

**IR-4 Ornamental Horticulture Program
Trifluralin + Isoxaben Crop Safety**

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Date: June 19, 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 Snapshot 2.5TG. The rates chosen for this research were 2.5, 5, and 10 pounds active ingredient per acre (lb ai per A) as the 1X, 2X and 4X rates. Seventy six different species were examined. Of these, forty-nine exhibited no or minimal transient injury after application at all three rates. Twelve crops exhibited no phytotoxicity at 2.5 lb ai per acre, but did have some injury at the higher rates. Eleven species exhibited phytotoxicity at even the 2.5 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 Snapshot 2.5TG.

Materials and Methods

Two applications of Snapshot 2.5TG (trifluralin + isoxaben) were made approximately 30 days apart. The application rates were 2, 4, and 8 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.

Snapshot 2.5 TG was supplied to researchers (See list of researchers in Appendix 2) by Dow Agro Sciences.

Results and Summary

Efficacy

Several researchers also examine efficacy in addition to crop safety.

Derr (2004) reported good control of large crabgrass at 2.5 lb ai per acre with excellent control at higher rates and excellent control of spotted spurge at all rates. Derr (2005) reported no control of dove weed, suppression of tassel flower at 5 and 10 lb per acre rates, good to excellent control of crabgrass, and excellent control of common chick weed and spotted spurge. Klett reported significant control of seeded broadleaf weeds (not specified). Gilliam reported significantly reduced natural occurring indigenous weed population (prostrate spurge, grip weed, and oxalis). Boydston reported significantly reduced kochia, barnyard grass, chickweed and green foxtail.

Phytotoxicity

Based on the type and nature of injury seen with Snapshot 2.5TG 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, Snapshot 2.5TG exhibited no or minimal negative impact on a range of plant species (Table 1). Forty-nine 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. With some plants including the *Penstemon* genera, it is recommended additional trials be conducted to clarify their response under various environmental conditions because major differences were seen among research locations (Table 2). Twelve crop species, exhibited no or little injury at the 2.5 lb ai per acre rate, but significant phytotoxicity occurred at the 5.0 or 10.0 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 Snapshot are considered safe at the 2.5 lb ai per acre rate but any higher rate may cause unacceptable injury.

There were eleven crops in the 2004 and 2005 testing that exhibited damage sufficient to recommend growers not utilize Snapshot 2.5TG as an over-the-top treatment for pre-emergent weed control (Table 4).

Please see Table 5 for a list of research on Snapshot 2.5 TG in 2004 and 2005 and the summary of the results received so far.

Table 1. List of Snapshot 2.5TG treated crops with no or minimal transitory injury.

<i>Agastache aurantiaca</i>	<i>Heliopsis helianthoides</i>
<i>Amsonia hubrichtii</i>	<i>Helleborus niger</i>
<i>Armeria maritima</i>	<i>Hibiscus syriacus</i>
<i>Artemisia ludoviciana</i>	<i>Hydrangea sp.</i>
<i>Asarum candanense</i>	<i>Iberis sempervirens</i>
<i>Asarum chinensis</i>	<i>Kniphofia uvaria</i>
<i>Asclepias tuberosa</i>	<i>Lantana hybrida</i>
<i>Bergenia cordifolia</i>	<i>Lantana montevidensis</i>
<i>Calamagrostis x acutiflora</i>	<i>Lavandula angustifolia</i>
<i>Carex buchananii</i>	<i>Leucanthemum maximum</i>
<i>Centranthus ruber</i>	<i>Ligularia dentata</i>
<i>Chasmanthium latifolium</i>	<i>Linum perenne</i>
<i>Clematis sp.</i>	<i>Liriope muscari</i>
<i>Cuphea hyssopifolia</i>	<i>Nepeta x faasennii</i> (note Neal's work)
<i>Delosperma nubigenum</i>	<i>Opuntia humifusa</i>
<i>Echinacea purpurea</i>	<i>Panicum virgatum</i>
<i>Echinacea paradoxa</i>	<i>Santolina chamaecyparissus</i>
<i>Eupatorium maculatum</i>	<i>Sempervivum arachnoideum</i>
<i>Eupatorium rugosum</i>	<i>Solidago rugosa</i>
<i>Gomphrena haageana</i>	<i>Solidago sempervirens</i>
<i>Gomphrena sp.</i>	<i>Solidago speciosa</i>
<i>Helenium autumnale</i>	<i>Solidago sphacelata</i>
<i>Helianthemum nummularium</i>	<i>Tradescantia x andersoniana</i>
<i>Helianthus salicifolius</i>	<i>Vernonia noveboracensis</i>
<i>Helianthus maximilianii</i>	

