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**IR-4 Ornamental Horticulture Program  
S-Metolachlor Crop Safety**

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Date: June 20, 2006**

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## **Abstract**

Several good herbicide products are available to manage weeds in and around nursery crops. Because growers produce many different plant species and cultivars and because many new crops are grown every year, this research was undertaken to expand the three pre-emergent herbicide labels: Pendulum 2G (pendimethalin), Pennant Magnum (s-metolachlor), and Snapshot 2.5TG (trifluralin + isoxaben). This report covers only Pennant Magnum. The rates chosen for this research were 2.5, 5.0 and 10.0 pounds active ingredient per acre (lb ai per A) as the 1X, 2X and 4X rates. Sixty-seven different species were examined. Of these, sixteen exhibited no or minimal transient injury after application at all three rates. Twelve crops require further research because of unclear results. Sixteen crops exhibited no phytotoxicity at 2.5 lb ai per acre, but did have some injury at the higher rates. Twenty-three species exhibited phytotoxicity at even the 2 lb ai per acre rate.

## Introduction

Control of weeds in the production of herbaceous perennials can be problematic because nurseries grow many different types of plants and herbicide product labels do not have some of the important species grown. Three pre-emergent herbicides, Pendulum 2G, Pennant Magnum, and Snapshot 2.5TG, were chosen for 2004 and 2005 research activities into level of crop safety on over 50 different plant species. This report covers the results from Pennant Magnum.

## Materials and Methods

Two applications of Pennant Magnum (s metolachlor) were made approximately 30 days apart. The application rates were 2.5, 5, and 10 lb ai per A, 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. For more detailed materials and methods, please see Appendix 1: Protocols.

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

## Results and Summary

### ***Efficacy***

Several researchers also examine efficacy in addition to crop safety.

Derr reported excellent control of large crabgrass, dove weed, and spotted spurge but no control of tassel flower. Gilliam reported that all rates reduced naturally occurring indigenous weed populations of prostrate spurge, gripe weed and oxalis.

### ***Phytotoxicity***

Based on the type and nature of injury seen with Pennant Magnum applications in the research conducted in 2004 and 2005, 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). Sixteen 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. There were twelve species of plants for which the results were unclear and are suggested as candidates for further research; *Antennaria parvifolia*, *Asarum candanense*, *Asarum chinensis*, *Athyrium nipponicum*, *Aubrieta sp.*, *Clematis sp.*, *Cuphea hyssopifolia*, *Delosperma nubigenum*, *Eupatorium maculatum*, *Eupatorium rugosum*, *Eupatorium purpureum*, and *Helianthemum nummularium* (Table 2). Sixteen 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 3). 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 twenty-three crops in the 2004 and 2005 testing that exhibited damage sufficient to recommend growers not utilize Pennant Magnum as an over-the-top treatment for pre-emergent weed control (Table 4).

Please see Table 5 for a list of research on Pennant Magnum in 2004 and 2005 and the summary of the results received so far.

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

<i>Iberis sempervirens</i>	<i>Liriope muscari</i>	<i>Ruellia carolinensis</i>
<i>Kniphofia uvaria</i>	<i>Opuntia humifusa</i>	<i>Sempervivum tectorum</i>
<i>Lantana hybrida</i>	<i>Panicum virgatum</i>	<i>Solidago sempervirens</i>
<i>Lantana montevidensis</i>	<i>Penstemon x mexicali</i>	<i>Vernonia noveboracensis</i>
<i>Lavandula angustifolia</i>	<i>Phlox subulata</i>	
<i>Ligularia dentata</i>	<i>Phormium colinsoi</i>	

**Table 2. List of Pennant Magnum treated crops where more research is needed to clarify response**

<i>Antennaria parvifolia</i>	<i>Cuphea hyssopifolia</i>
<i>Asarum candanense</i>	<i>Delosperma nubigenum</i>
<i>Asarum chinensis</i>	<i>Eupatorium maculatum</i>
<i>Athyrium nipponicum</i>	<i>Eupatorium rugosum</i>
<i>Aubrieta sp.</i>	<i>Eupatorium purpureum</i>
<i>Clematis sp.</i>	<i>Helianthemum nummularium</i>

**Table 3. 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>Hibiscus syriacus</i>
<i>Bergenia sp.</i>	<i>Linum perenne</i>
<i>Cimicifuga racemosa</i>	<i>Nepeta faassenii</i>
<i>Gazania sp.</i>	<i>Penstemon digitalis</i>
<i>Gomphrenia uvaria</i>	<i>Polemonium sp.</i>
<i>Helenium autumnale</i>	<i>Santolina chamaecyparissus</i>
<i>Helianthus salicifolius</i>	<i>Solidago rugosa</i>
<i>Helleborus niger</i>	<i>Verbena canadensis</i>

