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**IR-4 Ornamental Horticulture Program
Bentazon Crop Safety**

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Abstract

Basagran T/O has been registered for a number of years as a directed application and as an over-the-top application on limited plant species. However, growers have expressed the need to have additional plants added for over-the-top applications. Data collected throughout the history of the IR-4 Ornamental Horticulture Program are presented here to support specific Basagran T/O applications over the top of certain ornamental horticulture plants. The rates chosen for this research were 1.0, 2.0 and 4.0 pounds active ingredient per acre (lb ai per A) as the 1X, 2X and 4X rates. In addition, early studies compared single versus two consecutive applications of 1.0 lb ai per A or 2.0 lb ai per A followed with 1 lb ai per A. Throughout the years, 61 different crop species were examined for over the top applications. Of these, twenty-two exhibited no or minimal transient injury after application at all three rates. Fourteen crops require further research because of unclear results. Twelve crops exhibited no phytotoxicity at 1.0 lb ai per acre, but did have some injury at the higher rates or with repeat applications. Thirteen species exhibited phytotoxicity at even the 1.0 lb ai per acre rate.

Introduction

Materials and Methods

Single applications were made with Basagran T/O (bentazon) or two applications were made approximately 30 days apart. The application rates were 1.0, 2.0, and 4.0 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 varying scales. Some researchers recorded on a scale of 0 to 10 (0 = No phytotoxicity; 10 = Complete kill). Some researchers used a scale of 1 to 10 with 10 being no phytotoxicity and 1 being complete kill. Other researchers estimated percent foliage affected with 100% meaning kill. For more detailed materials and methods, please see Appendix 1: Protocols and Appendix 3: Research Reports.

Several trials were conducted using directed applications instead of over the top. These trials are included in the summary table (Table 5) but are not summarized in the results section.

Basagran T/O was supplied to researchers (See list of researchers in Appendix 2) by American Cyanamid, BASF or TopPro depending upon when the research was conducted.

Results and Summary

Efficacy

Several researchers also examined efficacy in addition to crop safety. In this set of research trials, Basagran T/O managed several weed species well: common chickweed, common lambsquarters, common purslane, common sowthistle, and pigweed. The performance for oxalis and yellow nutsedge was variable depending upon researcher, but most reports favored good control. Several weeds were not managed with Basagran T/O applications: annual grass, black willow, brassica, carpetweed, Carolina geranium, crabgrass, cudweed, eclipta, groundsel, mares tail, Pennsylvania bittercress, pine, prostrate spurge, ragweed, spurge, and trifolium.

Phytotoxicity

Based on the type and nature of injury seen with Basagran applications in the research conducted from 1977 through 2004, 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, Basagran exhibited no or minimal negative impact on a range of plant species (Table 1). Twenty-two 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 fourteen species of plants for which the results were unclear and are suggested as candidates for further research (Table 2). Twelve crop

species, exhibited no or little injury at the 1.0 lb ai per acre rate, but significant phytotoxicity occurred at the 4.0 lb ai per acre rate or with repeat applications (Table 3). It may be prudent to either conduct additional trials or place language on the label indicating applications of Basagran are considered safe at the 1.0 lb ai per acre rate but any higher rate or multiple applications may cause unacceptable injury.

There were thirteen crops in this research that exhibited damage sufficient to recommend growers not utilize Basagran T/O as an over-the-top treatment for pre-emergent weed control (Table 4).

Please see Table 5 for a list of research on Basagran T/O and the summary of the received results.

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

<i>Antirrhinum majus</i> (Field Container)	<i>Heuchera sp.</i>
<i>Berberis thunbergii</i>	<i>Hosta fortunei</i>
<i>Brassica oleracea</i> 'Color Up'	<i>Hydrangea sp.</i>
<i>Buddleia davidii</i>	<i>Jasminum sp.</i>
<i>Buxus sp.</i>	<i>Koelreuteria bipinnata</i>
<i>Caryopteris sp.</i> (See Fretz)	<i>Liriope sp.</i>
<i>Cynodon dactylon</i>	<i>Malus sp.</i>
<i>Euonymus japonicus</i>	<i>Petunia sp.</i>
<i>Hedera canariensis</i>	<i>Raphiolepis indica</i>
<i>Hedera helix L. ssp. Helix</i>	<i>Taxodium distichum</i>
<i>Hemerocallis sp.</i> (See Norcini)	<i>Taxus sp.</i>

Table 2. List of Bentazon treated crops where more research is needed to clarify response

