



[Environment Horticulture Program Research Summaries](#)

IR-4 Environmental Horticulture Program S-Metolachlor Crop Safety

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Abstract

From 2004 to 2022, IR-4 completed 231 trials on Pennant Magnum (s-metolachlor). The data contained in this report was generated to register uses of s-metolachlor on and around environmental horticulture plants with over-the-top applications. The s-metolachlor rates in the testing program were 2.5, 5.0, and 10.0 pounds active ingredient per acre (lb ai per A) as the 1X, 2X and 4X rates with 4, 6, or 8 week intervals between applications. Pennant Magnus has been applied to 97 plant genera or species. Of these, 12 plant species exhibited no or minimal transient injury after application at all three rates. Ten (10) crops exhibited no phytotoxicity at 2.5 lb ai per acre but did have some injury at 5.0 and/or 10.0 lb ai per acre. Twenty-five (25) crops exhibited significant phytotoxicity at even the lowest rate. For nine crops, the response among sites was variable, and 41 crops have less than three trials completed.

Introduction

Control of broadleaved weeds and sedges 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. Since 2004, Pennant Magnum (s-metolachlor) has been screened for crop safety on 97 plant genera or species. The early research activities led to an expansion of the label in 2010.

Materials and Methods

Prior to 2007, two applications were made approximately 30 days apart. In the 2007 protocol, two applications of Pennant Magnum were made approximately 8 weeks apart. Beginning in 2008, two applications of Pennant Magnum were made approximately 6 weeks apart. The application rates were 2.5, 5, and 10 lb ai per acre, plus a water treated control. A minimum of four plants (replicate treatments) 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, 4, 8, and 12 weeks after initial application. Some researchers also included readings 3 to 4 days after the initial and second applications. The following protocols were used: 04-001, 05-001, 06-009, 07-010, 18-020, 19-020, and 22-017. Please visit <https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-researcher-resources/#Protocols> to view and download these protocols.

Pennant Magnum was supplied to researchers (See list of researchers in Appendix 2) by Syngenta.

Results and Summary

Phytotoxicity

Based on the type and nature of injury seen with Pennant Magnum applications in the research conducted from 2004 to 2022, 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) injury was seen but additional research is warranted to clarify response, 3) no or minimal transitory injury seen at the 1X rate, but the 2X and/or 4X rates did cause significant phytotoxicity, 4) Significant injury sufficient to recommend growers not utilize this product.

In general, Pennant Magnum exhibited no or minimal negative impact on a range of plant species (Table 1). Twelve plant genera or species fell into this category. 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. Ten crop species exhibited no or little injury at the 2 lb ai per acre rate, but significant phytotoxicity occurred at the 4 lb ai per acre rate (Table 2). It may be prudent to either conduct additional trials or place language on the label indicating applications of Pennant Magnum are considered safe at the 2 lb ai per acre rate but any higher rate may cause unacceptable injury.

There were 25 crops that exhibited damage sufficient to recommend growers not utilize Pennant Magnum as an over-the-top treatment for pre-emergent weed control (Table 3).

There were nine species of plants for which the results were unclear and are suggested as candidates for further research: *Asarum sp.*, *Aubrieta sp.*, *Bergenia sp.*, *Eupatorium maculatum*, *Eupatorium rugosum*, *Eupatorium purpureum*, *Panicum virgatum*, *Polenium sp.* and *Sempervivium sp.* (Table 4). There were 41 plant species or genera where IR-4 has conducted less than three trials.

Please see Table 6 for a list of individual trial summaries for Pennant Magnum.

Table 1. List of Pennant Magnum treated crops with no or minimal transitory injury.

<i>Iberis sempervirens</i> ¹	<i>Penstemon digitalis</i>
<i>Kniphofia uvaria</i> ¹	<i>Phlox paniculata</i>
<i>Lavandula augustifolia</i> ¹	<i>Ruellia carolinensis</i> ¹
<i>Ligularia stenocephala</i>	<i>Sempervivum tectorum</i> ¹
<i>Linum perenne</i>	<i>Solidago rugosa</i>
<i>Nepeta faassenii</i>	<i>Solidago sempervirens</i> ¹

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

<i>Baptisia australis</i>	<i>Helianthus salicifolius</i>
<i>Cimicifuga racemosa</i>	<i>Helleborus niger</i>
<i>Gazania sp.</i>	<i>Hibiscus syriacus</i> ¹
<i>Gomphrena sp.</i>	<i>Santolina chamaecyparissus</i>
<i>Helenium autumnale</i>	<i>Verbena canadensis</i>

Table 3. List of Pennant Magnum treated crops exhibiting significant injury.

<i>Agastache aurantiaca</i>	<i>Echinacea purpurea</i>
<i>Agastache rugosa x foeniculum</i>	<i>Epimedium x rubrum</i>
<i>Agastache rupestris</i>	<i>Gerbera jamesonii</i>
<i>Alchemilla mollis</i>	<i>Heuchera sanguinea</i>
<i>Amsonia hubrichtii</i>	<i>Junus effusus</i>
<i>Amsonia tabernaemontana</i>	<i>Nepeta nervosa</i>
<i>Armeria maritima</i>	<i>Origanum libanoticum</i>
<i>Asarum candanense</i>	<i>Pentas sp.</i>
<i>Bergenia cordifolia</i>	<i>Primula malacoides</i>
<i>Chelone lyonii</i>	<i>Tiarella cordifolia</i>
<i>Chrysogonum virginianum</i>	<i>Tradescantia andersoniana</i>
<i>Delosperma nubigenum</i>	<i>Tradescantia ohiensis</i>
<i>Digitalis thapsi</i>	

Table 4. List of Pennant Magnum treated crops where more research is needed to clarify response

<i>Aubrieta sp.</i>	<i>Leucanthemum x superbum</i>
<i>Bergenia sp.</i>	<i>Panicum virgatum</i>
<i>Eupatorium maculatum</i>	<i>Polemonium sp.</i>
<i>Eupatorium rugosum</i>	<i>Sempervivum sp.</i>
<i>Eupatorium purpureum</i>	

Table 5. List of Pennant Magnum treated crops with insufficient trials to determine response

<i>Acorus sp.</i>	<i>Muhlenbergia capillaris</i>
<i>Actaea racemosa var. racemosa</i>	<i>Opuntia humifusa</i> ¹
<i>Andropogon gerardii</i>	<i>Penstemon x mexicali</i>
<i>Andropogon virginicus</i>	<i>Phlox subulata</i>
<i>Antennaria parvifolia</i>	<i>Phormium colinsoi</i> ¹
<i>Asarum chinensis</i>	<i>Platycodon grandiflorus</i>
<i>Athyrium nipponicum</i>	<i>Pulmonaria sp.</i>
<i>Aurinia saxatilis</i>	<i>Rubus calycinoides</i>
<i>Calamagrostis acutiflora</i>	<i>Rudbeckia hirta</i>
<i>Clematis sp.</i>	<i>Ruellia brittoniana</i>
<i>Cosmos sp.</i>	<i>Santolina sp.</i>
<i>Cuphea hyssopifolia</i>	<i>Scabiosa sp</i>
<i>Cyrtomium fortunei</i>	<i>Solidago caesia</i>
<i>Duranta erecta</i>	<i>Solidago speciosa</i>
<i>Helianthemum nummularium</i>	<i>Sporobolus heterolepis</i>
<i>Heliopsis helianthoides</i>	<i>Stokesia laevis</i>
<i>Helleborus sp.</i>	<i>Symphyotrichum ericoides</i>
<i>Hibiscus mosheutos</i> ¹	<i>Thymus serpyllum</i>
<i>Lantana hybrida</i> ¹	<i>Vernonia noveboracensis</i> ¹
<i>Lantana montevidensi</i> ¹	<i>Zinnia sp</i>
<i>Liriope muscari</i> ¹	

¹ Registered already on EPA label.

Table 6. Detailed Summary of Crop Safety Testing with Pennant Magnum

Note: Table entries are sorted by crop Latin name. Only those trials with research reports received by 5/1/2022 are listed below.

