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## **IR-4 Ornamental Horticulture Program Indaziflam Crop Safety**

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### **Acknowledgements**

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## Abstract

From 2011 through 2014 IR-4 has completed 102 trials evaluating indaziflam granular formulations for crop safety. The data contained in this report was generated to register the use of indaziflam on and around ornamental horticulture plants with over-the-top applications. The rates tested were 0.045, 0.089 and 0.178 pounds active ingredient per acre (lb ai per A) as the 1X, 2X and 4X rates. The indaziflam 0.03%G formulation was applied to 16 plant genera or species, the Marengo G formulation was applied to 28 crops. Of these crops, 7 exhibited no or minimal transient injury after application at all three rates including *Berberis sp.*, *Liriope sp.*, *Ophiopogon japonicus*, *Rhododendron sp.*, *Rosa sp.*, *Taxus media* and certain *Viburnum* species. The remaining crops evaluated have only been screened in 1 or two trials or exhibited minimal to significant injury. Further testing is required on many species before a conclusion can be made confirming crop safety.

## Introduction

Control of annual grasses, sedges and broadleaf weeds in the production of woody and herbaceous perennials can be problematic because nurseries grow many different types of plants and not all genera or species are listed on labels. These weeds can also be difficult to control in landscape settings for the same reason. This summary covers the results of trials conducted from 2011 through 2014.

## Materials and Methods

In the crop safety protocols, two applications of Indaziflam 0.03%G or Marengo G were made approximately 6 weeks apart. The application rates were 0.045, 0.089 and 0.178 lb ai per acre, (150, 300 and 600 lb product/A) plus a water treated control. A minimum of four plants per three blocks or ten plants per completely randomized design were required with many researchers exceeding this minimum. Phytotoxicity was recorded on a scale of 0 to 10 (0 = No phytotoxicity; 10 = Complete kill) at 1, 2, and 4 weeks after initial application. For more detailed materials and methods, please see protocols at <http://ir4.rutgers.edu/ornamental/OrnamentalDrafts.cfm>

Indaziflam 0.03%G and Marengo G was supplied to researchers (See list of researchers in Appendix 2) by the Bayer Corporation and OHP.

## Results and Summary

### ***Phytotoxicity***

Based on the type and nature of injury seen with indaziflam applications in the conducted research, 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 sufficient to recommend growers not utilize this product, and 4) more data is needed to make informed recommendations.

Indaziflam 0.03%G exhibited no or minimal negative impact on 3 plant species (*Rhododendron sp.*, *Rosa sp.* and *Taxus media*) with over the top, broadcast applications (Table 1). Some minimal injury may be acceptable for growers if applications are made several weeks to months in advance of crop sale particularly for woody ornamental crops. In the research presented here, no plant species exhibited significant injury at higher rates consistently among the research site and no crops exhibited damage sufficient to recommend growers not utilize Indaziflam 0.03%G as an over-the-top treatment for pre-emergent weed control. For 14 genera/species, more information is needed because only 1 or 2 trials were conducted to date (Table 4).

Marengo G exhibited no or minimal negative impact on 4 plant species (*Berberis sp.*, *Liriope sp.*, *Ophiopogon sp.* and *Viburnum sp.*) with over the top, broadcast applications (Table 5). Some minimal injury may be acceptable for growers if applications are made several weeks to months in advance of crop sale particularly for woody ornamental crops. In the research presented here, seven plant species exhibited significant injury at higher rates consistently among the research sites (Table 6) and six crops exhibited damage sufficient to recommend growers not utilize

Marengo G as an over-the-top treatment for pre-emergent weed control (Table 7). For 10 genera/species, more information is needed because only 1 or 2 trials were conducted to date (Table 4).

**Table 1. List of Indaziflam 0.03%G treated crops with no or minimal transitory injury.**

*Rhododendron sp. (azalea)* *Taxus media*<sup>2</sup>  
*Rosa sp.*

**Table 2. List of Indaziflam 0.03%G treated crops with no or minimal transitory injury seen at the 1X rate, but the 2X or 4X rate did cause significant phytotoxicity.**

*None*

**Table 3. List of Indaziflam 0.03%G treated crops exhibiting significant injury.**

*None*

**Table 4. List of Indaziflam 0.03%G treated crops where more information is needed.**

<i>Acer palmatum</i> <sup>2</sup>	<i>Nandina domestica</i> <sup>1</sup>
<i>Buxus sempervirens</i> <sup>1</sup>	<i>Picea pungens</i> <sup>1</sup>
<i>Carex comans</i> <sup>1</sup>	<i>Quercus spp.</i> <sup>1</sup>
<i>Chamaerops humilis</i> <sup>1</sup>	<i>Raphiolepis indica</i> <sup>1</sup>
<i>Gardenia radicans</i> <sup>1</sup>	<i>Spirea japonica</i> <sup>1</sup>
<i>Miscanthus sinensis</i>	<i>Syringa myeri</i> <sup>1</sup>
<i>Muhlenbergia capillaris</i>	<i>Syringa reticulata</i>

**Table 5. List of Marengo G treated crops with no or minimal transitory injury.**

*Berberis spp*<sup>1</sup> *Ophiopogon japonicus*  
*Liriope sp.* *Viburnum sp.*

<sup>1</sup> Little to no injury observed in one or two container trial(s).

