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## **IR-4 Environmental Horticulture Program Biathlon(Oxyfluorfen + Prodiamine) Crop Safety**

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## Abstract

From 2009 through 2018, IR-4 completed 246 trials evaluating Biathlon (oxyfluorfen + prodiamine) crop safety to crops grown in field containers. The data contained in this report were generated to register uses of oxyfluorfen + prodiamine as over-the-top applications on and around environmental horticulture plants. The rates tested were 2.75 (1X), 5.5 (2X) and 11.0 (4X) pounds active ingredient per acre (lb ai per acre). Biathlon was applied to 130 plant species / genera. Thirty-two species / genera exhibited no or minimal transient injury in at least 3 trials. Results are summarized at the species level, as there is some evidence that crop safety can differ at the varietal level. On the Biathlon label, *Potentilla fruticosa* appears twice: it may be used on the variety 'Abbotswood' but is not recommended on 'Goldfinger'. More data are needed to establish the actual varietal sensitivities within *Potentilla fruticosa* and identify other species with the same difficulty. Based on the data provided here, we recommend that *Acer palmatum*, *Arctostaphylos* sp., *Betula nigra*, *Camelia japonica*, *Chasmantium latifolium*, *Cornus florida*, *Cornus kousa*, *Cornus sericea*, *Dasiphora fruticosa*, *Dryopteris erythrosora*, *Distylium* sp., *Gladiolus* spp., *Lantana camara*, *Mahonia aquifolium*, *Pachysandra terminalis*, *Quercus rubra*, *Rosmarinus officinalis*, *Rudbeckia* spp., *Salvia nemorosa* and *Sedum* spp. be added to the Biathlon label along with 13 additional varieties of species already listed in the label.

## Introduction

Non-phytotoxic and effective residual control of broadleaved weeds and sedges in the production of woody and herbaceous perennials can be problematic. Nurseries grow many different types of plants, and not all genera or species are listed on labels. Some weeds may also be difficult to control in landscape settings for the same reason. Between 2009 and 2018, the IR-4 Project has conducted 246 trials evaluating Biathlon crop safety applied as over-the-top applications on and around environmental horticulture plants. The data contained in this summary report were generated to help add new crops to the Biathlon label.

## Materials and Methods

From 2009 to 2018, two applications of Biathlon were made approximately 6 weeks apart, with the first application within 7 days of transplanting, to plants grown in field containers. The application rates were 2.75, 5.5 and 11.0 lb ai per acre, plus a water treated control. A minimum number of 10 plants (replicate treatments) were required. Phytotoxicity was recorded using a scale of 0 to 10 (0 = no phytotoxicity; 10 = complete kill) at approximately 1, 2, 4, 7, 8 and 10 weeks after initial application. Plant size was also evaluated for several species at the time of the first application and again at the time of the last evaluation. The protocols used were 09-020, 10-001, 11-004, 12-014, 13-014, 14-009, 15-009, 16-010, 17-010 and 18-012. Please visit <https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-researcher-resources/#Protocols> to view and download these protocols.

Biathlon was supplied to researchers (See list of researchers in Appendix 1) by OHP, Inc.

## Results and Summary

### ***Phytotoxicity***

Based on the type and nature of injury seen with Biathlon 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 are needed to make informed recommendations.

Biathlon exhibited no or minimal negative impact on 32 species / genera when applied as a broadcast, over the top application to crops grown in field containers (Table 1). 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.

Three species / genera exhibited significant injury or growth reduction with Biathlon at the 2X and/or 4X rate (Table 2). Five of the tested species / genera exhibited damage sufficient to recommend growers not utilize Biathlon as an over-the-top treatment for pre-emergent weed control at the recommended label rate (Table 3). For 87 species / genera, more information is needed either because only 1 or 2 trials were conducted or because consistent results were not achieved among the research sites (Table 4). *Potentilla fruticosa* ‘Goldfinger’ exhibited no signs of injury in 3 trials conducted by IR-4, although use is not recommended specifically for this variety in the Biathlon label. Use of Biathlon is allowed in another variety of the same species, *Potentilla fruticosa* ‘Abbotswood’.

Please see Table 5 for a list of individual trial summaries on Biathlon.

**Table 1. List of Biathlon treated crops with no or minimal transitory injury in a minimum of three trials.**

<i>Acer</i> spp.	<i>Juniperus</i> spp.
<i>A. palmatum</i>	<i>Juniperus chinensis</i> ‘variegata’ <sup>1</sup>
<i>A. rubrum</i> <sup>1</sup>	<i>Juniperus horizontalis</i> <sup>1</sup>
<i>Arctostaphylos</i> spp.	<i>Juniperus virginiana</i> <sup>1</sup>
<i>Berberis thunbergii</i> <sup>1</sup>	<i>Lantana camara</i>
<i>Betula nigra</i>	<i>Mahonia aquifolium</i>
<i>Camellia japonica</i>	<i>Pachysandra terminalis</i>
<i>Chasmantium latifolium</i>	<i>Photinia</i> sp.
<i>Cornus</i> spp.	<i>Potentilla (Drasiphora) fruticosa</i> <sup>2,3</sup>
<i>Cornus florida</i>	<i>Quercus rubra</i>
<i>Cornus kousa</i>	<i>Rhododendron</i> sp. (Azalea) <sup>1</sup>
<i>Cornus sanguinea</i> <sup>1</sup>	<i>Rosa</i> spp. <sup>1</sup>
<i>Cornus sericea</i>	<i>Rosmarinus officinalis</i>
<i>Distylium</i> sp.	<i>Rudbeckia</i> sp.
<i>Dryopteris erythrosora</i>	<i>Salvia nemorosa</i>
<i>Euonymus japonica</i> <sup>1</sup>	<i>Sedum</i> sp.
<i>Gardenia jasminoides</i> <sup>1</sup>	<i>Viburnum</i> sp. <sup>1</sup>
<i>Gladiolus</i> sp. (see Mathers)	

<sup>1</sup>Already registered

<sup>2</sup>On label, use not recommended

<sup>3</sup>Variations in crop safety at the varietal level: IR-4 tested ‘Abbotswood’, ‘Goldfinger’ and ‘Pink Beauty’ with no observed injury, but the label indicates ‘Goldfinger’ is sensitive to Biathlon.

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

*Crassula radicans*  
*Hemerocallis* sp.  
*Kerria japonica*

**Table 3. List of Biathlon treated crops exhibiting significant injury at the 1X rate.**

*Crassula capitella*  
*Echeveria* sp.  
*Echeveria nodulosa*  
*Echeveria shaviana*  
*Osteospermum* sp.