<i>Antirrhinum majus</i> (Field In-Ground)	<i>Phlox sp.</i>
<i>Cornus florida</i>	<i>Photinia sp.</i> (See Derr)
<i>Cornus kousa</i>	<i>Quercus sp.</i>
<i>Cornus sericea</i>	<i>Rosa sp.</i>
<i>Cornus sibiricus</i>	<i>Tsuga canadensis</i>
<i>Crataegus sp.</i>	<i>Viburnum sp.</i> (response may be dependent on species)
<i>Ligustrum sp.</i>	
<i>Ophiopogon jaburan</i>	

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

<i>Centaurea gymnocarpa</i>	<i>Pinus sp.</i> (single application recommended)
<i>Cotoneaster sp.</i> (single application recommended)	<i>Pittosporum tobira</i>
<i>Gardenia sp.</i>	<i>Podocarpus macrophyllus</i>
<i>Ilex sp.</i> (single application recommended)	<i>Rhododendron sp.</i> (response may be dependent on cultivar)
<i>Lagerstroemia indica</i> (See Beste)	<i>Tagetes sp.</i> (single application recommended)
<i>Myrica cerifera</i>	<i>Viola sp.</i> (single application recommended)

Table 4. List of Bentazon treated crops exhibiting significant injury.

<i>Betula pendula</i>	<i>Gazania linearis</i>
<i>Betula platyphylla</i>	<i>Impatiens sp.</i>
<i>Brassica oleracea</i> 'Nagoya Garnish White'	<i>Juniperus sp.</i>
<i>Carissa grandiflora</i>	<i>Trachelospermum asiaticum</i>
<i>Cercis canadensis</i>	<i>Weigela sp.</i>
<i>Euonymus alatus</i>	<i>Zinnia sp.</i>
<i>Forsythia sp.</i>	

Table 5. Detailed Summary Crop Safety Testing with Basagran T/O

Notes: Table entries are sorted by crop Latin name. All data received by 6/15/2006 are included.

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
10837	Snapdragon	<i>Antirrhinum majus</i>	'Tahiti'	Field Container	Linderman	1991	No injury at 1 and 2 lb ai per acre.
10837	Snapdragon	<i>Antirrhinum majus</i>		Field Container	Schreiber	1991	No injury at 1 and 2 lb ai per acre.
10846	Snapdragon	<i>Antirrhinum majus</i>	'Scarlet'	Field In-Ground	Senesac	1991	No injury with single application; significant phytotoxicity with two applications of 1 lb ai per acre.
20647	Mugwort, Wormwood	<i>Artemisia sp.</i>	Powis Castle	Field In-Ground	Boydston	2004	No injury
20634	Aster	<i>Aster ericoides</i>	Aster novi-belgii 'Woods Light Blue'	Field In-Ground	Boydston	2004	Slight, moderate and high injury at 1X, 2X and 4X rates
25195	Japanese Barberry	<i>Berberis thunbergii</i>		Field Container	Senesac	1990	No visible injury, but there was a reduction in vigor and fresh weight.
5605	Birch	<i>Betula sp.</i>	B. pendula	Field In-Ground	Linderman	1994	No significant injury
5605	Birch	<i>Betula sp.</i>	B. platyphylla 'japonica'	Field In-Ground	Schreiber	1990	Significant injury
5605	Birch	<i>Betula sp.</i>	B. pendula	Field In-Ground	Senesac	1990	Significant injury <i>About 30% control of yellow nutsedge</i>
10835	Ornamental Cabbage, Ornamental Kale	<i>Brassica sp.</i>	B. oleracea 'Colorup'	Field Container	Linderman	1991	No injury.
10835	Ornamental Cabbage, Ornamental Kale	<i>Brassica sp.</i>	'Color Up'	Field Container	Linderman	1994	No injury.
10821	Ornamental Cabbage, Ornamental Kale	<i>Brassica sp.</i>	'Color Up'	Field In-Ground	Linderman	1994	No injury.
10835	Ornamental Cabbage, Ornamental Kale	<i>Brassica sp.</i>		Field Container	Schreiber	1991	No injury.
10835	Ornamental Cabbage, Ornamental Kale	<i>Brassica sp.</i>	B. oleracea 'Nagoya Garnish White'	Field Container	Senesac	1993	Significant injury at 1 and 2 lb ai per acre. Symptoms included discoloration and stunting.
25319	Butterfly Bush	<i>Buddleia davidii</i>	'Black Knight'	Field Container	Derr	2005	No injury
25321	Boxwood	<i>Buxus sp.</i>		Field Container	Derr	2005	No injury