Table 2. List of Snapshot 2.5TG treated crops where more research is needed to clarify response

<i>Aubrieta sp.</i>	<i>Penstemon digitalis</i>	<i>Veronica sp.</i>
<i>Gerbera jamesonii</i>	<i>Penstemon sp.</i>	
<i>Heuchera sanguinea</i>	<i>Penstemon x mexicali</i>	

Table 3. List of Snapshot 2.5TG treated crops with no or minimal transitory injury seen at the 1X rate, but the 2X or 4X rate did cause significant phytotoxicity

<i>Agastache sp.</i>	<i>Baptisia australis</i>	<i>Phormium colinsoi</i>
<i>Alchemilla mollis</i>	<i>Chelone lyonii</i>	<i>Ruellia carolinensis</i>
<i>Amsonia tabernaemontana</i>	<i>Eupatorium purpureum</i>	<i>Sempervivum tectorum</i>
<i>Antennaria parvifolia</i>	<i>Phlox subulata</i>	<i>Verbena canadensis</i>

Table 4. List of Snapshot 2.5TG treated crops exhibiting significant injury.

<i>Antennaria diodica</i>	<i>Digitalis thapsi</i>	<i>Polemonium boreale</i>
<i>Athyrium nipponicum</i>	<i>Epimedium x rubrum</i>	<i>Primula malacoides</i>
<i>Cimicifuga racemosa</i>	<i>Mertensia virginica</i>	<i>Tiarella wherryi</i>
<i>Chrysogonum virginiana</i>	<i>Origanum libanoticum</i>	

Table 5. Detailed Summary of 2005 Crop Safety Testing with Snapshot 2.5TG

Notes: Table entries are sorted by crop Latin name. All researchable studies for Snapshot are included in this table. Only those that were researched in 2004 and 2005 and were received by 6/1/2006 have summaries.

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
24768	Hyssop species	<i>Agastache sp.</i>	'Blue Fortune'	Field Container	Boydston	2005	No visible injury, but all rates caused brittle stems susceptible to wind damage
24768	Hyssop species	<i>Agastache sp.</i>	A. aurantiaca 'Coronado'	Field Container	Klett	2005	No significant injury
24768	Hyssop species	<i>Agastache sp.</i>	A. aurantiaca 'Coronado'	Field Container	Klett	2005	No significant injury
24768	Hyssop species	<i>Agastache sp.</i>	'Blue Fortune'	Field Container	Mathers & Case	2005	No injury at 2.5 and 5 lb ai per acre; moderate (brittle stems) at 10 lb ai per acre
20806	Lady's-Mantle	<i>Alchemilla sp.</i>	A. mollis 'Thriller'	Field Container	Ahrens & Mervosh	2005	All rates caused slight injury
23782	Lady's-Mantle	<i>Alchemilla sp.</i>	A. mollis 'Auslese'	Field Container	Derr	2004	Slight injury at all rates. <i>Good control of large crabgrass at 2.5 lb ai per acre; excellent control at higher rates. Excellent control of spotted spurge at all rates.</i>
23782	Lady's-Mantle	<i>Alchemilla sp.</i>	A. mollis 'Auslese'	Field Container	Lieth	2004	No injury at 2.5 lb ai per acre; little injury at 5 and 10 lb ai per acre
23782	Lady's-Mantle	<i>Alchemilla sp.</i>	A. mollis 'Thriller'	Field Container	Senesac	2004	No injury
23783	Bluestar	<i>Amsonia sp.</i>	A. tabernaemontana	Field Container	Gilliam	2004	No injury at 2.5 lb ai per acre but significant leaf burn at 5 and 10 lb ai per acre <i>All rates significantly reduced naturally-occurring indigenous weed population (prostrate spurge, gripweed, oxalis)</i>
23783	Bluestar	<i>Amsonia sp.</i>	A. hubrichtii	Field Container	Neal	2004	No injury
23783	Bluestar	<i>Amsonia sp.</i>	A. hubrichtii	Field Container	Senesac	2004	No injury
23784	Pussy-Toes, Stolomiferous	<i>Antennaria dioica</i>	Rose Pussytoes	Field Container	Roys	2005	All rates caused severe stunting and plant death
23785	Pussy-Toes, Small-leaf	<i>Antennaria parvifolia</i>	A. neglecta 'Gaspensis'	Field Container	Beste/Frank	2005	No injury at 2.5 and 5 lb per acre rates, but significant damage occurred with 10 lb per acre rate and all plants were smaller than untreated which would affect market value
23785	Pussy-Toes, Small-leaf	<i>Antennaria parvifolia</i>		Field Container	Neal	2005	No injury
23785	Pussy-Toes, Small-leaf	<i>Antennaria parvifolia</i>		Field Container	Senesac	2004	No significant injury