**Table 4. List of Biathlon treated crops where more research is needed to clarify response.**

<i>Agapanthus campanulatus</i>	<i>Forsythia</i> sp.	<i>Oxydendrum arboreum</i>
<i>Agapanthus</i> sp.	<i>Hedera helix</i> ssp. <i>Helix</i>	<i>Pennisetum setaceum</i>
<i>Aucuba japonica</i>	<i>Heuchera x brizoides</i>	<i>Penstemon digitalis</i>
<i>Berlandiera lyrata</i>	<i>Heuchera micrantha</i>	<i>Penstemon</i> sp.
<i>Betula papyrifera</i>	<i>Heuchera sanguinea</i>	<i>Photinia fraseri</i>
<i>Buddleia davidii</i> <sup>1</sup>	<i>Hibiscus moscheuto</i>	<i>Photinia</i> sp.
<i>Callistemon citrinus</i>	<i>Hibiscus syriacus</i> <sup>1</sup>	<i>Picea abies</i>
<i>Callistemon viminalis</i>	<i>Hosta fortunei</i>	<i>Picea pungens</i>
<i>Calluna</i> sp.	<i>Hosta</i> sp.	<i>Picea sitchensis</i>
<i>Calluna vulgaris</i>	<i>Hydrangea macrophylla</i> <sup>2</sup>	<i>Pieris japonica</i>
<i>Camellia sasanqua</i>	<i>Hypericum calycinum</i>	<i>Pinus contorta</i>
<i>Cassia</i> sp.	<i>Hypericum frondosum</i>	<i>Pinus mugo</i>
<i>Chamaecyparis pisifera</i>	<i>Iberis sempervirens</i>	<i>Prunus x cistena</i>
<i>Chrysanthemum x rubellum</i>	<i>Iberis</i> sp.	<i>Prunus</i> sp.
<i>Chrysanthemum / Dendranthema</i> sp.	<i>Iris</i> sp.	<i>Pseudotsuga menziesii</i>
<i>Cleyera japonica</i>	<i>Iris versicolor</i>	<i>Pyrus communis</i>
<i>Crataegus monogyna</i>	<i>Juglans regia</i>	<i>Quercus alba</i>
<i>Crataegus</i> sp.	<i>Juglans</i> sp.	<i>Quercus palustris</i>
<i>Cryptomeria japonica</i> <sup>1</sup>	<i>Kerria japonica</i>	<i>Quercus pinnata</i>
<i>Cupressus sempervirens</i>	<i>Leucanthemum maximum</i>	<i>Quercus virginiana</i>
<i>Cytisus scoparius</i>	<i>Leucanthemum x superbum</i>	<i>Raphiolepis indica</i>
<i>Delosperma cooperi</i>	<i>Lonicera involucrata</i>	<i>Santolina chamaecyparissus</i>
<i>Delosperma</i> sp.	<i>Lonicera nitida</i>	<i>Taxus x media</i> <sup>1</sup>
<i>Dendranthema zawadskii</i>	<i>Lonicera sempervirens</i>	<i>Trachelospermum asiaticum</i>
<i>Echinacea purpurea</i>	<i>Malus</i> sp.	<i>Tsuga canadensis</i>
<i>Echinacea</i> sp.	<i>Nandina domestica</i> <sup>1</sup>	<i>Tulipa</i> sp.
<i>Enkianthus campanulatus</i>	<i>Narcissus pseudonarcissus</i>	<i>Vinca minor</i> 'Bowles' <sup>1</sup>
<i>Euonymus alatus</i> <sup>2</sup>	<i>Narcissus</i> sp.	
<i>Forsythia intermedia</i>	<i>Nerium oleander</i>	
	<i>Ophiopogon jaburan</i>	
	<i>Osteospermum ecklonis</i>	

<sup>1</sup>Already registered

<sup>2</sup>On label, use not recommended

**Table 5. Detailed Summary of Crop Safety Testing with Oxyfluorfen + Prodiamine**

Notes: Table entries are sorted by crop Latin name. Only those trials with research reports received by 1/8/2018 are listed below.

PR #	Crop	Production Site	Researcher	State	Year	Application Type	Results
28979	Maple (Acer sp.) A. palmatum atropurpureum	Field Container	Beste/Frank (ARS)	MD	2010	Over the top	No crop injury or reduction in growth with one or two applications 2.75, 5.5, 11.0 lb ai per acre (unrelated leaf necrosis). Effective yel. Woodsorrel and spotted spurge control.
28979	Maple (Acer sp.) A. rubrum	Field Container	Beste/Frank (ARS)	MD	2011	Over the top	No significant injury, growth or marketability reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
28979	Maple (Acer sp.) A. rubrum	Field Container	Derr	VA	2010	Over the top	No crop injury with 2.75, 5.5, 11.0 lb ai per acre. Effective control of eclipta, crabgrass, and annual sedge with increasing rates.
28981	Lily-Of-The-Nile (Agapanthus sp.)	Field Container	Witcher	TN	2017	Over the top	No injury with 100, 200 and 400 lb per acre applied twice; minor height reduction with 2X and 4X.
28981	Lily-Of-The-Nile (Agapanthus sp.) A. campanulatus	Field Container	Beste	MD	2017	Over the top	Minor injury with 2.75, 5.5 and 11 lb ai per acre applied twice; all plants marketable.
28981	Lily-Of-The-Nile (Agapanthus sp.) 'Brilliant Blue'	Field Container	Wilén	CA	2017	Over the top	Minor and acceptable injury after the 1st applic, moderate and unacceptable after the 2nd applic, with 2.75, 5.5 and 11 lb ai per acre.
28983	Manzanita (Arctostaphylos sp.)	Field Container	Koivunen	CA	2016	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
28983	Manzanita (Arctostaphylos sp.)	Field Container	Miller	WA	2016	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
28983	Manzanita (Arctostaphylos sp.) A. uva ursi 'Massachusetts'	Field Container	DeFrancesco	OR	2016	Over the top	Very slight injury (leaf yellowing) only with 2.75 lb ai per acre; no growth reduction with 2.75, 5.5 and 11 lb ai per acre.
28984	Cape Weed (Arctotheca calendula) Osteospermum ecklonis	Field Container	Senesac	NY	2017	Over the top	Minor injury early with complete recovery with 2.75, 5.5 and 11 lb ai per acre applied twice.
28985	Aucuba (Aucuba sp.) A. japonica 'Gold Dust'	Field Container	Czarnota	GA	2013	Over the top	Inconclusive results due to variable injury from treatments, including untreated check.
28985	Aucuba (Aucuba sp.) A. japonica 'Variegata'	Field Container	Beste/Frank (ARS)	MD	2012	Over the top	Summer heat stress caused injury to all plants including untreated; trial should be repeated.
28985	Aucuba (Aucuba sp.) A. japonica 'Variegata'	Field Container	Pemberton	TX	2012	Over the top	No injury or growth reduction with 2.65, 5.3 and 10.6 lb ai per acre applied twice.
28985	Aucuba (Aucuba sp.) 'Lavender Dew'	Field Container	Uber	CA	2014	Over the top	Data not viable due to heat stress on plants.
28986	Barberry (Berberis sp.) B. thunbergii 'atropurpurea'	Field Container	Chandran	WV	2010	Over the top	No significant injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
28986	Barberry (Berberis sp.) B. thunbergii 'Crimson Pigmy'	Field Container	Beste/Frank (ARS)	MD	2011	Over the top	No significant injury, growth or marketability reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
28986	Barberry (Berberis sp.) B. thunbergii 'Crimson Pygmy'	Field Container	Beste/Frank (ARS)	MD	2010	Over the top	No crop injury or significant stunting with two applications at 2.75, 5.5, and 11 lb ai per acre. Excellent control of Eclipta, spotted spurge, PA bittercress and yel. Woodsorrel.
28986	Barberry (Berberis sp.) B. thunbergii 'Crimson Pygmy'	Field Container	Lieth	CA	2009	Over the top	No significant injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
28986	Barberry (Berberis sp.) B. thunbergii 'Crimson Pygmy'	Field Container	Mathers (OSU)	MI	2010	Over the top	Lincoln: No crop injury at 2.75, 5.5, and 11.0 lb ai per acre.