<sup>2</sup> Slight crop injury decreasing with time.

<sup>3</sup> Variable response observed with some trial exhibiting little to no injury at 1X with others exhibiting moderate injury.

<sup>4</sup> Little visible injury, but significant growth reduction observed in 2 trials.

**Table 6. List of Marengo G treated crops with no or minimal transitory injury seen at the 1X rate, but the 2X or 4X rate did cause significant phytotoxicity.**

<i>Chasmanthium sp.</i>	<i>Pennisetum sp.</i> <sup>3</sup>
<i>Delosperma spp.</i> <sup>4</sup>	<i>Rudbeckia sp.</i> <sup>3</sup>
<i>Echinacea sp.</i>	<i>Sedum sp.</i> <sup>3</sup>
<i>Heuchera sanguinea</i>	

**Table 7. List of Marengo G treated crops exhibiting significant injury.**

<i>Agave sp.</i>	<i>Hydrangea sp.</i>
<i>Hemerocallis sp.</i> <sup>3</sup>	<i>Iberis sp.</i>
<i>Hosta sp.</i>	<i>Salvia nemorosa</i>

**Table 8. List of Marengo G treated crops where more information is needed.**

<i>Aloe sp.</i>	<i>Hibiscus sp.</i> <sup>1</sup>
<i>Aucuba japonica</i> <sup>1</sup>	<i>Ilex sp.</i> <sup>1</sup>
<i>Buxus spp.</i> <sup>1</sup>	<i>Rosa sp.</i>
<i>Cornus kousa</i> <sup>1</sup>	<i>Thuja sp.</i>
<i>Euonymus alaus</i> <sup>1</sup>	
<i>Forsythia intermedia</i>	

<sup>1</sup> Little to no injury observed in one or two container trial(s).

<sup>2</sup> Slight crop injury decreasing with time.

<sup>3</sup> Variable response observed with some trial exhibiting little to no injury at 1X with others exhibiting moderate injury.

<sup>4</sup> Little visible injury, but significant growth reduction observed in 3 trials.

**Table 9. Detailed Summary of Crop Safety Testing with Indaziflam Granular Formulations**

Notes: Table entries are sorted by crop Latin name. Only those trials with research reports received by 5/27/15 are listed below.

PR#	Product	Crop	Production Site	Researcher	State	Year	Application Type	Results	EPA Reg ?
30004	Indaziflam 0.03% G	Maple, Japanese ( <i>Acer palmatum</i> )	Field Container	Senesac	NY	2011	Broadcast	Slight crop injury decreasing with time with two applications at 0.045, 0.089, or 0.178 lb aia. All plants marketable.	N
30007	Indaziflam 0.03% G	Boxwood ( <i>Buxus</i> sp.) B. sempervirens 'Graham Blandy'	Field Container	Senesac	NY	2011	Broadcast	No crop injury with two applications at 0.045, 0.089, or 0.178 lb aia.	Y
30031	Indaziflam 0.03% G	Sedge ( <i>Carex</i> sp.) c. comans 'Red Rooster'	Field Container	Boydston	WA	2011	Broadcast	Two sequential applications of Indaziflam 0.03% G applied 6 weeks apart at 0.045 lb, 0.089, and 0.178 lb ai per acre rates did not injure or affect growth of carex plants.	Y
30036	Indaziflam 0.03% G	Palm, Dwarf Fan ( <i>Chamaerops humilis</i> )	Field Container	Senesac	NY	2011	Broadcast	No crop injury with two applications at 0.045, 0.089, or 0.178 lb aia.	N
30013	Indaziflam 0.03% G	Jasmine, Cape, Common Gardenia ( <i>Gardenia</i> sp.) <i>G. radicans</i>	Field Container	Derr	VA	2011	Broadcast	No phytotoxicity with 0.045, .09, or .18 lb ai per acre but the 2 and 4x rates reduced growth and stand. Indaziflam gave fair to good control of bittercress, chamberbitter, eclipta, phyllanthus, and common groundsel with lower control of spotted spurge and	Y
30028	Indaziflam 0.03% G	Silver Grass ( <i>Miscanthus</i> sp.) <i>M. sinensis</i> 'Gracillimus'	Field Container	Neal	NC	2011	Broadcast	Initial application at 0.113 and 0.226 lb ai per acre reduced growth and flower production increasing with second application. At 0.056 lb ai per acre exhibited significant injury in only one of nine rating dates.	Y
30032	Indaziflam 0.03% G	Muhly, hairyawn ( <i>Muhlenbergia capillaris</i> ) <i>M. capillaris</i>	Field Container	Gilliam	AL	2012	Broadcast	No injury with 50, 100 and 200 g ai per ha after 1st applic., slight injury only with 200 g ai after 2nd applic.; slight stunting at the 2 higher rates.	Y
30032	Indaziflam 0.03% G	Muhly, hairyawn ( <i>Muhlenbergia capillaris</i> ) <i>M. capillaris</i>	Field Container	Neal	NC	2011	Broadcast	Necrosis and reduced growth and flower production observed with two applications at 0.056, 0.113, and 0.226 lb ai per acre increasing with rate.	Y
30017	Indaziflam 0.03% G	Heavenly Bamboo ( <i>Nandina domestica</i> ) N. 'Fire Power'	Field Container	Freiberger	NJ	2011	Broadcast	No crop injury or growth reduction with two applications at 50, 100, 200 g ai/ha.	Y
31339	Indaziflam 0.03% G	Spruce, Colorado ( <i>Picea pungens</i> ) <i>P. pungens</i> .var. <i>glauca</i>	Field Container	Mathers (OSU)	OH	2011	Broadcast	Little to no crop injury with two sequential applications at 0.11, 0.22 and 0.44 lb ai per acre using 7 gallon pot-in-pot system.	N
30018	Indaziflam 0.03% G	Oak ( <i>Quercus</i> sp.)	Field Container	Reding	OH	2012	Broadcast	No injury and no significant difference in growth or marketability at 200, 400 and 800 lb per acre applied twice.	N