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
34863	Sweet Flag (<i>Acorus</i> sp.) <i>A. gramineus</i> 'Ogon'	Field Container	Mathers	OH	2022	Over the top	No visible injury with 2.5, 5.0 or 10.0 lb ai per acre with two application 6 weeks apart. However, all rates significantly reduced crop growth (38 to 56%) four weeks after second application.
23828	Black Bugbane (<i>Actaea racemosa</i> var. <i>racemosa</i>)	Field Container	Neal	NC	2005	Over the top	Little to no injury at 2.5 lb ai per acre; moderate to severe at 5 lb ai per acre and 10 lb ai per acre, respectively
24724	Giant Hyssop, Sunset (<i>Agastache rupestris</i>) 'Sunset'	Field Container	Moretti	OR	2022	Over the top	Minor to no injury after first application at 2.5, 5, or 10 pt/a. Moderate to severe injury after second application of two higher rates. Plant volume data variable and no significant differences between treatments
24724	Giant Hyssop, Sunset (<i>Agastache rupestris</i>) 'Mango Tango'	Field Container	Senesac	NY	2022	Over the top	Minor to severe injury increasing with rate (2.5, 5.0 10.0 lb ai per acre).
24723	Giant Hyssop (<i>Agastache</i> sp.) <i>A. rugosa</i> X <i>foeniculum</i> 'Blue Fortune'	Field Container	Boydston	WA	2005	Over the top	Minor to severe injury increasing with rate (2.5, 5.0, 10 lb ai per acre).
24723	Giant Hyssop (<i>Agastache</i> sp.) <i>A. aurantiaca</i> 'Coronado'	Field Container	Klett	CO	2005	Over the top	Fort Collins: Minor to severe injury increasing with rate (2.5, 5.0, 10 lb ai per acre).
24723	Giant Hyssop (<i>Agastache</i> sp.) <i>A. aurantiaca</i> 'Coronado'	Field Container	Klett	CO	2005	Over the top	Grand Junction: Moderate injury at all rates (2.5, 5.0, 10 lb ai per acre).
24723	Giant Hyssop (<i>Agastache</i> sp.) <i>A. rugosa</i> X <i>foeniculum</i> 'Blue Fortune'	Field Container	Mathers (OSU)	OH	2005	Over the top	All rates (2.5, 5.0. 10.0 lb ai per acre) caused slight to moderate injury (leaf distortion and burning)
23819	Lady's-Mantle (<i>Alchemilla</i> sp.) <i>A. mollis</i> 'Thriller'	Field Container	Ahrens/ Mervosh	CT	2005	Over the top	Slight injury at 2.5 lb ai per acre and 5 lb ai per acre rates, moderate injury at 10 lb ai per acre
23819	Lady's-Mantle (<i>Alchemilla</i> sp.) <i>A. mollis</i> 'Selection 25'	Field Container	Boydston	WA	2005	Over the top	No injury with 2.5, 5.0 and 10 lb ai per acre.
23819	Lady's-Mantle (<i>Alchemilla</i> sp.) <i>A. mollis</i>	Field Container	Derr	VA	2004	Over the top	Slight injury at 2.5 lb ai per acre rate, moderate injury at 5 lb ai per acre and 10 lb ai per acre
23819	Lady's-Mantle (<i>Alchemilla</i> sp.) <i>A. mollis</i>	Field Container	Lieth	CA	2004	Over the top	All rates caused severe leaf necrosis
23819	Lady's-Mantle (<i>Alchemilla</i> sp.)	Field Container	Reding	OH	2005	Over the top	Slight injury at 2.5 lb ai per acre rate; slight to moderate injury at 5 lb ai per acre and 10 lb ai per acre
23819	Lady's-Mantle (<i>Alchemilla</i> sp.) <i>A. mollis</i>	Field Container	Senesac	NY	2004	Over the top	No injury at 2.5 lb ai per acre and 5 lb ai per acre rates, slight injury at 10 lb ai per acre
34865	Hubricht's Bluestar, Arkansas Amsonia (<i>Amsonia hubrichtii</i>)	Field Container	Larson	WA	2022	Over the top	Moderate leaf burning and no flowers with 10 lb ai per acre.

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
34865	Hubricht's Bluestar, Arkansas Amsonia (Amsonia hubrichtii)	Field Container	Neal	NC	2022	Over the top	Severe injury from all rates (2.5, 5 or 10 pt/a) 2 and 4 weeks after first application and persisted after second application. High rate was nearly mortal at each evaluation after second application.
34865	Hubricht's Bluestar, Arkansas Amsonia (Amsonia hubrichtii) 'Butterscotch'	Field Container	Senesac	NY	2022	Over the top	Moderate to severe injury increasing with rate (2.5, 5.0 10.0 lb ai per acre).
23820	Eastern Bluestar (Amsonia tabernaemontana) A. tabernaemontana	Field Container	Gilliam	AL	2004	Over the top	All rates caused serious leaf burn (2.5, 5.0, 10.0 lb ai per acre).
23820	Eastern Bluestar (Amsonia tabernaemontana) A. hubrichtii	Field Container	Neal	NC	2004	Over the top	All rates caused significant injury (2.5, 5.0, 10.0 lb ai per acre).
23820	Eastern Bluestar (Amsonia tabernaemontana) A. hubrichtii	Field Container	Senesac	NY	2004	Over the top	Slight injury at 2.5 lb ai per acre rate and moderate injury at 5 lb ai per acre and 10 lb ai per acre rates.
34950	Big Blue Stem (Andropogon gerardii)	Field Container	Moretti	OR	2022	Over the top	No injury or plant volume reductions from two applications at 2.5, 5 or 10 pt/a.
34950	Big Blue Stem (Andropogon gerardii)	Field Container	Neal	NC	2022	Over the top	No injury with 2.5 or 5.0 lb ai per acre after the first application or with 2.5 after two applications; 10 lb ai per acre had reduced quality after a single application. Foliar necrosis was observed with 5.0 and 10 lb ai per acre after the second application
34951	Broom Sedge Bluestem (Andropogon virginicus)	Field Container	Moretti	OR	2022	Over the top	Minor to moderate injury after first application at 2.5, 5 or 10 pt/a, increasing to moderate to severe after second application.
34951	Broom Sedge Bluestem (Andropogon virginicus)	Field Container	Neal	NC	2022	Over the top	No injury with 2.5 or 5.0 lb ai per acre; no injury with 10 lb ai per acre applied once, but moderate transient injury was observed after the second application.
23822	Pussy-Toes, Small-leaf (Antennaria parvifolia)	Field Container	Neal	NC	2004	Over the top	All rates caused moderate to severe injury (2.5, 5.0, 10.0 lb ai per acre).
23822	Pussy-Toes, Small-leaf (Antennaria parvifolia)	Field Container	Senesac	NY	2004	Over the top	No injury with 2.5, 5.0, 10.0 lb ai per acre.
24729	Thrift Sea Pink (Armeria maritima) 'Splendens'	Field Container	Boydston	WA	2005	Over the top	Moderate to severe injury increasing with rate (2.5, 5.0 and 10 lb ai per acre). Single application caused purpling of leaves; second application caused additional injury.
24729	Thrift Sea Pink (Armeria maritima) 'Splendens'	Field Container	Gilliam	AL	2005	Over the top	All rates caused moderate to severe injury (burn and discoloration) and stunting (2.5, 5, and 10 lb ai per acre).
24729	Thrift Sea Pink (Armeria maritima) 'Dusseldorf'	Field Container	Lieth	CA	2005	Over the top	All rates caused unacceptable growth suppression
23823	Canadian Wildginger (Asarum canadense)	Field Container	Moretti	OR	2022	Over the top	Severe injury after first application at 2.5, 5 or 10 pt/a. Nontreated also had severe injury. Injury after second application predominantly severe. Plant volume significantly reduced from two higher rates.
23823	Canadian Wildginger (Asarum canadense) A. chinensis	Field Container	Neal	NC	2005	Over the top	No injury at all rates (2.5, 5.0, 10.0 lb ai per acre).