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
24774	Thrift, Sea Pink	<i>Armeria maritima</i>	'Splendens'	Field Container	Boydston	2005	No injury
24774	Thrift, Sea Pink	<i>Armeria maritima</i>	'Splendens'	Field Container	Gilliam	2005	No injury but plants treated with 10 lb ai per acre were smaller
24774	Thrift, Sea Pink	<i>Armeria maritima</i>	'Dusseldorf'	Field Container	Lieth	2005	No injury but plants treated with 10 lb per acre were smaller
24776	Western sage	<i>Artemisia ludoviciana</i>		Field Container	Roys	2005	No injury
23786	Canadian Ginger	<i>Asarum canadense</i>	A. chinensis	Field Container	Neal	2005	No injury
23786	Canadian Ginger	<i>Asarum canadense</i>		Field Container	Senesac	2005	No significant injury
24780	Butterfly	<i>Asclepias tuberosa</i>		Field Container	Roys	2005	No injury
24783	Fern, Lady	<i>Athyrium nipponicum</i>		Field Container	Derr	2005	Little to no injury at 2.5 lb ai per acre; moderate and severe injury at 5 and 10 lb ai per acre
24783	Fern, Lady	<i>Athyrium nipponicum</i>	'Pretum'	Field Container	Mathers & Case	2005	All rates caused moderate to severe injury (frond scorching)
23787	Rock Cress	<i>Aubrieta sp.</i>	'Whitewell Gem'	Field Container	Lieth	2004	Slight injury at 2.5 and 5 lb ai per acre; moderate injury at 10 lb ai per acre
23787	Rock Cress	<i>Aubrieta sp.</i>	A. deltoidea 'Whitewell Gem'	Field Container	Neal	2004	No injury at 2.5 and 5 lb ai per acre; severe at 10 lb ai per acre
23787	Rock Cress	<i>Aubrieta sp.</i>		Field Container	Reding & Anderson	2005	No injury
23788	Blue False Indigo	<i>Baptisia australis</i>		Field Container	Derr	2004	All rates caused slight injury <i>Good control of large crabgrass at 2.5 lb ai per acre; excellent control at higher rates. Excellent control of spotted spurge at all rates.</i>
23788	Blue False Indigo	<i>Baptisia australis</i>		Field Container	Gilliam	2004	No injury at 2.5 and 5 lb ai per acre; slight injury at 10 lb ai per acre <i>All rates significantly reduced naturally-occurring indigenous weed population (prostrate spurge, gripeweed, oxalis)</i>
23788	Blue False Indigo	<i>Baptisia australis</i>		Field Container	Neal	2004	No injury
23788	Blue False Indigo	<i>Baptisia australis</i>		Field Container	Senesac	2005	No injury
24784	Heart-leaved Bergenia	<i>Bergenia cordifolia</i>	'Rotblum'	Field Container	Lieth	2005	No injury
24784	Heart-leaved Bergenia	<i>Bergenia cordifolia</i>	New Hybrid bergenia	Field Container	Neal	2005	No injury at 2.5 and 5 lb ai per acre; moderate injury at 10 lb ai per acre