**Table 4. List of Pennant Magnum treated crops exhibiting significant injury.**

<i>Agastache aurantiaca</i>	<i>Gerbera jamesonii</i>
<i>Agastache rugosa x foeniculum</i>	<i>Gomphrena sp.</i>
<i>Alchemilla mollis</i>	<i>Heliopsis helianthoides</i>
<i>Amsonia hubrichtii</i>	<i>Heuchera sanguinea</i>
<i>Amsonia tabernaemontana</i>	<i>Nepeta nervosa</i>
<i>Armeria maritima</i>	<i>Origanum libanoticum</i>
<i>Bergenia cordifolia</i>	<i>Primula malacoides</i>
<i>Chelone lyonii</i>	<i>Tiarella cordifolia</i>
<i>Chrysogonum virginianum</i>	<i>Tiarella wherryi</i>
<i>Digitalis thapsi</i>	<i>Tradescantia andersoniana</i>
<i>Epimedium x rubrum</i>	<i>Tradescantia ohiensis</i>
<i>Echinacea purpurea</i>	

**Table 5. Detailed Summary of 2005 Crop Safety Testing with Pennant Magnum**

Notes: Table entries are sorted by crop Latin name. All researchable studies for Pennant Magnum are included in this table. Only those that were researched in 2004 and 2005 and were received by 6/15/2006 have summaries.

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
24723	Hyssop species	<i>Agastache sp.</i>	A. rugosa X foeniculum 'Blue Fortune'	Field Container	Boydston	2005	All rates caused significant injury; treated plants not saleable.
24723	Hyssop species	<i>Agastache sp.</i>	A. aurantiaca 'Coronado'	Field Container	Klett	2005	Unacceptable injury
24723	Hyssop species	<i>Agastache sp.</i>	A. aurantiaca 'Coronado'	Field Container	Klett	2005	Unacceptable injury
24723	Hyssop species	<i>Agastache sp.</i>	A. rugosa X foeniculum 'Blue Fortune'	Field Container	Mathers	2005	All rates caused slight to moderate injury (leaf distortion and burning)
23819	Lady's-Mantle	<i>Alchemilla sp.</i>	A. mollis 'Thriller'	Field Container	Ahrens/Mervosh	2005	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 sp.</i>	A. mollis 'Selection 25'	Field Container	Boydston	2005	No injury
23819	Lady's-Mantle	<i>Alchemilla sp.</i>	A. mollis	Field Container	Derr	2004	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 sp.</i>	A. mollis	Field Container	Lieth	2004	All rates caused severe leaf necrosis
23819	Lady's-Mantle	<i>Alchemilla sp.</i>		Field Container	Reding	2005	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 sp.</i>	A. mollis	Field Container	Senesac	2004	No injury at 2.5 lb ai per acre and 5 lb ai per acre rates, slight injury at 10 lb ai per acre
24725	Golden Trumpet	<i>Allamanda sp.</i>		Field Container	Stamps	2005	
24726	Shellplant	<i>Alpinia zerumbet</i>		Field Container	Stamps	2005	
23820	Bluestar	<i>Amsonia sp.</i>	A. tabernaemontana	Field Container	Gilliam	2004	All rates caused serious leaf burn
23820	Bluestar	<i>Amsonia sp.</i>	A. hubrichtii	Field Container	Neal	2004	All rates caused significant injury
23820	Bluestar	<i>Amsonia sp.</i>	A. hubrichtii	Field Container	Senesac	2004	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
23822	Pussy-Toes, Small-leaf	<i>Antennaria parvifolia</i>		Field Container	Neal	2004	All rates caused moderate to severe injury
23822	Pussy-Toes, Small-leaf	<i>Antennaria parvifolia</i>		Field Container	Senesac	2004	No significant injury
24729	Thrift, Sea Pink	<i>Armeria maritima</i>	'Splendens'	Field Container	Boydston	2005	Single application caused purpling of leaves; second application caused additional injury. Plants did recover but were markedly shorter than untreated.



PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
24729	Thrift, Sea Pink	<i>Armeria maritima</i>	'Splendens'	Field Container	Gilliam	2005	All rates caused moderate to severe injury (burn and discoloration) and stunting
24729	Thrift, Sea Pink	<i>Armeria maritima</i>	'Dusseldorf'	Field Container	Lieth	2005	All rates caused unacceptable growth suppression
23823	Canadian Ginger	<i>Asarum canadense</i>	A. chinesis	Field Container	Neal	2005	No injury
23823	Canadian Ginger	<i>Asarum canadense</i>		Field Container	Senesac	2005	Moderate to high injury at all rates
25020	Butterfly	<i>Asclepias tuberosa</i>		Field Container	Stamps	2005	
24738	Fern, Lady	<i>Athyrium nipponicum</i>		Field Container	Derr	2005	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	2005	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
23824	Rock Cress	<i>Aubrieta sp.</i>	'Whitewell Gem'	Field Container	Lieth	2004	No injury but reduced plant width
23824	Rock Cress	<i>Aubrieta sp.</i>	'Whitewell Gem'	Field Container	Neal	2004	All rates caused significant injury
23824	Rock Cress	<i>Aubrieta sp.</i>		Field Container	Reding	2005	No injury
23825	Blue False Indigo	<i>Baptisia australis</i>		Field Container	Derr	2004	All rates caused slight injury <i>Excellent efficacy for large crabgrass and spotted spurge</i>
23825	Blue False Indigo	<i>Baptisia australis</i>		Field Container	Gilliam	2004	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 False Indigo	<i>Baptisia australis</i>		Field Container	Neal	2004	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 False Indigo	<i>Baptisia australis</i>		Field Container	Senesac	2005	No injury
24739	Heart-leaved Bergenia	<i>Bergenia cordifolia</i>	'Rotblum'	Field Container	Lieth	2005	Significant injury and unacceptable growth suppression
24739	Heart-leaved Bergenia	<i>Bergenia cordifolia</i>	'New Hybrid'	Field Container	Neal	2005	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
23826	Turtlehead, Snakehead	<i>Chelone sp.</i>	C. lyonii 'Hot Lips'	Field Container	Derr	2004	Slight injury at 2.5 lb ai per acre rate, moderate at 5 lb ai per acre severe at 10 lb ai per acre
23826	Turtlehead, Snakehead	<i>Chelone sp.</i>	C. lyonii 'Hot Lips'	Field Container	Neal	2004	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	<i>Chelone sp.</i>	C. lyonii 'Hot Lips'	Field Container	Senesac	2004	All rates caused moderate injury

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
23827	Golden Star	<i>Chrysogonum sp.</i>	C. virginianum 'Alan Bush'	Field Container	Derr	2004	Moderate injury increasing with rate Excellent efficacy for large crabgrass and spotted spurge
23827	Golden Star	<i>Chrysogonum sp.</i>	C. virginianum 'Alan Bush'	Field Container	Neal	2004	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	<i>Chrysogonum sp.</i>	C. virginianum 'Alan Bush'	Field Container	Senesac	2005	No significant injury at 2.5 lb ai per acre rate; moderate to high injury at 5 lb ai per acre and 10 lb ai per acre
23828	Bugbane & Cohosh, Black	<i>Cimicifuga racemosa</i>		Field Container	Neal	2005	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
24830	Clematis	<i>Clematis sp.</i>	'Midnight Showers'	Field Container	Mathers	2005	All rates caused slight injury but plants recovered
25296	Mexican Heather, False Heather, Elfin Herb	<i>Cuphea hyssopifolia</i>		Field In-Ground	Chen	2005	Moderate injury: plants recovered in a short time
24832	Hardy Ice Plant, Yellow Ice Plant	<i>Delosperma nubigenum</i>		Field Container	Boydston	2005	All rates caused slight stunting and delayed flowering; some 10 lb ai per acre treated plants not saleable
24741	Foxglove	<i>Digitalis sp.</i>	D. thaspi 'Spanish Peaks'	Field Container	Klett	2005	Unacceptable injury
24741	Foxglove	<i>Digitalis sp.</i>	D. thaspi 'Spanish Peaks'	Field Container	Klett	2005	Unacceptable injury
24742	Purple Coneflower	<i>Echinacea sp.</i>	E. purpurea 'Magnus'	Field Container	Derr	2005	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 sp.</i>	E. purpurea 'Magnus'	Field Container	Gilliam	2005	All rates caused moderate to severe injury (leaf curl and leaf distortion) and stunting
23829	Barrenwort	<i>Epimedium sp.</i>	E. X rubrum	Field Container	Ahrens/Mervosh	2005	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	Barrenwort	<i>Epimedium sp.</i>	E. X rubrum	Field Container	Senesac	2005	Moderate injury at all rates.
23830	Joepyee weed, Spotted	<i>Eupatorium maculatum</i>	'Gateway'	Field Container	Ahrens/Mervosh	2005	No injury at 2.5 lb ai per acre and 5 lb ai per acre rates; slight injury at 10 lb ai per acre
23832	Joepyee weed, Sweetscented	<i>Eupatorium purpureum</i>	'Gateway'	Field Container	Neal	2005	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	Joepyee weed, Sweetscented	<i>Eupatorium purpureum</i>		Field Container	Senesac	2004	All rates caused light to moderate injury
24743	Thoroughwort	<i>Eupatorium sp.</i>	E. rugosum 'Chocolate'	Field Container	Boydston	2005	No injury
24744	Gazania	<i>Gazania linearis</i>	'Colorado Gold'	Field Container	Ludwig	2005	