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
23823	Canadian Wildginger (<i>Asarum canadense</i>)	Field Container	Senesac	NY	2005	Over the top	Moderate to severe injury increasing with rate (2.5, 5.0, 10.0 lb ai per acre).
23823	Canadian Wildginger (<i>Asarum canadense</i>)	Field Container	Senesac	NY	2022	Over the top	Severe injury with 2.5, 5.0 and 10.0 lb ai per acre.
24738	Fern, Lady (<i>Athyrium nipponicum</i>)	Field Container	Derr	VA	2005	Over the top	No injury at 2.5 lb ai per acre and 5 lb ai per acre rate, slight injury at 10 lb ai per acre
24738	Fern, Lady (<i>Athyrium nipponicum</i>) 'Pretum'	Field Container	Mathers (OSU)	OH	2005	Over the top	Slight injury (frond scorching) at 2.5 lb ai per acre and 5 lb ai per acre rates; moderate injury from 10 lb ai per acre
26018	Lilacbush (<i>Aubrieta</i> sp.) 'Large Flo'	Greenhouse	Freiberger	NJ	2006	Over the top	Light to high injury increasing with rates (2.5, 5 and 10 lb ai per acre)
23824	Lilacbush (<i>Aubrieta</i> sp.) 'Whitewell Gem'	Field Container	Lieth	CA	2004	Over the top	No injury but reduced plant width
26018	Lilacbush (<i>Aubrieta</i> sp.) 'Whitewell Gem'	Greenhouse	Mickelbart	IN	2006	Over the top	No significant injury or growth reduction at 2.5 lb ai per acre; significant injury at 5 and 10 lb ai
23824	Lilacbush (<i>Aubrieta</i> sp.) 'Whitewell Gem'	Field Container	Neal	NC	2004	Over the top	All rates caused significant injury (2.5, 5.0, 10.0 lb ai per acre).
23824	Lilacbush (<i>Aubrieta</i> sp.)	Field Container	Reding	OH	2005	Over the top	No injury
34866	Basket-Of-Gold (<i>Aurinia saxatilis</i>) 'Summit'	Field Container	Koski	CO	2022	Over the top	Little to no injury from 2.5 lb ai/a applied twice. Moderate injury after first application of 5 or 10 lb ai/a, increasing to severe after second application of each rate.
23825	Blue Wild Indigo (<i>Baptisia australis</i>)	Field Container	Derr	VA	2004	Over the top	All rates caused slight transient injury (2.5. 5.0. 10.0 lb ai per acre). Excellent efficacy for large crabgrass and spotted spurge
23825	Blue Wild Indigo (<i>Baptisia australis</i>)	Field Container	Gilliam	AL	2004	Over the top	No injury at 2.5 lb ai per acre and 5 lb ai per acre rates, slight injury at 10 lb ai per acre
23825	Blue Wild Indigo (<i>Baptisia australis</i>)	Field Container	Neal	NC	2004	Over the top	No injury at 2.5 lb ai per acre rate, acceptable at 5 lb ai per acre and unacceptable at 10 lb ai per acre
23825	Blue Wild Indigo (<i>Baptisia australis</i>)	Field Container	Senesac	NY	2005	Over the top	No injury at all rates (2.5, 5.0, 10.0 lb ai per acre).
24739	Siberian Tea (<i>Bergenia cordifolia</i>) 'Rotblum'	Field Container	Lieth	CA	2005	Over the top	Significant injury and unacceptable growth suppression
26021	Siberian Tea (<i>Bergenia cordifolia</i>) 'Winter Glow'	Greenhouse	Mickelbart	IN	2006	Over the top	No significant injury or growth reduction (2.5, 5 and 10 lb ai per acre)
24739	Siberian Tea (<i>Bergenia cordifolia</i>) 'New Hybrid'	Field Container	Neal	NC	2005	Over the top	Slight to moderate injury at 2.5 lb ai per acre rate. Severe at 5 lb ai per acre and 10 lb ai per acre
34952	Feather Reed Grass (<i>Calamagrostis acutiflora</i>)	Field Container	Derr	VA	2022	Over the top	Minor injury with 2.5, 5.0 and 10.0 lb ai per acre
34952	Feather Reed Grass (<i>Calamagrostis acutiflora</i>) 'Karl Foerster'	Field Container	Moretti	OR	2022	Over the top	Moderate to severe injury from two applications at 2.5, 5 or 10 pt/a, despite low injury after first application. All rates decreased plant volume compared to nontreated.

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
23826	Turtlehead, Snakehead (Chelone sp.) C. lyonii 'Hot Lips'	Field Container	Derr	VA	2004	Over the top	Slight injury at 2.5 lb ai per acre rate, moderate at 5 lb ai per acre severe at 10 lb ai per acre
34867	Turtlehead, Snakehead (Chelone sp.)	Field Container	Larson	WA	2022	Over the top	No injury with 2.5, 5, and 10 lb ai per acre.
23826	Turtlehead, Snakehead (Chelone sp.) C. lyonii 'Hot Lips'	Field Container	Neal	NC	2004	Over the top	Slight injury at 2.5 lb ai per acre rate, severe injury at 5 lb ai per acre and 10 lb ai per acre rates
23826	Turtlehead, Snakehead (Chelone sp.) C. lyonii 'Hot Lips'	Field Container	Senesac	NY	2004	Over the top	All rates caused moderate injury (2.5. 5.0. 10.0 lb ai per acre).
23827	Golden Star (Chrysogonum virginianum) C. virginianum 'Alan Bush'	Field Container	Derr	VA	2004	Over the top	Moderate injury increasing with rate Excellent efficacy for large crabgrass and spotted spurge
23827	Golden Star (Chrysogonum virginianum) C. virginianum 'Alan Bush'	Field Container	Neal	NC	2004	Over the top	Slight injury at 2.5 lb ai per acre rate, moderate at 5 lb ai per acre and severe at 10 lb ai per acre
23827	Golden Star (Chrysogonum virginianum) C. virginianum 'Alan Bush'	Field Container	Senesac	NY	2005	Over the top	No significant injury at 2.5 lb ai per acre rate; moderate to severe injury at 5 lb ai per acre and 10 lb ai per acre.
31436	Leather Flower (Clematis sp.) C integrifolia 'PSHarlan'	Field Container	Koski	CO	2022	Over the top	No injury from two application of 2.5 lb ai/a. Moderate injury from first application of 5 lb ai/a, increasing to severe after second application. Moderate injury after first application of 10 lb ai/a and declined until second application when it increas
24830	Leather Flower (Clematis sp.) 'Midnight Showers'	Field Container	Mathers (OSU)	OH	2005	Over the top	All rates (2.5, 5.0. 10.0 lb ai per acre) caused slight injury but plants recovered
13129	Cosmos (Cosmos sp.)	Field In-Ground	Miller	WA	2018	Over the top	Minor injury with 2.6, 5.2 and 10.4 pt per acre applied twice; moderate growth reduction with 4X.
13129	Cosmos (Cosmos sp.)	Field In-Ground	Sellmer	PA	2001	Over the top	
25296	False Heather, Elfin Herb, Mexican Heather (Cuphea hyssopifolia)	Field In-Ground	Chen	LA	2005	Over the top	Moderate injury with 2.5, 5.0 and 10 lb ai per acre; plants recovered in a short time
34870	Asian Nervein Hollyfern (Cyrtomium fortunei)	Field Container	Marble	FL	2022	Over the top	No to minimal phyto from first application of 42, 84, or 168 fl oz/a Minor phyto from all rates after second application. Significant growth rate reduction from highest rate.
24832	Hardy Ice Plant, Yellow Ice Plant (Delosperma nubigenum)	Field Container	Boydston	WA	2005	Over the top	Slight injury with 2.5 and 5.0 lb ai per acre; severe injury with 10 lb ai per acre. All rates caused slight stunting and delayed flowering.
24832	Hardy Ice Plant, Yellow Ice Plant (Delosperma nubigenum) D. Hardy Ice Plant yellow	Field Container	Boydston	WA	2006	Over the top	Significant injury and growth reduction at all rates (2.5, 5 and 10 lb ai per acre); marketability questionable
24832	Hardy Ice Plant, Yellow Ice Plant (Delosperma nubigenum)	Field Container	Linderman	OR	2006	Over the top	No injury at 2.5, 5 and 10 lb ai per acre
24741	Foxglove (Digitalis sp.) D. purpurea 'Foxy'	Field Container	Boydston	WA	2006	Over the top	No injury or growth reduction at 1X rate (2.5, lb ai per acre) only; 2X and 4X plants not saleable