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
23521	Feather Reed Grass	<i>Calamagrostis acutiflora</i>	'Overdam'	Field Container	Boydston	2004	No injury Significantly reduced kochia, barnyardgrass, chickweed and green foxtail
23522	Sedge	<i>Carex sp.</i>	C. buchananii	Field Container	Boydston	2004	No injury Significantly reduced kochia, barnyardgrass, chickweed and green foxtail
24785	Jupiter's Beard	<i>Centranthus ruber</i>		Field Container	Reding & Anderson	2005	No injury
24785	Jupiter's Beard	<i>Centranthus ruber</i>		Field Container	Roys	2005	No injury
23523	Northern Sea Oats, Wild Oats	<i>Chasmanthium latifolium</i>		Field Container	Boydston	2004	No injury Significantly reduced kochia, barnyardgrass, chickweed and green foxtail
23789	Turtlehead, Snakehead	<i>Chelone sp.</i>	C. lyonii 'Hot Lips'	Field Container	Derr	2004	Slight injury at 2.5 and 5 lb ai per acre; moderate injury at 10 lb ai per acre Good control of large crabgrass at 2.5 lb ai per acre; excellent control at higher rates. Excellent control of spotted spurge at all rates.
23789	Turtlehead, Snakehead	<i>Chelone sp.</i>	C. lyonii 'Hot Lips'	Field Container	Neal	2004	No injury at 2.5 lb ai per acre rate; slight and severe injury at 5 and 10 lb ai per acre rates
23789	Turtlehead, Snakehead	<i>Chelone sp.</i>	C. lyonii 'Hot Lips'	Field Container	Senesac	2004	No statistically significant injury
20810	Golden Star	<i>Chrysogonum sp.</i>	C. virginianum 'Alan Bush'	Field Container	Derr	2004	Slight injury at 2.5 lb ai per acre; moderate injury at 5 and 10 lb ai per acre rates Good control of large crabgrass at 2.5 lb ai per acre; excellent control at higher rates. Excellent control of spotted spurge at all rates.
20810	Golden Star	<i>Chrysogonum sp.</i>	C. virginianum 'Pierre'	Field Container	Neal	2004	All rates caused stunting but plants recovered
20810	Golden Star	<i>Chrysogonum sp.</i>	C. virginianum	Field Container	Senesac	2005	Slight injury at 2.5 and 5 lb ai per acre; moderate injury at 10 lb ai per acre
23791	Bugbane & Cohosh, Black	<i>Cimicifuga racemosa</i>		Field Container	Neal	2005	Moderate injury at 2.5 and 5 lb ai per acre; severe injury at 10 lb ai per acre
24895	Clematis	<i>Clematis sp.</i>	'Midnight Showers'	Field Container	Mathers & Case	2005	No injury