PR#	Product	Crop	Production Site	Researcher	State	Year	Application Type	Results	EPA Reg ?
30018	Indaziflam 0.03% G	Oak (Quercus sp.) Q. ellipsoidal	Field Container	Freiberger	NJ	2011	Broadcast	Little to no crop injury or growth reduction with two applications at 50, 100, 200 g ai/ha. Some pots had fallen over and dried out over weekend.	N
30015	Indaziflam 0.03% G	Indian Hawthorn (Raphiolepis indica) R. 'Pink Lady'	Field Container	Uber	CA	2011	Broadcast	No crop injury or reduction in growth with 150, 300, and 600 lb ai per acre.	Y
30005	Indaziflam 0.03% G	Azalea (Rhododendron sp.) R. 'Haps Pink'	Field Container	Freiberger	NJ	2011	Broadcast	No crop injury or growth reduction with two applications at 50, 100, 200 g ai/ha.	Y
30005	Indaziflam 0.03% G	Azalea (Rhododendron sp.) R. 'Mother's Day'	Field Container	Freiberger	NJ	2011	Broadcast	No crop injury or growth reduction with two applications at 50, 100, 200 g ai/ha.	Y
30005	Indaziflam 0.03% G	Azalea (Rhododendron sp.) R. 'Red Ruffle'	Field Container	Gilliam	AL	2011	Broadcast	No crop injury or reduction in growth with 50, 100, 200 g/ha.	Y
30019	Indaziflam 0.03% G	Rose (Rosa sp.) R. 'Caramba'	Field Container	Boydston	WA	2011	Broadcast	Two sequential applications of Indaziflam 0.03% G applied 6 weeks apart at 0.045 lb, 0.089, and 0.178 lb ai per acre rates did not injure or affect growth or flowering of rose plants.	Y
30019	Indaziflam 0.03% G	Rose (Rosa sp.) R. 'Homerun'	Field Container	Freiberger	NJ	2011	Broadcast	No crop injury or growth reduction with two applications at 50, 100, 200 g ai/ha.	Y
30019	Indaziflam 0.03% G	Rose (Rosa sp.) R. 'Radrazz'	Field Container	Freiberger	NJ	2011	Broadcast	No crop injury or growth reduction with two applications at 50, 100, 200 g ai/ha.	Y
30019	Indaziflam 0.03% G	Rose (Rosa sp.) R. simsii 'Knockout'	Field Container	Gilliam	AL	2011	Broadcast	No crop injury or reduction in growth with 50, 100, 200 g/ha.	Y
30020	Indaziflam 0.03% G	Bridal-Wreath (Spiraea sp.) S. japonica 'Little Princess'	Field Container	Mickelbart	MI	2011	Broadcast	No crop injury with 50 and 100 g ai/ha, reduction in final width with 200 g ai/ha.	Y
30016	Indaziflam 0.03% G	Lilac (Syringa sp.) S. myeri 'Palibin'	Field Container	Mickelbart	MI	2011	Broadcast	No crop injury or reduction in growth at 50, 100, 200 g ai/A.	Y
30016	Indaziflam 0.03% G	Lilac (Syringa sp.) S. reticulata 'Ivory Silk'	Field Container	Mathers (OSU)	OH	2011	Broadcast	Slight yellowing of leaves in plant treated with 0.11 0.22 0.44 lb ai per acre but transplant shock confounded ratings. Resercher notes in a similar trial in MI plants (data not shown) in 4" pots were injured by 2x and 4x while no injury was evident in 1	Y
30022	Indaziflam 0.03% G	Yew (Taxus sp.) T. media	Field Container	Senesac	NY	2011	Broadcast	No crop injury with two applications at 0.045, 0.089, or 0.178 lb aia.	N
30022	Indaziflam 0.03% G	Yew (Taxus sp.) T. 'Runyon'	Field Container	Mathers (OSU)	OH	2011	Broadcast	Little to no crop injury with two sequential applications at 0.11 and 0.22 lb ai per acre but significant injury and growth reduction with 0.44 lb ai per acre.	N
30022	Indaziflam 0.03% G	Yew (Taxus sp.) T. x media 'Densiformis'	Field Container	Mickelbart	MI	2011	Broadcast	Minor crop injury observed among plants treated with 50, 100, 200 g ai/ha but all plants saleable.	N