PR #	Crop	Production Site	Researcher	State	Year	Application Type	Results
28986	Barberry (Berberis sp.) B. thunbergii 'Crimson Pygmy'	Field Container	Mathers (OSU)	OH	2010	Over the top	Ohio: No crop injury at 2.75, 5.5, and 11.0 lb ai per acre.
28986	Barberry (Berberis sp.) B. thunbergii 'Crimson Pygmy'	Field Container	Mathers (OSU)	MI	2010	Over the top	Spring Meadow: No crop injury at 2.75, 5.5, and 11.0 lb ai per acre.
28986	Barberry (Berberis sp.) B. thunbergii 'Crimson Pygmy'	Field Container	Mathers (OSU)	MI	2010	Over the top	Zelenka: No crop injury at 2.75, 5.5, and 11.0 lb ai per acre.
28986	Barberry (Berberis sp.) B. thunbergii 'Helmond Pillar'	Field Container	Trader	MS	2009	Over the top	No injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
31095	Chocolate Flower/Lyreleaf Greeneyes (Berlandiera lyrata)	Field Container	Klett	CO	2017	Over the top	No injury or significant growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
28987	Birch, River (Betula nigra)	Field Container	Witcher	TN	2016	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
28987	Birch, River (Betula nigra) B. nigra 'Little King'	Field Container	Beste/Frank (ARS)	MD	2013	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice; no reduction in marketability.
28987	Birch, River (Betula nigra) B. nigra 'Summer Cascade'	Field Container	Boydston	WA	2013	Over the top	No injury or growth reduction with 2.75, 5.5, and 11.0 lb ai per acre applied twice; all plants saleable.
32542	Birch, Paper (Betula papyrifera)	Field Container	Siefer	OH	2017	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
28728	Butterfly Bush (Buddleia davidii) B. 'Nanho White'	Field Container	Derr	VA	2010	Over the top	No crop injury with 2.75, 5.5, and 11.0 lb ai per acre. Effective control of eclipta, crabgrass, and annual sedge with increasing rates.
28989	Bottlebrush (Callistemon sp.) C. citrinus	Field Container	Uber	CA	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
28989	Bottlebrush (Callistemon sp.) C. viminalis 'Macarthur'	Field Container	Wilen	CA	2017	Over the top	Very minor injury, no growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
28990	Heather (Calluna sp.)	Field Container	Miller	WA	2018	Over the top	No significant injury or growth reduction with 2.75, 5.5 and 11.0 lb ai per acre applied twice.
28990	Heather (Calluna sp.) C. vulgaris 'Winter Chocolate'	Field Container	Senesac	NY	2017	Over the top	Minor injury with 2.75, 5.5 and 11 lb ai per acre applied twice.
28991	Camellia (Camellia sp.) C. japonica 'Kanjiro'	Field Container	Gilliam	AL	2010	Over the top	No crop injury or reduction in growth with one or two applications at 2.75, 5.5, 11 lb ai per acre.
28991	Camellia (Camellia sp.) C. japonica 'Mrs. Tingley'	Field Container	Uber	CA	2010	Over the top	No crop injury observed with 2.75, 5.5, and 11.0 lb ai per acre at any time. Good efficacy on euphorbia maculata noted.
28991	Camellia (Camellia sp.) C. japonica 'Spring's Promise'	Field Container	Beste/Frank (ARS)	MD	2010	Over the top	No significant injury at 2.75, 5.5 and 11.0 lb ai per acre, but 27% reduction in height at 4X; no reduction in marketability at all rates. Excellent control of oxalis.
28991	Camellia (Camellia sp.) C. sasanqua 'Yuletide'	Field Container	Beste/Frank (ARS)	MD	2011	Over the top	No significant injury, growth or marketability reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
28993	Cassia; Senna (Cassia sp.)	Field Container	Witcher	TN	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
28998	Cedar (Chamaecyparis sp.) C. pisifera 'Gold Mop'	Field Container	Senesac	NY	2017	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre applied twice.
28998	Cedar (Chamaecyparis sp.) C. pisifera 'Vintage Gold'	Field Container	Siefer	OH	2017	Over the top	No injury or significant growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.

PR #	Crop	Production Site	Researcher	State	Year	Application Type	Results
31098	Indian Woodoats (Chasmanthium latifolium)	Field Container	Cochran	IA	2014	Over the top	Moderate injury with 2.75, 5.5 and 11 lb ai per acre applied twice; no significant growth reduction.
31098	Indian Woodoats (Chasmanthium latifolium)	Field Container	Hanson	CA	2013	Over the top	Slight injury (leaf necrosis) after the 2nd applic. with 2.75, 5.5 and 11 lb ai per acre; no significant growth reduction.
31098	Indian Woodoats (Chasmanthium latifolium)	Field Container	Senesac	NY	2015	Over the top	No injury after the first application, minor injury after second, with 2.75, 5.5 and 11 lb ai per acre.
31098	Indian Woodoats (Chasmanthium latifolium)	Field Container	Wilen	CA	2015	Over the top	No significant injury with 100, 200 and 400 lb per acre after 1st application, slight acceptable injury after 2nd applic. with 2X and 4X; no growth reduction. However, 4 months after application, shoot and root growth was decreased with increasing rate.
32713	Chrysanthemum x rubellum (Chrysanthemum x rubellum) 'Clara Curtis'	Field Container	Senesac	NY	2017	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre applied twice.
32713	Chrysanthemum x rubellum (Chrysanthemum x rubellum) Dendranthema zawadskii 'Clara Curtis'	Field Container	Klett	CO	2016	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
31099	Chrysanthemum, Garden (Chrysanthemum/Dendranthema sp.) 'Danielle Purple'	Field Container	Senesac	NY	2017	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre applied twice.
31099	Chrysanthemum, Garden (Chrysanthemum/Dendranthema sp.) 'Yolanda Yellow'	Field Container	Miller	WA	2016	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29001	Sakaki, Cleyera (Cleyera japonica)	Field Container	Neal	NC	2017	Over the top	No significant injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29002	Dogwood (Cornus sp.) C. florida	Field Container	Mathers (OSU)	OH	2010	Over the top	Ohio: No crop injury at 2.75, 5.5, and 11.0 lb ai per acre.
29002	Dogwood (Cornus sp.) C. kousa	Field Container	Derr	VA	2011	Over the top	No crop injury and little to no reduction in growth with 2.75, 5.5 or 11 lb ai per acre. Good bittercress control, poor to good control of spotted spurge, phyllanthus, and chamberbitter, good to excellent fragrant flatsedge control and poor ecipta control
29002	Dogwood (Cornus sp.) C. kousa 'Chinensis'	Field Container	Beste/Frank (ARS)	MD	2011	Over the top	No significant injury, growth or marketability reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29002	Dogwood (Cornus sp.) C. sanguinea 'Arctic Sun'	Field Container	Mathers (OSU)	MI	2010	Over the top	Spring Meadow: No crop injury at 2.75, 5.5, and 11.0 lb ai per acre.
29002	Dogwood (Cornus sp.) C. sericea 'Arctic Sun'	Field Container	Trader	MS	2009	Over the top	No injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
29002	Dogwood (Cornus sp.) C. sericea 'Baileyi'	Field Container	Mathers (OSU)	MI	2010	Over the top	Lincoln: No crop injury at 2.75, 5.5, and 11.0 lb ai per acre.
29002	Dogwood (Cornus sp.) C. sericea 'Silver and Gold'	Field Container	Beste/Frank (ARS)	MD	2010	Over the top	Very slight transient injury at 2.75, 5.5 and 11.0 lb ai per acre, but no reduction in height or width and all plants were marketable; good to excellent control of various weeds.
31100	Pygmyweed (Crassula sp.) C. capitella 'Campfire'	Field Container	Senesac	NY	2017	Over the top	Severe injury with 2.75, 5.5 and 11 lb ai per acre applied twice.