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
24744	Gazania	<i>Gazania linearis</i>	'Colorado Gold'	Field Container	Neal	2005	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
24746	Transvaal Daisy	<i>Gerbera sp.</i>	G. jamesonii 'Lambada'	Field Container	Lieth	2005	Significant injury and severe growth suppression
24747	Globe Amaranth	<i>Gomphrena sp.</i>	G. uvaria	Field Container	Gilliam	2005	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
23833	Common sneezeweed	<i>Helenium autumnale</i>		Field Container	Lieth	2004	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	2004	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	2005	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	2005	Minor injury after second application but plants recovered by end of experiment
24748	Sun Rose, Rock Rose	<i>Helianthemum sp.</i>	H. nummularium 'Belgravia Rose'	Field Container	Lieth	2005	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	2005	No injury
23834	Sunflower, Willowleaf	<i>Helianthus salicifolius</i>	'First Light'	Field Container	Senesac	2005	No significant injury at 2.5 lb ai per acre and 5 lb ai per acre rates, moderate injury at 10 lb ai per acre
24749	Sunflower	<i>Helianthus sp.</i>		Field Container	Stamps	2005	
23836	False Sunflower, Smooth Oxeye	<i>Heliopsis helianthoides</i>	'Summer Sun'	Field Container	Boydston	2005	Significant injury, plants treated with 5 lb ai per acre and 10 lb ai per acre rates not saleable.
23837	Hellebore, Christmas rose, Lenten Rose	<i>Helleborus niger</i>	H. X orientalis 'White Spotted Lady'	Field Container	Senesac	2005	Slight to moderate injury increasing with rate
24750	Coral Bells, Alumroot	<i>Heuchera sanguinea</i>		Field Container	Boydston	2005	Single application caused reddening and necrosis; second application caused additional injury.
24750	Coral Bells, Alumroot	<i>Heuchera sanguinea</i>		Field Container	Klett	2005	Unacceptable injury
24750	Coral Bells, Alumroot	<i>Heuchera sanguinea</i>		Field Container	Klett	2005	Unacceptable injury

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
24750	Coral Bells, Alumroot	<i>Heuchera sanguinea</i>	'Firefly'	Field Container	Lieth	2005	Significant injury and growth suppression with increasing suppression at increased rates
25788	Rose-Of-Sharon, Althaea	<i>Hibiscus syriacus</i>	H. moscheutos 'Splash Pinot Noir'	Field Container	Senesac	2005	
24833	Candytuft	<i>Iberis sp.</i>	I. sempervivens 'Snowflake'	Field Container	Lieth	2005	No significant injury; plant growth suppression
23838	Poker Plant, Red-Hot-Poker	<i>Kniphofia sp.</i>	K. uvaria 'Flamenco'	Field Container	Boydston	2005	No injury
23838	Poker Plant, Red-Hot-Poker	<i>Kniphofia sp.</i>	K. uvaria 'Flamenco mix'	Field Container	Derr	2005	No injury
23838	Poker Plant, Red-Hot-Poker	<i>Kniphofia sp.</i>	K. uvaria	Field Container	Gilliam	2005	No injury
23838	Poker Plant, Red-Hot-Poker	<i>Kniphofia sp.</i>	K. uvaria 'Border Ballet'	Field Container	Lieth	2004	No injury
23838	Poker Plant, Red-Hot-Poker	<i>Kniphofia sp.</i>	K. uvaria 'Pfitzers Hybrid'	Field Container	Neal	2005	No injury
23838	Poker Plant, Red-Hot-Poker	<i>Kniphofia sp.</i>		Field Container	Stamps	2005	
25298	Shrub Verbena	<i>Lantana sp.</i>	L. hybrida 'New Gold'	Field In-Ground	Chen	2005	Slight injury
24688	Shrub Verbena	<i>Lantana sp.</i>	L. montevidensis	Field Container	Lieth	2005	No injury or plant growth suppression
23839	English Lavender	<i>Lavandula angustifolia</i>		Field Container	Gilliam	2004	No injury
23839	English Lavender	<i>Lavandula angustifolia</i>	'Vera'	Field Container	Lieth	2004	No injury
23839	English Lavender	<i>Lavandula angustifolia</i>	'Munstead'	Field Container	Neal	2004	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	English Lavender	<i>Lavandula angustifolia</i>	'Munstead'	Field Container	Senesac	2004	No injury
23840	Golden Rockets	<i>Ligularia stenocephala</i>	'Dark Leaf'	Field Container	Boydston	2005	No injury
23840	Golden Rockets	<i>Ligularia stenocephala</i>	'The Rocket'	Field Container	Senesac	2005	No significant injury
23841	Blue flax	<i>Linum perenne L. ssp. Perenne</i>	'Sapphire'	Field Container	Lieth	2004	No injury
23841	Blue flax	<i>Linum perenne L. ssp. Perenne</i>	'Sapphire'	Field Container	Neal	2004	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	Blue flax	<i>Linum perenne L. ssp. Perenne</i>		Field Container	Senesac	2004	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;Giant	<i>Liriope muscari</i>	'Big Blue'	Field In-Ground	Chen	2005	No significant injury

