.1
	3.2 oz	14	1.5 f	1.4 d	2.1
Heritage 50W (azoxystrobin)	2.0 oz	14	13.6 b-f	10.4 cd	3.0
	3.0 oz	21	30.7 abc	59.3 bcd	2.3
Systhane 40WSP (myclobutanil)	2.0 oz	14	0.0 f	0.0 d	1.6
	4.0 oz	14	0.0 f	0.0 d	2.3
Nontreated	-	-	42.4 a	122.2 a	3.9

* Not an IR-4 Experiment: F&N Tests Vol 58:OT015. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P=0.05). Colony count taken on 3/16, 60 days after last spray application.

^y AUDPC) was used as a means of summarizing the number of powdery mildew colonies occurring on the bracts from on Dec 30; Jan 6, 8, 11, 13 and 15.

^z Residue rated on a scale of 1 to 4 where 1=heavy, 2=moderate, 3=light, and 4=no residue. Observations made one day after last fungicide application.

Treatments applied on Oct 29; 6, 13, 26 Nov 6, 13, 26; Dec 4, 10, 18, 23, 31; and Jan 7, 2000.

During 1999 and 2000, Daughtrey conducted two greenhouse experiments to determine efficacy of several fungicides for the control of powdery mildew on poinsettia (*Euphorbia pulcherrima*) ‘Freedom Red’. In 1999, all treatments, except Heritage, significantly reduced a severe disease pressure (Table 67). BAS 500 and Triact provided similar control to that achieved with the industry standard Terraguard. Triact was phytotoxic, causing stunting of leaves and bracts as well as some bract edge necrosis. BAS 500 also caused some necrotic spotting down the midvein of bracts, as well as slight fading of the red bract color. In 2000, all treatments provided effective control of a severe disease pressure (Table 68). No phytotoxicity was observed in any treatment.

Table 67. *Efficacy on Powdery Mildew (*Oidium sp.*) on Poinsettia (*Euphorbia pulcherrima*) ‘Freedom Red’, Daughtrey, NY, 1999.

Treatment	Rate Per 100 Gal	Spray Interval (days)	No. Colonies Per Leaf ^x		
			Nov 2	Nov 16	Nov 30
BAS 500 00 F (pyraclostrobin)	12 fl oz	14	0.0 a	0.0 a	0.0 a
Heritage 50WDG (azoxystrobin)	2.0 oz	14	30.4 bc	1.1 a	8.6 be
	4.0 oz	28	36.6 c	1.2 a	12.0 c
Terraguard 50 WP (triflumizole)	8.0 oz	14	0.6 a	0.0 a	0.0 a
Triact 70 EC (neem oil)	0.5 gal	7	0.7 a	0.2 a	0.3 ab
Nontreated Inoculated	-	-	47.1 c	3.4 b	37.5 d

* Not an IR-4 Experiment: F&N Tests 55:559. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05).

Treatments applied at 7-, 14- or 28-day intervals, beginning Oct 14.

Table 68. *Efficacy on Powdery Mildew (*Oidium sp.*) on Poinsettia (*Euphorbia pulcherrima*) ‘Freedom Red’, Daughtrey, NY, 2000.

Treatment	Rate Per 100 Gal	Spray Interval (days)	No. Colonies Per Leaf ^x			No. Colonies Per Bract		
			Oct 30	Nov 6	Nov 13	Nov 21	Nov 27	Dec 4
Decree 50WDG (fenhexamid)	24 oz	7	0.0 a	0.0 a	0.0 a	0.0 a	0.1 a	0.1 a
Heritage 50WDG (azoxystrobin)	2 oz	7	0.3 a	0.3 a	0.5 a	0.0 a	1.1 a	1.8 a
Pipron 2EC (piperalin)	8 fl oz	7	0.0 a	0.0 a	0.1 a	0.0 a	0.0 a	0.0 a
Systhane 40WSP (myclobutanil) alternated with Cygnus 50WDG (kresoxim-methyl)	4 oz alt 1 oz	14	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Nontreated Inoculated	-	-	21.0 b*	45.5 b	59.0 b	13.0 b	25.1 b	37.0 b

* Not an IR-4 Experiment: F&N Tests Vol 56:OT25. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD Test, P=0.05).

Treatments applied on Oct 16 to Nov 29. Pipron and Cygnus mixed with Latron B-1956 spreader-sticker (2 oz/100 gal)

In 2001, Hausbeck conducted a greenhouse experiment to determine efficacy of registered and unregistered fungicides for the control of powdery mildew (*Oidium sp.*) on poinsettia. All treatments significantly reduced a severe disease pressure (Table 69). Fourteen days following the last spray, Systhane completely prevented development of powdery mildew, and Cygnus and Compass limited disease to less than 20%. At 42 days, Systhane limited powdery mildew to 5% or less of the foliage

infected. At the end of the experiment (61 days after the last spray), Cygnus and Compass limited disease to less than 27%.

Table 69. *Efficacy on Powdery (*Oidium sp.*) on Poinsettia (*Euphorbia pulcherrima*) ‘Freedom Red’, Hausbeck, MI, 2001.

Treatment	Rate Per 100 Gal	Spray Interval (days)	Percent Infected Leaves ^x							
			Nov 13	Nov 20	Nov 27	Dec 4	Dec 11	Dec 29	Jan 5	Feb 5
AQ-10 Biofungicide (<i>Ampelomyces quisqualis</i>)	1.0 oz	7	19.7 ab	34.0 bc	38.8 bcd	55.4 cd	57.3 cd	50.9 bc	84.5 b	88.4 e
Cleary’s 3336 4F (thiophanate-methyl)	20.0 fl oz	7	16.8 ab	25.1 b	28.7 bc	27.8 b	25.7 b	17.6 a	24.1 a	50.4 d
Compass 50WDG (trifloxystrobin)	2.0 oz	14	0.3 a	1.3 a	7.4 a	13.4 ab	19.5 ab	14.9 a	15.8 a	24.7 c
Cygnus 50WG (kresoxim-methyl)	3.2 oz	14	1.7 a	1.9 a	5.5 a	7.1 ab	11.1 ab	10.6 a	10.3 a	17.3 bc
Heritage 50WDG (azoxystrobin)	3.0 oz	14	26.9 a-d	36.5 bc	50.7 c-f	56.9 cd	56.6 cd	51.5 bc	85.0 b	86.9 e
Milsana EC (<i>Reynoutria sachalinensis</i> extract)	0.5 gal	7	26.7 a-d	47.4 bc	51.1 c-f	51.9 cd	54.6 cd	58.9 bc	86.3 b	82.4 e
Serenade (<i>Bacillus subtilis</i> strain QST 713)	1.5 gal	7	15.0 ab	25.1 b	25.9 bc	27.3 b	34.3 bc	43.1 b	73.1 b	83.7 e
Sythane 40WSP (myclobutanil)	4.0 oz	14	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	1.1 a	5.4 ab
Nontreated	-	-	44.6 cd	54.1 c	69.2 f	75.0 d	90.4 e	72.5 c	93.6 b	87.3 e

* Not an IR-4 Experiment: F&N Tests Vol 58:OT013. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P=0.05).

Treatments applied from Nov 1 to Dec 5.

During 2001 and 2002, Hausbeck conducted four experiments in Florida to determine efficacy of various fungicides for the control of powdery mildew (*Oidium* sp.) on field-grown gerbera daisy (*Gerbera jamesonii*). In 2001, all treatments significantly reduced a severe disease pressure, with Compass providing 100% control, Insignia, Eagle, and Terraguard, limited disease development to 1% or less infection, while Strike and Milsana were least effective (Table 70). In the first 2002 an experiment, all treatments, except Camelot and Milsana, significantly reduced a severe disease pressure throughout the an experiment (Table 71). By the conclusion of the study, Compass + Latron and Systhane provided control that was significantly better than all of the other treatments. In the second 2002 an experiment, all treatments significantly reduced a severe disease pressure (Table 72). By the conclusion of the study, Compass + Latron and Systhane provided control that was significantly better than all of the other treatments. In the third 2002 an experiment, all treatments were equally effective at limiting a severe disease infection when evaluations were made within the spray interval (Table 73). Three treatments limited powdery mildew to $\leq 30\%$ foliar infection 28 days after the last spray: Systhane, Terraguard, and Compass + Latron B-1956.

Table 70. *Efficacy on Powdery (*Oidium* sp.) on Gerbera Daisy (*Gerbera jamesonii*) ‘New Mexico Red’, Hausbeck, FL, 2001.

Treatment	Rate Per 100 Gal	Disease severity ^x			% Infection		
		Jan 11	Jan 25	Feb 7	Jan 11	Jan 25	Feb 7
Compass 50WDG (trifloxystrobin)	3 oz	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Eagle 20 (myclobutanol)	6 fl oz	0.0 a	0.3 a	0.8 a	0.0 a	2.5 a	10.0 ab
Heritage 50WDG (azoxystrobin)	3 oz	0.0 a	1.0 a	1.3 a	0.0 a	7.5 a	20.0 ab
Insignia 20WDG (pyraclostrobin)	4 oz	0.3 a	0.3 a	0.3 a	2.5 a	2.5 a	2.5 ab
Milsana EC (<i>Reynoutria sachalinensis</i> extract)	0.5 gal	1.3 ab	3.3 bc	5.5 b	10.0 ab	27.5 ab	62.5 c
Rubigan EC (fenarimol)	5 fl oz	0.0 a	0.5 a	2.3 a	0.0 a	5.0 a	25.0 b
Strike 25WDG (triadimefon)	4 oz	0.3 a	2.5 ab	4.3 b	2.5 a	25.0 ab	47.5 c
Terraguard 50 WP (triflumizole)	8 oz	0.0 a	0.5 a	1.0 a	0.0 a	5.0 a	7.5 ab
Nontreated	-	2.0 b	4.8 c	7.5 c	20.0 b	45.0 b	87.5 d

* Not an IR-4 Experiment: F&N Tests Vol 58:OT008. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P=0.05). Rated on a scale of 0 to 10, where 0=no powdery mildew colonies present, to 10=plant death.

Treatments applied from Nov 20, 2000 to Jan 25, 2001 at 14-day intervals. Compass, Heritage and Milsana tank-mixed with Latron B-1956 (2.0 fl oz).

Table 71. *Efficacy on Powdery (*Oidium sp.*) on Gerbera Daisy (*Gerbera jamesonii*) ‘New Mexico Red’, Hausbeck, FL, 2002, Experiment 1.