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
1233	Boxwood	<i>Buxus sp.</i>	B. microphylla	Field In-Ground	Linderman	1994	No significant injury
1233	Boxwood	<i>Buxus sp.</i>	B. japonica 'Little Gem'	Field In-Ground	Talbert	1990	Multiple applications required for good yellow nutsedge control
25434	Natal Plum	<i>Carissa grandiflora</i>	Emerald Blanket	Field Container	Norcini	1991	Stunting of vegetative growth increasing with rate.
5561	Bluebeard	<i>Caryopteris sp.</i>	C. x clandonensis 'Longwood Blue'	Field In-Ground	Buriff	1997	No injury.
26133	Bluebeard	<i>Caryopteris sp.</i>	C. X clandonensis 'Blue Mist'	Field Container	Fretz	1977	Excessive damage increasing with rate (0.75, 1.5, 3, and 6 lb ai per acre)
5561	Bluebeard	<i>Caryopteris sp.</i>	C. X clandonensis	Field In-Ground	Linderman	1994	No significant injury
10832	Dusty-Miller	<i>Centaurea gymnocarpa</i>	'Diamond'	Field Container	Buriff	1995	Extensive injury observed; however some dead plants had Pythium isolated from them so the level of phytotoxicity rated is suspect
10832	Dusty-Miller	<i>Centaurea gymnocarpa</i>	C. cineraria	Field Container	Linderman	1991	No injury.
10818	Dusty-Miller	<i>Centaurea gymnocarpa</i>	'Silverdust'	Field In-Ground	Norcini	1993	Applications at 1.0 lb ai per acre had minimal impact; 2 application of 2.0 lb ai per acre resulted in almost complete mortality
10832	Dusty-Miller	<i>Centaurea gymnocarpa</i>		Field Container	Schreiber	1991	No injury.
10832	Dusty-Miller	<i>Centaurea gymnocarpa</i>		Field Container	Talbert	1995	Slight injury.
402	Red Bud, Eastern	<i>Cercis canadensis</i>		Field In-Ground	Buriff	1995	No injury.
402	Red Bud, Eastern	<i>Cercis canadensis</i>		Field In-Ground	Buriff	1996	No injury.
12303	Red Bud, Eastern	<i>Cercis canadensis</i>		Field Container	Buriff	1997	No injury.
12303	Red Bud, Eastern	<i>Cercis canadensis</i>		Field Container	Fraelich	1999	No significant injury
25202	Dogwood, Red-barked	<i>Cornus alba</i>	sibericus	Field Container	Linderman	1990	First application showed no phytotoxicity; second application caused leaf necrosis followed by leaf death.
5562	Dogwood, Flowering	<i>Cornus florida</i>		Field In-Ground	Buriff	1995	No significant injury
552	Dogwood, Flowering	<i>Cornus florida</i>		Field Container	Glaze	1992	No significant injury; Weed control was fair
552	Dogwood, Flowering	<i>Cornus florida</i>		Field Container	Schreiber	1991	Moderate phytotoxicity to mortality increasing with rate.
25197	Dogwood, Kousa	<i>Cornus kousa</i>		Field Container	Senesac	1991	Some injury with two applications of 1 lb ai per acre, but no reduction in vigor or fresh weight.