PR #	Crop	Production Site	Researcher	State	Year	Application Type	Results
31100	Pygmyweed (Crassula sp.) C. radicans 'Red Carpet'	Field Container	Aulakh	CT	2017	Over the top	Minor injury and growth reduction with 100, moderate with 200 and 400 lb per acre applied twice.
29005	Hawthorn (Crataegus sp.)	Field Container	Cochran	IA	2016	Over the top	No injury with 2.75, 5.5 and 11.0 lb ai per acre applied twice.
29005	Hawthorn (Crataegus sp.) C. monogyna	Field Container	Miller	WA	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29301	Japanese Cedar (Cryptomeria japonica) C. japonica 'Yoshino'	Field Container	Neal	NC	2010	Over the top	No injury from any dose (2.75, 5.5. and 11 lb ai per) at anytime during the evaluation.
29301	Japanese Cedar (Cryptomeria japonica) 'Yoshino'	Field Container	Trader	MS	2009	Over the top	No injury or significant growth reduction at 2.75, 5.5 and 11 lb ai per acre..
29006	Cypress, Mediterranean (Cupressus sempervirens)	Field Container	Neal	NC	2017	Over the top	No injury with 100, 200 and 400 lb per acre applied twice.
29006	Cypress, Mediterranean (Cupressus sempervirens)	Field Container	Uber	CA	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29008	Broom (Cytisus sp.) C. scoparius	Field Container	Miller	WA	2018	Over the top	No significant injury or growth reduction with 2.75, 5.5 and 11.0 lb ai per acre applied twice.
29053	Cinquefoil, Shrubby (Dasiphora fruticosa) 'Abbotswood'	Field Container	Lieth	CA	2009	Over the top	No significant injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
29053	Cinquefoil, Shrubby (Dasiphora fruticosa) 'Abbotswood'	Field Container	Trader	MS	2009	Over the top	No injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
29053	Cinquefoil, Shrubby (Dasiphora fruticosa) 'Goldfinger'	Field Container	Boydston	WA	2010	Over the top	Trial 1: No injury during the 6 week evaluation period with two applications of Biathlon 2.75G (OHP 052908) at 2.7, 5.5 and 11 lb ai per acre to shrubby cinquefoil. This experiment was repeated due to overwatering concerns and reported as PR#29053B or tr
29053	Cinquefoil, Shrubby (Dasiphora fruticosa) 'Goldfinger'	Field Container	Boydston	WA	2010	Over the top	Trial 2: Two sequential applications of Biathlon 2.75G applied 6 weeks apart at 2.75, 5.5, and 11.0 lb ai per acre did not injure shrubby cinquefoil plants. All plants were saleable.
29053	Cinquefoil, Shrubby (Dasiphora fruticosa) 'Goldfinger'	Field Container	Mathers (OSU)	OH	2010	Over the top	Ohio: No crop injury at 2.75, 5.5, and 11.0 lb ai per acre.
29053	Cinquefoil, Shrubby (Dasiphora fruticosa) 'Pink Beauty'	Field Container	Mathers (OSU)	MI	2010	Over the top	Lincoln: No crop injury at 2.75, 5.5, and 11.0 lb ai per acre.
29009	Delosperma (Delosperma sp.) D. cooperi	Field Container	Derr	VA	2017	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29009	Delosperma (Delosperma sp.) D. cooperi 'Table Mountain'	Field Container	Senesac	NY	2017	Over the top	Minor injury with 2.75 and 5.5, minor to moderate with 11 lb ai per acre applied twice.
33018	Distylium (Distylium sp.)	Field Container	Neal	NC	2016	Over the top	No injury or growth reduction with 2.75 and 5.5 lb ai per acre applied twice; moderate with 11 lb ai per acre after 2nd applic.
33018	Distylium (Distylium sp.)	Field Container	Neal	NC	2017	Over the top	No significant injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
33018	Distylium (Distylium sp.) 'Blue Cascade'	Field Container	Marble	FL	2018	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
33018	Distylium (Distylium sp.) 'Emerald Heights'	Field Container	Witcher	TN	2018	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.

PR #	Crop	Production Site	Researcher	State	Year	Application Type	Results
30970	Fern, Wood (Dryopteris sp.) D. erythroa 'Brilliance'	Field Container	Senesac	NY	2016	Over the top	Minimal injury with 2.75, minor with 5.5 and 11 lb ai per acre applied twice.
30970	Fern, Wood (Dryopteris sp.) D. erythroa	Field Container	Gilliam	AL	2013	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
30970	Fern, Wood (Dryopteris sp.) D.erythroa	Field Container	DeFrancesco	OR	2015	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
31216	Echeveria (Echeveria sp.) 'Blue 2'	Field Container	Wilén	CA	2016	Over the top	Moderate injury with 100, 200 and 400 lb per acre applied twice.
31216	Echeveria (Echeveria sp.) E. nodulosa	Field Container	Uber	CA	2017	Over the top	Moderate to severe injury increasing with rates (100, 200 and 400 lb per acre) applied twice.
31216	Echeveria (Echeveria sp.) E. shaviana 'Black Prince'	Field Container	Senesac	NY	2017	Over the top	Moderate injury with 2.75, severe with 5.5 and 11 lb ai per acre applied twice.
30971	Purple Coneflower (Echinacea sp.) E. purpurea 'Hot Summer'	Field Container	Boydston	WA	2014	Over the top	Slight injury and growth reduction with 2.75, 5.5 and 11.0 lb ai per acre applied twice; all treated plants marketable.
30971	Purple Coneflower (Echinacea sp.) E. purpurea 'Magnus'	Field Container	Senesac	NY	2015	Over the top	Minor injury with 2.75, 5.5 and 11 lb ai per acre applied twice.
30971	Purple Coneflower (Echinacea sp.) 'Magnus'	Field Container	Boydston	WA	2013	Over the top	Very minor injury with complete recovery with 2.75, 5.5, and 11.0 lb ai per acre applied twice; no growth reduction; all plants saleable.
33019	Enkianthus (Enkianthus sp.) E. campanulatus	Field Container	Neal	NC	2016	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice. High incidence of Phytophthora root rot in plants in this study.
29013	Spindletree (Euonymus sp.) E. alatus 'compactus'	Field Container	Boydston	WA	2010	Over the top	No injury during the 6 week evaluation period with two applications of Biathlon 2.75G (OHP 052908) at 2.7, 5.5 and 11 lb ai per acre.
29013	Spindletree (Euonymus sp.) E. alatus 'Compactus'	Field Container	Boydston	WA	2011	Over the top	No crop injury or reduction in growth with two applications at 2.75, 5.5 and 11.0 lb ai per acre.
29013	Spindletree (Euonymus sp.) E. japonica 'Aurea Marginata'	Field Container	Uber	CA	2010	Over the top	No crop injury observed with 2.75, 5.5, and 11.0 lb ai per acre at any time. Good efficacy on Euphorbia maculata noted.
29013	Spindletree (Euonymus sp.) E. japonicas 'Japanese Spindle'	Field Container	Uber	CA	2011	Over the top	No crop injury or reduction in growth with 2.75, 5.5, and 11.0 lb ai per acre.
29013	Spindletree (Euonymus sp.) E. japonicus 'Aureomarginatus'	Field Container	Lieth	CA	2009	Over the top	Slight injury where granules were not washed off (leaf burning) at 2.75, 5.5 and 11 lb ai per acre.
29015	Forsythia (Forsythia sp.) F. intermedia 'Golden Bells'	Field Container	Beste/Frank (ARS)	MD	2013	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29015	Forsythia (Forsythia sp.) Forsythia x intermedia	Field Container	Gilliam	AL	2015	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29015	Forsythia (Forsythia sp.) 'Lynwood Gold'	Field Container	Uber	CA	2015	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29016	Gardenia (Gardenia sp.) G. jasminoides 'Daisy'	Field Container	Trader	MS	2009	Over the top	No injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
29016	Gardenia (Gardenia sp.) G. jasminoides 'Frostproof'	Field Container	Derr	VA	2010	Over the top	No crop injury with 2.75, 5.5, 11 lb ai per acre. Increasing control of spotted spurge, chamber bitter, eclipta, annual sedges with increasing rates.
29016	Gardenia (Gardenia sp.) G. jasminoides 'Veitchii'	Field Container	Uber	CA	2010	Over the top	No crop injury observed with 2.75, 5.5, and 11.0 lb ai per acre at any time. Good efficacy on euphorbia maculata noted.