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
25294	Mexican Heather, False Heather, Elfin Herb	<i>Cuphea hyssopifolia</i>		Field In-Ground	Chen	2005	No injury
24839	Hardy Ice Plant, Yellow Ice Plant	<i>Delosperma nubigenum</i>	Yellow Ice Plant	Field Container	Boydston	2005	No injury
24786	Foxglove	<i>Digitalis sp.</i>	D. thaspi	Field Container	Klett	2005	Unacceptable injury
24786	Foxglove	<i>Digitalis sp.</i>	D. thaspi	Field Container	Klett	2005	Unacceptable injury
24787	Purple Coneflower	<i>Echinacea sp.</i>	E. purpurea 'Magnus'	Field Container	Derr	2005	No injury
24787	Purple Coneflower	<i>Echinacea sp.</i>	'Magnus'	Field Container	Gilliam	2005	No injury but plants treated with 10 lb ai per acre were smaller
24787	Purple Coneflower	<i>Echinacea sp.</i>	E. paradoxa	Field Container	Roys	2005	No injury
23792	Barrenwort	<i>Epimedium sp.</i>	E. x rubrum	Field Container	Ahrens & Mervosh	2005	All rates reduced plant vigor
23792	Barrenwort	<i>Epimedium sp.</i>	E. x rubrum	Field Container	Senesac	2005	Moderate injury at all rates
23793	Joepy weed, Spotted	<i>Eupatorium maculatum</i>	'Gateway'	Field Container	Ahrens & Mervosh	2005	No injury
23793	Joepy weed, Spotted	<i>Eupatorium maculatum</i>		Field Container	Roys	2005	No injury
23794	Boneset	<i>Eupatorium perfoliatum</i>		Field Container	Neal	2005	No injury at 2.5 and 5 lb ai per acre, slight injury at 10 lb ai per acre
23795	Joepy weed, Sweetscented	<i>Eupatorium purpureum</i>		Field Container	Roys	2005	No injury at 2.5 lb ai per acre; unacceptable injury at 5 and 10 lb ai per acre
23795	Joepy weed, Sweetscented	<i>Eupatorium purpureum</i>		Field Container	Senesac	2004	No statistically significant injury
24788	Thoroughwort	<i>Eupatorium sp.</i>	E. rugosum 'Chocolate'	Field Container	Boydston	2005	No injury
24791	Transvaal Daisy	<i>Gerbera sp.</i>	G. jamesonii 'Lambada'	Field Container	Lieth	2005	No phytotoxicity but plant growth significantly reduced
24792	Globe Amaranth	<i>Gomphrena sp.</i>	Globe Amaranth	Field Container	Gilliam	2005	No injury
24792	Globe Amaranth	<i>Gomphrena sp.</i>	G. haageana	Field Container	Roys	2005	No injury
23796	Common sneezeweed	<i>Helenium autumnale</i>		Field Container	Lieth	2004	Low levels of chlorosis and stunting of new leaves increasing with rate
23796	Common sneezeweed	<i>Helenium autumnale</i>	'Summer Sun'	Field Container	Neal	2004	No injury
23796	Common sneezeweed	<i>Helenium autumnale</i>		Field Container	Reding & Anderson	2005	No injury
23796	Common sneezeweed	<i>Helenium autumnale</i>		Field Container	Roys	2005	No injury
23796	Common sneezeweed	<i>Helenium autumnale</i>		Field Container	Senesac	2005	No significant injury

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
24793	Sun Rose, Rock Rose	<i>Helianthemum sp.</i>	'Belgravia Rose'	Field Container	Lieth	2005	No significant injury; 5 and 10 lb ai per acre reduced plant height
23798	Sunflower, Maximilian	<i>Helianthus maximiliani</i>		Field Container	Roys	2005	No injury
23797	Sunflower, Willowleaf	<i>Helianthus salicifolius</i>	'First Light'	Field Container	Mathers & Case	2005	No injury
23797	Sunflower, Willowleaf	<i>Helianthus salicifolius</i>	'First Light'	Field Container	Senesac	2005	No injury
23799	False Sunflower, Smooth Oxeye	<i>Heliopsis helianthoides</i>		Field Container	Boydston	2005	No injury
23799	False Sunflower, Smooth Oxeye	<i>Heliopsis helianthoides</i>	'Summer Sun'	Field Container	Neal	2004	
23800	Hellebore, Christmas rose, Lenten Rose	<i>Helleborus niger</i>		Field Container	Fraelich	2004	
23800	Hellebore, Christmas rose, Lenten Rose	<i>Helleborus niger</i>	'Shmiemann Strain white Spot'	Field Container	Senesac	2005	No significant injury
24795	Coral Bells, Alumroot	<i>Heuchera sanguinea</i>	'Crimson Curls'	Field Container	Boydston	2005	Single application caused reddening and necrosis; second application caused additional damage.
24795	Coral Bells, Alumroot	<i>Heuchera sanguinea</i>		Field Container	Klett	2005	Slight injury at 2.5 lb ai per acre rate; moderate to severe injury at 5 and 10 lb ai per acre
24795	Coral Bells, Alumroot	<i>Heuchera sanguinea</i>		Field Container	Klett	2005	Slight injury at 2.5 lb ai per acre rate; moderate to severe injury at 5 and 10 lb ai per acre
24795	Coral Bells, Alumroot	<i>Heuchera sanguinea</i>	'Firefly'	Field Container	Lieth	2005	No injury
25789	Rose-Of-Sharon, Althaea	<i>Hibiscus syriacus</i>	'Splash Pinot Noir'	Field Container	Senesac	2005	No significant injury
20813	Hydrangea, Climbing	<i>Hydrangea anomala petiolaris</i>	'Nikko Blue'	Field Container	Derr	2004	No injury <i>Excellent large crabgrass control</i>
24841	Candytuft	<i>Iberis sp.</i>	'Snowflake'	Field Container	Lieth	2005	No significant injury, but significant plant growth suppression
23801	Poker Plant, Red-Hot-Poker	<i>Kniphofia sp.</i>	'Flamenco'	Field Container	Boydston	2005	No injury
23801	Poker Plant, Red-Hot-Poker	<i>Kniphofia sp.</i>	Flamenco mix	Field Container	Derr	2005	No injury, but reduced shoot weight
24796	Poker Plant, Red-Hot-Poker	<i>Kniphofia sp.</i>	Red Hot Poker	Field Container	Gilliam	2005	No injury
23801	Poker Plant, Red-Hot-Poker	<i>Kniphofia sp.</i>	K. uvaria 'Border Ballet'	Field Container	Lieth	2004	No injury