Treatment	Rate Per 100 Gal	Foliar Infection ^x		
		Dec 18	Jan 4	Jan 16
Camelot 58EC (copper octanoate)	3 pt	3.8 cd	5.0 d	5.8 d
Compass 50WDG (trifloxystrobin)+ Latron B-1956	3 oz + 2 fl oz	1.0 a	1.5 a	1.8 a
Decree 50WDG (fenhexamid)	1.5 lb	3.3 bc	5.0 d	5.8 d
First Step (potassium bicarbonate)	2.5 lb	1.3 a	4.3 cd	5.0 cd
Milsana EC (<i>Reynoutria sachalinensis</i> extract)	1 gal	2.5 b	7.5 e	7.8 e
Phyton-27 (copper sulfate pentahydrate)	25 fl oz	2.8 b	4.3 cd	4.5 c
Sythane 40WSP (myclobutanil)	5 oz	1.5 a	2.0 ab	2.5 ab
Terraguard 50 WP (triflumizole)	4 oz	1.3 a	3.0 bc	3.0 b
	8 oz	1.3 a	3.3 bc	3.5 b
Nontreated	-	4.3 d	8.0 e	9.5 f

* Not an IR-4 Experiment: F&N Tests Vol 58:OT004.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P= 0.05). Rated on a scale of 1 to 10, where 1=no lesions to 10=100% infection of plant with powdery mildew. Treatments applied on Nov 8, 19, Dec 4, 18, 2001, and Jan 4, 18, 2002.

Table 72. *Efficacy on Powdery (*Oidium sp.*) on Gerbera Daisy (*Gerbera jamesonii*) ‘New Mexico Red’, Hausbeck, FL, 2002, Experiment 2.

Treatment	Rate Per 100 Gal	Foliar Infection ^x	
		Jan 4	Jan 16
Camelot 58EC (copper octanoate)	2 pt	3.7 b	5.0 c
Compass 50WDG (trifloxystrobin)	2 oz	1.7 a	2.3 a
	3 oz	1.3 a	2.0 a
Heritage 50WDG (azoxystrobin)	2 oz	2.0 a	3.0 ab
Insignia 20WDG (pyraclostrobin)	3. oz	2.0 a	3.3 b
Spectro 90WDG (chlorothalonil + thiophanate methyl)	1.0 lb	3.3 b	4.7 c
	1.5 lb	4.3 b	5.0 c
Sythane 40WSP (myclobutanil)	5 oz	1.7 a	2.7 ab
Nontreated	-	6.0 c	9.3 d

* Not an IR-4 Experiment: F&N Tests Vol 58:OT005. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P= 0.05). Rated on a scale of 1 to 10, where 1=no lesions to 10=100% infection of plant with powdery mildew. Treatments applied on Dec 4, 18 2001, and Jan 4, 16 2002. Compass and Heritage tank-mixed with Latron B-1956 (2.0 fl oz).

Table 73. *Efficacy on Powdery (*Oidium sp.*) on Gerbera Daisy (*Gerbera jamesonii*) ‘Michelle’, Hausbeck, FL, 2002, Experiment 3.

Treatment	Rate Per 100 Gal	Foliar Infection ^x				
		Within spray interval			Days after last spray	
		Dec 18	Jan 4	Jan 16	14 (Jan 30)	28 (Feb 13)
Compass 50WDG (trifloxystrobin)	3 oz	1.0 a	1.7 a	2.0 a	2.3 a	4.0 a
Heritage 50WDG (azoxystrobin)	2 oz	1.3 a	1.7 a	1.7 a	4.0 b	6.7 cd
Insignia 20WDG (pyraclostrobin)	3 oz	1.0 a	2.0 a	2.7 a	5.0 c	6.0 c
Sythane 40WSP (myclobutanil)	5 oz	1.0 a	2.0 a	2.3 a	2.3 a	3.7 a
Terraguard 50 WP (triflumizole)	8 oz	1.0 a	2.3 a	2.3 a	2.3 a	4.3 ab
Nontreated	-	2.3 b	4.3 b	6.7 b	9.3 d	10.0 f

* Not an IR-4 Experiment: F&N Tests Vol 58:OT006. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, $P=0.05$). Rated on a scale of 1 to 10, where 1=no lesions to 10=100% infection of plant with powdery mildew. Treatments applied on Dec 4, 18 2001, and Jan 4, 16 2002. Compass and Heritage tank-mixed with Latron B-1956 (2.0 fl oz).

In 2010, Villavicencio conducted two greenhouse experiments to determine efficacy of Regalia alone and in rotation, or tank mixed, with industry-standard fungicides for the control of powdery mildew (*Oidium sp.*) on gerbera daisy (*Gerbera jamesonii*). None of the treatments completely suppressed disease development, but all treatments significantly reduced severe disease pressures in both experiments (Table 74, Table 75). In experiment 1, the rotation of Regalia, Compass O and Banner MAXX was not as effective in limiting disease severity compared to the other treatments. A rate response was observed with Regalia in An experiment 1, but was not observed in experiment 2. In experiment 2, all treatments limited the severity of disease to less than 6% of the total leaf surfaces with visible signs of infection. No phytotoxicity was observed in any treatment.

Table 74. *Efficacy on Powdery Mildew (*Oidium sp.*) on Gerbera Daisy (*Gerbera jamesonii*) ‘Revolution Red’, Villavicencio, CA, 2010. Experiment 1.

Treatment and Rate Per 100 Gal	Disease Severity ^x			
	Feb 10	Feb 17	Feb 24	Mar 3
Compass O 50WDG 1oz Banner MAXX 5oz	4.5 a	10.6 cd	16.3 c	7.8 cd
Regalia 0.5% (<i>Reynoutria sachalinensis</i> extract)	6.3 a	2.5 d	10.3 cd	15.9 c
Regalia 1%	4.5 a	3.0 d	3.6 d	3.4 d
Regalia 0.5% Compass O 50WDG 4oz Banner MAXX 8oz ^y	5.6 a	31.9 b	42.5 b	33.1 b
Regalia 0.5% + Compass O 50WDG 1oz Regalia 0.5% + Banner MAXX 5oz ^z	2.5 a	16.5 bc	3.3 d	4.6 d
Nontreated	4.8 a	51.3 a	75.0 a	80.0 a

* Not an IR-4 Experiment: Plant Disease Management Reports 5:OT020.

^x Column means followed by the same letter are not significantly different (Fisher’s Protected LSD), $P=0.05$. Percentage of total leaf area of plant with visible signs of powdery mildew infection.

^y Regalia was applied on Feb3, 24, Compass O on Feb 10 and Banner MAXX on Feb 17.

^z Rotation of Regalia tank mixed with Compass O followed by Regalia tank mixed with Banner MAXX.

Table 75. *Efficacy on Powdery Mildew (*Oidium sp.*) on Gerbera Daisy (*Gerbera jamesonii*) ‘Revolution Red’, Villavicencio, CA, 2010. Experiment 2.

Treatment and Rate Per 100 Gal	Disease Severity ^x		
	Apr 20	Apr 27	May 5
MilStop 5lb (Potassium bicarbonate) + Cease 256 fl oz (<i>Bacillus subtilis</i> strain QST 713)	0.1 b	1.3 b	1.4 b
Regalia 0.5% (<i>Reynoutria sachalinensis</i> extract)	0.5 b	3.6 b	5.9 b
Regalia 1%	0.1 b	2.8 b	2.0 b
Regalia MAXX 0.125% (<i>Reynoutria sachalinensis</i> extract)	0.3 b	4.1 b	5.8 b
Regalia MAXX 0.25%	0.4 b	0.9 b	1.3 b
Nontreated	1.5 a	73.8 a	78.8 a

^x Column means followed by the same letter are not significantly different (Fisher’s Protected LSD), $P=0.05$. Percentage of total leaf area of plant with visible signs of powdery mildew infection.

In 2001, Hausbeck conducted a greenhouse experiment to determine efficacy of several fungicides for the control of powdery mildew (*Oidium sp.*) on pincushion flower (*Scabiosa columbaria*). All treatments significantly reduced a moderate disease pressure (Table 76). At the end of the study, plants treated with Strike and Systhane did not have any lesions on the plants.

Table 76. *Efficacy on Powdery Mildew (*Oidium sp.*) on Pincushion Flower (*Scabiosa columbaria*) ‘Pink Mist’, Hausbeck, MI, 2002.

Treatment	Rate Per 100 Gal	Number of Powdery Mildew Lesions ^x			
		May 29	Jun 6	Jun 12	Jun 24
Compass 50WDG (trifloxystrobin)	2 oz	1.8 a	2.3 a	1.8 a	2.3 a
Heritage 50WDG (azoxystrobin)	4 oz	8.3 a	3.2 a	2.3 a	2.6 a
Insignia 20WDG (pyraclostrobin)	3 oz	1.3 a	2.0 a	1.3 a	0.8 a
Strike 25WDG (triadimefon)	4 oz	0.0 a	0.0 a	0.0 a	0.0 a
Sythane 40WSP (myclobutanil)	5 oz	0.0 a	0.0 a	0.3 a	0.0 a
Terraguard 50 WP (triflumizole)	8 oz	0.3 a	0.3 a	0.3 a	0.3 a
Nontreated	-	9.5 a	20.0 b	21.0 b	27.5 b

* Not an IR-4 Experiment: F&N Tests Vol 58:OT010. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, $P=0.05$). Treatments applied from May 21 to Jun 4 at 14-day intervals.

During 2002 to 2004, Hausbeck conducted six greenhouse experiments to determine efficacy of various fungicides for the control of powdery mildew (*Oidium sp.*) on verbena (*Verbena x hybrida*). In the first 2002 an experiment, all treatments significantly reduced a severe disease pressure, limiting powdery mildew to <10% foliar infection (ratings=1.0-2.3) (Table 77). In the second 2002 an experiment, all fungicides significantly reduced a severe disease pressure when applied either before or after the appearance of disease symptoms (Table 78). Applications of Compass + Latron B-1956, Systhane, Terraguard, and Strike were significantly better in controlling powdery mildew than Camelot and Spectro and kept plants nearly disease free. In the first 2003 an experiment, Compass and Systhane provided excellent control of a severe disease pressure, while 710-145f was poor (Table 79). In the second 2003 an experiment, all fungicides significantly reduced a severe disease pressure with the industry standards Banner MAXX and Systhane providing good control, while Compass, Heritage and Zyban were less effective (Table 80). In the first 2004 an experiment, the standard Eagle significantly reduced a severe disease pressure better than other treatments (Table 81). On the last rating date, STBX-013 (6.4 fl oz) applied preventatively significantly reduced infection. In the second 2004 an experiment, Compass O and Systhane significantly reduced a severe disease pressure (Table 82).

Systhane completely prevented infection on all rating dates. No phytotoxicity was observed in any treatment.

Table 77. *Efficacy on Powdery (*Oidium sp.*) on Verbena (*Verbena x hybrida*) ‘Spitfire Rose/White Star’, Hausbeck, MI, 2002, Experiment 1.

Treatment	Rate Per 100 Gal	Disease Rating ^x		
		Apr 3	Apr 15	May 2
Bayleton 50DF (triadimefon) + Silwet	5.5 oz + 16 fl oz	1.0 a	1.0 a	1.8 b
Strike 25WDG (triadimefon)	4 oz	1.0 a	1.0 a	2.3 b
Systhane 40WSP (myclobutanil)	5 oz	1.0 a	1.0 a	1.0 a
Nontreated	-	2.3 b	9.8 d	10.0 e

* Not an IR-4 Experiment: F&N Tests Vol 58:OT011. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P=0.05). Rated on a scale of 1 to 10, where 1=no lesions to 10=100% infection of plant with powdery mildew. Treatments applied from Mar 6 to Apr 17 at 14-day intervals.