PR #	Crop	Production Site	Researcher	State	Year	Application Type	Results
29017	Gladiolus (Gladiolus sp.)	Field Container	Koivunen	CA	2016	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29017	Gladiolus (Gladiolus sp.)	Field Container	Mathers	OH	2016	Over the top	No significant injury with 2.75, 5.5 and 11 lb ai per acre applied twice; some growth reduction with 4X.
29017	Gladiolus (Gladiolus sp.)	Field Container	Miller	WA	2016	Over the top	No injury or significant growth reduction with 100, 200 and 400 lb per acre applied twice.
29017	Gladiolus (Gladiolus sp.) 'Firecracker'	Field Container	Aulakh	CT	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29018	Ivy, English (Hedera helix)	Field Container	Miller	WA	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29018	Ivy, English (Hedera helix)	Field Container	Witcher	TN	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
30972	Daylily (Hemerocallis sp.) 'Green Flutter'	Field Container	Senesac	NY	2014	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre applied twice.
30972	Daylily (Hemerocallis sp.) 'Lavender Dew'	Field Container	Uber	CA	2014	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre applied twice.
30972	Daylily (Hemerocallis sp.) 'Stella de Oro'	Field Container	Beste/Frank (ARS)	MD	2012	Over the top	No significant injury, growth or marketability reduction with 2.75 lb ai per acre applied twice; moderate injury, width reduction and reduced marketability with 5.5 and 11 lb.
30972	Daylily (Hemerocallis sp.) 'Stella d'Oro'	Field Container	Mathers (OSU)	OH	2013	Over the top	Minor injury with 100, moderate and high with 200 and 400 lb per acre applied twice.
30973	Alumroot (Heuchera sp.) H. micrantha 'Bressingham Hybrid'	Field Container	Klett	CO	2012	Over the top	No data analyzed because plants in all treatments had very non-uniform growth.
30973	Alumroot (Heuchera sp.) H. micrantha var. diversifolia 'Palace Purple'	Field Container	Boydston	WA	2012	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice; all plants saleable.
30973	Alumroot (Heuchera sp.) H. sanguinea	Field Container	Reding	OH	2012	Over the top	No injury and no significant difference in growth or marketability at 100, 200 and 400 lb per acre applied twice.
30973	Alumroot (Heuchera sp.) Heuchera x brizoides	Field Container	Klett	CO	2013	Over the top	No injury or growth reduction with 100 and 200, slight injury only with 400 lb per acre applied twice.
29019	Rosemallow (Hibiscus sp.) H. moscheutos 'Pink Swirl'	Field Container	Boydston	WA	2011	Over the top	Two sequential applications of Biathlon 2.75G applied 6 weeks apart at 2.75, 5.5, and 11.0 lb ai per acre did not injure or affect growth of hibiscus plants.
29019	Rosemallow (Hibiscus sp.) H. moscheutos 'Luna Rose'	Field Container	Senesac	NY	2010	Over the top	Moderate crop injury (25-35%) from 5.5 and 11.0 lb ai per acre at 2 WAT with recovery by season end.
29019	Rosemallow (Hibiscus sp.) H. syriacus 'Minerva'	Field Container	Lieth	CA	2009	Over the top	No significant injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
29019	Rosemallow (Hibiscus sp.) H. syriacus 'Sanchoyo'	Field Container	Trader	MS	2009	Over the top	No injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
30974	Plantain Lily (Hosta sp.)	Field Container	Reding	OH	2012	Over the top	No injury and no significant difference in growth or marketability at 100, 200 and 400 lb per acre applied twice.
30974	Plantain Lily (Hosta sp.) H. fortunei 'Francee'	Field Container	Boydston	WA	2014	Over the top	Slight injury (leaf necrosis) but no growth reduction with 2.75, 5.5 and 11.0 lb ai per acre applied twice; all 1X- and most 2X- and 4X-treated plants marketable.

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30974	Plantain Lily (Hosta sp.) H. fortunei 'Francee'	Field Container	Fraelich	GA	2013	Over the top	No injury with 100, 200 and 400 lb per acre after 1st application, very slight leaf burn with complete recovery after 2nd; no growth reduction; all plants marketable.
30974	Plantain Lily (Hosta sp.) H. fortunei 'Gold Standard'	Field Container	Senesac	NY	2014	Over the top	Slight injury with 2.75, 5.5 and 11 lb ai per acre applied twice.
30974	Plantain Lily (Hosta sp.) 'Hadspen Blue'	Field Container	Boydston	WA	2012	Over the top	Moderate injury but no growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice; some treated plants saleable.
29020	Hydrangea (Hydrangea sp.) H. macrophylla 'Nikko Blue'	Field Container	Lieth	CA	2009	Over the top	No to slight injury in leaf margins where granules were not washed off (leaf burning) at 2.75, 5.5 and 11 lb ai per acre.
29021	St. John's Wort (Hypericum sp.) H. calycinum	Field Container	Miller	WA	2018	Over the top	No significant injury or growth reduction with 2.75, 5.5 and 11.0 lb ai per acre applied twice.
29021	St. John's Wort (Hypericum sp.) H. frondosum 'Sunburst'	Field Container	Senesac	NY	2017	Over the top	Minor injury early with complete recovery with 2.75, 5.5 and 11 lb ai per acre applied twice.
31101	Candytuft (Iberis sp.) 'Candytuft'	Field Container	Boydston	WA	2013	Over the top	No injury or growth reduction with 2.75, 5.5, and 11.0 lb ai per acre applied twice; all plants saleable.
31101	Candytuft (Iberis sp.) I. sempervirens	Field Container	Uber	CA	2013	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
31101	Candytuft (Iberis sp.) Iberis sempervirens	Field Container	Klett	CO	2013	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29023	Iris (Iris sp.) 'Blue Diamond'	Field Container	Miller	WA	2016	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29023	Iris (Iris sp.) I. versicolor	Field Container	Derr	VA	2016	Over the top	No significant injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29023	Iris (Iris sp.) I. versicolor 'Blue Flag'	Field Container	Aulakh	CT	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29025	Walnut (Non-Bearing) (Juglans sp.)	Field Container	Cochran	IA	2017	Over the top	No significant injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29025	Walnut (Non-Bearing) (Juglans sp.) J. regia	Field Container	Miller	WA	2018	Over the top	No injury or growth reduction with 2.75, 5.5 and 11.0 lb ai per acre applied twice.
29026	Juniper (Juniperus sp.) J. chinensis 'Old Gold'	Field Container	Uber	CA	2010	Over the top	No crop injury observed with 2.75, 5.5, and 11.0 lb ai per acre at any time. Good efficacy on euphorbia maculata noted.
29026	Juniper (Juniperus sp.) J. chinensis 'Sea Green'	Field Container	Senesac	NY	2011	Over the top	No crop injury with two applications at 2.75, 5.5, and 11.0 lb aia.
29026	Juniper (Juniperus sp.) J. horizontalis 'Andorra'	Field Container	Gilliam	AL	2010	Over the top	No crop injury with one or two applications at 2.75, 5.5, 11 lb ai per acre. Plants treated with 1 and 2x were larger than the control.
29026	Juniper (Juniperus sp.) J. virginiana 'Grey Owl'	Field Container	Trader	MS	2009	Over the top	No injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
31102	Japanese Rose (Kerria japonica) K. japonica 'pleniflora'	Field Container	Siefer	OH	2017	Over the top	No significant injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
31102	Japanese Rose (Kerria japonica) 'Pleniflora'	Field Container	Senesac	NY	2017	Over the top	Minor injury with 2.75 and 5.5, moderate with 11 lb ai per acre applied twice.
29205	Lantana (Lantana sp.) L. camara 'Lemon Drop'	Field Container	Klett	CO	2010	Over the top	Trial 1: no crop injury with 2.75, 5.5, 11 lb ai per acre. The untreated control had greater width and dry mass than treated.