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
26024	Foxglove (<i>Digitalis</i> sp.) 'Excelsior Mix'	Greenhouse	Freiberger	NJ	2006	Over the top	No injury after 1st application at all rates (2.5, 5 and 10 lb ai per acre), moderate and high injury at 2X and 4X after 2nd application
24741	Foxglove (<i>Digitalis</i> sp.) <i>D. thaspi</i> 'Spanish Peaks'	Field Container	Klett	CO	2005	Over the top	Fort Collins: Moderate to severe injury increasing with rate (2.5, 5.0, 10 lb ai per acre).
24741	Foxglove (<i>Digitalis</i> sp.) <i>D. thaspi</i> 'Spanish Peaks'	Field Container	Klett	CO	2005	Over the top	Grand Junction: No to severe injury increasing with rate (2.5, 5.0, 10 lb ai per acre).
24741	Foxglove (<i>Digitalis</i> sp.) <i>D. purpurea</i>	Field Container	Linderman	OR	2006	Over the top	No injury at 2.5, 5 and 10 lb ai per acre
26024	Foxglove (<i>Digitalis</i> sp.) 'Pam's Choice'	Greenhouse	Mickelbart	IN	2006	Over the top	No significant injury or growth reduction (2.5, 5 and 10 lb ai per acre)
24741	Foxglove (<i>Digitalis</i> sp.) <i>D. ambigua</i>	Field Container	Treat	WA	2006	Over the top	Severe injury (leaf burn) and stunting at all rates (2.5, 5 and 10 lb ai per acre)
34871	Golden Dewdrops (<i>Duranta erecta</i>) 'Cuban Gold'	Field Container	Moretti	OR	2022	Over the top	Minor to severe injury after first of two applications at 2.5, 5 or 10 pt/a. No injury from lower two rates at time of second application and minor to no injury from any rate after second application. No plant volume reductions from any rate.
33361	Eastern Purple Coneflower (<i>Echinacea purpurea</i>) 'Magnus'	Field In-Ground	Aulakh	CT	2018	Over the top	No injury or growth reduction with 2.6, 5.2 and 10.4 pt per acre after 1st applic, moderate after the 2nd application with 2X and 4X.
33361	Eastern Purple Coneflower (<i>Echinacea purpurea</i>) 'Cheyenne Spirit'	Field In-Ground	Derr	VA	2021	Over the top	No injury with 2 pint per acre.
24742	Purple Coneflower (<i>Echinacea</i> sp.) <i>E. purpurea</i> 'White Swan'	Field Container	Boydston	WA	2006	Over the top	Significant injury at all rates (2.5, 5 and 10 lb ai per acre); 4X plants smaller
24742	Purple Coneflower (<i>Echinacea</i> sp.) <i>E. purpurea</i> 'Magnus'	Field Container	Derr	VA	2005	Over the top	Very slight injury at 2.5 lb ai per acre and 5 lb ai per acre rates, slight injury at 10 lb ai per acre rate.
24742	Purple Coneflower (<i>Echinacea</i> sp.) <i>E. purpurea</i>	Field Container	Fraelich	GA	2006	Over the top	Slight injury; no differences in growth or marketability
26027	Purple Coneflower (<i>Echinacea</i> sp.) 'Magnus'	Greenhouse	Freiberger	NJ	2006	Over the top	No injury at all rates (2.5, 5 and 10 lb ai per acre)
24742	Purple Coneflower (<i>Echinacea</i> sp.) <i>E. purpurea</i> 'Magnus'	Field Container	Gilliam	AL	2005	Over the top	All rates caused moderate to severe injury (leaf curl and leaf distortion) and stunting (2.5, 5, and 10 lb ai per acre).
24742	Purple Coneflower (<i>Echinacea</i> sp.) <i>E. purpurea</i> 'Magnus'	Field Container	Linderman	OR	2006	Over the top	No injury at 2.5, 5 and 10 lb ai per acre
26027	Purple Coneflower (<i>Echinacea</i> sp.) 'White Swan'	Greenhouse	Mickelbart	IN	2006	Over the top	Slight injury and growth reduction (2.5, 5 and 10 lb ai per acre)
23829	Epimedium (<i>Epimedium</i> sp.) <i>E. X rubrum</i>	Field Container	Ahrens/ Mervosh	CT	2005	Over the top	Slight injury at 2.5 lb ai per acre and 5 lb ai per acre rates; moderate to severe injury at 10 lb ai per acre
23829	Epimedium (<i>Epimedium</i> sp.) <i>E. X rubrum</i>	Field Container	Senesac	NY	2005	Over the top	Moderate injury at all rates (2.5, 5.0, 10.0 lb ai per acre).
23830	Joe Pye Weed (<i>Eupatorium maculatum</i>) 'Gateway'	Field Container	Ahrens/ Mervosh	CT	2005	Over the top	No injury at 2.5 lb ai per acre and 5 lb ai per acre rates; slight injury at 10 lb ai per acre

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23831	Common Boneset (<i>Eupatorium perfoliatum</i>) <i>E. rugosum</i> 'Chocolate'	Field Container	Boydston	WA	2006	Over the top	No to moderate injury increasing with rate; slight growth reduction at all rates (2.5, 5 and 10 lb ai per acre); all plants saleable
23832	Joe Pye Weed (<i>Eupatorium purpureum</i>) <i>E. dubium</i> 'Little Joe'	Field Container	Boydston	WA	2006	Over the top	No injury or growth reduction at 1X rate (2.5 lb ai per acre) only; 1X and 2X plants saleable
23832	Joe Pye Weed (<i>Eupatorium purpureum</i>) 'Gateway'	Field Container	Neal	NC	2005	Over the top	No injury at 2.5 lb ai per acre rate, moderate at 5 lb ai per acre and severe at 10 lb ai per acre
23832	Joe Pye Weed (<i>Eupatorium purpureum</i>)	Field Container	Senesac	NY	2004	Over the top	Slight to moderate injury increasing with rate (2.5, 5.0, 10.0 lb ai per acre).
23832	Joe Pye Weed (<i>Eupatorium purpureum</i>) <i>E. 'Sweet Scented'</i>	Field Container	Treat	WA	2006	Over the top	Slight to severe injury increasing with rate (2.5, 5.0, 10.0 lb ai per acre).
24743	Thoroughwort (<i>Eupatorium</i> sp.) <i>E. rugosum</i> 'Chocolate'	Field Container	Boydston	WA	2005	Over the top	No injury with 2.5, 5.0 and 10 lb ai per acre.
24743	Thoroughwort (<i>Eupatorium</i> sp.)	Field Container	Larson	WA	2022	Over the top	No injury with 2.5, 5, and 10 lb ai per acre.
24743	Thoroughwort (<i>Eupatorium</i> sp.) <i>E. dubium</i> 'Baby Joe'	Field Container	Senesac	NY	2022	Over the top	Minor to moderate injury increasing with rate (2.5, 5.0 10.0 lb ai per acre).
24743	Thoroughwort (<i>Eupatorium</i> sp.) <i>E. colelestinum</i>	Field Container	Treat	WA	2006	Over the top	Minor to severe injury increasing with rate (2.5, 5.0, 10.0 lb ai per acre) with recovery by end of the experiment at 2.5 lb ai per acre, but some mortality did occur with the 10.0 lb ai per acre rate.
24744	Treasureflower (<i>Gazania linearis</i>) 'Colorado Gold'	Field Container	Neal	NC	2005	Over the top	No injury at 2.5 lb ai per acre rate, moderate injury at 5 lb ai per acre severe at 10 lb ai per acre
24744	Treasureflower (<i>Gazania linearis</i>) 'Colorado Gold'	Field Container	Treat	WA	2006	Over the top	Significant injury with complete recovery by trial's end at 1X rate (2.5 lb ai per acre); unacceptable at higher rates
26831	<i>Gazania</i> (<i>Gazania</i> sp.) 'Daybreak Mix'	Greenhouse	Freiberger	NJ	2006	Over the top	No injury at 2.5 lb ai per acre, slight and moderate at 5 and 10 lb ai
24746	Transvaal Daisy (<i>Gerbera</i> sp.) <i>G. jamesonii</i>	Field Container	Chandran	WV	2005	Over the top	No injury at 2.5, 5 and 10 lb ai per acre
24746	Transvaal Daisy (<i>Gerbera</i> sp.) <i>Gerbera jamesonii</i>	Field Container	Fraelich	GA	2006	Over the top	Moderate injury at higher rates but plants recovered; no differences in growth or marketability
24746	Transvaal Daisy (<i>Gerbera</i> sp.) <i>G. jamesonii</i> 'Lambada'	Field Container	Lieth	CA	2005	Over the top	Significant injury and severe growth suppression
24746	Transvaal Daisy (<i>Gerbera</i> sp.) <i>G. jamesonii</i>	Field Container	Linderman	OR	2006	Over the top	No injury at 2.5, 5 and 10 lb ai per acre
24746	Transvaal Daisy (<i>Gerbera</i> sp.) 'Dark Eye Orange'	Field Container	Treat	WA	2006	Over the top	Severe injury (leaf burn and stunting) increasing with rates (2.5, 5 and 10 lb ai per acre)
24747	Globe Amaranth (<i>Gomphrena</i> sp.)	Field Container	Aulakh	CT	2022	Over the top	No to minor necrosis after first application from 5 lb ai/a, increasing to moderate after second application. Moderate but transient necrosis after both applications at 10 lb ai/a. Moderate stunting 28 days after first application of 10 lb ai/a, but no s