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
26134	Dogwood, Red Osier	<i>Cornus sericea</i>		Field Container	Fretz	1977	Excessive damage increasing with rate (0.75, 1.5, 3, and 6 lb ai per acre)
26144	Cotoneaster, cranberry	<i>Cotoneaster apiculatus</i>	C. apiculata	Greenhouse	Schreiber	1990	Control plants had significant damage; cannot make determination of phyto from this study
550	Cotoneaster	<i>Cotoneaster sp.</i>	C. dammeri 'Royal Beauty'	Field Container	Fretz	1977	Excessive damage increasing with rate (0.75, 1.5, 3, and 6 lb ai per acre)
550	Cotoneaster	<i>Cotoneaster sp.</i>	C. microphylla	Field Container	Linderman	1990	Single application had no apparent effect; second application severely damaged plants, some to mortality
550	Cotoneaster	<i>Cotoneaster sp.</i>	Moonglo	Field Container	Senesac	1990	No visible injury, but slight reduction in vigor and fresh weight.
7818	Cotoneaster	<i>Cotoneaster sp.</i>	C. horizontalis 'Rock Spray'	Field In-Ground	Talbert	1990	No damage with single application, some with second application <i>15 - 40% control of yellow nutsedge</i>
550	Cotoneaster	<i>Cotoneaster sp.</i>	C. horizontalis 'Rock Spray'	Field Container	Talbert	1990	No damage with single or multiple applications
12305	Hawthorn	<i>Crataegus sp.</i>	C. phaenopyrum 'Medic'	Field Container	Buriff	1997	No injury.
12305	Hawthorn	<i>Crataegus sp.</i>		Field Container	Fraelich	1997	Phytotoxicity increased as rate increased; 1 lb ai per acre exhibited slight injury and mortality occurred at 4 lb ai per acre.
5619	Hawthorn	<i>Crataegus sp.</i>	C. phaenopyrum	Field In-Ground	Linderman	1994	No injury
1	Bermudagrass	<i>Cynodon dactylon</i>		Turf	King	1977	Minor transient
20664	Bleeding Heart	<i>Dicentra sp.</i>		Field Container	Boydston	2004	Treated plants not saleable
20664	Bleeding Heart	<i>Dicentra sp.</i>	Dicentra spectabilis	Field Container	Williams (IL)	2003	Minimal injury
25435	Winged Burning Bush	<i>Euonymus alatus</i>	'Compacta'	Field Container	Senesac	1991	Significant reduction in vigor and fresh weight.
2474	Euonymus	<i>Euonymus sp.</i>	E. japonicus	Field In-Ground	Derr	1993	Slight injury observed.
25320	Euonymus	<i>Euonymus sp.</i>		Field Container	Derr	2005	No injury
2474	Euonymus	<i>Euonymus sp.</i>	E. japonicus 'Colerata'	Field In-Ground	Williams (IL)	1995	No phytotoxicity.
2474	Euonymus	<i>Euonymus sp.</i>	E. fortunei 'Coloratus'	Field In-Ground	Williams (IL)	2003	No injury.
25320	Euonymus	<i>Euonymus sp.</i>	Euonymus fortunei 'Coloratus'	Field Container	Williams (IL)	2003	No injury
2471	Golden Bells	<i>Forsythia sp.</i>		Field In-Ground	Ahrens	1977	Significant injury increasing with rate
10839	Jasmine, Cape, Common Gardenia	<i>Gardenia sp.</i>		Field Container	Fraelich	1996	Slight injury at 1 and 2 lb ai per acre; some mortality at 4 lb ai per acre.
10839	Jasmine, Cape, Common Gardenia	<i>Gardenia sp.</i>		Field Container	Glaze	1993	No injury. All plant marketable at the end of the experiment. <i>Trifolium control was poor, brassica control increased with the number of applications.</i>

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
25191	Gazania	<i>Gazania linearis</i>	Sunshine Mix	Field In-Ground	Senesac	1991	Two applications of 1lb ai/acre caused significant damage; single app had slight phytotoxicity
10814	Algerian Ivy	<i>Hedera canariensis</i>		Field In-Ground	Linderman	1994	No injury.
2468	English Ivy	<i>Hedera helix L. ssp. Helix</i>	Euonymus sp.	Field In-Ground	Talbert	1979	No phytotoxicity at 2.2 kg per hectare; minimal at 4.5 kg per hectare; minor at 9.0 kg per hectare <i>Excellent efficacy for pigweed</i>
10816	Daylily	<i>Hemerocallis sp.</i>	'Stella De Oro'	Field In-Ground	Buriff	1995	No significant injury
10830	Daylily	<i>Hemerocallis sp.</i>		Field Container	Linderman	1991	No injury.
10816	Daylily	<i>Hemerocallis sp.</i>	'Hyperion'	Field In-Ground	Linderman	1994	No significant injury
21435	Daylily	<i>Hemerocallis sp.</i>	'Aztec Gold'	Greenhouse	Norcini	1991	Leaf tip chlorosis and necrosis; younger plants recovered by the end of the experiment, older plants did not.
10830	Daylily	<i>Hemerocallis sp.</i>		Field Container	Schreiber	1991	No injury.
10830	Daylily	<i>Hemerocallis sp.</i>	'Signal'	Field Container	Senesac	1991	Significant reduction in fresh weight and vigor.
10816	Daylily	<i>Hemerocallis sp.</i>	Stella de Oro	Field In-Ground	Williams (IL)	2003	No injury
20638	Alumroot	<i>Heuchera sp.</i>	Heucher x brizoides 'Firefly'	Field In-Ground	Boydston	2004	High injury
20638	Alumroot	<i>Heuchera sp.</i>		Field In-Ground	Simmons	2005	No injury
25193	Lily, Plantain	<i>Hosta fortunei</i>	Brigham Blue	Field Container	Senesac	1990	No visible injury, but there was a reduction in vigor and fresh weight.
25193	Lily, Plantain	<i>Hosta fortunei</i>	August Moon	Field Container	Senesac	1990	No visible injury, but there was a reduction in vigor and fresh weight.
25193	Lily, Plantain	<i>Hosta fortunei</i>	'White Beauty'	Field Container	Senesac	1990	No visible injury, but there was a reduction in vigor and fresh weight.
25318	Hydrangea	<i>Hydrangea sp.</i>		Field Container	Derr	2005	Very low injury
93	Holly	<i>Ilex sp.</i>	I. crenata 'Helleri'	Field In-Ground	Beste	1990	No significant visible phytotoxicity. <i>Excellent control of yellow nutsedge</i>
48	Holly	<i>Ilex sp.</i>	I. crenata 'Helleri'	Field Container	Beste	1990	Significant foliar injury. <i>Poor control of prostrate spurge, woodsorrel and bittercress</i>
48	Holly	<i>Ilex sp.</i>	crenata 'Helleri'	Field Container	Beste	1991	<i>Poor control of Pennsylvania bittercress, yellow woodsorrel, and prostrate spurge</i>
48	Holly	<i>Ilex sp.</i>	compacta	Field Container	Derr	1990	Slight injury.
48	Holly	<i>Ilex sp.</i>	I. cornuta bufordii	Field Container	Glaze	1990	Slight differences in plant growth, but plants were marketable.
48	Holly	<i>Ilex sp.</i>	I. crenata 'Convexa'	Field Container	Linderman	1990	No injury
93	Holly	<i>Ilex sp.</i>	I. cornuta 'Dwarf Buford'	Field In-Ground	Talbert	1990	Single application did no damage; second application caused transient phytotoxicity