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29205	Lantana (Lantana sp.) L. camara 'Lemon Drop'	Field Container	Klett	CO	2010	Over the top	Trial 2: no crop injury with 2.75, 5.5, 11 lb ai per acre. Control plants had greater height than treated.
29205	Lantana (Lantana sp.) L. camara 'Radiation'	Field Container	Lieth	CA	2009	Over the top	Slight injury (leaf burning), no growth reduction at 2.75, 5.5 and 11 lb ai per acre.
31103	Max Chrysanthemum (Leucanthemum maximum)	Field Container	Derr	VA	2017	Over the top	No injury with 100, minor with 200 and 400 lb per acre applied twice.
31103	Max Chrysanthemum (Leucanthemum maximum)	Field Container	Miller	WA	2016	Over the top	Significant injury with 100, 200 and 400 lb per acre applied twice, with complete recovery 1-2 months after 2nd applic; no significant growth reduction.
31103	Max Chrysanthemum (Leucanthemum maximum) 'Superbum'	Field Container	Aulakh	CT	2017	Over the top	Moderate injury after 1st applic with 100, 200 and 400 lb per acre, complete recovery after 2nd applic; minor stunting.
32711	Daisy (Leucanthemum x superbum) 'Becky'	Field Container	Nackley	OR	2017	Over the top	Minor injury with complete recovery with 2.75, 5.5 and 11 lb ai per acre applied twice; no growth reduction.
32711	Daisy (Leucanthemum x superbum) 'Becky'	Field Container	Senesac	NY	2017	Over the top	No injury with 2.75 and 5.5, minor to moderate with 11 lb ai per acre applied twice.
32711	Daisy (Leucanthemum x superbum) 'Snowcap'	Field Container	Klett	CO	2016	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre applied twice; moderate growth reduction with 2X and 4X.
29031	Honeysuckle (Lonicera sp.) L. involucrata	Field Container	Miller	WA	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29031	Honeysuckle (Lonicera sp.) L. nitida 'Edmee Gold'	Field Container	Gilliam	AL	2016	Over the top	No significant injury or growth reduction with 100, 200 and 400 lb per acre applied twice, although 4X considered unacceptable.
29031	Honeysuckle (Lonicera sp.) L. sempervirens 'Alabama'	Field Container	Senesac	NY	2016	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre applied twice.
29033	Barberry, Hollyleaved (Mahonia aquifolium)	Field Container	DeFrancesco	OR	2016	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29033	Barberry, Hollyleaved (Mahonia aquifolium)	Field Container	Lieth	CA	2009	Over the top	No significant injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
29033	Barberry, Hollyleaved (Mahonia aquifolium)	Field Container	Miller	WA	2016	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29035	Apple (Malus sp.)	Field Container	Cochran	IA	2017	Over the top	No significant injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29036	Sacred Bamboo (Nandina domestica)	Field Container	Lieth	CA	2009	Over the top	No significant injury at 2.75 and 5.5, slight at 11 lb ai per acre; no growth reduction.
29036	Sacred Bamboo (Nandina domestica)	Field Container	Neal	NC	2010	Over the top	No crop injury with one or two applications at 2.75, 5.5 or 11.0 lb ai per acre.
29037	Daffodil (Narcissus sp.) 'Chromocolor'	Field Container	Derr	VA	2016	Over the top	Minor reduction in number of stems and flowers with 11 lb ai per acre (4X rate), no reduction with 2.75 and 5.5 lb.
29037	Daffodil (Narcissus sp.) 'Chromocolor'	Field Container	Derr	VA	2017	Over the top	Minor reduction in number of stems and flowers with 11 lb ai per acre (4X rate), no reduction with 2.75 and 5.5 lb.
33502	Daffodil (Narcissus sp.) 'Ferris Wheel'	Field In-Ground	Derr	VA	2017	Over the top	Minor injury with 2.75 and 5.5 lb, moderate with 11 lb ai per acre; no reduction in number of stems and flowers.
29037	Daffodil (Narcissus sp.) N. pseudonarcissus	Field Container	Nackley	OR	2017	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre after 1st applic. minor injury after 2nd applic.; no growth reduction.

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29038	Oleander, Rosebay (Nerium oleander) 'Red'	Field Container	Doohan	OH	2018	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29040	Aztec Grass, Lillyturf (Ophiopogon jaburan)	Field Container	Witcher	TN	2018	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29041	Daisybush (Osteospermum sp.) 'Purple Asti'	Field Container	Aulakh	CT	2017	Over the top	Unacceptable injury with 100, 200 and 400 lb per acre applied twice.
29042	Sourwood, Sorrel Tree (Oxydendrum arboreum)	Field Container	Boydston	WA	2013	Over the top	No injury or growth reduction with 2.75, 5.5, and 11.0 lb ai per acre applied twice; all plants saleable.
29043	Japanese Pachysandra (Pachysandra terminalis)	Field Container	Klett	CO	2017	Over the top	No injury or significant growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29043	Japanese Pachysandra (Pachysandra terminalis)	Field Container	Marble	FL	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29043	Japanese Pachysandra (Pachysandra terminalis) 'Green Carpet'	Field Container	Aulakh	CT	2015	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
31104	Crimson Fountain Grass (Pennisetum setaceum)	Field Container	Witcher	TN	2018	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
31105	Beard-Tongue (Penstemon sp.) 'Dark Towers'	Field Container	Klett	CO	2016	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
31105	Beard-Tongue (Penstemon sp.) 'Husker Red'	Field Container	Mathers	OH	2016	Over the top	No significant injury with 2.75, severe with 5.5 and 11 lb ai per acre applied twice.
31105	Beard-Tongue (Penstemon sp.) P. digitalis 'Husker Red'	Field Container	Neal	NC	2016	Over the top	No injury with 2.75 lb ai per acre applied twice, moderate, with complete recovery, with 5.5, moderate to severe with 11 lb.
31105	Beard-Tongue (Penstemon sp.) P. digitalis 'Husker's Red'	Field Container	Miller	WA	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29046	Chokeberry (Photinia sp.)	Field Container	Cochran	IA	2017	Over the top	No significant injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
29046	Chokeberry (Photinia sp.) P. fraseri	Field Container	Uber	CA	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29047	Spruce (Picea sp.) P. abies 'Pumilo'	Field Container	Mathers	OH	2016	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29047	Spruce (Picea sp.) P. pungens	Field Container	Senesac	NY	2017	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre applied twice.
29047	Spruce (Picea sp.) P. sitchensis	Field Container	Miller	WA	2017	Over the top	Moderate injury with some recovery with 100, 200 and 400 lb per acre applied twice; no growth reduction.
29048	Andromeda, Japanese; Japanese Pieris (Pieris japonica) 'Red Mill'	Field Container	Mathers (OSU)	OH	2012	Over the top	No injury with 100, 200 and 400 lb per acre applied twice.
29048	Andromeda, Japanese; Japanese Pieris (Pieris japonica) 'Red Mill'	Field Container	Mathers (OSU)	OH	2013	Over the top	No injury with 100, 200 and 400 lb per acre.
29048	Andromeda, Japanese; Japanese Pieris (Pieris japonica) 'Shojo'	Field Container	Lieth	CA	2009	Over the top	Data inconclusive because of plant death within all treatments.
29049	Pine (Pinus sp.) P. contorta	Field Container	Miller	WA	2016	Over the top	No injury or significant growth reduction with 100, 200 and 400 lb per acre applied twice.
29049	Pine (Pinus sp.) P. mugo 'Slow Mound'	Field Container	Mathers	OH	2016	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.