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24747	Globe Amaranth (<i>Gomphrena</i> sp.)	Field Container	Chandran	WV	2005	Over the top	No significant injury at 2.5, 5 and 10 lb ai per acre
24747	Globe Amaranth (<i>Gomphrena</i> sp.) <i>G. uvaria</i>	Field Container	Gilliam	AL	2005	Directed	Slight injury (leaf burn and discoloration) at 2.5 lb ai per acre and 5 lb ai per acre rates, moderate at 10 lb ai per acre
24747	Globe Amaranth (<i>Gomphrena</i> sp.) 'Las Vegas Purple'	Field Container	Koski	CO	2022	Over the top	Little no injury from 2.5 lb ai/a applied twice. Moderate injury after first application of 5 and 10 lb ai/a, increasing to severe after second application.
24747	Globe Amaranth (<i>Gomphrena</i> sp.) <i>G. globosa</i> 'Buddy Series Purple'	Field Container	Treat	WA	2006	Over the top	Slight to moderate injury with complete recovery by trial's end at 1X rate (2.5 lb ai per acre); unacceptable at higher rates
23833	Common Sneezeweed (<i>Helenium autumnale</i>)	Field Container	Lieth	CA	2004	Over the top	No injury at 2.5 lb ai per acre and 5 lb ai per acre rates slight injury at 10 lb ai per acre
23833	Common Sneezeweed (<i>Helenium autumnale</i>) 'Summer Sun'	Field Container	Neal	NC	2004	Over the top	No injury at 2.5 and 5 lb ai per acre; slight at 10 lb ai per acre, but plants recovered
23833	Common Sneezeweed (<i>Helenium autumnale</i>)	Field Container	Reding	OH	2005	Over the top	No significant injury at 2.5 lb ai per acre and 5 lb ai per acre rates; plants outgrew slight to moderate injury at 10 lb ai per acre
23833	Common Sneezeweed (<i>Helenium autumnale</i>)	Field Container	Senesac	NY	2005	Over the top	Minor injury after second application but plants recovered by end of experiment
26847	Sneezeweed (<i>Helenium</i> sp.) 'Hoopes II Yellow'	Greenhouse	Freiberger	NJ	2006	Over the top	No injury at 2.5 lb ai per acre, slight at 5 and 10 lb ai
24748	Frostweed (<i>Helianthemum</i> sp.) 'Ben Ledi'	Field Container	Koski	CO	2022	Over the top	No injury from two applications of 2.5 lb ai/a. Moderate injury after first application of both 5 or 10 lb ai/a, increasing to severe after second application of 5 lb ai/a while moderate injury persisted after second application of 10 lb ai/a.
24748	Frostweed (<i>Helianthemum</i> sp.) <i>H. nummularium</i> 'Belgravia Rose'	Field Container	Lieth	CA	2005	Over the top	No significant injury at 2.5 lb ai per acre and 5 lb ai per acre rates, all rates reduced growth.
23834	Sunflower, Willowleaf (<i>Helianthus salicifolius</i>) 'First Light'	Field Container	Mathers (OSU)	OH	2005	Over the top	No injury with 2.5, 5.0. 10.0 lb ai per acre.
23834	Sunflower, Willowleaf (<i>Helianthus salicifolius</i>) 'First Light'	Field Container	Senesac	NY	2005	Over the top	No significant injury at 2.5 lb ai per acre and 5 lb ai per acre rates, minor injury at 10 lb ai per acre
24749	Sunflower (<i>Helianthus</i> sp.) <i>H. salicifolius</i> 'First light'	Field Container	Treat	WA	2006	Over the top	Minor to severe injury (leaf burn and stunting) increasing with rates (2.5, 5 and 10 lb ai per acre)
23836	Smooth Oxeye (<i>Heliopsis helianthoides</i>) 'Summer Sun'	Field Container	Boydston	WA	2005	Over the top	Slight injury with 2.5 and 5.0 lb ai per acre; moderate injury with 10 lb ai per acre. No significant height differences with 2.5 lb ai per acre, but significant stunting with 5.0 and 10.0 lb ai per acre.
26030	Smooth Oxeye (<i>Heliopsis helianthoides</i>) 'Summer Nights'	Greenhouse	Mickelbart	IN	2006	Over the top	Slight to high injury with increasing rates (2.5, 5 and 10 lb ai per acre); no growth reduction
23837	Hellebore, Black (<i>Helleborus niger</i>) <i>H. X orientalis</i> 'White Spotted Lady'	Field Container	Senesac	NY	2005	Over the top	Slight to moderate injury increasing with rate (2.5, 5.0, 10.0 lb ai per acre), but dissipating over time.

