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

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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 'Pfizers 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 (Pendulum)

Dow AgroSciences, Mike Melichar, 317-337-4982, mwymelichar@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. 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.