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31218	Portulacaria (Portulacaria sp.) 'Red Stem'	Field Container	Doohan	OH	2018	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29054	Plum (Prunus sp.) 'Black Gold'	Field Container	Cochran	IA	2015	Over the top	No significant injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29054	Plum (Prunus sp.) 'Montmorency'	Field Container	Cochran	IA	2016	Over the top	No injury with 2.75 and 5.5, minor injury with complete recovery with 11 lb ai per acre applied twice; no growth reduction.
29054	Plum (Prunus sp.) P. x cistena 'Big Cis'	Field Container	Boydston	WA	2013	Over the top	No injury or growth reduction with 2.75, 5.5, and 11.0 lb ai per acre applied twice; all plants saleable.
29055	Fir, Douglas (Pseudotsuga menziesii)	Field Container	Aulakh	CT	2017	Over the top	No injury with 100, 200 and 400 lb per acre applied twice; moderate growth reduction at 4X.
29055	Fir, Douglas (Pseudotsuga menziesii)	Field Container	Miller	WA	2016	Over the top	No injury or significant growth reduction with 100, 200 and 400 lb per acre applied twice.
29055	Fir, Douglas (Pseudotsuga menziesii)	Field Container	Siefer	OH	2017	Over the top	No significant injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29056	Firethorn (Pyracantha sp.) P. santa cruz	Field Container	Uber	CA	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29057	Common Pear (Pyrus communis)	Field Container	Cochran	IA	2017	Over the top	No significant injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29057	Common Pear (Pyrus communis)	Field Container	Nackley	OR	2017	Over the top	No injury or significant growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
32543	Oak, Pin (Quercus palustris)	Field Container	Siefer	OH	2017	Over the top	No significant injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29058	Oak, Red (Quercus rubra)	Field Container	Aulakh	CT	2016	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29058	Oak, Red (Quercus rubra) Q. rubra	Field Container	Boydston	WA	2011	Over the top	No crop injury or reduction in growth with two applications at 2.75, 5.5, 11.0 lb ai per acre.
29058	Oak, Red (Quercus rubra) Q. rubra	Field Container	Reding	OH	2012	Over the top	No injury and no significant difference in growth or marketability at 100, 200 and 400 lb per acre applied twice.
32544	Oak (Quercus sp.) Q. alba	Field Container	Aulakh	CT	2016	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
32544	Oak (Quercus sp.) Q. pinnata	Field Container	Mathers (OSU)	OH	2011	Over the top	Two sequential applications at 2.75, 5.5, 11.0 lb ai per acre caused marginal leaf yellowing at all rates and significant growth reduction at 2x. All plants marketable. More research warranted.
32544	Oak (Quercus sp.) Q. virginiana	Field Container	Marble	FL	2016	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice; all plants marketable.
29059	Indian Hawthorn (Raphiolepis indica)	Field Container	Doohan	OH	2018	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29060	Azalea (Rhododendron sp.) 'Karen'	Field Container	Mathers (OSU)	OH	2012	Over the top	No injury with 100 and 200 lb per acre applied twice, very slight with 400 lb.
29060	Azalea (Rhododendron sp.) R. 'Fashion' azalea	Field Container	Gilliam	AL	2010	Broadcast	No injury or reduction in growth with any rate during the evaluation period.
29060	Azalea (Rhododendron sp.) 'Red Bird'	Field Container	Uber	CA	2013	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.

PR #	Crop	Production Site	Researcher	State	Year	Application Type	Results
29061	Rhododendron (Rhododendron sp.) 'Delaware Valley'	Field Container	Senesac	NY	2015	Over the top	Minor injury with some recovery at 2.75, 5.5 and 11 lb ai per acre applied twice.
29061	Rhododendron (Rhododendron sp.) 'Nova Zembla'	Field Container	Mathers (OSU)	OH	2013	Over the top	No injury with 100, 200 and 400 lb per acre.
29061	Rhododendron (Rhododendron sp.) 'PJM Elite'	Field Container	Mathers	OH	2016	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29061	Rhododendron (Rhododendron sp.) 'Virginia Richards'	Field Container	DeFrancesco	OR	2015	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29062	Rose (Rosa sp.) 'Candy OH Vivid Red'	Field Container	Trader	MS	2009	Over the top	No injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
29062	Rose (Rosa sp.) 'Flower Red Carpet'	Field Container	Lieth	CA	2009	Over the top	No significant injury at 2.75, slight at 5.5 and 11 lb ai per acre; no growth reduction.
29062	Rose (Rosa sp.) 'Knock Out'	Field Container	Boydston	WA	2010	Over the top	No injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre; all treated plants saleable.
29062	Rose (Rosa sp.) 'Knock Out Red'	Field Container	Senesac	NY	2010	Over the top	No crop injury but significant reduction in root rating.
29062	Rose (Rosa sp.) R. 'Knock Out Red'	Field Container	Gilliam	AL	2011	Over the top	No crop injury or reduction in growth with 2.75, 5.5, 11.0 lb ai per acre.
29062	Rose (Rosa sp.) R. megililli 'Peach Drift'	Field Container	Chandran	WV	2010	Over the top	No significant injury or growth reduction at 2.75, 5.5 and 11 lb ai per acre.
29063	Rosemary (Rosmarinus officinalis)	Field Container	Denny	MS	2013	Over the top	No injury or growth reduction with 2.75, 5.5 and 11.0 lb ai per acre applied twice.
29063	Rosemary (Rosmarinus officinalis)	Field Container	Uber	CA	2013	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29063	Rosemary (Rosmarinus officinalis) 'Arp'	Field Container	Beste/Frank (ARS)	MD	2012	Over the top	No significant injury, growth or marketability reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29063	Rosemary (Rosmarinus officinalis) 'Arp'	Field Container	Senesac	NY	2014	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre applied twice.
29063	Rosemary (Rosmarinus officinalis) 'Tuscan Blue'	Field Container	DeFrancesco	OR	2014	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
30975	Coneflower (Rudbeckia sp.)	Field Container	Reding	OH	2012	Over the top	No injury and no significant difference in growth or marketability at 100, 200 and 400 lb per acre applied twice.
30975	Coneflower (Rudbeckia sp.) 'Goldstrum'	Field Container	Boydston	WA	2013	Over the top	No injury or growth reduction with 2.75, 5.5, and 11.0 lb ai per acre applied twice; all plants saleable.
30975	Coneflower (Rudbeckia sp.) R. fulgida 'Goldstrum'	Field Container	Beste/Frank (ARS)	MD	2012	Over the top	No significant injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice; no reduction in marketability.
30976	Woodland Sage (Salvia nemorosa) 'May Night'	Field Container	Beste/Frank (ARS)	MD	2012	Over the top	No injury, growth or marketability reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
30976	Woodland Sage (Salvia nemorosa) 'May Night'	Field Container	Boydston	WA	2014	Over the top	No injury with 2.75, slight stunting with full recovery at 5.5 and 11.0 lb ai per acre applied twice; all treated plants marketable.
30976	Woodland Sage (Salvia nemorosa) 'May Night'	Field Container	Derr	VA	2012	Over the top	No injury at 2.75, 5.5 and 11 lb ai per acre applied twice.
30976	Woodland Sage (Salvia nemorosa) S. sylvestris 'Blue Hill'	Field Container	Senesac	NY	2014	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre applied twice.