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24750	Coral Bells (<i>Heuchera sanguinea</i>)	Field Container	Boydston	WA	2005	Over the top	Moderate to severe injury increasing with rate (2.5, 5.0 and 10 lb ai per acre). Single application caused reddening and necrosis; second application caused additional injury.
24750	Coral Bells (<i>Heuchera sanguinea</i>)	Field Container	Klett	CO	2005	Over the top	Fort Collins: Moderate to severe injury increasing with rate (2.5, 5.0, 10 lb ai per acre).
24750	Coral Bells (<i>Heuchera sanguinea</i>)	Field Container	Klett	CO	2005	Over the top	Grand Junction: Severe injury at all rates (2.5, 5.0, 10 lb ai per acre).
24750	Coral Bells (<i>Heuchera sanguinea</i>) 'Firefly'	Field Container	Lieth	CA	2005	Over the top	Significant injury and growth suppression with increasing suppression at increased rates
34872	Foamy Bells (<i>Heucherella</i> sp.)	Field Container	Larson	WA	2022	Over the top	No injury with 2.5, 5, and 10 lb ai per acre.
25788	Rose-Of-Sharon (<i>Hibiscus syriacus</i>) H. moscheutos 'Splash Pinot Noir'	Field Container	Senesac	NY	2005	Over the top	Slight injury at 2.5 and 5, moderate at 10 lb ai per acre.
24833	Candytuft (<i>Iberis</i> sp.) <i>I. sempervirens</i> 'Alexander's White'	Field Container	Boydston	WA	2006	Over the top	No injury or growth reduction at all rates (2.5, 5 and 10 lb ai per acre); all plants saleable
26840	Candytuft (<i>Iberis</i> sp.) 'White'	Greenhouse	Freiberger	NJ	2006	Over the top	No injury at 2, 4 and 8 lb ai per acre.
24833	Candytuft (<i>Iberis</i> sp.) <i>I. sempervirens</i> 'Snowflake'	Field Container	Lieth	CA	2005	Over the top	No significant injury; plant growth suppression
24833	Candytuft (<i>Iberis</i> sp.) <i>I. sempervirens</i> 'Purite'	Field Container	Treat	WA	2006	Over the top	No injury at 2.5 and 5 lb ai per acre; 10 lb ai per acre unacceptable
34955	Common Rush (<i>Juncus effusus</i>) 'Big Twister'	Field Container	Mathers	OH	2022	Over the top	Severe injury from 2.5, 5.0 and 10 lb ai/a six weeks after first application, despite low injury at earlier evaluations. Injury persisted from all treatments after second application.
34955	Common Rush (<i>Juncus effusus</i>) 'Big Twister'	Field Container	Moretti	OR	2022	Over the top	Moderate to severe injury from two applications at 2.5, 5 or 10 pt/a, despite low injury after first application. All rates substantially decreased plant volume compared to nontreated, though not significant.
23838	Poker Plant (<i>Kniphofia</i> sp.) <i>K. uvaria</i> 'Flamenco'	Field Container	Boydston	WA	2005	Over the top	No injury with 2.5, 5.0 and 10.0 lb ai per acre.
23838	Poker Plant (<i>Kniphofia</i> sp.) <i>K. uvaria</i> 'Flamenco mix'	Field Container	Derr	VA	2005	Over the top	No injury at all rates (2.5, 5.0, 10.0 lb ai per acre).
23838	Poker Plant (<i>Kniphofia</i> sp.) <i>K. uvaria</i>	Field Container	Gilliam	AL	2005	Directed	No injury with 2.5, 5, and 10 lb ai per acre.
23838	Poker Plant (<i>Kniphofia</i> sp.) <i>K. uvaria</i> 'Border Ballet'	Field Container	Lieth	CA	2004	Over the top	No injury
23838	Poker Plant (<i>Kniphofia</i> sp.) <i>K. uvaria</i> 'Pfizers Hybrid'	Field Container	Neal	NC	2005	Over the top	No injury at all rates (2.5, 5.0, 10.0 lb ai per acre).
25298	Lantana (<i>Lantana</i> sp.) <i>L. hybrida</i> 'New Gold'	Field In-Ground	Chen	LA	2005	Over the top	Slight injury with 2.5, 5.0 and 10 lb ai per acre.
24688	Lantana (<i>Lantana</i> sp.) <i>L. montevidensis</i>	Field Container	Lieth	CA	2005	Over the top	No injury or plant growth suppression

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23839	Lavender, English (<i>Lavandula angustifolia</i>)	Field Container	Gilliam	AL	2004	Over the top	No injury with 2.1, 4.2, and 8.4 lb ai per acre.
23839	Lavender, English (<i>Lavandula angustifolia</i>) 'Vera'	Field Container	Lieth	CA	2004	Over the top	No injury with 2.1, 4.2, and 8.4 lb ai per acre.
23839	Lavender, English (<i>Lavandula angustifolia</i>) 'Munstead'	Field Container	Neal	NC	2004	Over the top	No injury at 2.5 lb ai per acre, slight injury at 5 lb ai per acre rate and unacceptable at 10 lb ai per acre
23839	Lavender, English (<i>Lavandula angustifolia</i>) 'Munstead'	Field Container	Senesac	NY	2004	Over the top	No injury with 2.5, 5.0, and 10.0 lb ai per acre.
34874	Daisy, Shasta (<i>Leucanthemum x superbum</i>)	Field Container	Larson	WA	2022	Over the top	No injury with 2.5, 5, and 10 lb ai per acre.
34874	Daisy, Shasta (<i>Leucanthemum x superbum</i>) 'Becky'	Field Container	Neal	NC	2022	Over the top	Minor to no injury after first application at 2.5, 5. or 10 pt/a. Minor to moderate, transient injury after second application. Significant reduction in marketable plants from two higher rates one week after second application but full recovery by 7 weeks
34874	Daisy, Shasta (<i>Leucanthemum x superbum</i>) 'Madonna'	Field Container	Senesac	NY	2022	Over the top	Moderate to severe injury increasing with rate (2.5, 5.0 10.0 lb ai per acre).
23840	Golden Rockets (<i>Ligularia stenocephala</i>) 'Dark Leaf'	Field Container	Boydston	WA	2005	Over the top	No injury with 2.5, 5.0 and 10.0 lb ai per acre.
23840	Golden Rockets (<i>Ligularia stenocephala</i>)	Field Container	Fraelich	GA	2005	Over the top	No injury or growth differences at all rates
23840	Golden Rockets (<i>Ligularia stenocephala</i>) 'The Rocket'	Field Container	Senesac	NY	2005	Over the top	No significant injury at all rates (2.5, 5.0, 10.0 lb ai per acre).
13195	Sealavender (<i>Limonium</i> sp.)	Field In-Ground	Sellmer	PA	2001	Over the top	
23841	Perennial Flax (<i>Linum perenne</i>) 'Sapphire'	Field Container	Lieth	CA	2004	Over the top	No injury at 2.1, 2.4, or 8.4 lb ai per acre.
23841	Perennial Flax (<i>Linum perenne</i>) 'Sapphyr"	Field Container	Neal	NC	2004	Over the top	No injury at 2.5 lb ai per acre and 5 lb ai per acre rates, slight injury at 10 lb ai per acre.
23841	Perennial Flax (<i>Linum perenne</i>)	Field Container	Senesac	NY	2004	Over the top	No injury at 2.5 lb ai per acre and 5 lb ai per acre rates, slight injury at 10 lb ai per acre.
24985	Lilyturf, Big Blue (<i>Liriope muscari</i>) 'Big Blue'	Field In-Ground	Chen	LA	2005	Over the top	No significant injury with 2.5, 5.0 and 10 lb ai per acre
34956	Muhly, Hairyawm (<i>Muhlenbergia capillaris</i>)	Field Container	Moretti	OR	2022	Over the top	Minor to no injury from two applications at 2.5, 5 or 10 pt/a. Plant volume significantly reduced from two highest rates applied twice.
23843	Nepeta (<i>Nepeta x faassenii</i>) 'Walker's Low'	Field Container	Derr	VA	2004	Over the top	All rates caused slight injury (2.5. 5.0. 10.0 lb ai per acre).
23843	Nepeta (<i>Nepeta x faassenii</i>) 'Dropmore'	Field Container	Gilliam	AL	2004	Over the top	No injury with 2.1, 2.4, and 8.4 lb ai per acre.
23843	Nepeta (<i>Nepeta x faassenii</i>) 'Dropmore'	Field Container	Lieth	CA	2004	Over the top	No injury with 2.1, 2.4, and 8.4 lb ai per acre.