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
23843	Catmint	<i>Nepeta x faasseni</i>	'Walker's Low'	Field Container	Derr	2004	All rates caused slight injury
23843	Catmint	<i>Nepeta x faasseni</i>		Field Container	Gilliam	2004	No injury
23843	Catmint	<i>Nepeta x faasseni</i>	'Dropmore'	Field Container	Lieth	2004	No injury at 2.5 lb ai per acre and 5 lb ai per acre rates, slight injury at 10 lb ai per acre
23843	Catmint	<i>Nepeta x faasseni</i>	N. nervosa 'Blue Carpet'	Field Container	Neal	2004	Severe injury at all rates
23843	Catmint	<i>Nepeta x faasseni</i>	'Walker's Low'	Field Container	Senesac	2004	No injury
23844	Devil's-tongue prickly pear	<i>Opuntia humifusa</i>	'Lemon Form'	Field Container	Senesac	2005	No injury
24754	Hopflower Oregano	<i>Origanum libanoticum</i>		Field Container	Klett	2005	Unacceptable injury
24834	Switch-Grass	<i>Panicum virgatum</i>	'Dallas Blues'	Field Container	Mathers	2005	No injury
24755	Beard-Tongue	<i>Penstemon sp.</i>	P. digitalis 'Scarlet Queen'	Field Container	Boydston	2005	No injury
24755	Beard-Tongue	<i>Penstemon sp.</i>	P. digitalis 'Husker Red'	Field Container	Derr	2005	Slight injury at 5 lb ai per acre but plants outgrew injury
24755	Beard-Tongue	<i>Penstemon sp.</i>	P. X mexicali 'Red Rocks'	Field Container	Lieth	2005	Very slight, no effect on plant growth
24755	Beard-Tongue	<i>Penstemon sp.</i>	P. digitalis 'Husker Red'	Field Container	Neal	2005	No injury at 2.5 lb ai per acre, moderate at 5 lb ai per acre, severe at 10 lb ai per acre
24757	Pentas	<i>Pentas sp.</i>		Field Container	Stamps	2005	
25300	Carolinia Phlox	<i>Phlox sp.</i>	P. subulata 'Candy Strip'	Field In-Ground	Chen	2005	Slight injury
24758	New Zealand Flax	<i>Phormium sp.</i>	P. colinsoi	Field Container	Lieth	2005	No injury, significant increase in plant growth
24758	New Zealand Flax	<i>Phormium sp.</i>		Field Container	Stamps	2005	
23845	Jacob's Ladder	<i>Polemonium sp.</i>	'Heavenly Habit'	Field Container	Boydston	2005	Rates of 2.5 and 5.0 lbs did not cause injury. The 10 lb rate with both single and sequential applications did cause significant chlorosis, necrosis and stunting.
24760	Primrose, Fairy	<i>Primula malacoides</i>		Field Container	Lieth	2005	Significant injury and plant growth supression
25305	Mexican Petunia	<i>Ruellia carolinensis</i>	R. brittoniana 'Katie'	Field In-Ground	Chen	2005	No significant injury
24762	Lavender cotton	<i>Santolina chamaecyparissus</i>	'Compacta'	Field Container	Lieth	2005	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
23847	Hen and chicks	<i>Sempervivum tectorum</i>	'Cobweb'	Field Container	Ahrens/Mervosh	2005	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(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
23847	Hen and chicks	<i>Sempervivum tectorum</i>	'Sunset'	Field Container	Lieth	2004	No injury
23847	Hen and chicks	<i>Sempervivum tectorum</i>		Field Container	Senesac	2004	No injury
23851	Goldenrod, Wrinkleleaf	<i>Solidago rugosa</i>	'Fireworks'	Field Container	Lieth	2004	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	2004	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	2005	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	Senesac	2004	No injury
24763	Goldenrod	<i>Solidago sp.</i>		Field Container	Stamps	2005	
23854	Foamflower, Heartleaf	<i>Tiarella cordifolia</i>	T. wherryi	Field Container	Neal	2004	All rates caused severe injury
23854	Foamflower, Heartleaf	<i>Tiarella cordifolia</i>		Field Container	Senesac	2005	All rates caused injury
24766	Spiderwort	<i>Tradescantia ohiensis</i>	'Osprey'	Field Container	Boydston	2005	All rates caused moderate to severe injury, stunting and delayed flowering; treated plants not saleable.
24765	Spiderwort	<i>Tradescantia x andersoniana</i>	'Concord Grape'	Field Container	Derr	2005	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>	'Sweet Kate'	Field Container	Mathers	2005	All rates caused severe injury (distorted and dead plants)
25306	Vervain	<i>Verbena sp.</i>	V. canadensis 'Homestead Purple'	Field In-Ground	Chen	2005	Moderate injury; plants recovered in a short time
24689	Vervain	<i>Verbena sp.</i>	V. canadensis 'Homestead Purple'	Field Container	Neal	2005	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	2004	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	2004	No injury