PR #	Crop	Production Site	Researcher	State	Year	Application Type	Results
30976	Woodland Sage ( <i>Salvia nemorosa</i> ) 'Sensation Deep Rose'	Field Container	Klett	CO	2014	Over the top	No injury or significant growth reduction with 100, 200 and 400 lb per acre applied twice.
29065	Lavender Cotton ( <i>Santolina chamaecyparissus</i> )	Field Container	Senesac	NY	2017	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre applied twice.
29065	Lavender Cotton ( <i>Santolina chamaecyparissus</i> )	Field Container	Wilen	CA	2017	Over the top	Minor injury after the 2nd applic, with complete recovery, at 2.75, 5.5 and 11 lb ai per acre; no growth reduction.
29066	Stonecrop ( <i>Sedum</i> sp.)	Field Container	Reding	OH	2012	Over the top	No injury and no significant difference in growth or marketability at 100, 200 and 400 lb per acre applied twice.
29066	Stonecrop ( <i>Sedum</i> sp.) 'Autumn Joy'	Field Container	Boydston	WA	2012	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice; all treated plants saleable.
29066	Stonecrop ( <i>Sedum</i> sp.) <i>S. album</i> 'Coral Carpet'	Field Container	Boydston	WA	2012	Over the top	No injury or growth reduction with 2.75 and 5.5 lb ai per acre applied twice; all plants saleable.
29066	Stonecrop ( <i>Sedum</i> sp.) <i>S. spurium</i> 'Red Carpet'	Field Container	Klett	CO	2012	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre applied twice, slight growth reduction.
29070	Yew ( <i>Taxus</i> sp.) <i>T. media</i> 'Margarita'	Field Container	Trader	MS	2009	Over the top	No injury or significant growth reduction at 2.75, 5.5 and 11 lb ai per acre.
29072	Jasmine, Asian Star ( <i>Trachelospermum asiaticum</i> )	Field Container	Gilliam	AL	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29072	Jasmine, Asian Star ( <i>Trachelospermum asiaticum</i> )	Field Container	Witcher	TN	2017	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29073	Hemlock, Eastern ( <i>Tsuga canadensis</i> )	Field Container	Doohan	OH	2018	Over the top	No injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29074	Tulip ( <i>Tulipa</i> sp.) 'Ile de France'	Field Container	Miller	WA	2016	Over the top	No injury with 100, 200 and 400 lb per acre applied twice.
29074	Tulip ( <i>Tulipa</i> sp.) 'Caravelle'	Field Container	Derr	VA	2016	Over the top	Minor leaf injury with 11 lb ai per acre (4X rate), no injury with 2.75, 5.5 lb; no reduction in number of stems and flowers.
29074	Tulip ( <i>Tulipa</i> sp.) 'Caravelle'	Field Container	Derr	VA	2017	Over the top	No leaf injury with 2.75 and 5.5, minor with 11 lb ai per acre; no reduction in number of stems and flowers.
33503	Tulip ( <i>Tulipa</i> sp.) 'Princess Irene'	Field In-Ground	Derr	VA	2017	Over the top	Moderate leaf injury with 2.75, 5.5 lb and 11 lb ai per acre; no reduction in number of stems and flowers.
29075	Arrowwood ( <i>Viburnum</i> sp.) <i>V. dentatum</i>	Field Container	Neal	NC	2010	Over the top	No significant injury observed at 1, 2, or 6 WAT or 1 WAT2.
29075	Arrowwood ( <i>Viburnum</i> sp.) <i>V. dentatum</i>	Field Container	Uber	CA	2011	Over the top	No crop injury or reduction in growth with 2.75, 5.5, and 11.0 lb ai per acre.
29075	Arrowwood ( <i>Viburnum</i> sp.) <i>V. rhytidophyllum</i> 'Alleghany'	Field Container	Beste/Frank (ARS)	MD	2011	Over the top	No injury, growth or marketability reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.
29076	Periwinkle ( <i>Vinca</i> sp.)	Field Container	Gilliam	AL	2016	Over the top	No significant injury or growth reduction with 100, 200 and 400 lb per acre applied twice.
29076	Periwinkle ( <i>Vinca</i> sp.) 'Bowles'	Field Container	Aulakh	CT	2015	Over the top	No injury with 2.75, 5.5 and 11 lb ai per acre applied twice; moderate growth reduction with 2X and 4X.
29076	Periwinkle ( <i>Vinca</i> sp.) <i>V. minor</i> 'Bowles'	Field Container	Koivunen	CA	2016	Over the top	No injury or growth reduction with 2.75, 5.5 and 11 lb ai per acre applied twice.

## Label Suggestions

For Biathlon, it is suggested the following crops not currently on the label be added for over-the-top applications.

*Acer palmatum* ‘Atropurpureum’

*Arctostaphylos* spp.

*Betula nigra*

*Camelia japonica*

*Chasmantium latifolium*

*Cornus florida*

*Cornus kousa*

*Cornus sericea*

*Dasiphora fruticosa*

*Distylium* sp.

*Dryopteris erythrosora*

*Gladiolus* spp.

*Lantana camara*

*Mahonia aquifolium*

*Pachysandra terminalis*

*Quercus rubra*

*Rosmarinus officinalis*

*Rudbeckia* spp.

*Salvia nemorosa*

*Sedum* spp.

*Buddleia davidii* ‘Nanho White’, as ‘Nanho Blue’ and ‘Nanho Purple’ are labeled.

*Cornus sanguinea* (= *stolonifera*) ‘ArticSun’, as ‘ArticFire’ is labeled.

*Gardenia jasminoides* ‘Frostproof’ as ‘Daisy’, *G. japonica* and *G. veitchii* are labeled.

*Hibiscus syriacus* ‘Minerva’ as *Hibiscus syriacus* ‘Sanchoyo’ is already labeled.

*Rhododendron* sp. azalea ‘Fashion’, ‘Karen’ and ‘Red Bird’ as *Rhododendron indicum* azalea ‘Coral Bells’ is labeled.

*Rhododendron* ‘Delaware Valley’, ‘Nova Zembla’ and ‘Virginia Richards’ as

*Rhododendron yakushimanum* hybrid is labeled.

*Rosa* ‘Knock Out’ and ‘Red Knock Out’, as well as ‘Rainbow & Double Knock Out’ are labeled.

In addition, it is suggested the following crops *Crassula capitella*, *Crassula radicans*, *Echeveria* spp., *Hemerocallis* spp., *Kerria japonica*, and *Osteospermum* spp. which exhibited injury with over-the-top application in these experiments be added under the section '**Injury on the following plant species has been observed following applications of Biathlon and use is not recommended**' in the Biathlon label.

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