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23843	Nepeta (Nepeta x faassenii) N. nervosa 'Blue Carpet'	Field Container	Neal	NC	2004	Over the top	Severe injury at all rates (2.5, 5.0, 10.0 lb ai per acre)
23843	Nepeta (Nepeta x faassenii) 'Walker's Low'	Field Container	Senesac	NY	2004	Over the top	No injury with 2.5, 5.0 and 10.0 lb ai per acre.
23844	Devil's-tongue; Eastern Prickly Pear (Opuntia humifusa) 'Lemon Form'	Field Container	Senesac	NY	2005	Over the top	No injury with 2.5, 5.0, 10.0 lb ai per acre.
24754	Hopflower Oregano; Majoram (Origanum libanoticum)	Field Container	Klett	CO	2005	Over the top	Fort Collins: Moderate to severe injury increasing with rate (2.5, 5.0, 10 lb ai per acre).
24754	Hopflower Oregano; Majoram (Origanum libanoticum)	Field Container	Klett	CO	2005	Over the top	Grand Junction: Severe injury at all rates (2.5, 5.0, 10 lb ai per acre).
24834	Switch Grass (Panicum virgatum) P. virgatum 'Trailblazer'	Field Container	Boydston	WA	2006	Over the top	No injury or growth reduction at 1X and 2X rates (2.5 and 5 lb ai per acre), 4x rate plants slightly smaller; all plants saleable
26833	Switch Grass (Panicum virgatum)	Greenhouse	Freiberger	NJ	2006	Over the top	High injury at all rates (2.5, 5 and 10 lb ai per acre)
24834	Switch Grass (Panicum virgatum)	Field Container	Lieth	CA	2006	Over the top	No injury but unacceptable growth reduction at 2.5, 5 and 10 lb ai per acre
24834	Switch Grass (Panicum virgatum) 'Dallas Blues'	Field Container	Mathers (OSU)	OH	2005	Over the top	No injury
24755	Beard-Tongue (Penstemon sp.) P. digitalis 'Scarlet Queen'	Field Container	Boydston	WA	2005	Over the top	No injury with 2.5, 5.0 and 10 lb ai per acre.
24755	Beard-Tongue (Penstemon sp.) P. digitalis 'Husker Red'	Field Container	Derr	VA	2005	Over the top	Slight injury at 5 lb ai per acre but plants outgrew injury
24755	Beard-Tongue (Penstemon sp.) P. X mexicali 'Red Rocks'	Field Container	Lieth	CA	2005	Over the top	Very slight, no effect on plant growth
24755	Beard-Tongue (Penstemon sp.) P. digitalis 'Husker Red'	Field Container	Neal	NC	2005	Over the top	No injury at 2.5 lb ai per acre, moderate at 5 lb ai per acre, severe at 10 lb ai per acre
26836	Pentas (Pentas sp.) 'New Look Pink'	Greenhouse	Freiberger	NJ	2006	Over the top	High injury at all rates (2.5, 5 and 10 lb ai per acre)
25300	Phlox, Carolina (Phlox carolinia) P. subulata 'Candy Strip'	Field In-Ground	Chen	LA	2005	Over the top	Slight injury with 2.5, 5.0 and 10 lb ai per acre.
33364	Phlox, Fall (Phlox paniculata) 'Festival'	Field Container	Fraelich	GA	2022	Over the top	No to very slight injury with 2.5, 5.0, and 10.0 lb ai per acre, no impact on growth.
33364	Phlox, Fall (Phlox paniculata) 'Glamour Girl'	Field Container	Koski	CO	2022	Over the top	Little to no injury from two applications of 2.5 lb ai/a. Minor to slight injury from two applications of 5 lb ai/a. Moderate to minor injury from two applications of 10 lb ai/a.
33364	Phlox, Fall (Phlox paniculata)	Field Container	Larson	WA	2022	Over the top	No injury with 2.5, 5, and 10 lb ai per acre.
24758	Flax, New Zealand (Phormium tenax) P. colinsoi	Field Container	Lieth	CA	2005	Over the top	No injury, significant increase in plant growth
34876	Balloon Flower (Platycodon grandiflorus) 'Pop Star Blue'	Field Container	Koski	CO	2022	Over the top	Little to no injury from 2.5 lb ai/a applied twice. Moderate injury after first application of 5 or 10 lb ai/a, increasing to severe after second application of each rate.

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23845	Jacob's Ladder (Polemonium sp.) 'Heavenly Habit'	Field Container	Boydston	WA	2005	Over the top	No injury to minor injury increasing with rate (2.5, 5.0 and 10 lb ai per acre). However, significant stunting occurred with 10 lb ai per acre.
23845	Jacob's Ladder (Polemonium sp.) P. reptans	Field Container	Fraelich	GA	2006	Over the top	Slight injury and stunting; no reduction in marketability
23845	Jacob's Ladder (Polemonium sp.) P. reptans 'Stairway to Heaven'	Field Container	Linderman	OR	2006	Over the top	No injury at 2.5, 5 and 10 lb ai per acre
23845	Jacob's Ladder (Polemonium sp.) P. 'Caeruleum Blue'	Field Container	Treat	WA	2006	Over the top	Severe injury at 2.5, 5 and 10 lb ai per acre.
34910	Solomon's Seal, Variegated (Polygonatum odoratum)	Field Container	Larson	WA	2022	Over the top	No injury with 2.5, 5, and 10 lb ai per acre.
24760	Primrose, Fairy (Primula malacoides)	Field Container	Lieth	CA	2005	Over the top	Significant injury and plant growth suppression
24760	Primrose, Fairy (Primula malacoides) 'Prima Carmine Rose'	Field Container	Treat	WA	2006	Over the top	Severe injury (leaf burn and stunting) at all rates (2.5, 5 and 10 lb ai per acre)
24759	Lungwort (Pulmonaria sp.) P. longifolia 'Roy Davidson'	Field Container	Koski	CO	2022	Over the top	Little to no injury from 2.5 lb ai/a applied twice. Moderate injury from 5 lb ai/ at all evaluations. Moderate injury from 10 lb ai/a after first application but increased to severe after second application
24759	Lungwort (Pulmonaria sp.) P. x cevennensis 'Silver Bouquet'	Field Container	Senesac	NY	2022	Over the top	Minor to moderate injury increasing with rate (2.5, 5.0 10.0 lb ai per acre).
34878	Yu-shan Raspberry; Creeping Raspberry (Rubus calycinoides)	Field Container	Fraelich	GA	2022	Over the top	No to moderate injury increasing with rate (2.5, 5.0 and 10 lb ai per acre) and a statistically significant reduction in number of vines as rate increased.
33362	Black-Eyed Susan (Rudbeckia hirta) 'Marmalade'	Field In-Ground	Aulakh	CT	2018	Over the top	No injury or growth reduction with 2.6 pt per acre applied twice, moderate with 5.2, and severe with 10.4 pt per acre.
25305	Carolina Wild Petunia (Ruellia caroliniensis) R. brittoniana 'Katie'	Field In-Ground	Chen	LA	2005	Over the top	No significant injury with 2.5, 5.0 and 10 lb ai per acre.
24762	Lavender Cotton (Santolina chamaecyparissus) S. incana	Field Container	Boydston	WA	2006	Over the top	No injury or growth reduction at all rates (2.5, 5 and 10 lb ai per acre); all plants saleable
24762	Lavender Cotton (Santolina chamaecyparissus) 'Compacta'	Field Container	Lieth	CA	2005	Over the top	No injury at 2.5 lb ai per acre, slight injury at 5 lb ai per acre and moderate at 10 lb ai per acre rate; no effect on plant growth
26033	Pincushions (Scabiosa sp.) 'Blue Diamonds'	Greenhouse	Mickelbart	IN	2006	Over the top	No significant injury or growth reduction at 2.5 lb ai per acre; significant at higher rates
23848	Houseleek, Cobweb (Sempervivum arachnoideum)	Field Container	Senesac	NY	2004	Over the top	No injury with 2.5, 5.0, 10.0 lb ai per acre.
26842	Houseleek (Sempervivum sp.)	Greenhouse	Freiberger	NJ	2006	Over the top	No injury after 1st application at all rates (2.5, 5 and 10 lb ai per acre), high at 2X and 4X after 2nd application
23847	Houseleek, Common (Sempervivum tectorum) 'Cobweb'	Field Container	Ahrens/ Mervosh	CT	2005	Over the top	Slight injury at 2.5 lb ai per acre rate, moderate at 5 lb ai per acre and 10 lb ai per acre.