Table 78. *Efficacy on Powdery (*Oidium sp.*) on Verbena (*Verbena x hybrida*) ‘Sparkler’, Hausbeck, MI, 2002, Experiment 2.

Treatment	Rate Per 100 Gal	Treatments applied before disease symptoms			Treatments applied after disease symptoms	
		Disease Severity ^x			Disease Severity ^x	
		Feb 8	Feb 22	Mar 5	Feb 22	Mar 5
Camelot 58EC (copper octanoate)	2.0 pt	4.8 bc	7.5 cd	8.5 c	4.5 b	5.8 b
	3.0 pt	3.3 b	6.0 b	6.8 b	4.3 b	5.3 b
Compass 50WDG (trifloxystrobin) + Latron B-1956	2.0 oz + 1 fl oz	1.0 a	1.0 a	1.0 a	1.5 a	1.3 a
Spectro 90WDG (chlorothalonil + thiophanate methyl)	1.0 lb	3.0 ab	6.0 b	7.3 b	5.8 c	7.0 c
	1.5 lb	3.5 b	7.0 c	9.3 cd	6.3 c	7.5 c
Strike 25WDG (triadimefon)	4.0 oz	1.0 a	1.0 a	1.0 a	1.5 a	1.5 a
Systhane 40WSP (myclobutanil)	5.0 oz	1.5 a	1.0 a	1.0 a	1.8 a	1.8 a
Terraguard 50 WP (triflumizole)	4.0 oz	1.0 a	1.0 a	1.0 a	1.8 a	1.8 a
	8.0 oz	1.0 a	1.0 a	1.0 a	1.8 a	1.5 a
Nontreated	-	5.5 c	8.0 d	9.8 d	6.3 d	8.5 d

* Not an IR-4 Experiment: F&N Tests Vol 58:OT012.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P=0.05). Rated on a scale of 1 to 10, where 1=no lesions to 10=100% infection of plant with powdery mildew. In the first experiment, treatments were applied Jan 25, Feb 8 and 22, and were initiated prior to appearance of disease symptoms. In the second experiment, treatments were applied on Feb 8 and 22 after appearance of powdery mildew symptoms.

Table 79. *Efficacy on Powdery Mildew (*Oidium sp.*) on Verbena (*Verbena x hybrida*) ‘Sparkler Red/White’, Hausbeck, MI, 2003, Experiment 1.

Treatment	Rate Per 100 Gal	Disease Severity ^x			
		Apr 30	May 7	May 14	May 21
710-145f 0.14% (<i>Bacillus licheniformis</i>)	45.0 fl oz	5.3 bc	6.8 bc	7.8 bc	8.3 b
	67.5 fl oz	5.0 bc	5.0 b	6.8 bc	7.5 b
	90.0 fl oz	3.3 ab	4.5 b	6.3 b	7.8 b
Compass 50WDG (trifloxystrobin)	2.0 oz	1.0 a	1.0 a	1.0 a	1.8 a
Sythane 40WSP (myclobutanil)	4.0 oz	1.0 a	1.0 a	1.0 a	1.0 a
Nontreated	-	6.8 c	7.8 c	9.0 c	9.3 b

* Not an IR-4 Experiment: F&N Tests Vol 59:OT013. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P= 0.05).

Rated on a scale of 1 to 10, where 1=no lesions to 10=100% infection of plant with powdery mildew.

Treatments applied from Apr 16 to May 14; 710-145f applied on 7- day intervals, while Compass and Sythane applied on 14-day intervals.

Table 80. *Efficacy on Powdery Mildew (*Oidium sp.*) on Verbena (*Verbena x hybrida*) ‘Sparkler Red/White’, Hausbeck, MI, 2003, Experiment 2.

Treatment	Rate Per 100 Gal	Spray Interval (days)	Disease Severity ^x		
			May 21	May 28	Jun 4
Banner MAXX 9.5ME (propiconazole)	5.2 fl oz	14	2.0 a	2.0 a	1.8 a
Compass 50WDG (trifloxystrobin)	4.0 oz	14	3.3 abc	4.8 cde	5.0 bc
Heritage 50WDG (azoxystrobin)	1.0 oz	7	4.8 bc	5.8 e	7.3 de
Heritage 50WDG (azoxystrobin)	4.0 oz	28	5.3 c	7.0 f	8.3 ef
Sythane 40WSP (myclobutanil)	2.0 oz	14	2.5 a	2.5 ab	2.0 a
Zyban 80WSP (thiophanate-methyl + mancozeb)	24 oz	14	3.0 ab	3.0 a	4.0 b
Nontreated	-	-	7.0 d	8.8 f	9.5 f

* Not an IR-4 Experiment: F&N Tests Vol 59:OT014. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P= 0.05).

Rated on a scale of 1 to 10, where 1=no lesions to 10=100% infection of plant with powdery mildew.

Treatments applied from May 7 to 28.

Table 81. *Efficacy on Powdery Mildew (*Oidium sp.*) on Verbena (*Verbena x hybrida*) ‘Sparkler Red/White’, Hausbeck, MI, 2004, Experiment 1.

Treatment	Rate Per 100 Gal	Application Timing	Disease Severity ^x		
			Aug 12	Aug 20	Aug 26
Eagle (myclobutanol)	8.0 fl oz	Preventive	1.0 a	1.0 a	1.0 a
STBX-013 (STBX-013)	6.4 fl oz	Preventive	2.8 b	2.8 b	3.8 b
	12.8 fl oz	Preventive	2.8 b	3.5 b	4.3 bc
ZeroTol 27% (hydrogen peroxide)	42.2 fl oz	Preventive	2.3 b	3.0 b	4.5 bc
STBX-013 ^y		Curative	2.8 b	3.3 b	5.5 bc
ZeroTol 27% ^z		Curative	2.8 b	3.5 b	5.5 bc
Nontreated	-	-	2.5 b	4.0 b	6.0 c

* Not an IR-4 Experiment: F&N Tests Vol 60:OT007.

^x Means within column followed by the same letter are not significantly different (Fisher’s protected LSD, P=0.05). Rated on a scale of 1 to 10, where 1=no foliage infected to 10=100% foliage infected.

^y Curative treatments applied for three consecutive days starting 12 Aug at a rate of 25.6 fl oz and thereafter every 7-days at a rate of 12.8 fl oz on Aug 20 and 26.

^z Curative treatments applied for three consecutive days starting 12 Aug at a rate of 128 fl oz and thereafter every 7-days at a rate of 42.2 fl oz on Aug 20 and 26.

Preventive treatments were applied on Jul 29, Aug 5, 12, 20, and 26.

Table 82. *Efficacy on Powdery Mildew (*Oidium sp.*) on Verbena (*Verbena x hybrida*) ‘Sparkler Red/White’, Hausbeck, MI, 2004, Experiment 2.

Treatment	Rate Per 100 Gal	Final Disease Severity ^x	AUDPC ^y
Compass 50WDG (trifloxystrobin)	4 oz	4.0 bc	356.1 bc
EXP 710-145f 0.14% w/v (<i>Bacillus licheniformis</i>)	50 fl oz	8.3 a	963.0 a
	75 fl oz	6.5 ab	714.9 ab
	100 fl oz	8.3 a	924.0 a
Heritage 50WDG (azoxystrobin)	4 oz	8.5 a	954.2 a
Systhane 40WSP (myclobutanol)	4 oz	1.0 c	0.0 c
Nontreated	-	8.5 a	1138.0 a

* Not an IR-4 Experiment: F&N Tests Vol 60:OT008. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P=0.05). Rated on a scale of 1 to 10, where 1=healthy and 10=plant death.

^y Area under disease progress curve.

Treatments applied from Apr 23 to Jun 4 at 7-day intervals.

In 2011, Hausbeck conducted a greenhouse experiment to determine efficacy of several fungicides for the control of powdery mildew (*Oidium sp.*) on trailing petunia (*Calibrachoa x hybrida*). Terraguard was the only treatment that prevented infection from a severe disease pressure throughout the duration of the experiment (Table 83). Trinity also provided effective control, while Heritage applied as a drench was ineffective. No phytotoxicity was observed in any treatment.

Table 83. *Efficacy on Powdery (*Oidium sp.*) on Trailing Petunia (*Calibrachoa x hybrida*) ‘Cabaret Scarlet’, Hausbeck, MI, 2011.

Treatment	Rate Per 100 Gal	Application ^z	Number of Infected Leaves ^x		Plant Health ^y	
			Apr 28	May 5	Apr 28	May 5
Heritage 50WDG (azoxystrobin)	4 oz	28 day drench	7.7 a	14.2 b	1.8 c	4.3 b
Terraguard 50 WP (triflumizole)	16 fl oz	14 day spray	0.0 a	0.0 a	0.0 a	0.0 a
Trinity SC (triticonazole)	6 fl oz	14 day spray	0.8 a	5.0 a	0.2 a	1.2 a
	8 fl oz	14 day spray	1.0 a	3.2 a	0.3 ab	0.7 a
	12 fl oz	14 day spray	2.0 a	5.5 a	0.7 abc	1.0 a
	24 fl oz	14 day spray	3.0 a	7.3 a	0.7 abc	1.5 a
Nontreated	-	-	8.5 b	15.3 b	1.7 bc	3.7 b

* Not an IR-4 Experiment Plant Disease Management Reports 6:OT006. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P= 0.05).

^y Rated on a scale of 0 to 10; 0=no infection, 1=1-10% of total plant leaf area infected, 2=11-20%, 3=21-30%, 4=31-40%, 5=41-50%, 6=51-60%, 7=61-70%, 8=71-80%, 9=81-90%, 10=91-100%.

^z DBI=days before inoculation; DAI=days after inoculation.

Treatments were applied either as a soil drench (6 fl.oz/pot) or as a foliar spray on Apr 14 and 29 (unless noted differently in the table).

Comparative Efficacy on Podosphaera pannosa

In 1999, Hausbeck conducted a greenhouse experiment to determine efficacy of several fungicides for the control of powdery mildew (*Podosphaera pannosa*) on miniature rose (*Rosa hybrida*). Due to the variability of disease occurrence among the replicates, significant differences were not observed on some observation dates in the percentage of infected foliage or flowers. The overall data indicate that Cygnus, with or without Latron B-1956, provided the best control, while BAS 114 UBF, Strike and Heritage were ineffective (Table 84).

Table 84. *Efficacy on Powdery Mildew (*Podosphaera pannosa*) on Miniature Rose (*Rosa hybrida*) 'Mini Brite', 'Sunblazer', Hausbeck, MI, 1999.