PR#	Product	Crop	Production Site	Researcher	State	Year	Application Type	Results	EPA Reg ?
31327	Marengo G (0.0224%)	Century Plant (Agave sp.) 'Blue Flame'	Field Container	Villavicencio	CA	2012	Broadcast	Severe chlorosis and necrosis with 200, 400 and 800 lb per acre applied twice; moderate discoloration at 2X and 4X; no growth reduction.	N
31326	Marengo G (0.0224%)	Aloe (Aloe sp.) 'Blue Elf'	Field Container	Villavicencio	CA	2012	Broadcast	Slight necrosis and spotting with 200, 400 and 800 lb per acre applied twice; moderate discoloration at 4X; no growth reduction.	N
30924	Marengo G (0.0224%)	Aucuba (Aucuba sp.) A. japonica 'Variegata'	Field Container	Pemberton	TX	2012	Broadcast	No injury or growth reduction with 150, 300 and 600 lb per acre applied twice.	Y
30006	Marengo G (0.0224%)	Barberry (Berberis sp.) B. thunbergii atropurpurea 'Rosy Glow'	Field Container	Beste/Frank (ARS)	MD	2012	Broadcast	No injury, growth or marketability reduction with 200, 400 and 800 per acre applied twice.	Y
30006	Marengo G (0.0224%)	Barberry (Berberis sp.) B. thunbergii 'Crimson Pigmy'	Field Container	Beste/Frank (ARS)	MD	2013	Over-the-top	No injury or growth reduction with 200, 400 and 800 lb per acre applied twice; no reduction in marketability.	Y
30006	Marengo G (0.0224%)	Barberry (Berberis sp.) 'Crymson Pygmy'	Field Container	Mathers (OSU)	OH	2012	Broadcast	No injury with 200, 400 and 800 lb per acre applied twice.	Y
31315	Marengo G (0.0224%)	Boxwood (Buxus sp.) 'Green Mountain'	Field Container	Beste/Frank (ARS)	MD	2012	Broadcast	No significant injury observed at 0.045, 0.09, and 0.179 lb ai per acre.	Y
31315	Marengo G (0.0224%)	Boxwood (Buxus sp.) 'Green Velvet'	Field Container	Mathers (OSU)	OH	2012	Broadcast	Virtually no injury with 200, 400 and 800 lb per acre applied twice.	Y
31067	Marengo G (0.0224%)	Northern Sea Oats, Wild Oats (Chasmanthium latifolium)	Field Container	Hanson	CA	2013	Over the top	No injury after 1st applic., slight to severe injury (leaf necrosis) with 50, 100 and 200 g ai per acre after 2nd applic.; slight to severe growth reduction.	N
31067	Marengo G (0.0224%)	Northern Sea Oats, Wild Oats (Chasmanthium latifolium)	Field Container	Wilen	CA	2014	Over the top	Moderate to high injury increasing with rates (200, 400 and 800 lb per acre) applied twice; no growth reduction.	N
31067	Marengo G (0.0224%)	Northern Sea Oats, Wild Oats (Chasmanthium latifolium) D. nubigenum 'Basutoland'	Field Container	Senesac	NY	2014	Over the top	Slight injury with 0.0448, 0.0896 and 0.1792 lb ai per acre applied twice.	N
30011	Marengo G (0.0224%)	Dogwood (Cornus sp.) C. kousa	Field Container	Derr	VA	2011	Broadcast	No crop injury or growth reduction with 0.045, 0.09, 0.18 lb ai per acre. Indaziflam gave fair to good control of bittercress, chamberbitter, eclipta, phyllanthus, and common groundsel with lower control of spotted spurge and fragrant flatsedge, depending	N
30932	Marengo G (0.0224%)	Delosperma sp. (Delosperma sp.)	Field Container	Reding	OH	2012	Broadcast	No injury with 200 and 400, moderate with 800 lb per acre, applied twice; significant growth reduction at 2X and 4X; not marketable at 4X.	N