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
23847	Houseleek, Common (<i>Sempervivum tectorum</i>) 'Sunset	Field Container	Lieth	CA	2004	Over the top	No injury
23847	Houseleek, Common (<i>Sempervivum tectorum</i>)	Field Container	Senesac	NY	2004	Over the top	No injury
23850	Goldenrod, Wreath; Goldenrod, Blue Stem (<i>Solidago caesia</i>)	Field Container	Marble	FL	2022	Over the top	No injury from 42, 84 or 168 fl oz/a.
23851	Goldenrod, Wrinkleleaf (<i>Solidago rugosa</i>) 'Goldenrod'	Field Container	Fraelich	GA	2005	Over the top	No injury or growth differences at all rates
23851	Goldenrod, Wrinkleleaf (<i>Solidago rugosa</i>) 'Fireworks'	Field Container	Lieth	CA	2004	Over the top	No injury at 2.5 lb ai per acre rate, slight injury at 5 lb ai per acre and 10 lb ai per acre rates
23851	Goldenrod, Wrinkleleaf (<i>Solidago rugosa</i>)	Field Container	Neal	NC	2004	Over the top	No injury at 2.5 lb ai per acre rate, slight injury at 5 lb ai per acre and 10 lb ai per acre rates
23851	Goldenrod, Wrinkleleaf (<i>Solidago rugosa</i>)	Field Container	Reding	OH	2005	Over the top	Significant injury; plants outgrew slight injury at 2.5 lb ai per acre and 5 lb ai per acre rates
23852	Goldenrod, Seaside (<i>Solidago sempervirens</i>)	Field Container	Fraelich	GA	2005	Over the top	No injury or growth differences at all rates
23852	Goldenrod, Seaside (<i>Solidago sempervirens</i>)	Field Container	Fraelich	GA	2006	Over the top	No injury or growth differences at all rates
23852	Goldenrod, Seaside (<i>Solidago sempervirens</i>)	Field Container	Senesac	NY	2004	Over the top	No injury with 2.5, 5.0, 10.0 lb ai per acre.
33378	Goldenrod (<i>Solidago</i> sp.) <i>S. rugosa</i> 'Fireworks	Field In-Ground	Aulakh	CT	2018	Over the top	No injury or growth reduction with 2.6, 5.2 and 10.4 pt per acre after 1st applic, moderate after the 2nd application with 2X and 4X.
24763	Goldenrod (<i>Solidago</i> sp.) <i>S. speciosa</i>	Field Container	Fraelich	GA	2006	Over the top	No injury or growth differences at all rates
24763	Goldenrod (<i>Solidago</i> sp.) <i>S. sempervirens</i>	Field Container	Linderman	OR	2006	Over the top	No injury at 2.5, 5 and 10 lb ai per acre
24763	Goldenrod (<i>Solidago</i> sp.) <i>S. cabadensis</i>	Field Container	Treat	WA	2006	Over the top	No injury at 2.5, 5 and 10 lb ai per acre.
23853	Goldenrod, Showy (<i>Solidago speciosa</i>)	Field Container	Larson	WA	2022	Over the top	No injury with 2.5, 5, and 10 lb ai per acre.
23853	Goldenrod, Showy (<i>Solidago speciosa</i>)	Field Container	Marble	FL	2022	Over the top	Minor to moderate phyto from 42, 84, and 168 fl oz/a after both applications. Significant growth rate reductions from all rates.
34957	Prairie Dropseed (<i>Sporobolus heterolepis</i>)	Field Container	Derr	VA	2022	Over the top	Minor to moderate injury with 2.5, 5.0, and 10.0 lb ai per acre.
10780	Aster, Stokes (<i>Stokesia</i> sp.) <i>S. laevis</i> 'Mini Mels'	Field Container	Koski	CO	2022	Over the top	No injury after either of two applications at 2.5 lb ai/a. Moderate injury from 5 lb ai/a, increasing to severe after second application. Severe injury at all evaluations from 10 lb ai/a. applied twice.
10780	Aster, Stokes (<i>Stokesia</i> sp.) ' <i>S. laevis</i> '	Field Container	Marble	FL	2022	Over the top	Minor crop injury from 42, 84 and 168 fl oz/a 2 weeks after application

PR#	Crop	Production Site	Researcher	State	Year	Application Type	Results
27704	Aster, White Heath (<i>Symphotrichum ericoides</i>) 'Snow Flurry'	Field Container	Chandran	WV	2005	Over the top	No significant injury at 2.5, 5, and 10 lb ai per acre.
24836	Thyme, Creeping (<i>Thymus serpyllum</i>) 'Magic Carpet'	Field Container	Koski	CO	2022	Over the top	Minor injury after first application of 2.5 lb ai/a but declined and did not increase after second application. Moderate injury after first application of 5 lb ai/a increasing to severe after second application. severe injury after both applications of 1
23854	Foamflower, Heartleaf (<i>Tiarella cordifolia</i>)	Field Container	Neal	NC	2004	Over the top	All rates caused significant injury (2.5, 5.0, 10.0 lb ai per acre).
23854	Foamflower, Heartleaf (<i>Tiarella cordifolia</i>)	Field Container	Senesac	NY	2005	Over the top	Moderate to severe injury increasing with rate (2.5, 5.0, 10.0 lb ai per acre).
24766	Ohio Spiderwort; Bluejacket (<i>Tradescantia ohiensis</i>) 'Osprey'	Field Container	Boydston	WA	2005	Over the top	All rates (2.5, 5.0 and 10 lb ai per acre) caused moderate to severe injury, stunting and delayed flowering; treated plants not saleable.
26843	Spiderwort (<i>Tradescantia</i> sp.)	Greenhouse	Freiberger	NJ	2006	Over the top	Slight injury after 1st, high injury after 2nd application at all rates (2.5, 5 and 10 lb ai per acre)
24765	Spiderwort (<i>Tradescantia x andersoniana</i>) 'Concord Grape'	Field Container	Derr	VA	2005	Over the top	No injury at 2.5 lb ai per acre slight injury at 5 lb ai per acre, moderate at 10 lb ai per acre
24765	Spiderwort (<i>Tradescantia x andersoniana</i>) 'Baby Bunny Bellies'	Field Container	Lieth	CA	2006	Over the top	Unacceptable injury and growth reduction at 2.5, 5 and 10 lb ai per acre
24765	Spiderwort (<i>Tradescantia x andersoniana</i>) 'Sweet Kate'	Field Container	Mathers (OSU)	OH	2005	Over the top	All rates (2.5, 5.0, 10.0 lb ai per acre) caused severe injury (distorted and dead plants)
25306	Vervain (<i>Verbena</i> sp.) <i>V. canadensis</i> 'Homestead Purple'	Field In-Ground	Chen	LA	2005	Over the top	Moderate injury with 2.5, 5.0 and 10 lb ai per acre; plants recovered in a short time
24689	Vervain (<i>Verbena</i> sp.) <i>V. canadensis</i> 'Homestead Purple'	Field Container	Neal	NC	2005	Over the top	No injury at 2.5 lb ai per acre rate, moderate at 5 lb ai per acre rate and severe at 10 lb ai per acre
23855	Ironweed, New York (<i>Vernonia noveboracensis</i>)	Field Container	Neal	NC	2004	Over the top	No injury at 2.5 lb ai per acre rate, slight injury at 5 lb ai per acre and 10 lb ai per acre rates
23855	Ironweed, New York (<i>Vernonia noveboracensis</i>)	Field Container	Senesac	NY	2004	Over the top	No injury with 2.5, 5.0, 10.0 lb ai per acre.
13131	Strawflower, Bracted (<i>Xerochrysum bracteatum</i>)	Field In-Ground	Sellmer	PA	2001	Over the top	
33358	Zinnia (<i>Zinnia</i> sp.) 'Purple Prince'	Field In-Ground	Aulakh	CT	2018	Over the top	Minor injury with good recovery, and no growth reduction, with 2.6, 5.2 and 10.4 pt per acre applied twice.

Label Suggestions

We recommend that six crops exhibiting no injury in these experiments be added to the current Pennant Magnum label for over-the-top applications.

Ligularia stenocephala
Linum perenne
Nepeta faassenii
Penstemon digitalis
Phlox paniculata
Solidago rugosa

We also suggest that the 25 plant species / genera exhibiting significant injury with over-the-top applications be added to a sensitive plant list.

Agastache aurantiaca
Agastache rugosa x foeniculum
Agastache rupestris
Alchemilla mollis
Amsonia hubrichtii
Amsonia tabernaemontana
Armeria maritima
Asarum candanense
Bergenia cordifolia
Chelone lyonii
Chrysogonum virginianum
Delosperma nubigenum
Digitalis thapsi
Echinacea purpurea
Epimedium x rubrum
Gerbera jamesonii
Heuchera sanguinea
Junus effusus
Nepeta nervosa
Origanum libanoticum
Pentas sp.
Primula malacoides
Tiarella cordifolia
Tradescantia andersoniana
Tradescantia ohiensis

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