Treatment	Rate Per 100 Gal	Spray Interval (days)	Foliage ^x							
			% Infected ^x				Rating ^y			
			Oct 29	Nov 12	Dec 21	Jan 6	Oct 29	Nov 12	Dec 21	Jan 6
BAS 114 UBF/Milsana (<i>Reynoutria sachalinensis</i> extract)	0.5% v/v	7	7.3 bc	4.0 ab	11.5 a	7.5 a	2.0 be	1.3 ab	1.8 b	1.5 a
Cygnus 50WG (kresoxym-methyl)	0.1 lb	7	2.7 ab	0.3 a	0.8 a	0.5 a	1.0 ab	0.2 a	0.5 ab	0.3 a
	0.2 lb	14	3.0 ab	2.0 ab	2.2 a	5.2 a	1.5 ab	0.7 ab	0.5 ab	0.8 a
Cygnus 50WG + Latron B-1956	0.1 lb + 2 fl oz	7	0.2 a	0.5 a	0.8a	2.0 a	0.2 a	0.0 a	0.7 ab	0.7 a
	0.2 lb + 2 fl oz	14	0.8 a	0.5 a	0.3 a	0.8 a	0.3 a	0.3 ab	0.2 a	0.5 a
	0.4 lb + 2 fl oz	7	3.0 ab	1.2 ab	1.0 a	2.7 a	1.0 ab	0.7 ab	0.3 ab	0.7 a
Heritage 50WDG (azoxystrobin)	2.0 oz	14	6.2 abc	2.8 ab	4.8 a	8.0 a	1.7 ab	1.0 ab	0.8 ab	1.0 a
Latron B-1956	2 fl oz	7	4.8 ab	4.5 ab	5.7 a	9.7 a	2.0 be	1.3 ab	1.5 ab	2.2 a
Strike 25WDG (triadimefon) + Latron	4.0 oz + 2 fl oz	14	2.7 ab	5.2 ab	2.8 a	10.8 a	1.2 ab	1.2 ab	1.0 ab	1.3 a
Sythane 40WP (myclobutanil)	5.0 oz	14	1.2 a	1.3 ab	0.5 a	4.3 a	0.3 a	0.5 ab	0.3 ab	0.8 a
Nontreated	-	-	10.2 c	7.2 b	10.5 a	19.3 a	3.0 c	2.0 b	1.8 b	2.2 a
Treatment	Rate Per 100 Gal	Spray Interval (days)	Flowers ^y							
			% Infected ^x				Rating ^y			
			Oct 29	Nov 12	Dec 21	Jan 6	Oct 29	Nov 12	Dec 21	Jan 6
BAS 114 UBF/Milsana (<i>Reynoutria sachalinensis</i> extract)	0.5% v/v	7	71.5 b	70.0 c	38.1 a	34.0 a	1.8 a	2.3 b	2.3 b	1.7 a
Cygnus 50WG (kresoxym-methyl)	0.1 lb	7	40.3 ab	0.0 a	0.0 a	0.0 a	1.0 a	0.0 a	0.0 a	0.0 a
	0.2 lb	14	20.0 ab	11.8 ab	0.0 a	16.7 a	0.7 a	0.7 ab	0.0 a	0.5 a
Cygnus 50WG + Latron B-1956	0.1 lb + 2 fl oz	7	13.8 ab	0.0 a	0.0 a	3.3 a	0.7 a	0.0 a	0.0 a	0.2 a
	0.2 lb + 2 fl oz	14	6.8 a	2.3 a	0.0 a	9.2 a	0.5 a	0.2 ab	0.0 a	0.7 a
	0.4 lb + 2 fl oz	7	8.3 a	0.0 a	0.0 a	14.8 a	0.3 a	0.0 a	0.0 a	0.7 a
Heritage 50WDG (azoxystrobin)	2.0 oz	14	63.7 ab	53.7 be	16.7 a	30.7 a	1.8 a	2.0 b	0.7 a	0.8 a
Latron B-1956	2 fl oz	7	8.3 a	24.3 abc	0.0 a	17.7 a	0.3 a	1.2 ab	0.0 a	0.8 a
Strike 25WDG (triadimefon) + Latron	4.0 oz + 2 fl oz	14	35.0 ab	38.5 abc	30.0 a	33.3 a	1.3 a	1.3 ab	0.7 a	1.3 a
Sythane 40WP (myclobutanil)	5.0 oz	14	16.7 ab	3.3 a	3.3 a	21.2 a	1.0 a	0.2 a	0.5 a	1.5 a
Nontreated	-	-	71.7 b	32.0 abc	33.3 a	16.7 a	2.2 a	1.5 ab	1.2 a	0.5 a

* Not an IR-4 Experiment: F&N Tests 55:562.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P=0.05). Visual estimation of percentage of foliage or flowers affected.

^y Rated on a scale of 0 to 5, 0 = no powdery mildew colonies present, 5 = tissue covered with colonies.

Treatments applied from Oct 14 to Dec 9.

In 1999, Pemberton conducted a greenhouse experiment to determine efficacy of several fungicides for the control of powdery mildew (*Podosphaera pannosa*) on miniature rose (*Rosa sp.*). There was a low level of powdery mildew infection prior to the start of treatments so initial ratings were high and generally decreased during the course of the experiment for all treatments (Table 85). By the last rating, Compass gave the best control with no phytotoxicity or growth regulator effects. Sentinel also gave good control but it resulted in noticeable plant growth regulator effects including smaller, darker leaves and reduced shoot growth. Pipron resulted in phytotoxicity expressed as blotchy yellowing and subsequent defoliation on older foliage.

Table 85. *Efficacy on Powdery Mildew (*Podosphaera pannosa*) on Miniature Rose (*Rosa sp.*) 'Pretty Cupido', Pemberton, TX, 1999.

Treatment	Rate Per 100 Gal	Disease Rating ^x			Overall Performance ^y		PGR Rating ^z
		Sep 30	Oct 14	Nov 4	Sep 30	Nov 4	Nov 4
Banner MAXX 14.3%EC (propiconazole)	5 fl oz	4.4 b	3.6 de	2.7 b	2.2 b	1.8 b	3.0 a
Compass 50WDG (trifloxystrobin)	1 oz	2.3 e	1.8 f	1.5 cd	1.8 b	1.0 d	1.0 b
	2 oz	3.2 cde	1.9 f	1.2 d	2.0 b	1.0 d	1.0 b
Heritage 50WDG (azoxystrobin)	2 oz	3.8 bcd	2.9 de	2.5 b	2.0 b	2.0 b	1.2 b
	4 oz	4.0 bc	2.8 e	2.6 b	2.2 b	1.8 b	1.0 b
Kaligreen 82W (potassium bicarbonate)	2 lb	4.4 b	4.4 c	2.1 bc	2.0 b	1.8 b	1.2 b
Pipron 84.4%LC (piperonyl)	4 fl oz	4.1 bc	3.7 cd	2.1 bc	2.2 b	1.7 bc	1.0 b
Sentinel 40WG (<i>Bacillus amyloliquefaciens</i> strain D747)	1.76 oz	2.9 de	1.8 f	1.7 cd	2.0 b	1.2 d	2.8 a
Nontreated	-	7.5 a	7.8 a	8.2 a	3.7 a	4.0 a	1.0 b

* Not an IR-4 Experiment: F&N Tests Vol 56:OT033. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD, P=0.05). Rated on a scale of 1 to 10 with 1 = no disease, 2 = disease light and localized, 5 = general disease with good sporulation, 7 = heavy, active infection generally distributed, and 10 = very heavy disease with distribution on all shoot parts.

^y Overall Performance: on a scale of 1 to 4 with 1 = excellent control, 2 = acceptable with a controllable level of disease, 3 = marginal control, and 4 = unacceptable control.

^z Plant Growth Regulator (PGR) Rating: on a scale of 1 to 3 with 1 = none, 2 = moderate, and 3 = very noticeable. Treatments applied weekly from Sep 23 to Oct 28 except Sentinel which was applied biweekly. Latron B-1956 was added to all treatments at the rate of 0.06% v/v.

During 2004 and 2008, Mulrooney conducted two field experiments to determine efficacy of several fungicides for the control of powdery mildew (*Podosphaera pannosa*) on rose (*Rosa sp.*). In the 2004 an experiment, Eagle and the 16 oz rate of Insignia provided the best control of powdery mildew (Table 86). No phytotoxicity or objectionable residue was observed on any treatment in this an experiment. In the 2008 an experiment, all treatments significantly reduced a moderate disease pressure (Table 87). No phytotoxicity was observed for any treatment in this test, but the 18 oz rate of Pageant did leave a noticeable white residue on the treated leaves.

Table 86. *Efficacy on Powdery Mildew Mildew (*Podosphaera pannosa*) on Rose (*Rosa sp.*) 'Tropicana', Mulrooney.DE, 2004.

Treatment	Rate Per 100 Gal	Spray Interval (days)	Disease Rating ^x
Eagle 40 WP (mycobutanil)	6 oz	14	2.9 a
Insignia 20 DG (pyraclostrobin)	4 oz	7	3.9 bc
Insignia 20 DG (pyraclostrobin)	4 oz	14	4.3 bc
	8 oz	14	4.5 c
	16 oz	14	3.5 ab
Nontreated	-	-	5.3 d

* Not an IR-4 Experiment: F&N Tests Vol 60:OT017.

^x Means within column followed by the same letter are not significantly different (Duncan-Waller *k*-ratio *t* test, *k*=100). Rated on Sep 1 using the Horsfall-Barratt Rating System where 1=0%, 2=0-3%, 3=3-6%, 4=6-12%, 5=12-25%, 6=25-50%, 7=50-75%, 8=75-87%, 9=87-94%, 10=94-97%, 11=97-100%, 12=100% of leaves infected or defoliated.

Treatments applied from May 14 to Aug 27. Latron B-1956 spreader-sticker (4.0 fl oz/100 gal) was added to fungicide treatments.

Table 87. *Efficacy on Powdery Mildew Mildew (*Podosphaera pannosa*) on Rose (*Rosa sp.*) 'Tropicana', Mulrooney.DE, 2008.

Treatment	Rate Per 100 Gal	No. Infected Terminals ^x	
		Jun 20	Sep 2
Eagle 40WP (mycobutanil) + Latron B-1956	6 oz + 4 fl oz	1.3 a	1.3 a
Pageant 38WP (pyraclostrobin + boscalid)	18 oz	2.8 a	18.3 a
Pageant 38WP + Capsule	12.5 oz + 8 fl oz	3.7 ab	21.0 a
Pageant 38 WP + Latron B-1956	12.5 oz + 4 fl oz	2.5 a	19.2 a
Trinity 1.69 EC (triticonazole)	12 fl oz	11.7 b	11.0 a
Trinity 1.69 EC + Capsule	8 fl oz + 8 fl oz	4.2 ab	13.0 a
Trinity 1.69 EC + Latron B-1956	8 fl oz + 4 fl oz	5.5 ab	10.0 a
Nontreated	-	28.2 c	13.8 a

* Not an IR-4 Experiment: Plant Disease Management Reports 3:OT004.