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
23801	Poker Plant, Red-Hot-Poker	<i>Kniphofia sp.</i>		Field Container	Neal	2004	No injury
23801	Poker Plant, Red-Hot-Poker	<i>Kniphofia sp.</i>	Pfizer's Hybrid red hot poker	Field Container	Neal	2005	No injury
25443	Shrub Verbena	<i>Lantana sp.</i>	L. hybrida 'New Gold'	Field In-Ground	Chen	2005	No significant injury at 2.5 lb ai per acre; slight injury at 5 and 10 lb ai per acre
24697	Shrub Verbena	<i>Lantana sp.</i>	L. montevidensis	Field Container	Lieth	2005	No injury or plant suppression
23802	English Lavender	<i>Lavandula angustifolia</i>		Field Container	Gilliam	2004	No injury <i>All rates significantly reduced naturally-occurring indigenous weed population (prostrate spurge, gripeweed, oxalis)</i>
23802	English Lavender	<i>Lavandula angustifolia</i>	'Vera'	Field Container	Lieth	2004	No injury
23802	English Lavender	<i>Lavandula angustifolia</i>	'Munstead'	Field Container	Neal	2004	Slight stunting at all rates
23802	English Lavender	<i>Lavandula angustifolia</i>	'Munstead'	Field Container	Senesac	2004	No injury
24390	Shasta Daisy	<i>Leucanthemum maximum</i>	'Snowcap'	Field Container	Boydston	2005	No injury
23803	Golden Rockets	<i>Ligularia stenocephala</i>	'Dark Leaf'	Field Container	Boydston	2005	No injury
23803	Golden Rockets	<i>Ligularia stenocephala</i>	'The Rocket'	Field Container	Senesac	2005	No significant injury
23804	Blue flax	<i>Linum perenne L. ssp. Perenne</i>	'Sapphire'	Field Container	Lieth	2004	No injury
23804	Blue flax	<i>Linum perenne L. ssp. Perenne</i>	'Saphyr'	Field Container	Neal	2004	No injury at 2.5 and 5 lb ai per acre; slight injury at 10 lb ai per acre
23804	Blue flax	<i>Linum perenne L. ssp. Perenne</i>		Field Container	Senesac	2004	No statistically significant injury
24984	Lilyturf, Big Blue;Giant	<i>Liriope muscari</i>	'Big Blue'	Field In-Ground	Chen	2005	No injury
23805	Virginia bluebells	<i>Mertensia virginica</i>		Field Container	Beste/Frank	2005	All plants were unmarketable at the end of the study
23806	Catmint	<i>Nepeta x faasseni</i>	'Walkers Low'	Field Container	Derr	2004	All rates caused slight injury <i>Good control of large crabgrass at 2.5 lb ai per acre; excellent control at higher rates. Excellent control of spotted spurge at all rates.</i>