PR#	Product	Crop	Production Site	Researcher	State	Year	Application Type	Results	EPA Reg ?
30932	Marengo G (0.0224%)	Delosperma sp. (Delosperma sp.) D. congestum 'White Nugget'	Field Container	Klett	CO	2014	Over the top	No injury with 200, 400 and 800 lb per acre applied twice; slight and moderate growth reduction with 2X and 4X	N
30932	Marengo G (0.0224%)	Delosperma sp. (Delosperma sp.) D. cooperi	Field Container	Klett	CO	2012	Broadcast	No injury with 200 and 400 lb per acre applied twice, slight with 800 lb; slight growth reduction only at 2X.	N
30932	Marengo G (0.0224%)	Delosperma sp. (Delosperma sp.) D. cooperi 'Purple Mountain'	Field Container	Boydston	WA	2014	Over the top	No injury or growth reduction with 0.0446, 0.0892 and 0.1784 lb ai per acre applied twice; all treated plants marketable.	N
30932	Marengo G (0.0224%)	Delosperma sp. (Delosperma sp.) D. nubigenum 'Basutoland'	Field Container	Senesac	NY	2014	Over the top	Slight injury with 0.0448, 0.0896 and 0.1792 lb ai per acre applied twice.	N
30736	Marengo G (0.0224%)	Purple Coneflower (Echinacea sp.)	Field Container	Harvey	WA	2012	Broadcast	Some injury with 200, moderate with 400 and 800 lb per acre applied twice; untreated Check also showed some injury.	Y
30736	Marengo G (0.0224%)	Purple Coneflower (Echinacea sp.) 'Magnus'	Field Container	Boydston	WA	2012	Broadcast	No injury with 200, 400 and 800 lb per acre after 1st application, slight to moderate injury and growth reduction after 2nd applic; all 1X, and 4 of 6 treated plants saleable.	Y
30736	Marengo G (0.0224%)	Purple Coneflower (Echinacea sp.) 'Magnus'	Field Container	Boydston	WA	2013	Broadcast	Minor injury, no growth reduction with 0.0446 and 0.0892 lb ai per acre; severe with 0.1784 lb; 4X plants not saleable.	Y
30012	Marengo G (0.0224%)	Euonymus (Euonymus sp.) E. alatus 'Compacta'	Field Container	Mathers (OSU)	OH	2012	Broadcast	Slight, acceptable injury with 200, 400 and 800 lb per acre applied twice; comparable to untreated check.	Y
30012	Marengo G (0.0224%)	Euonymus (Euonymus sp.) E. alatus 'Compactus'	Field Container	Boydston	WA	2013	Broadcast	No injury or growth reduction with 0.0446, 0.0892 and 0.1784 lb ai per acre applied twice; all plants saleable.	Y
30937	Marengo G (0.0224%)	Golden Bells (Forsythia sp.) F. intermedia 'Golden Bells'	Field Container	Beste/Frank (ARS)	MD	2013	Over-the-top	Results inconclusive because 80 % of plants died due to water-logging; researcher suggested repeating trial.	Y
30737	Marengo G (0.0224%)	Daylily (Hemerocallis sp.)	Field Container	Harvey	WA	2012	Broadcast	No injury with 200, 400 and 800 lb per acre applied twice.	Y
30737	Marengo G (0.0224%)	Daylily (Hemerocallis sp.) 'Happy Returns' & 'Stella de Oro'	Field Container	Ahrens/Mervosh	CT	2012	Over the top	Very slight injury with 200, 400, and 800 lb per acre applied twice.	Y
30737	Marengo G (0.0224%)	Daylily (Hemerocallis sp.) 'Stella de Oro'	Field Container	Beste/Frank (ARS)	MD	2012	Broadcast	No significant injury, growth or marketability reduction with 200 lb per acre applied twice; reduction in marketability at 400 and 800 lb due to reduced growth and flowering.	Y

