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**IR-4 Ornamental Horticulture Program
Benzovindiflupyr + Azoxystrobin Crop Safety**

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**Acknowledgements
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Abstract

In 2013, as part of the crop safety screening for new active ingredients and recently registered fungicides, IR-4 started testing Mural WDG (benzovindiflupyr + azoxystrobin) for safety on several ornamental horticulture crops. During 2013 to 2017, the IR-4 Project completed 78 trials on 27 ornamental plant genera or species examining phytotoxicity related to foliar and/or drench applications. In these trials, no injury was observed on any species or genera. If a list of tested plants is placed on the Mural WDG label, 15 of the IR-4 screened plants can be added to the EPA label based on having 3 or more completed trials: *Aquilegia* sp., *Buddleia davidii*, *Buxus* sp., *Calibrachoa* sp., *Camellia* sp., *Dianthus* sp., *Helianthus* sp., *Heuchera* sp., *Juniperus* sp., *Lamium* sp., *Lavandula* sp., *Monarda* sp., *Osteospermum* sp., *Rhaphiolepis* sp., and *Scindapsus aureus*

Introduction

In 2013 as part of the crop safety screening for new active ingredients and recently registered fungicides, IR-4 started testing Mural WDG (benzovindiflupyr + azoxystrobin) for safety on several ornamental horticulture crops. During 2013 to 2017, the IR-4 Project completed 78 trials on 27 ornamental plant genera or species examining phytotoxicity related to foliar and/or drench applications of Mural WDG.

Materials and Methods

Mural WDG was tested as foliar and drench applications. Foliar applications were applied 3 times at 14 day intervals. The drench applications were applied once. For foliar applications, the application rates were 4.0, 7.0 and 14.0 oz per 100 gal; for drench applications, the rates were 2.0, 3.0 and 6.0 oz per 100 gal. All experiments had an untreated control. A minimum of 10 plants (replicate treatments) were required. Phytotoxicity was planned to be recorded on a scale of 0 to 10 (0 = No phytotoxicity; 10 = Complete kill), although one research used a 1 to 10 scale instead. Phytotoxicity was rated 7 days after each application. For testing, the following protocols were used: 13-010, 13-011, and 14-003, 15-003, 16-004, and 17-004. Please visit <http://ir4.rutgers.edu/ornamental/OrnamentalDrafts.cfm> to view and download these protocols.

Mural WDG was provided by Syngenta. See list of researchers in Appendix 1.

Results and Summary

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

Phytotoxicity

Across all plant species tested, benzovindiflupyr + azoxystrobin exhibited no or minimal negative impact (Table 1) on 15 plant genera or species fell into this category. No crops exhibited significant injury (Table 3). There are 12 species or genera where less than 3 trials were conducted for either foliar or drench applications so there is not enough information available at this time (Table 4).

Please see Table 5 for a summary of the individual trial results.

Table 1. List of benzovindiflupyr + azoxystrobin treated crops with no or minimal transitory injury.

<i>Aquilegia</i> sp.	<i>Juniperus</i> sp.
<i>Buddleia davidii</i>	<i>Lamium</i> sp.
<i>Buxus</i> sp.	<i>Lavandula</i> sp.
<i>Calibrachoa</i> sp.	<i>Monarda</i> sp.
<i>Camellia</i> sp.	<i>Osteospermum</i> sp.
<i>Dianthus</i> sp.	<i>Rhaphiolepis</i> sp.
<i>Helianthus</i> sp.	<i>Scindapsus aureus</i>
<i>Heuchera</i> sp.	

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

None

Table 3. List of benzovindiflupyr + azoxystrobin treated crops with significant injury at 1X.

None

Table 4. List of benzovindiflupyr + azoxystrobin treated crops where more information is needed.

<i>Abies</i> sp.	<i>Hydrangea</i> sp.
<i>Aglaonema</i> sp.	<i>Phlox</i> sp.
<i>Aster</i> sp.	<i>Pseudotsuga menziesii</i>
<i>Berberis</i> sp.	<i>Salvia officinalis</i>
<i>Ceanothus gloriosus</i>	<i>Salvia microphylla</i>
<i>Chamaerops humilis</i>	
<i>Hibiscus</i> sp.	

Table 5 Detailed Summary of Crop Safety Testing with Benzovindiflupyr + azoxystrobin

Notes: Table entries are sorted by crop Latin name. Only those trials with research reports received by 11/28/2017 are listed below.