## **Label Suggestions**

It is suggested based upon data accumulated through the IR-4 research program in 2004 and 2005 that Syngenta consider adding to the container-grown crop section of the Pennant Magnum label the plant species listed above exhibiting no or minimal transitory injury.

## **Appendix 1: Protocol**



**PHYTOTOXICITY TO HERBACEOUS PERENNIAL PLANTS WITH PRE-EMERGENT  
APPLICATIONS OF PENDULUM, PENNANT MAGNUM AND SNAPSHOT**

Date: 12/04

Ornamental Protocol Number: 001

General label directions: Refer to product labels.

Research program:

Pest(s)/Plants – As attached.

Pesticide (common name and trade name) – Refer to treatment list shown below.

**For label, material & if needed spray oil surfactant contact:**

BASF, Kathie Kalmowitz, 919-785-9659, email: [kalmowk@basf-corp.com](mailto:kalmowk@basf-corp.com) (Pendulum)

Dow AgroSciences, Mike Melichar, 317-337-4982, [mwymelichar@dow.com](mailto:mwymelichar@dow.com) (Snapshot)

Syngenta, Dave Ross, 336-632-6411, [david.ross@syngenta.com](mailto:david.ross@syngenta.com) (Pennant Magnum)

Experimental design:

Plot size: Must be adequate to reflect actual use condition.

Replicates Minimum of 3 replications (preferably 4) with 3 of each species per pot per replicate

Controls: Untreated controls to be included in all experiments.

<u>Application:</u>	<u>PENDULUM 2G</u>	<u>SNAPSHOT 2.5TG</u>	<u>PENNANT MAGNUM 7.62EC</u>
<u>Dosages</u> - 1x	2 lbs.ai/A	2.5 lbs.ai/A	2.5 lbs.ai/A
2x	4 lbs.ai/A	5.0 lbs.ai/A	5.0 lbs.ai/A
4x	8 lbs ai/A	10.0 lbs.ai/A	10.0 lbs.ai/A

Active Ingredient: Pendulum (pendimethalin), Pennant Magnum (s-metolachlor), Snapshot (isoxaben+trifluralin).

Volume - Minimum of 20 gal/A for liquid applications.

Timing - 2 applications, 30 Days Spray Interval. Make first application within 7 days of potting. Evaluate crop at 7, 14, 30 days after each application.

Reports:

Method of application: Treatments should be made over the top of the plants using application equipment consistent with conventional commercial equipment. Report completely on experimental design and method of application. Report liner size, plant size height x width, and growth stage before each treatment and at evaluation dates.

Weather – Maintain temperature and precipitation (including irrigation) data.

Soil type – Identify soil type used in experimental area.

Product – When submitting data, include EPA registration number of product used.

Efficacy – Data should include both actual counts and percent control as well as an indication that infestation was light, heavy, etc. Record all application and evaluation dates.

Phytotoxicity – Record phytotoxicity data at all rates. Use a 0-10 scale. 0 = No Phytotoxicity 10 = complete kill.

Please direct questions to: Ely Vea, 308 Aston Forest Lane, Crownsville, MD 21032, Phone & FAX#: 410-923-488, E-mail: [evvea@comcast.net](mailto:evvea@comcast.net).