^x Means within column followed by the same letter are not significantly different (Fisher's Protected LSD, *P*=0.05). Treatments applied from May 8 to Aug 26 every 13-15 days.

Comparative Efficacy on *Podosphaera xanthii*

From 2005 through 2011, 7 experiments were conducted for *Podosphaera xanthii* on verbena (*Verbena x hybrida*), gerbera daisy (*Gerbera jamesonii*), and trailing petunia (*Calibrachoa x hybrida*). The BAS 510, BAS516 / Pageant, Eagle, and Terraguard treatments provided the most consistent levels of control across the experiments (Table 88). GANTEC Green, Palladium, SP2059, SP2169, and Zyban also provided good or excellent control in one or two experiments. Heritage, provided mixed efficacy (poor to good) on this pathogen across experiments. Compass, Cygnus, Disarm, Insignia, Plantshield, Rhapsody, and ZeroTol performed poorly in one or two experiments. See the following paragraphs for summaries of each experiment.

Table 88. General summary of efficacy for *Podosphaera xanthii* on various crops.

Product	Verbena			Gerbera Daisy			Trailing Petunia
	Hausbeck 2005*	Hausbeck 2005*	Hausbeck 2005*	Hausbeck 2008*	Hausbeck 2008*	Hausbeck 2009*	Hausbeck 2011*
BAS 510	++	++	++				
BAS 516, Pageant			++			+	++
Compass				+/-			
Cygnus		-					
Disarm						-	-
Eagle	++	++		++	++	+	
GANTEC Green							+
Heritage				+/-	+		-
Insignia			-				
Palladium					++		+
Plantshield			-				
Rhapsody			-				
SP2059					+		
SP2169						+	
Terraguard		++		++		+	++
ZeroTol			-				
Zyban				++			

* Not an IR-4-sponsored experiment.

1 Rating Scale: ++ = clearly statistically equivalent or better than Nontreated non-inoculated and/or clearly statistically different than Nontreated inoculated; + = statistically different from Nontreated inoculated and Nontreated non-inoculated; +/- statistically equivalent to both Nontreated inoculated and Nontreated non-inoculated; - = statistically equivalent to Nontreated inoculated. For experiments without non-inoculated check, efficacy determined on author's conclusions, % control or comparisons to standard product(s).

2 Where more than one rate or application type for a product was included in the experiment and each performed statistically different, the better rating is provided in this table.

In 2005, Hausbeck conducted three greenhouse experiments to determine efficacy of several fungicides for the control of powdery mildew (*Podosphaera xanthii*) on verbena (*Verbena x hybrida*). In the first experiment, both BAS 510 and the standard Eagle significantly reduced a severe disease pressure (Table 89). Plants treated preventively every 7-days did not have any powdery mildew colonies on the last rating. BAS 510 was not as effective as Eagle 20EW when applied curatively. In the second experiment, all treatments, except Cygnus, provided effective control of a severe disease pressure applied either preventive or curative (Table 90). In the third experiment, BAS 510 and BAS 516 provided effective control of a severe disease pressure, while Insignia, Plantshield, Rhapsody and ZeroTol were ineffective (Table 91). In all experiments, no phytotoxicity was observed from any treatment.

During 2008 and 2009, Hausbeck conducted three greenhouse experiments to determine efficacy of several fungicides for the control of powdery mildew (*Podosphaera xanthii*) on gerbera daisy (*Gerbera jamesonii*). In the first 2008 an experiment, Eagle, Inspire, Terraguard, and Zyban treatments completely prevented powdery mildew infection (Table 92). No phytotoxicity was observed. In the second 2008 an experiment, all treatments significantly reduced a severe disease pressure, with Eagle and Palladium generally providing the best control (Table 93). In the 2009 an experiment where fungicides were applied as curative, all treatments, except Disarm, significantly reduced a severe disease pressure (Table 94). Newly registered product Pageant limited infection comparable to industry standards Eagle and Terraguard. No phytotoxicity was observed in any treatment.

Table 89. *Efficacy on Powdery Mildew (*Podosphaera xanthii*) on Verbena (*Verbena x hybrida*) ‘Obsession Lilac’, Hausbeck, MI, 2005, Experiment 1.

Treatment	Rate Per 100 Gal	Application Timing ^y	Disease Severity Rating ^x				
			Jun 3	Jun 13	Jun 20	Jun 27	Jul 5
BAS 510 70WG (boscalid)	11 oz	7-day	0.0 a	0.0 a	0.0 a	0.2 a	0.0 a
BAS 510 70WG (boscalid)	11 oz	14-day	0.0 a	0.5 a	0.3 a	0.5 a	0.5 a
BAS 510 70WG (boscalid)	11 oz	21-day	0.2 a	0.2 a	0.0 a	0.5 a	0.8 a
BAS 510 70WG (boscalid)	11 oz	curative	4.8 c	5.0 c	4.2 c	4.8 c	4.3 b
Eagle 20EW (myclobutanil)	8 fl oz	7-day	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Eagle 20EW (myclobutanil)	8 fl oz	14-day	0.7 a	2.2 b	1.8 b	2.2 ab	2.0 a
Eagle 20EW (myclobutanil)	8 fl oz	21-day	0.5 a	0.7 a	0.7 ab	0.8 a	1.3 a
Eagle 20EW (myclobutanil)	8 fl oz	curative	2.2 b	2.3 b	2.0 b	2.7 b	2.2 a
Nontreated	-	-	5.3 c	6.5 d	6.5 d	7.5 d	8.8 c

* Not an IR-4 Experiment: F&N Tests Vol 61:OT012.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P= 0.05). Rated on scale of 0-10; 0=no infection, 1=1-10% foliage infected, 2=11-20%, 3=21-30%, 4=31-40%, 5=41-50%, 6=51-60%, 7=61-70%, 8=71-80%, 9=81-90%, 10=91-100% foliage infected.

^y Preventive treatments applied prior to disease development and then every 7-, 14-, or 21-days. Curative treatments were initiated 31 May when disease first observed and every 7-days thereafter. Treatments applied May 24, 31, Jun 7, 14 and 20.

Table 90. *Efficacy on Powdery Mildew (*Podosphaera xanthii*) on Verbena (*Verbena x hybrida*) ‘Obsession Lilac’, Hausbeck, MI, 2005, Experiment 2.

Treatment	Rate Per 100 Gal	Application Timing ^y	Disease Severity Rating ^x			
			Jun 13	Jun 20	Jun 27	Jul 5
BAS 510 70WG (boscalid)	11.0 oz	preventive	0.2 a	0.2 a	0.2 a	0.0 a
BAS 510 70WG (boscalid)	11.0 oz	curative	3.0 cd	1.7 b	1.8 ab	1.8 a
Cygnus 50WG (kresoxim-methyl)	3.2 oz	preventive	4.3 cd	3.8 c	4.2 cd	5.3 b
Cygnus 50WG (kresoxim-methyl)	3.2 oz	curative	5.2 d	5.7 d	5.5 d	8.0 b
Eagle 20EW (myclobutanil)	8.0 fl oz	preventive	0.2 a	0.2 a	0.2 a	0.0 a
Eagle 20EW (myclobutanil)	8.0 fl oz	curative	1.2 ab	0.5 a	0.7 a	0.5 a
Terraguard 50 WP (triflumizole)	8.0 oz	preventive	0.0 a	0.3 a	0.0 a	0.0 a
Terraguard 50 WP (triflumizole)	8.0 oz	curative	2.2 b	2.0 b	2.8 bc	1.8 a
Nontreated control	-	-	4.7 cd	5.0 cd	5.8 d	7.7 b

* Not an IR-4 Experiment: F&N Tests Vol 61:OT013.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P= 0.05). Rated on scale of 0-10; 0=no infection, 1=1-10% foliage infected, 10=91-100% foliage infected.

^y Preventive treatments were applied prior to disease development and then every 7-days. Curative treatments initiated May 31 when disease was first observed and applied every 7-days thereafter. Treatments applied May 24, 31, Jun 7, 14 and 20.

Table 91. *Efficacy on Powdery Mildew (*Podosphaera xanthii*) on Verbena (*Verbena x hybrida*) ‘Obsession Lilac’, Hausbeck, MI, 2005, Experiment 3.

Treatment	Rate Per 100 Gal	Disease Severity Rating ^x				
		Jun 3	Jun 14	Jun 20	Jun 27	Jul 5
BAS 510 70WG (boscalid)	11 oz	0.5 ab	0.7 a	0.8 a	1.0 a	1.0 a
BAS 516 38WG (pyraclostrobin + boscalid)	23 oz	0.3 ab	0.8 a	0.8 a	1.2 a	1.3 a
Insignia 20W (pyraclostrobin)	3 oz	0.7 ab	3.2 b	6.2 b	8.7 b	9.5 c
Plantshield WP (<i>Trichoderma harzianum</i>)	50 oz	1.0 b	3.7 b	6.7 b	8.3 b	9.5 c
Rhapsody AS (<i>Bacillus subtilis</i>)	4 qt	1.0 b	2.3 b	5.2 b	7.3 b	9.0 c
ZeroTol (hydrogen dioxide)	50 fl oz	0.7 ab	2.3 b	5.0 b	6.3 b	7.0 b
Nontreated	-	0.7 ab	2.5 b	5.3 b	7.7 b	9.0 c

* Not an IR-4 Experiment: F&N Tests Vol 61:OT014.

^x Means within column followed by the same letter are not significantly different (Student-Newman-Keuls, P=0.05). Rated on scale of 0-10; 0=no infection, 1=1-10% foliage infected, 10=91-100% foliage infected. Treatments applied May 24, 31, Jun 7, 14, 20 and 27.

Table 92. *Efficacy on Powdery Mildew (*Podosphaera xanthii*) on Gerbera Daisy (*Gerbera jamesonii*) ‘Festival Orange’, Hausbeck, MI, 2008, Experiment 1.

Treatment	Rate Per 100 Gal	% Leaf Area Infected ^x		
		Jul 22	Aug 4	Aug 29
Compass 50WDG (trifloxystrobin)	2 oz	5.0 a	5.8 a	17.5 a
Eagle 20EW (myclobutanil)	8 fl oz	0.0 a	0.0 a	0.0 a
Heritage 50WDG (azoxystrobin)	4 oz	5.8 ab	6.7 a	16.7 a
Terraguard 50W (triflumizole)	16 oz	0.0 a	0.0 a	0.0 a
Zyban WP (thiophanate-methyl + mancozeb)	22.7 oz	0.0 a	0.0 a	0.0 a
Nontreated	-	8.0 ab	10.0 a	24.0 ab

* Not an IR-4 Experiment: Plant Disease Management Reports 3:OT008. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Student-Newman Keuls, P=0.05). Treatments applied from Jun 20 to Aug 15 at 14-day intervals.

Table 93. *Efficacy on Powdery Mildew (*Podosphaera xanthii*) on Gerbera Daisy (*Gerbera jamesonii*) ‘Festival Orange’, Hausbeck, MI, 2008, Experiment 2.