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
31502	Fir (Abies sp.) A. balseama	Field Container	Brazeo	MA	2013	Foliar	No injury with 4, 7 and 14 fl oz per 100 gal applied 3 times; minor height reduction with 4X.
31502	Fir (Abies sp.) Abies procera	Field Container	DeFrancesco	OR	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31503	Aglaonema (Aglaonema sp.)	Field Container	Palmateer	FL	2015	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times biweekly.
31503	Aglaonema (Aglaonema sp.) 'Silver Queen'	Field Container	Gu	TX	2013	Foliar	No injury or growth reduction with X4602B at 4, 7 and 14 fl oz per 100 gal applied 3 times.
31751	Columbine (Aquilegia sp.)	Field Container	Grunwald	OR	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal; all plants saleable.
31751	Columbine (Aquilegia sp.) A. canadensis 'Little Lanterns'	Field Container	Catlin	NY	2014	Foliar	No injury or significant growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times; slight spray residue after 3rd application.
31751	Columbine (Aquilegia sp.) A. chrysantha 'Yellow Queen'	Field Container	DeFrancesco	OR	2015	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times biweekly.
31751	Columbine (Aquilegia sp.) 'Texas Gold'	Field Container	Gu	TX	2015	Foliar	No significant injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times. Researcher recommends repeating trial.
31593	Aster (Aster sp.) 'Believe Purple'	Field Container	Freiberger	NJ	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31593	Aster (Aster sp.) 'Purple Dome'	Field Container	Wade	SC	2017	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times biweekly; all plants marketable.
31511	Barberry (Berberis sp.)	Field Container	Harvey	WA	2013	Drench	No injury with 2, 3 and 6 oz per 100 gal.
31511	Barberry (Berberis sp.) B. thunbergii 'Aurea'	Field Container	Wade	SC	2013	Drench	No injury or growth reduction with 2, 3 and 6 oz per 100 gal applied 3 times; all plants marketable.
31511	Barberry (Berberis sp.) 'Orange Rocket'	Field Container	Gu	TX	2015	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times. Researcher recommends repeating trial.
31752	Butterfly Bush (Buddleia davidii)	Field Container	Grunwald	OR	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal; all plants saleable.
31752	Butterfly Bush (Buddleia davidii)	Field Container	Harvey	WA	2014	Foliar	No injury with 4, 7 and 14 oz per 100 gal applied 3 times.
31752	Butterfly Bush (Buddleia davidii) 'Black Knight'	Field Container	Wade	SC	2017	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times biweekly; all plants marketable.
31512	Boxwood (Buxus sp.) B. macrophylla japonica	Field Container	Uber	CA	2016	Foliar	No injury or growth reduction with 4 and 7 oz per 100 gal applied 3 times.
31512	Boxwood (Buxus sp.) B. microphylla japnica 'Winter Gem'	Field Container	Fraelich	GA	2013	Drench	No injury or growth reduction at 4, 7, and 14 oz per 100 gal.

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
31512	Boxwood (Buxus sp.) 'Green Velvet'	Field Container	Fraelich	GA	2016	Foliar	No injury or difference in plant growth and marketability with 4, 7 and 14 oz per 100 gal applied 3 times.
31706	Calibrachoa (Calibrachoa sp.)	Greenhouse	Koivunen	CA	2015	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31706	Calibrachoa (Calibrachoa sp.)	Greenhouse	Williams	IL	2013	Drench	No injury with 4, 7 and 14 fl oz per 100 gal applied 3 times at monthly intervals slight width reduction at 4X.
31706	Calibrachoa (Calibrachoa sp.)	Greenhouse	Williams	IL	2013	Foliar	No injury or growth reduction with 4, 7 and 14 fl oz per 100 gal applied 3 times at monthly intervals.
31706	Calibrachoa (Calibrachoa sp.) 'Superbells® Strawberry Punch' and 'Superbells® Ch	Greenhouse	Wick	MA	2015	Foliar	No injury to 3 cultivars with 4, 7 and 14 fl oz per 100 gal applied 3 times.
31706	Calibrachoa (Calibrachoa sp.) 'Cabaret Purple'	Greenhouse	Williams-Woodward	GA	2013	Foliar	No significant injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31706	Calibrachoa (Calibrachoa sp.) Kabloom White	Greenhouse	Freiberger	NJ	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times
31504	Camellia (Camellia sp.) C. japonica 'Elena'	Field Container	Henn	MS	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31504	Camellia (Camellia sp.) C. japonica 'Kramer's Supreme'	Field Container	Meador	CA	2015	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times; comparable to Heritage.
31504	Camellia (Camellia sp.) 'ShiShi Gashira'	Field Container	Wade	SC	2013	Drench	No injury or growth reduction with 2, 3 and 6 oz per 100 gal applied 3 times; all plants marketable.
31504	Camellia (Camellia sp.) 'ShiShi Gashira'	Field Container	Wade	SC	2013	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times; all plants marketable.
31753	Ceanothus (Ceanothus sp.) C. americanus	Field Container	Brazee	MA	2015	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31753	Ceanothus (Ceanothus sp.) C. gloriosus 'Point Reyes'	Field Container	DeFrancesco	OR	2016	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times biweekly.
33069	Palm, Mediterranean Fan (Chamaerops humilis)	Field Container	Palmateer	FL	2016	Foliar	No injury or growth reduction with 4, 7 and 14 fl oz per 100 gal applied 3 times.
31754	Pink (Dianthus sp.)	Field Container	Grunwald	OR	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal; all plants saleable.
31754	Pink (Dianthus sp.) D. chinensis 'First Love'	Field Container	DeFrancesco	OR	2014	Foliar	No injury with 4, 7 and 14 oz per 100 gal applied 3 times; slight to moderate growth reduction.
31754	Pink (Dianthus sp.) D. gratianopolitanus 'Firewitch'	Field Container	Hausbeck	MI	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times; visible spray residue on treated plants.
31754	Pink (Dianthus sp.) 'Neon Star'	Field Container	Hand	OH	2014	Foliar	No injury or growth reduction with 8, 14 and 28 oz per 100 gal applied 3 times.
31505	Sunflower (Helianthus sp.)	Field Container	Grunwald	OR	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal; all plants saleable.
31505	Sunflower (Helianthus sp.)	Field Container	Harvey	WA	2013	Drench	No injury with 2, 3 and 6 oz per 100 gal.