## Phytotoxicity to herbaceous perennial plants with pre-emergent applications of Pendulum, Pennant Magnum, and Snapshot

**Ornamental Protocol Number:** 05-001

**Objective:** Determine phytotoxicity of Pendulum, Pennant Magnum, and Snapshot to unlabelled perennial plants commonly grown in nurseries.

### Experimental Design:

**Plot Size:** Must be adequate to reflect actual use conditions.

**Replicates:** Minimum of 3 replications (preferably 4) with 3 plants per replicate

**Application Instructions:** Two applications made approximately 4 weeks apart with the first application within 7 days of potting. Plant materials must have broken dormancy prior to first application. For liquid applications, use a minimum of 20 gal per acre. Applications should be made over the top of the plants using application equipment consistent with conventional commercial equipment. Please see table below for instructions for post-application irrigation.

**Plant Materials:** See attached list of plant materials. Plants grown in field containers are preferred to in-ground.

**Evaluations:** Record phytotoxicity on a scale of 0 to 10 at 7, 14, and 28 days after each application. If phytotoxicity is observed in treated plants, take pictures comparing treated and untreated plant material.

**Recordkeeping:** Keep detailed records of weather conditions including temperature and precipitation, soil-type or soil-less media, application equipment, irrigation, liner size, plant height & width, and plant growth stage at application and data collection dates.

### Treatments:

Product	Rate	Post-Application Irrigation Instructions
Pendulum 2G (pendimethalin)	2.0 lb ai/A	
	4.0 lb ai/A	
	8.0 lb ai/A	
Pennant MAGNUM 7.62EC (s-metalochlor)	2.5 lb ai/A	Follow with sufficient overhead irrigation to wash Pennant Magnum from the foliage to reduce the chance of injury
	5.0 lb ai/A	
	10.0 lb ai/A	
Snapshot 2.5TG (isoxaben+trifluralin)	2.5 lb ai/A	Follow with sufficient overhead irrigation to wash Snapshot from the foliage to reduce the chance of injury
	5.0 lb ai/A	
	10.0 lb ai/A	
Untreated	--	--

### For labels, materials, and any required adjuvants contact:

Pendulum - BASF, Kathie Kalmowitz, 919-785-9659, email: [kalmowk@basf-corp.com](mailto:kalmowk@basf-corp.com)

Pennant Magnum - Syngenta, Dave Ross, 336-632-6411, [david.ross@syngenta.com](mailto:david.ross@syngenta.com)

Snapshot - Dow AgroSciences, Mike Melichar, 317-337-4982, [mwmelichar@dow.com](mailto:mwmelichar@dow.com)

### Reports:

Report must include a brief summary paragraph of results, a summary table with appropriate statistical analyses, a section on experimental design and materials and methods, with raw data and recordkeeping information as listed above included as appendices. If pictures were taken, please include them.

An electronic report is preferred but not required. If the report is provided electronically, the basic report can be sent in MS Word or WordPerfect, the recordkeeping information as pdf or other electronic documents, and the raw data in MS Excel or other suitable program such as ARM.

**Please direct questions to:** Cristi Palmer, IR-4 HQ, Rutgers University, 681 US Hwy 1 S, North Brunswick, NJ 08902-3390, Phone 732-932-9575 x629, [palmer@aesop.rutgers.edu](mailto:palmer@aesop.rutgers.edu) OR Ely Vea, 308 Aston Forest Lane, Crownsville, MD 21032, Phone & FAX#: 410-923-488, E-mail: [evvea@comcast.net](mailto:evvea@comcast.net).