PR#	Product	Crop	Production Site	Researcher	State	Year	Application Type	Results	EPA Reg ?
30737	Marengo G (0.0224%)	Daylily (Hemerocallis sp.) 'Stella de Oro'	Field Container	Boydston	WA	2012	Broadcast	Moderate injury with 0.0446, 0.0892 and 0.1784 lb ai per acre applied twice; some plants not saleable.	Y
30737	Marengo G (0.0224%)	Daylily (Hemerocallis sp.) 'Stella de Oro'	Field Container	Neal	NC	2012	Broadcast	Moderate injury (leaf chlorosis and tip necrosis, reduced growth) with 0.045, 0.09 and 0.18 lb ai per acre with 2 applic.	Y
30738	Marengo G (0.0224%)	Coral Bells, Alumroot (Heuchera sanguinea)	Field Container	Harvey	WA	2012	Broadcast	No injury with 200, 400 and 800 lb per acre applied twice.	N
30738	Marengo G (0.0224%)	Coral Bells, Alumroot (Heuchera sanguinea)	Field Container	Reding	OH	2012	Broadcast	No injury and no significant difference in growth or marketability at 200, 400 and 800 lb per acre applied twice.	N
30738	Marengo G (0.0224%)	Coral Bells, Alumroot (Heuchera sanguinea) 'Ruby Bells'	Field Container	Beste/Frank (ARS)	MD	2012	Broadcast	No significant injury, growth or marketability reduction with 200 and 400 lb per acre applied twice; high injury and growth reduction at 4X.	N
30027	Marengo G (0.0224%)	Mallow, Rose Mallow (Hibiscus sp.)	Field Container	Reding	OH	2012	Broadcast	No injury and no significant difference in growth or marketability at 200, 400 and 800 lb per acre applied twice.	Y
30027	Marengo G (0.0224%)	Mallow, Rose Mallow (Hibiscus sp.) H. moscheutos 'Luna White'	Field Container	Boydston	WA	2012	Broadcast	No injury or growth reduction with 0.0446, 0.0892 and 0.1784 lb ai per acre applied twice.	Y
30741	Marengo G (0.0224%)	Hosta (Hosta sp.)	Field Container	Harvey	WA	2012	Broadcast	No injury with 200, 400 and 800 lb per acre applied twice.	Y
30741	Marengo G (0.0224%)	Hosta (Hosta sp.) H. fortunei 'Gold Standard'	Field Container	Ahrens/Mervosh	NY	2012	Over the top	Slight injury with 200, 400, and 800 lb per acre applied twice.	Y
30741	Marengo G (0.0224%)	Hosta (Hosta sp.) 'Hadspen Blue'	Field Container	Boydston	WA	2012	Broadcast	Moderate injury but no growth reduction with 200, 400 and 800 lb per acre applied twice; some treated plants saleable.	Y
30741	Marengo G (0.0224%)	Hosta (Hosta sp.) 'Pineapple Upside Down'	Field Container	Neal	NC	2012	Broadcast	Moderate injury (leaf spotting, reduced growth) with 0.045, 0.09 and 0.18 lb ai per acre with 2 applic.	Y
30740	Marengo G (0.0224%)	Hydrangea (Hydrangea sp.)	Field Container	Harvey	WA	2012	Broadcast	Severe injury with 200, 400 and 800 lb per acre applied twice.	Y
30740	Marengo G (0.0224%)	Hydrangea (Hydrangea sp.) 'Endless Summer'	Field Container	Mathers (OSU)	OH	2012	Broadcast	Severe injury with 200, 400 and 800 lb per acre applied twice.	Y
30740	Marengo G (0.0224%)	Hydrangea (Hydrangea sp.) H. macrophylla 'Endless Summer'	Field Container	Ahrens/Mervosh	CT	2012	Over the top	Severe injury with 200, 400, and 800 lb per acre applied twice.	Y
30740	Marengo G (0.0224%)	Hydrangea (Hydrangea sp.) 'Invincibelle'	Field Container	Mathers (OSU)	OH	2012	Broadcast	Moderate to severe injury with 200, 400 and 800 lb per acre applied twice.	Y
30740	Marengo G (0.0224%)	Hydrangea (Hydrangea sp.) 'Limelight'	Field Container	Mathers (OSU)	OH	2012	Broadcast	Slight injury with complete recovery at 200 lb per acre applied twice; moderate and high injury with recovery to acceptable injury at 400 and 800 lb per acre.	Y