Treatment	Rate Per 100 Gal	% Leaf Area Infected ^x		
		Jul 28	Aug 4	Aug 29
Eagle 20EW (myclobutanil)	12 fl oz	0.0 a	0.0 a	0.0 a
Heritage 50WDG (azoxystrobin)	0.4 oz	4.2 ab	4.2 a	16.7 a-d
	0.9 oz	3.7 ab	4.3 a	23.3 cd
	1.8 oz	5.0 ab	4.2 a	26.7 d
Palladium 62.5WDG (cyprodinil + fludioxonil)	4 oz	0.0 a	0.0 a	0.0 a
	6 oz	0.0 a	0.0 a	2.5 ab
SP2059 (SP2059)	106 oz	6.7 ab	0.0 a	9.2 abc
Nontreated	-	5.0 b	30.0 b	46.7 e

* Not an IR-4 Experiment: Plant Disease Management Reports 3:OT009. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (Fisher’s Protected LSD, P=0.05). Treatments applied from Jun 20 to Aug 20. SP2059 applied every 7 days, all other treatments applied every 14 days.

Table 94. *Efficacy on Powdery Mildew (*Podosphaera xanthii*) on Gerbera Daisy (*Gerbera jamesonii*) ‘Royal Dark Eye Deep Orange’, Hausbeck, MI, 2009.

Treatment	Rate Per 100 Gal	% Leaves Infected ^x			Disease severity ^y		
		Jul 28	Aug 10	Aug 20	Jul 28	Aug 10	Aug 20
Disarm O SC (fluoxastrobin)	2 fl oz	86.9 c	93.9 c	85.9 b	7.8 b	8.5 b	7.5 b
	4 fl oz	87.5 c	97.0 c	93.4 b	8.3 b	8.3 b	8.3 b
Eagle 20EW (myclobutanil)	12 fl oz	52.0 ab	41.3 ab	47.0 a	3.5 a	4.3 a	3.5 a
Pageant 38WG (boscalid + pyraclostrobin)	12.5 oz	52.7 ab	49.9 b	45.4 a	4.0 a	4.5 a	2.8 a
SP2169 (SP2169)	6.15 fl oz	51.1 ab	38.1 a	36.8 a	3.8 a	3.3 a	2.3 a
	12.3 fl oz	59.8 b	42.9 ab	31.5 a	5.0 a	3.3 a	2.8 a
	24.6 fl oz	53.7 ab	40.2 ab	38.5 a	3.8 a	3.5 a	3.0 a
Terraguard 50W (triflumizole)	8 oz	47.7 a	37.3 a	34.1 a	4.0 a	3.3	2.8 a
Nontreated	-	85.8 c	97.5 c	93.2 b	7.8 b	8.8 b	8.8 b

* Not an IR-4 Experiment: Plant Disease Management Reports 4:OT010.

^x Means within column followed by the same letter are not significantly different (Fisher’s protected LSD, P= 0.05).

^y Rated on a scale of 0 to 10, 0=no infection, 1=1-10% foliage infected, 10=91-100% foliage infected.

Treatments applied from Jun 29 to Aug 11 at 14-day intervals.

In 2011, Hausbeck conducted a greenhouse experiment to determine efficacy of several fungicides for the control of powdery mildew (*Podosphaera xanthii*) on trailing petunia (*Calibrachoa x hybrida*). The industry standard Terraguard provided the most effective control of a severe disease pressure throughout the duration of the experiment (Table 95). Pageant also provided effective control, while Heritage applied as a drench and Disarm, were ineffective. No phytotoxicity was observed in any treatment.

Table 95. *Efficacy on Powdery Mildew (*Podosphaera xanthii*) on Trailing Petunia (*Calibrachoa x hybrida*) ‘Cabaret Scarlet’, Hausbeck, MI, 2011.

Treatment	Rate Per 100 Gal	Application	Number of Infected Leaves ^x		Plant Health ^y	
			Apr 28	May 5	Apr 28	May 5
Disarm O SC (fluoxastrobin)	4 fl oz	14-day spray	9.3 c	18.5 e	2.3 d	3.7 d
GANTEC Green EC (neem oil)	8 fl oz	7-day spray	0.0 a	2.7 ab	0.2 a	0.7 a-c
Heritage 50WDG (azoxystrobin)	9 oz	21-day drench	7.0 bc	13.8 de	1.7 cd	3.7 d
Heritage WG + Capsil	4 oz + 4 fl oz	7-day spray	3.8 a	10.7 ab	0.8 a-c	2.3 b-d
Pageant 38WG (boscalid + pyraclostrobin)	12 oz	14-day spray	0.0 a	1.5 ab	0.0 a	0.3 ab
Palladium WG (cyprodinil + fludioxonil) + Capsil	6 oz + 4 fl oz	14-day spray	1.2 a	11.0 b-e	0.3 a	1.7 a-d
	4 oz + 4 fl oz	7-day spray	0.5 a	3.8 a-c	0.3 a	0.7 a-c
Terraguard SC (triflumizole)	16 fl oz	14-day spray	0.0 a	0.0 a	0.0 a	0.0 a
Nontreated	-	-	6.7 bc	12.3 b-e	1.5 b-d	2.7 cd

* Not an IR-4 Experiment Plant Disease Management Reports 7:OT030. Not all products tested included in table.

^x Means within column followed by the same letter are not significantly different (LSD, P=0.05).

^y Rated on a scale of 0 to 10; where 0=no sporulation, 1=1-5%, 2=6-10%, 3=11-20%, 4=21-30%, 5= 31-40%, 6=41-50%, 7=51-60%, 8=61-80%, 9=81-99%, and 10=100% of foliage sporulating with the pathogen.

Treatments were applied either as a soil drench (6 fl.oz/pot) or as a foliar spray on Apr 14 and reapplied as noted in the table until Apr 29.

Efficacy Summary by Product/Active Ingredient

A brief efficacy summary for select products applied as foliar sprays is given below, with a reminder that there are very limited data available to draw definitive conclusions for many products. Products were selected based on interest in these products for testing in Powdery Mildew efficacy projects from 2012 to 2016. This summary includes mostly non-IR-4 data; it is not exhaustive and other data for powdery mildew products may be available.

Azoxystrobin. Heritage generally provided good to excellent control of *Golovinomyces cichoracearum* in 12 experiments, excellent control of *Erysiphe lagerstroemia* in one experiment, good and excellent control of *Erysiphe monardae* in 2 experiments, good to excellent control of *Erysiphe polygoni* in 8 experiments, good to excellent control of *Erysiphe pulchra* in 5 experiments, mediocre control of *Erysiphe azaleae* in one experiment, good control of *Erysiphe lonicerae* var. *lonicerae* in one experiment, poor to excellent control of *Oidium* sp. in 9 experiments, poor to good control of *Podosphaera xanthii* in 3 experiments, and poor and good control of *Podosphaera pannosa* in 2 experiments.

Azoxystrobin + Benzovindiflupyr. Mural provided good to excellent control of *Golovinomyces cichoracearum* in two experiments, excellent control of *Erysiphe lagerstroemia* in one experiment, good control of *Erysiphe pulchra* in one experiment, and good to excellent control of *Erysiphe lonicerae* var. *lonicerae* in 2 experiments.

BLAD/Lupinus extract. F9110 provided mediocre control of *Golovinomyces cichoracearum* in one experiment, good control of *Erysiphe pulchra* in one experiment, and poor control of *Erysiphe lonicerae* var. *lonicerae* in two experiments.

Chlorothalonil. Daconil and other chlorothalonil products provided mixed efficacy (poor to excellent) on *Golovinomyces cichoracearum* in 4 experiments, good control of *Erysiphe monardae* in one experiment, fair to excellent control of *Erysiphe polygoni* in 3 experiments, and excellent control of *Erysiphe pulchra* in 2 experiments.

Copper Products. The copper products (Bonide Liquid Copper Fungicide, Camelot, Junction, Kocide, Phyton 27 and Southern Ag Liquid Copper Fungicide) provided mixed efficacy (poor to excellent) on *Golovinomyces cichoracearum* in single experiments, mediocre control of *Erysiphe monardae* in one experiment, good to excellent control of *Erysiphe polygoni* in 5 experiments, and poor control of *Oidium* sp. in 4 experiments.

Cyflufenamid. NF-149 provided excellent control of *Golovinomyces cichoracearum* in one experiment, and poor and good control of *Erysiphe lonicerae* var. *lonicerae* in 2 experiments.

Fenarimol. Rubigan provided mediocre control of *Erysiphe polygoni* in 3 experiments, and good control of *Oidium* sp. in one experiment.

Fenazaquin. Magus provided excellent efficacy for lilac powdery mildew in one experiment.

Fluoxastrobin. Disarm provided poor control of *Podosphaera xanthii* in 2 experiments.

Flutianil. Gatten provided generally good to excellent efficacy for *Golovinomyces cichoracearum* in four experiments and excellent control of *G. orontii* in one experiment.

Fluxapyroxad + Pyraclostrobin. Orkestra provided excellent control of *Golovinomyces cichoracearum* and *Erysiphe lonicerae* var. *lonicerae* in single experiments.

Hydrogen dioxide. ZeroTol provided good control of *Golovinomyces cichoracearum*, poor control of *Erysiphe lonicerae* var. *lonicerae*, poor control of *Oidium* sp., and poor control of *Podosphaera xanthii* in single experiments.

IKF-309. This new fungicide provided variable control of *Golovinomyces cichoracearum* in two experiments.

Kresoxym-methyl. Cygnus provided mediocre control of *Golovinomyces cichoracearum* in one experiment, good to excellent control of *Oidium* sp. in 3 experiments, poor control of *Podosphaera xanthii* in one experiment, and good control of *Podosphaera pannosa* in one experiment. Kresoxym-

methyl is no longer commercially available in the United States.

MBI-121. This new contact biological ingredient provided variable efficacy from poor to good for *Golovinomyces cichoracearum* in four experiments.

Mefentrifluconazole. Aveylo provided great to excellent control of *Golovinomyces cichoracearum* in two experiments.

Myclobutanil. Eagle, Systhane and other myclobutanil products provided good to excellent control of *Golovinomyces cichoracearum* in six experiments, excellent control of *Erysiphe knautiae* and *Erysiphe lagerstroemia* in single experiments, good to excellent control of *Erysiphe polygoni* in nine experiments, excellent control of *Erysiphe pulchra* in 16 experiments, mediocre control of *Erysiphe azaleae* in one experiment, good and excellent control of *Oidium* sp. in 14 experiments, good to excellent control of *Podosphaera xanthii* in 5 experiments, and good to excellent control of *Podosphaera pannosa* in three experiments.

Neem Oil extract. Triact, Neem Oil Concentrate, and other neem oil products provided mediocre control of *Erysiphe polygoni* in three experiments, poor to excellent control of *Erysiphe pulchra* in four experiments, excellent control of *Oidium* sp. in one experiment, and good control of *Podosphaera xanthii* in one experiment.