Revision Date: 1/05

Revised By: CLP

## 2005 Super A Plant List

Latin Name	Common Name	Pendulum	Pennant Magnum	Snapshot
Agastache spp.	Hyssop species	Y-24678	Y-24723	Y-24768
Agastache rupestris	Sunset Hyssop	N	Y-24724	Y-24769
Allamanda cathartica	Golden Trumpet	Y-24680	Y-24725	Y-24770
Alpinia zerumbet	Shellplant	Y-24681	Y-24726	Y-24771
Amorpha canescens	Leadplant	Y-24682	Y-24727	Y-24772
Anthurium andraeanum	Flamingo-lily	Y-24683	Y-24728	Y-24773
Armeria maritima	Thrift, Sea Pinks	Y-24684	Y-24729	Y-24774
Artemisia ludoviciana	Western Sage	N	Y-24731	Y-24776
Artemisia pontica	Artemisia	N	Y-24733	Y-24778
Artemisia schmidtiana	Silver Mound	N	Y-24730	N
Artemisia stelleriana	Beach Wormwood, Dusty Miller	N	N	Y-24777
Artemisia versicolor	Seafoam	N	Y-24734	Y-24779
Asclepias tuberosa	Butterflyweed	N	N	Y-24780
Aspidistra elatior	Cast Iron Plant	N	Y-24736	Y-24781
Aster ericoides	Aster	Y-24692	N	Y-24782
Astilbe spp.	Astilbe	N	Y	Y
Athyrium nipponicum	Ladyfern	Y-24693	Y-24738	Y-24783
Bergenia cordifolia	Heart-leaved Bergenia	Y-24694	Y-24739	Y-24784
Centranthus ruber	Jupiter's Beard	Y	Y-24740	Y-24785
Clematis spp.	Clematis	Y	Y	Y – but not C. integrifolia cerulea
Dianthus deltoides	Maiden Pink	Y	Y	Y
Delosperma nubegenum	Yellow Ice Plant	Y	Y	Y
Delphinium spp.	Larkspur	Y	N	Y
Digitalis thapsi	Foxglove	Y-24696	Y-24741	Y-24786
Echinacea spp.	Purple coneflower	Y - but not E. purpurea	Y-24742	Y-24787 - but not E. purpurea
Eupatorium spp.	Thoroughwort	Y-24698	Y-24743	Y-24788
Gazania linearis	Gazania	Y-24699	Y-24744	N
Geranium magniflorum	Geranium	N	N	Y-24790
Gerbera jamesonii	Transvaal Daisy	Y-24701	Y-24746	Y-24791
Gomphrena spp.	Globe Amaranth	Y-24702	Y-24747	Y-24792
Helianthemum nummularium	Sunrose	Y-24703	Y-24748	Y-24793
Helianthus spp.	Sunflower	Y-24704	Y-24749	Y-24794
Heuchera sanguinea	Coral Bells	Y-24705	Y-24750	Y-24795
Iberis spp.	Candytuft	Y	Y	Y
Iris spp.	Iris	Y	N	Y – but not I. pumila or I. siberica
Kniphofia uvaria	Redhot Poker	Y-24706	Y-24751	Y-24796
Lantana	Shrub Verbena	Y-24679	Y-24688	Y-24697
Mimulus × hybridus	Monkeyflower	Y-24707	Y-24752	Y-24797
Oenothera macrocarpa	Evening Primrose	Y-24708	N	Y-24798
Origanum libanoticum	Hopflower Oregano	Y-24709	Y-24754	Y-24799
Panicum virgatum	Switchgrass	Y?	Y?	Y
Penstemon x mexicali 'Red Rocks' or 'Pikes Peak Purple'	Beardtongue	N	Y-24754	Y-24799
Penstemon spp.	Beardtongue	N	Y-24755	Y-24800

Pentas spp.	Pentas	Y-24712	Y-24757	Y-24802
Phlox	Phlox	Y	N	Y-24711
Phormium spp. - dwarf hybrids	New Zealand Flax	Y-24713	Y-24758	Y-24803
Pulmonaria spp.	Lungwort	Y-24713	Y-24758	Y-24803
Primula malacoides	Fairy Primrose	Y-24715	Y-24760	Y-24805
Ruellia carolinensis	Mexican Primrose	Y-24687	Y-24691	Y-24735
Ruscus hypophyllum	Israeli Ruscus	Y-24716	Y-24761	Y-24806
Santolina chamaecyparissus	Lavender Cotton	Y-24717	Y-24762	Y-24807
Solidago spp.	Goldenrod	Y-24718	Y-24763	Y-24808
Stipa spp.	Mexican Feathergrass	Y	Y	Y
Thymus spp. (ornamental varieties only)	Thyme	Y	Y	Y
Tradescantia ohiensis	Spiderwort	Y-24719	Y-24764	Y-24809
Tradescantia x andersoniana	Spiderwort	Y-24720	Y-24765	Y-24810
Tradescantia virginiana	Spiderwort	Y-24721	Y-24766	Y-24811
Veronica liwanensis	Turkish Veronica	Y-24722	N	Y-24812
Veronica spicata	Speedwell	Y-24685	N	Y-24710
Mexican Heather	Mexican Heather	Y-24686	Y-24690	Y-24732

Y-00000 = Researchable followed by PR Number

Y = Researchable, PR Number to be assigned pending manufacturer confirmation

N = Not researchable, already on label or manufacturer declined additional data

## Appendix 2: Contributing Researchers

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### **Appendix 3: Submitted Data**

Data on following pages are those reports from Drs. Chen, Mathers & Case, and Senesac which cover multiple PR numbers. The rest of the data are sorted in order by PR number then by researchers' last names and are contained in a separate binder.