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
31505	Sunflower (<i>Helianthus</i> sp.)	Field Container	Harvey	WA	2013	Foliar	No injury with 4, 7 and 14 oz per 100 gal applied 3 times.
31505	Sunflower (<i>Helianthus</i> sp.) 'Table Mountain'	Field Container	Gu	TX	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31506	Alumroot (<i>Heuchera</i> sp.)	Field Container	Grunwald	OR	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal; all plants saleable.
31506	Alumroot (<i>Heuchera</i> sp.)	Field Container	Harvey	WA	2013	Drench	No injury with 2, 3 and 6 oz per 100 gal.
31506	Alumroot (<i>Heuchera</i> sp.)	Field Container	Harvey	WA	2013	Foliar	No injury with 4, 7 and 14 oz per 100 gal applied 3 times.
31506	Alumroot (<i>Heuchera</i> sp.) <i>H. americana</i> 'Electra'	Field Container	DeFrancesco	OR	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31507	Rosemallow (<i>Hibiscus</i> sp.) 'Disco Belle Rosy Red'	Field Container	Wade	SC	2013	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times; all plants marketable.
31507	Rosemallow (<i>Hibiscus</i> sp.) <i>H. trionum</i> 'Simply Love'	Field Container	DeFrancesco	OR	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31755	Hydrangea (<i>Hydrangea</i> sp.)	Field Container	Harvey	WA	2014	Foliar	No injury with 4, 7 and 14 oz per 100 gal applied 3 times.
31755	Hydrangea (<i>Hydrangea</i> sp.) <i>H. macrophylla</i> 'Nikko Blue'	Field Container	Fraelich	GA	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31513	Juniper (<i>Juniperus</i> sp.)	Field Container	Harvey	WA	2013	Drench	No injury with 2, 3 and 6 oz per 100 gal.
31513	Juniper (<i>Juniperus</i> sp.) <i>J. conferta</i> 'Blue Pacific'	Field Container	Fraelich	GA	2016	Foliar	No injury or difference in plant growth and marketability with 4, 7 and 14 oz per 100 gal applied 3 times.
31513	Juniper (<i>Juniperus</i> sp.) <i>J. virginiana</i>	Field Container	Braze	MA	2015	Foliar	No injury or growth reduction with 4, 7 and 14 fl oz per 100 gal applied 3 times.
31513	Juniper (<i>Juniperus</i> sp.) <i>Juniperus conferta</i> 'Blue Pacific'	Field Container	Fraelich	GA	2015	Foliar	No injury or difference in plant growth and marketability with 4, 7 and 14 oz per 100 gal applied 3 times.
31756	Dead Nettle (<i>Lamium</i> sp.)	Field Container	Grunwald	OR	2015	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31756	Dead Nettle (<i>Lamium</i> sp.) <i>L. maculatum</i> 'Golden Anniversary'	Field Container	Catlin	NY	2015	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times biweekly.
31756	Dead Nettle (<i>Lamium</i> sp.) <i>L. maculatum</i> 'Lemon Frost'	Field Container	Klett	CO	2016	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times (6/23, 8/5, 8/18).
31760	Lavender (<i>Lavandula</i> sp.)	Field Container	Grunwald	OR	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal; all plants saleable.
31760	Lavender (<i>Lavandula</i> sp.)	Field Container	Harvey	WA	2014	Foliar	No injury with 4, 7 and 14 oz per 100 gal applied 3 times.
31760	Lavender (<i>Lavandula</i> sp.) <i>L. angustifolia</i> 'Munstead'	Field Container	Hand	OH	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31760	Lavender (<i>Lavandula</i> sp.) <i>L. angustifolia</i> 'Munstead'	Field Container	Hausbeck	MI	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
31760	Lavender (<i>Lavandula</i> sp.) <i>L. x intermedia</i> 'Grosso'	Field Container	DeFrancesco	OR	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31757	Beebalm, Scarlet (<i>Monarda didyma</i>)	Field Container	Grunwald	OR	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal; all plants saleable.