Piperalin. Pipron provided excellent control of *Golovinomyces cichoracearum* in one experiment, excellent control of *Oidium* sp. in two experiments, and good control of *Podosphaera pannosa* in one experiment.

Potassium bicarbonate. Milstop, Kaligreen or Armicarb provided mediocre and excellent control of *Golovinomyces cichoracearum* in two experiments, mediocre to excellent control of *Erysiphe polygoni* in 3 experiments, and mediocre control of *Erysiphe azaleae*, excellent control of *Erysiphe lonicerae* var. *lonicerae*, poor control of *Oidium* sp., and good control of *Podosphaera pannosa* in single experiments.

Propiconazole. Banner MAXX and other propiconazole products generally provided good to excellent control of *Golovinomyces cichoracearum* in four experiments, excellent control of *Erysiphe polygoni* in five experiments, excellent control of *Erysiphe pulchra* in seven experiments, good control of *Erysiphe azaleae* in one experiment, poor control of *Erysiphe lonicerae* var. *lonicerae* in one experiment, good and excellent control of *Oidium* sp. in two experiments, and mediocre control of *Podosphaera pannosa* in one experiment.

Pydiflumetofen. Picatina and other pydiflumetofen products (Picatina Flora and Picatina Gold) provided excellent control of *Erysiphe lagerstroemia* in one experiment, and good to excellent control of *Erysiphe pulchrae* in two experiments.

Pyraclostrobin. Insignia or BAS 500 provided mediocre and excellent control of *Oidium* sp. in five experiments; and excellent control of *Erysiphe polygoni*, good control of *Golovinomyces cichoracearum* and *Podosphaera pannosa*, and poor control of *Podosphaera xanthii* in single experiments.

Pyraclostrobin + Boscalid. BAS 516, Pageant or Pristine provided excellent control of *Golovinomyces cichoracearum* and *Erysiphe lagerstroemia* in single experiments, good control of *Erysiphe pulchra* in three experiments, good to excellent control of *Podosphaera xanthii* in three experiments, and good control of *Podosphaera pannosa* in one experiment.

Pyriofenone. IKI-309 provided good control of *Golovinomyces cichoracearum* in one experiment.

Regime. Some reduction of powdery mildew in 5 experiments.

Reynoutria sachalinensis extract. Regalia provided poor control of *Erysiphe lonicerae* var. *lonicerae* in one experiment; Milsana provided poor control in 2 experiments while Regalia and Regalia MAXX provided excellent control of *Oidium* sp. in 2 experiments; Milsana provided poor control of *Podosphaera pannosa* in one experiment.

SP2478. SP2478 provided good to excellent efficacy of *Golovinomyces cichoracearum* in three experiments.

SP2700 WP. SP2700 provided fair to good efficacy of *Golovinomyces cichoracearum* in four experiments.

Sulfur. Bonide Citrus, Fruit, and Nut Orchard Spray Concentrate provided excellent control of *Erysiphe polygona* in two experiments, and Garden Fungicide provided good control of *Erysiphe azaleae* in one experiment.

TDA-NC-1. This new contact active ingredient provided variable efficacy from poor to good for *Golovinomyces cichoracearum* in four experiments.

Tebuconazole. Bayer Disease Control provided excellent control of *Golovinomyces cichoracearum* and *Erysiphe pulchra* in single experiments.

Tetraconazole. Mettle provided poor and good control of *Erysiphe lonicerae* var. *lonicerae* in two experiments.

Thiophanate-methyl. 3336 or Domain provided good and excellent control of *Golovinomyces cichoracearum* in two experiments, excellent control of *Erysiphe lagerstroemia* in one experiment, good and excellent control of *Erysiphe monardae* in two experiments, generally excellent control of *Erysiphe pulchra* in eight experiments, and poor and mediocre control of *Oidium* sp. in two experiments.

Triadimefon. Bayleton or Strike provided mediocre and good control of *Erysiphe pulchra* in three experiments, mediocre to excellent control of *Oidium* sp. in five experiments, and poor control of *Podosphaera pannosa* in one experiment.

Trifloxystrobin. Compass provided excellent control of *Golovinomyces cichoracearum* in three experiments, excellent control of *Erysiphe polygona* in one experiment, good control of *Erysiphe azaleae* in one experiment, generally good control of *Oidium* sp. in 13 experiments, mediocre control of *Podosphaera xanthii* in an experiment, and excellent control of *Podosphaera pannosa* in one experiment.

Triflumizole. Terraguard provided good to excellent control of *Golovinomyces cichoracearum*, in two experiments, generally excellent control of *Oidium* sp. in 7 experiments, and good to excellent control of *Podosphaera xanthii* in four experiments.

Please see Table 96 for individual summaries of IR-4 experiments conducted during 1981 to 2016.

Phytotoxicity

No phytotoxicity was observed with the products listed above in 80 experiments with the exception of 5 experiments. In a zinnian experiment, Kocide 101 caused a severe marginal leaf burn. Slight stunting was observed with Banner Maxx and SunSpray Ultra-Fine Oil, and slight injury with Phyton 27 and SunSpray Ultra Fine Oil observed in single dogwood tests. In an azalean experiment, Garden Fungicide (sulfur) had several necrotic or sunburned leaves within a week after the first treatment when record temperatures in the mid 90's F were recorded. In a poinsettian experiment, Triact caused stunting of leaves and bracts as well as some bract edge necrosis, and BAS 500 also caused some necrotic spotting down the midvein of bracts, as well as slight fading of the red bract color. Pipron caused phytotoxicity expressed as blotchy yellowing and subsequent defoliation on older foliage in a rose an experiment.

Table 96. Summary of product efficacy by pathogen and crop.

Note: Table entries are sorted by product, pathogen Latin name, and then by crop Latin name. Only those IR-4 experiments received by 6/30/2023 are included in the table below.

PR#	Product (Active Ingredients)	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
31501	Banner MAXX (Propiconazole)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2012	Foliar	Significantly reduced % infection with 5 fl oz per 100 gal applied once.
31501	Banner MAXX (Propiconazole)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2013	Foliar	Data inconclusive due to low infection levels.
32814	Bayleton 25WP (Triadimefon)	Powdery mildew, azalea (Erysiphe azaleae)	Sweet Pea (Lathyrus odoratus)	Field In-Ground	McCain	CA	1985	Foliar	Significant reduction in disease incidence with 4 oz per 100 gal applied once; no injury observed.
32757	Bayleton 25WP (Triadimefon)	Powdery mildew, azalea (Erysiphe azaleae)	Azalea (Rhododendron sp.)	Field In-Ground	Peterson	NJ	1982	Foliar	Good efficacy with heavy inoculum load with 4 and 8 oz per 100 gal; 2 oz per 100 gal provided slight reduction.
32794	Bayleton 25WP (Triadimefon)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Begonia (Begonia sp.) 'Whiskey' and 'Vodka'	Greenhouse	Peterson	NJ	1982	Foliar	Excellent efficacy with 1, 2, 4, and 8 oz per 100 gal.
32758	Bayleton 25WP (Triadimefon)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Peterson	NJ	1981	Foliar	Good to excellent efficacy increasing with rate (2, 4, and 8 oz per 100 gal).
07778	Bayleton 25WP (Triadimefon)	Powdery Mildew, Rose (Podosphaera pannosa)	Rose (Rosa sp.)	Field In-Ground	Peterson	NJ	1981	Foliar	Great efficacy at 2, 4, and 8 oz per 100 gal; no injury was observed.
32795	Bayleton 50WP (triadimefon)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Begonia (Begonia sp.) 'White Bank'	Shadehouse/ Lathehouse	Kontaxis	CA	1983	Foliar	Excellent efficacy through 85 days after last spray with 10 oz per 100 gal.
32799	Baytan (KWG 0519) 25DF (triadimenol)	Powdery mildew, azalea (Erysiphe azaleae)	Azalea (Rhododendron sp.)	Field In-Ground	Peterson	NJ	1984	Foliar	Excellent efficacy with 2 and 4 oz per 100 gal applied at 10 day intervals.
32759	Benlate 50WP (Benomyl)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Peterson	NJ	1981	Foliar	Excellent efficacy with 4 oz ai per 100 gal.
32798	CGA 71818 10W (penconazole)	Powdery mildew, azalea (Erysiphe azaleae)	Azalea (Rhododendron sp.)	Field In-Ground	Peterson	NJ	1984	Foliar	Excellent efficacy with 4 and 8 oz per 100 gal applied at 10 day intervals.

PR#	Product (Active Ingredients)	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
32946	F9110 (F9110)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Zinnia angustifolia (Zinnia angustifolia) 'Star Gold'	Field Container	Freiberger	NJ	2016	Foliar	No powdery mildew present on this zinnia species.
32940	F9110 (F9110)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Zinnia (Zinnia elegans) 'Magellan Yellow'	Field Container	Freiberger	NJ	2016	Foliar	Poor efficacy on a moderate disease pressure with 20 and 46 fl oz per 100 gal applied 5 times weekly.
31413	F9110 (F9110)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2012	Foliar	Significantly reduced % infection with 20.5 and 46 fl oz per 100 gal applied once.
31413	F9110 (F9110)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2013	Foliar	Data inconclusive due to low infection levels.
31413	F9110 (F9110)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2015	Foliar	Poor control of a low to moderate disease pressure with 20 and 46 fl oz per 100 gal applied 4 times.
32220	F9944 (F9944)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2014	Foliar	No data collected because disease did not present during 2015.
32796	Funginex (Triforine 18.2) (Triforine)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Begonia (Begonia sp.) 'White Bank'	Shadehouse/ Lathehouse	Kontaxis	CA	1983	Foliar	Excellent efficacy through 45 days after last spray with 2.18 oz ai per 100 gal.
32947	Heritage (Azoxystrobin)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Zinnia angustifolia (Zinnia angustifolia) 'Star Gold'	Field Container	Freiberger	NJ	2016	Foliar	No powdery mildew present on this zinnia species.
32941	Heritage (Azoxystrobin)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Zinnia (Zinnia elegans) 'Magellan Yellow'	Field Container	Freiberger	NJ	2016	Foliar	Good efficacy on a moderate disease pressure with 4 oz per 100 gal applied 3 times biweekly.
32332	Heritage (Azoxystrobin)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2014	Foliar	No data collected because disease did not present during 2015.
32332	Heritage (Azoxystrobin)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2015	Foliar	Good control of a low to moderate disease pressure with 4 oz per 100 gal applied twice.
32948	IKF-309 (IKF-309)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Zinnia angustifolia (Zinnia angustifolia) 'Star Gold'	Field Container	Freiberger	NJ	2016	Foliar	No powdery mildew present on this zinnia species.
32942	IKF-309 (IKF-309)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Zinnia (Zinnia elegans) 'Magellan Yellow'	Field Container	Freiberger	NJ	2016	Foliar	Mediocre to good efficacy on a moderate disease pressure with 3.84, 5.76 and 11.52 fl oz per