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
23806	Catmint	<i>Nepeta x faasseni</i>	'Dropmore'	Field Container	Gilliam	2004	No injury All rates significantly reduced naturally-occurring indigenous weed population (prostrate spurge, gripeweed, oxalis)
23806	Catmint	<i>Nepeta x faasseni</i>	'Dropmore'	Field Container	Lieth	2004	No injury
23806	Catmint	<i>Nepeta x faasseni</i>	N. nervosa 'Blue Carpet'	Field Container	Neal	2004	All rates caused unacceptable injury
23806	Catmint	<i>Nepeta x faasseni</i>	'Walker's Low'	Field Container	Senesac	2004	No injury
23807	Devil's-tongue prickly pear	<i>Opuntia humifusa</i>	'Lemon Form'	Field Container	Senesac	2005	No injury
24799	Hopflower Oregano	<i>Origanum libanoticum</i>		Field Container	Klett	2005	All rates caused slight to moderate visual injury
24799	Hopflower Oregano	<i>Origanum libanoticum</i>		Field Container	Klett	2005	All rates caused slight to moderate visual injury
23526	Switch-Grass	<i>Panicum virgatum</i>		Field Container	Boydston	2004	No injury Significantly reduced kochia, barnyardgrass, chickweed and green foxtail
23526	Switch-Grass	<i>Panicum virgatum</i>	'Dallas Blues'	Field Container	Mathers & Case	2005	No injury
24800	Beard-Tongue	<i>Penstemon sp.</i>	P. hartwegii 'Scarlet Queen'	Field Container	Boydston	2005	No injury
24800	Beard-Tongue	<i>Penstemon sp.</i>		Field Container	Derr	2005	All rates caused slight injury and reduced shoot weight
24800	Beard-Tongue	<i>Penstemon sp.</i>	P X mexicali 'Red Rocks'	Field Container	Lieth	2005	No significant injury at 2.5 lb ai per acre; significant plant growth suppression at 10 lb ai per acre
24800	Beard-Tongue	<i>Penstemon sp.</i>	'Husker Red'	Field Container	Neal	2005	Severe injury at all rates
24800	Beard-Tongue	<i>Penstemon sp.</i>		Field Container	Reding & Anderson	2005	No injury
20848	Creeping Phlox, Moss Pink	<i>Phlox subulata</i>	'Candy Strip'	Field In-Ground	Chen	2005	No significant injury at 2.5 and 5 lb ai per acre rates; slight injury (leaf burn and loss of flowers) at 10 lb ai per acre
24803	New Zealand Flax	<i>Phormium sp.</i>	P. colinsoi	Field Container	Lieth	2005	No injury; significant increase in plant growth
23808	Jacob's Ladder	<i>Polemonium sp.</i>		Field Container	Beste/Frank	2005	Single application caused no injury; second application caused significant injury with dead plants at the end of the experiment
23808	Jacob's Ladder	<i>Polemonium sp.</i>	'Heavenly Habit'	Field Container	Boydston	2005	Single application caused no injury; second injury caused some cupping of leaves and stunting. Plants were still saleable.

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
24805	Primrose, Fairy	<i>Primula malacoides</i>		Field Container	Lieth	2005	Significant injury and plant growth suppression
25304	Mexican Petunia	<i>Ruellia carolinensis</i>	R. brittoniana 'Katie'	Field In-Ground	Chen	2005	No significant injury at 2.5 and 5.0 lb ai per acre; slight injury (purple leaves) at 10 lb ai per acre
24807	Lavender cotton	<i>Santolina chamaecyparissus</i>	'Compacta'	Field Container	Lieth	2005	No injury; significant increase in plant growth
23811	Hen and chicks	<i>Sempervivum arachnoideum</i>	'Purple Beauty'	Field Container	Beste/Frank	2005	No injury
23811	Hen and chicks	<i>Sempervivum arachnoideum</i>		Field Container	Senesac	2004	No injury
23810	Hen and chicks	<i>Sempervivum tectorum</i>	'Cobweb'	Field Container	Ahrens & Mervosh	2005	Slight injury at 2.5 lb ai per acre; moderate at 5 and 10 lb ai per acre
23810	Hen and chicks	<i>Sempervivum tectorum</i>	'Sunset'	Field Container	Lieth	2004	No injury
23814	Goldenrod, Wrinkleleaf	<i>Solidago rugosa</i>	'Fireworks'	Field Container	Lieth	2004	No injury
23814	Goldenrod, Wrinkleleaf	<i>Solidago rugosa</i>	'Fireworks'	Field Container	Neal	2004	No injury
23814	Goldenrod, Wrinkleleaf	<i>Solidago rugosa</i>		Field Container	Reding & Anderson	2005	No injury
23814	Goldenrod, Wrinkleleaf	<i>Solidago rugosa</i>		Field Container	Roys	2005	No injury
23815	Goldenrod, Seaside	<i>Solidago sempervirens</i>		Field Container	Senesac	2004	No injury
23816	Goldenrod, Showy	<i>Solidago speciosa</i>		Field Container	Roys	2005	No injury
23812	Goldenrod, Autumn	<i>Solidago sphacelata</i>		Field Container	Roys	2005	No injury
23817	Foamflower, Heartleaf	<i>Tiarella cordifolia</i>	T. wherryi	Field Container	Neal	2004	Slight stunting at 2.5 lb ai per acre; significant injury at 5 and 10 lb ai per acre
25782	Foamflower, Heartleaf	<i>Tiarella cordifolia</i>		Field Container	Senesac	2005	No injury after the first application; significant injury after second application at all rates
24810	Spiderwort	<i>Tradescantia x andersoniana</i>	'Osprey'	Field Container	Boydston	2005	No significant injury at 2.5 lb ai per acre; 5 and 10 lb ai per acre slightly delayed blooming
24810	Spiderwort	<i>Tradescantia x andersoniana</i>		Field Container	Derr	2005	No injury
24810	Spiderwort	<i>Tradescantia x andersoniana</i>	'Sweet Kate'	Field Container	Mathers & Case	2005	No injury