31757	Beebalm, Scarlet (<i>Monarda didyma</i>) 'Marshal's Delight'	Field Container	DeFrancesco	OR	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31757	Beebalm, Scarlet (<i>Monarda didyma</i>) 'Pink Supreme'	Field Container	Gu	TX	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31508	Daisybush (<i>Osteospermum</i> sp.)	Greenhouse	Williams	IL	2013	Foliar	No injury or growth reduction with 4, 7 and 14 fl oz per 100 gal applied 3 times at monthly intervals.
31508	Daisybush (<i>Osteospermum</i> sp.) 'Akila'	Greenhouse	Freiberger	NJ	2014	Drench	No injury or growth reduction with 2, 3 and 6 oz per 100 gal.
31508	Daisybush (<i>Osteospermum</i> sp.) 'Akila'	Greenhouse	Freiberger	NJ	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31508	Daisybush (<i>Osteospermum</i> sp.) <i>O. ecklonis</i> 'Summertime Blueberry'	Greenhouse	DeFrancesco	OR	2013	Drench	No injury or growth reduction with 2, 3 and 6 oz per 100 gal.
31758	Phlox, Fall (<i>Phlox paniculata</i>)	Field Container	Harvey	WA	2014	Foliar	No injury with 4, 7 and 14 oz per 100 gal applied 3 times.
31758	Phlox, Fall (<i>Phlox paniculata</i>) 'David'	Field Container	Catlin	NY	2015	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times biweekly.
31509	Fir, Douglas (<i>Pseudotsuga menziesii</i>)	Greenhouse	Grunwald	OR	2013	Drench	No injury or growth reduction with 2, 3 and 6 fl oz per 100 gal; all plants marketable.
31510	Indian Hawthorn (<i>Rhaphiolepis indica</i>)	Field Container	Uber	CA	2015	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31510	Indian Hawthorn (<i>Rhaphiolepis indica</i>) 'Alba'	Field Container	Wade	SC	2013	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times; all plants marketable.
31510	Indian Hawthorn (<i>Rhaphiolepis indica</i>) <i>R. umbellata</i> 'Southern Moon Yedda'	Field Container	Fraelich	GA	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31514	Common Sage (<i>Salvia officinalis</i>)	Field Container	Wade	SC	2013	Drench	No injury or growth reduction with 2, 3 and 6 oz per 100 gal applied 3 times; all plants marketable.
32867	Sage (<i>Salvia</i> sp.) <i>S. microphylla</i> 'Hotlips'	Field Container	DeFrancesco	OR	2016	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31594	Centipede Tongavine (<i>Scindapsus aureus</i>)	Greenhouse	Catlin	NY	2013	Drench	No injury or growth reduction with 2, 3 and 6 oz per 100 gal.
31594	Centipede Tongavine (<i>Scindapsus aureus</i>)	Greenhouse	Gu	TX	2014	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times.
31594	Centipede Tongavine (<i>Scindapsus aureus</i>)	Greenhouse	Palmateer	FL	2015	Foliar	No injury or growth reduction with 4, 7 and 14 oz per 100 gal applied 3 times biweekly.

Label Suggestions

In this report, all 27 species or genera exhibited minimal or no injury after foliar and/or drench treatments of benzovindiflupyr + azoxystrobin. If a list of tested plants is placed on the Mural WDG label, 15 of the IR-4 screened plants can be added to the EPA label based on having 3 or more completed trials:

Aquilegia sp.
Buddleia davidii
Buxus sp.
Calibrachoa sp.
Camellia sp.
Dianthus sp.
Helianthus sp.
Heuchera sp.

Juniperus sp.
Lamium sp.
Lavandula sp.
Monarda sp.
Osteospermum sp.
Rhaphiolepis sp.
Scindapsus aureus

Appendix 1: Contributing Researchers

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