PR#	Product	Crop	Production Site	Researcher	State	Year	Application Type	Results	EPA Reg ?
31071	Marengo G (0.0224%)	Candytuft (Iberis sp.) 'Candytuft'	Field Container	Boydston	WA	2013	Broadcast	Moderate injury at 0.0446, severe at 0.0892 and 0.1784 lb ai per acre applied twice; plants not saleable.	N
30014	Marengo G (0.0224%)	Holly (Ilex sp.)	Field Container	Reding	OH	2012	Broadcast	No injury and no significant difference in growth or marketability at 200, 400 and 800 lb per acre applied twice.	Y
30014	Marengo G (0.0224%)	Holly (Ilex sp.) I. vomitoria 'Stoke's Dwarf'	Field Container	Fraelich	GA	2012	Broadcast	No injury or significant difference in plant growth or marketability with 200, 400 and 800 lb per acre applied twice.	Y
30954	Marengo G (0.0224%)	Lilyturf, Creeping (Liriope sp.) L. gigantea	Field Container	Uber	CA	2012	Broadcast	No injury or growth reduction with 200, unacceptable with 400 and 800 lb per acre applied twice.	Y
30954	Marengo G (0.0224%)	Lilyturf, Creeping (Liriope sp.) L. muscari 'Aztec Grass'	Field Container	Fraelich	GA	2012	Broadcast	No injury or significant difference in plant growth or marketability with 200, 400 and 800 lb per acre applied twice.	Y
30954	Marengo G (0.0224%)	Lilyturf, Creeping (Liriope sp.) L. muscari 'Big Blue'	Field Container	Czarnota	GA	2012	Over the top	No injury with 200 and 400 lb per acre, slight with 800 lb, applied twice; no height reduction.	Y
30954	Marengo G (0.0224%)	Lilyturf, Creeping (Liriope sp.) L. spicata	Field Container	Gilliam	AL	2012	Broadcast	No injury or growth reduction with 50, 100 and 200 g ai per ha applied twice.	Y
30955	Marengo G (0.0224%)	Mondo Grass, Lilyturf, Ker-Gawl (Ophiopogon sp.) O. japonica	Field Container	Uber	CA	2012	Broadcast	No injury with 200, moderate with 400 and 800 lb per acre, applied twice; moderate growth reduction at 2X and 4X.	Y
30955	Marengo G (0.0224%)	Mondo Grass, Lilyturf, Ker-Gawl (Ophiopogon sp.) O. japonicas	Field Container	Czarnota	GA	2012	Over the top	No injury with 200, 400 and 800 lb per acre applied twice; no height reduction.	Y
30955	Marengo G (0.0224%)	Mondo Grass, Lilyturf, Ker-Gawl (Ophiopogon sp.) O. japonicus	Field Container	Gilliam	AL	2012	Broadcast	No injury or growth reduction with 50, 100 and 200 g ai per ha applied twice.	Y
30029	Marengo G (0.0224%)	Feathergrass (Pennisetum sp.)	Field Container	Harvey	WA	2012	Broadcast	No injury with 200, 400 and 800 lb per acre applied twice.	Y
30029	Marengo G (0.0224%)	Feathergrass (Pennisetum sp.) P. alopecuroides 'Hameln'	Field Container	Boydston	WA	2012	Broadcast	No injury with 200, slight with 400 and 800 lb per acre applied twice; all 1X and 2X plants, and 4 of 6 4X plants, saleable.	Y
30029	Marengo G (0.0224%)	Feathergrass (Pennisetum sp.) P. setaceum	Field Container	Gilliam	AL	2012	Broadcast	Minor injury at 50 and 100 g ai per ha, moderate at 200 ga ai after the first applic., moderate to severe injury after 2nd applic.	Y
30029	Marengo G (0.0224%)	Feathergrass (Pennisetum sp.) P. villosum	Field Container	Senesac	NY	2012	Broadcast	Low injury with 0.045, 0.09 and 0.179 lb ai per acre after 1st application; severe injury (lack of vigor) after 2nd application.	Y
31319	Marengo G (0.0224%)	Azalea (Rhododendron sp.)	Field Container	Harvey	WA	2012	Broadcast	Data from trial inconclusive because of severe injury in untreated Check.	Y