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
25307	Vervain	<i>Verbena sp.</i>	V. canadensis 'Homestead Purple'	Field In-Ground	Chen	2005	No significant injury at 2.5 and 5 lb ai per acre; slight injury (leaf burn) at 10 lb ai per acre
24710	Vervain	<i>Verbena sp.</i>	V. canadensis 'Homestead Purple'	Field Container	Neal	2005	Little to no injury at 2.5 lb ai per acre; moderate and severe injury at 5 and 10 lb ai per acre rates
23818	Ironweed, New York	<i>Vernonia noveboracensis</i>		Field Container	Neal	2004	No injury at 2.5 and 5 lb ai per acre; slight injury at 10 lb ai per acre
23818	Ironweed, New York	<i>Vernonia noveboracensis</i>		Field Container	Senesac	2004	No injury
24812	Turkish veronica	<i>Veronica liwanensis</i>		Field Container	Boydston	2005	All rates caused significant injury and reduced plant growth
20825	Speedwell, Brooklime	<i>Veronica sp.</i>	'Goodness Grows'	Field Container	Boydston	2004	No injury <i>Significantly reduced kochia, barnyardgrass, chickweed and green foxtail</i>

Label Suggestions

It is suggested that all 49 crop genera or species exhibiting no injury in these experiments be added to the Snapshot 2.5TG label under the Groundcovers/Perennials header.

It is suggested the following crops be added to the list where injury has been observed: *Antennaria diodica*, *Athyrium nipponicum*, *Cimicifuga racemosa*, *Chrysogonum virginiana*, *Digitalis thapsi*, *Epimedium x rubrum*, *Mertensia virginica*, *Origanum libanoticum*, *Polemonium boreale*, *Primula malacoides*, and *Tiarella wherryi*.

It is also suggested that Dow AgroSciences consider adding language indicating a single application of Snapshot 2.5 TG is considered not injurious at the 2.5 lb ai per acre rate but any higher rate or multiple applications may cause unacceptable injury for *Agastache sp.*, *Alchemilla mollis*, *Amsonia tabernaemontana*, *Antennaria parvifolia*, *Baptisia australis*, *Chelone lyonii*, *Eupatorium purpureum*, *Phlox subulata*, *Phormium colinsoi*, *Ruellia carolinensis*, *Sempervivum tectorum*, and *Verbena canadensis*.

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 (Pendulum)

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

Syngenta, Dave Ross, 336-632-6411, 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.

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

Pennant Magnum - Syngenta, Dave Ross, 336-632-6411, david.ross@syngenta.com

Snapshot - Dow AgroSciences, Mike Melichar, 317-337-4982, 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 OR Ely Vea, 308 Aston Forest Lane, Crownsville, MD 21032, Phone & FAX#: 410-923-488, E-mail: 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. Arhens & Mervosh, Chen, Derr, 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.