PR#	Product (Active Ingredients)	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
									100 gal applied 5 times weekly; slightly inferior to Heritage.
32501	Magus (Fenazaquin)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2015	Foliar	Complete control of a low to moderate disease pressure with 2.5 oz per 100 gal applied twice.
31414	Mettle (Tetraconazole)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2012	Foliar	Did not significantly reduce % infection with 2.5 fl oz per 100 gal applied once.
31414	Mettle (Tetraconazole)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2013	Foliar	Data inconclusive due to low infection levels.
31414	Mettle (Tetraconazole)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2014	Foliar	No data collected because disease did not present during 2015.
31414	Mettle (Tetraconazole)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2015	Foliar	Good control of a low to moderate disease pressure with 2.5 fl oz per 100 gal applied 4 times.
32800	Milban 39EC (Dodemorph)	Powdery mildew, azalea (Erysiphe azaleae)	Azalea (Rhododendron sp.)	Field In-Ground	Peterson	NJ	1984	Foliar	Poor to good efficacy increasing with rate (32, 64, 96 fl oz per 100 gal).
32793	Milban 39EC (Dodemorph)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Begonia (Begonia sp.) 'Whiskey' and 'Vodka'	Greenhouse	Peterson	NJ	1982	Foliar	Excellent efficacy with 32, 64, and 96 fl oz per 100 gal.
31415	MilStop (Potassium bicarbonate)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2012	Foliar	Significantly reduced % infection with 4 lb per 100 gal applied once.
31415	MilStop (Potassium bicarbonate)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2013	Foliar	Data inconclusive due to low infection levels.
32949	Mural (A18126B) WDG (Azoxystrobin + benzovindiflupyr)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Zinnia angustifolia (Zinnia angustifolia) 'Star Gold'	Field Container	Freiberger	NJ	2016	Foliar	No powdery mildew present on this zinnia species.
32943	Mural (A18126B) WDG (Azoxystrobin +	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Zinnia (Zinnia elegans) 'Magellan Yellow'	Field Container	Freiberger	NJ	2016	Foliar	Good efficacy on a moderate disease pressure with 4.25 oz per 100 gal applied 3 times biweekly; comparable to Heritage.

PR#	Product (Active Ingredients)	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
	benzovindiflupyr)								
31419	Mural (A18126B) WDG (Azoxystrobin + benzovindiflupyr)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2012	Foliar	reduces % infection with 4.25 and 8.5 oz per 100 gal applied once.
31419	Mural (A18126B) WDG (Azoxystrobin + benzovindiflupyr)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2014	Foliar	No data collected because disease did not present during 2015.
31419	Mural (A18126B) WDG (Azoxystrobin + benzovindiflupyr)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2015	Foliar	Almost complete control of a low to moderate disease pressure with 4.25 oz per 100 gal applied either 2 or 4 times.
32950	NF-149 (Cyflufenamid)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Zinnia angustifolia (Zinnia angustifolia) 'Star Gold'	Field Container	Freiberger	NJ	2016	Foliar	No powdery mildew present on this zinnia species.
32944	NF-149 (Cyflufenamid)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Zinnia (Zinnia elegans) 'Magellan Yellow'	Field Container	Freiberger	NJ	2016	Foliar	Good efficacy on a moderate disease pressure with 3.4 fl oz per 100 gal applied 3 times biweekly; comparable to Heritage.
31417	NF-149 (Cyflufenamid)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2012	Foliar	Significantly reduced % infection with 3.4 fl oz per 100 gal applied once.
31417	NF-149 (Cyflufenamid)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2013	Foliar	Data inconclusive due to low infection levels.
31417	NF-149 (Cyflufenamid)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2014	Foliar	No data collected because disease did not present during 2015.
31417	NF-149 (Cyflufenamid)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2015	Foliar	Mediocre control of a low to moderate disease pressure with 3.4 fl oz per 100 gal applied either 2 or 4 times.

PR#	Product (Active Ingredients)	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
32951	Orkestra Intrinsic (BAS703 06F/BAS703 01F) (Fluxapyroxad + pyraclostrobin)	Powdery Mildew, Cucurbit (<i>Golovinomyces cichoracearum</i>)	Zinnia <i>angustifolia</i> (Zinnia <i>angustifolia</i>) 'Star Gold'	Field Container	Freiberger	NJ	2016	Foliar	No powdery mildew present on this zinnia species.
32945	Orkestra Intrinsic (BAS703 06F/BAS703 01F) (Fluxapyroxad + pyraclostrobin)	Powdery Mildew, Cucurbit (<i>Golovinomyces cichoracearum</i>)	Zinnia (Zinnia <i>elegans</i>) 'Magellan Yellow'	Field Container	Freiberger	NJ	2016	Foliar	Good efficacy on a moderate disease pressure with 6 fl oz per 100 gal applied 3 times biweekly; comparable to Heritage.
32219	Orkestra Intrinsic (BAS703 06F/BAS703 01F) (Fluxapyroxad + pyraclostrobin)	Powdery Mildew, Lilac (<i>Erysiphe lonicerae</i> var. <i>lonicerae</i>)	Lilac, Common (<i>Syringa vulgaris</i>)	Field In-Ground	Freiberger	NJ	2014	Foliar	No data collected because disease did not present during 2015.
32219	Orkestra Intrinsic (BAS703 06F/BAS703 01F) (Fluxapyroxad + pyraclostrobin)	Powdery Mildew, Lilac (<i>Erysiphe lonicerae</i> var. <i>lonicerae</i>)	Lilac, Common (<i>Syringa vulgaris</i>)	Field In-Ground	Freiberger	NJ	2015	Foliar	Complete control of a low to moderate disease pressure with 8 and 10 fl oz per 100 gal applied twice.
31418	Regalia O5 (MOI-10605) (Extract of <i>Reynoutria sachalinensis</i>)	Powdery Mildew, Lilac (<i>Erysiphe lonicerae</i> var. <i>lonicerae</i>)	Lilac, Common (<i>Syringa vulgaris</i>)	Field In-Ground	Freiberger	NJ	2012	Foliar	Did not significantly reduce % infection with 1 gal per 100 gal applied once.
31418	Regalia O5 (MOI-10605) (Extract of <i>Reynoutria sachalinensis</i>)	Powdery Mildew, Lilac (<i>Erysiphe lonicerae</i> var. <i>lonicerae</i>)	Lilac, Common (<i>Syringa vulgaris</i>)	Field In-Ground	Freiberger	NJ	2013	Foliar	Data inconclusive due to low infection levels.
32221	SP2770 10WP (SP2770)	Powdery Mildew, Lilac (<i>Erysiphe lonicerae</i> var. <i>lonicerae</i>)	Lilac, Common (<i>Syringa vulgaris</i>)	Field In-Ground	Freiberger	NJ	2014	Foliar	No data collected because disease did not present during 2015.

PR#	Product (Active Ingredients)	Target	Crop	Production Site	Researcher	State	Year	Application Type	Results
31416	Tank Mix: MilStop + Cease (potassium bicarbonate + Bacillus subtilis)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2012	Foliar	Significantly reduced % infection with 2 lb + 4 qt per 100 gal applied once.
31416	Tank Mix: MilStop + Cease (potassium bicarbonate + Bacillus subtilis)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2013	Foliar	Data inconclusive due to low infection levels.
32797	Tilt 3.6E (CGA 64250 3.6E) (Propiconazole)	Powdery Mildew, Cucurbit (Golovinomyces cichoracearum)	Begonia (Begonia sp.) 'White Bank'	Shadehouse/ Lathehouse	Kontaxis	CA	1983	Foliar	Excellent efficacy through 45 days after last spray with 10 oz per 100 gal.
32050	X4602B (X4602B)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2013	Foliar	Data inconclusive due to low infection levels.
31420	ZeroTol (Hydrogen dioxide)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2012	Foliar	Did not significantly reduce % infection with 1 gal per 100 gal applied once.
31420	ZeroTol (Hydrogen dioxide)	Powdery Mildew, Lilac (Erysiphe lonicerae var. lonicerae)	Lilac, Common (Syringa vulgaris)	Field In-Ground	Freiberger	NJ	2013	Foliar	Data inconclusive due to low infection levels.

Appendix 1: Contributing Researchers

Dr. Fulya Baysal-Gurel	Tennessee State University Otis L. Floyd Research Center 472 Cadillac Lane McMinnville, TN 37110
Dr. Chris Becker	BAAR Scientific LLC 6374 Rt. 89 Romulus, NY 14541 607-869-9511
Mr. Dave Bodine (<i>retired</i>)	Rutgers University USDA-ARS 283 Route 539 Cream Ridge, NJ
Dr. J. W. Buck	University of Georgia-Griffin Department of Plant Pathology Griffin, GA 30224-1797
Ms. M. L. Daughtrey	Cornell University Long Island Horticultural Research and Extension Center Riverhead, NY 11901
Mr. Tom Freiberger (<i>retired</i>)	Rutgers University USDA-ARS 283 Route 539 Cream Ridge, NJ
Dr. A. K. Hagan (<i>retired</i>)	Auburn University Department of Entomology and Plant Pathology Auburn University, AL 36849
Dr. Mary Hausbeck	Michigan State University Dept. of Plant Pathology 140 Plant Pathology Building East Lansing, MI 48824
Dr. J. C. Jacobi (<i>retired</i>)	Alabama Cooperative Extension System Birmingham, AL 35223
Mr. R. C. Lambe (<i>retired</i>)	P. O. Box 65483 Port Ludlow, WA 98365
Dr. Demetrios G. Kontaxis (<i>retired</i>)	University of California Cooperative Extension 1700 Oak Park Boulevard Pleasant Hill, CA 94523

Dr. J. A. LaMondia <i>(retired)</i>	Connecticut Agricultural Experiment Station Department of Plant Pathology and Ecology 153 Cook Hill Road Windsor CT 06095
Dr. Arthur H. McCain <i>(retired)</i>	UC Berkeley Department of Plant Pathology Berkeley, CA 94720
Dr. R. P. Mulrooney	University of Delaware Department of Plant and Soil Sciences Newark, DE 19716-2170
Dr. H. Brent Pemberton	Texas A&M University Agricultural Research and Extension Center P. O. Box 200 Overton, TX 75684
Dr. J. Peterson <i>(retired)</i>	Rutgers University Cook College Department of Plant Pathology New Brunswick, NJ 08901
Dr. J. W. Pscheidt	Oregon State University Department of Botany and Plant Pathology Corvallis, OR 97331-2903
Dr. J. Robbins <i>(retired)</i>	University of Arkansas Department of Horticulture and Cooperative Extension Service 2301 S. University Avenue Little Rock, AR 72203
Dr. V. L. Smith <i>(retired)</i>	Connecticut Agricultural Experiment Station P. O. Box 1106 New Haven, CT 06504
Dr. Lucia Villavicencio <i>(past affiliate)</i>	Center for Applied Horticultural Research 3742 Blue Bird Canyon Road Vista, CA 92084