PR#	Product	Crop	Production Site	Researcher	State	Year	Application Type	Results	EPA Reg ?
31319	Marengo G (0.0224%)	Azalea (Rhododendron sp.) 'Delaware Valley White'	Field Container	Ahrens/Mervosh	CT	2012	Over the top	Virtually no injury with 200 and 400, minor with 800 lb per acre applied twice.	Y
31320	Marengo G (0.0224%)	Rose (Rosa sp.)	Field Container	Harvey	WA	2012	Over the top	No injury with 200, 400 and 800 lb per acre applied twice.	Y
31320	Marengo G (0.0224%)	Rose (Rosa sp.) 'Knockout'	Field Container	Mathers (OSU)	OH	2012	Broadcast	No injury with 200 and 400 lb per acre applied twice; slight, acceptable injury with 800 lb.	Y
30743	Marengo G (0.0224%)	Coneflower (Rudbeckia sp.)	Field Container	Gilliam	AL	2013	Over the top	Unacceptable injury with 200, 400 and 800 lb per acre applied twice.	N
30743	Marengo G (0.0224%)	Coneflower (Rudbeckia sp.) 'Goldsturm'	Field Container	Boydston	WA	2013	Broadcast	No to slight injury or growth reduction at 0.0446 and 0.0892 lb ai per acre applied twice, moderate at 0.1784 lb; 4X plants not saleable.	N
30743	Marengo G (0.0224%)	Coneflower (Rudbeckia sp.) 'Goldsturm'	Field Container	Boydston	WA	2014	Over the top	No injury with 0.0446, slight and moderate with 0.0892 and 0.1784 lb ai per acre applied twice; all 1X- and most 2X-treated plants marketable.	N
30743	Marengo G (0.0224%)	Coneflower (Rudbeckia sp.) 'Tiger Eye Gold'	Field Container	Senesac	NY	2014	Over the top	Slight injury with 0.0448, 0.0896 and 0.1792 lb ai per acre applied twice.	N
30744	Marengo G (0.0224%)	Pasture Sage (Salvia nemorosa) 'Caradonna'	Field Container	Beste/Frank (ARS)	MD	2012	Broadcast	Severe injury with 200, 400 and 800 lb per acre after one application.	Y
30744	Marengo G (0.0224%)	Pasture Sage (Salvia nemorosa) 'May Night'	Field Container	Boydston	WA	2012	Broadcast	Slight injury but no growth reduction with 0.0446, 0.0892 and 0.1784 lb ai per acre applied twice; all plants saleable.	Y
30744	Marengo G (0.0224%)	Pasture Sage (Salvia nemorosa) 'May Night'	Field Container	Derr	VA	2012	Broadcast	Unacceptable injury with 0.045, 0.089 and 0.178 lb ai per acre applied twice.	Y
30745	Marengo G (0.0224%)	Stonecrop (Sedum sp.)	Field Container	Reding	OH	2012	Broadcast	No injury and no significant difference in growth or marketability at 200, 400 and 800 lb per acre applied twice.	N
30745	Marengo G (0.0224%)	Stonecrop (Sedum sp.) 'Kamschaticum'	Field Container	Boydston	WA	2012	Broadcast	No injury or growth reduction with 0.0446 and 0.0892 lb ai per acre applied twice; all plants saleable.	N
30745	Marengo G (0.0224%)	Stonecrop (Sedum sp.) 'Matrona'	Field Container	Boydston	WA	2012	Broadcast	No injury or growth reduction with 200, 400 and 800 lb per acre applied twice; all treated plants saleable.	N
30745	Marengo G (0.0224%)	Stonecrop (Sedum sp.) S. spurium 'Dragon's Blood'	Field Container	Klett	CO	2012	Broadcast	No injury with 200 lb per acre applied twice, slight with 400 and severe with 800; moderate and severe growth reduction at 2X and 4X.	N
30745	Marengo G (0.0224%)	Stonecrop (Sedum sp.) S. ternatum 'Larinem Park'	Field Container	Senesac	NY	2012	Broadcast	Low injury with 0.045, 0.09 and 0.179 lb ai per acre after 1st application; severe injury (lack of vigor and necrosis) after 2nd application.	N
31440	Marengo G (0.0224%)	Arborvitae (Thuja sp.) T. nigra	Field Container	Mathers (OSU)	OH	2012	Broadcast	No injury with 200, 400 and 800 lb per acre applied twice.	Y

PR#	Product	Crop	Production Site	Researcher	State	Year	Application Type	Results	EPA Reg ?
30021	Marengo G (0.0224%)	Arrowwood (Viburnum sp.)	Field Container	Harvey	WA	2012	Broadcast	No injury with 200, 400 and 800 lb per acre applied twice.	Y
30021	Marengo G (0.0224%)	Arrowwood (Viburnum sp.) 'Jeddi'	Field Container	Mathers (OSU)	OH	2012	Broadcast	Slight, acceptable injury with 200, 400 and 800 lb per acre applied twice.	Y
30021	Marengo G (0.0224%)	Arrowwood (Viburnum sp.) 'St. Veverne'	Field Container	Mathers (OSU)	OH	2012	Broadcast	Moderate injury with 200, 400 and 800 lb per acre applied twice; comparable to untreated check.	Y

## Label Suggestions

It is suggested that the following crops be added to the Marengo G label:

*Taxus media*

For Marengo G, it is suggested that several crop species exhibiting moderate to severe injury in testing be placed on the label as sensitive with over the top applications:

*Agave sp.*

*Chasmanthium sp.*

*Delosperma spp.* (stunting)

*Echinacea sp.*

*Hemerocallis sp.*

*Heuchera sanguinea*

*Hosta sp.*

*Iberis sp.*

*Pennisetum sp.*

*Rudbeckia sp.*

*Sedum sp.*



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