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
48	Holly	<i>Ilex sp.</i>	I. cornuta 'Dwarf Buford'	Field Container	Talbert	1990	Single application caused no damage; second application caused transient discoloration
10833	Balsam	<i>Impatiens sp.</i>	'Little Gem'	Field Container	Linderman	1991	Substantial reduction in bloom production and growth
10833	Balsam	<i>Impatiens sp.</i>	I. wallerana 'Southeast Salmon Blush'	Field Container	Norcini	1993	In both newly transplanted and established plants, significant injury occurred with both 1 and 2 lb ai per acre
10833	Balsam	<i>Impatiens sp.</i>		Field Container	Schreiber	1991	No injury.
10819	Balsam	<i>Impatiens sp.</i>	'Accent Carmine'	Field In-Ground	Senesac	1991	Moderate to significant phytotoxicity increasing with rate
10829	Jasmine, Jessamine	<i>Jasminum sp.</i>		Field Container	Fraelich	1996	Slight phytotoxicity at all tested rates.
10829	Jasmine, Jessamine	<i>Jasminum sp.</i>		Field Container	Fraelich	1999	No observable injury.
126	Juniper	<i>Juniperus sp.</i>		Field In-Ground	Ahrens	1977	Significant injury increasing with rate
126	Juniper	<i>Juniperus sp.</i>		Field In-Ground	Ahrens	1978	Significant injury increasing with rate
125	Juniper	<i>Juniperus sp.</i>	J. horizontalis 'Plumosa'	Field Container	Fretz	1977	Excessive damage increasing with rate (0.75, 1.5, 3, and 6 lb ai per acre)
125	Juniper	<i>Juniperus sp.</i>	J. horizontalis moench 'plumosa'	Field Container	Glaze	1990	Uniform slight injury across rates.
125	Juniper	<i>Juniperus sp.</i>	J. horizontalis 'Bar Harbor'	Field Container	Linderman	1990	Mortality seen in two applications of 1lb ai/acre. Some damage in later ratings with single application
125	Juniper	<i>Juniperus sp.</i>	J. horizontalis 'Bar Harbor'	Field Container	Norcini	1991	Some mortality at 1 and 2 lb ai per acre.
125	Juniper	<i>Juniperus sp.</i>	J. conferta 'Shore'	Field Container	Talbert	1990	No injury with single or two applications
126	Juniper	<i>Juniperus sp.</i>	J. chinensis 'Hetzi'	Field In-Ground	Williams (IL)	1977	No injury noted <i>Acceptable nutsedge control</i>
20653	Poker Plant, Red-Hot-Poker	<i>Kniphofia sp.</i>	Flamenco	Field In-Ground	Boydston	2004	Treated plants not saleable
5560	Golden-Rain Tree	<i>Koelreuteria bipinnata</i>		Field In-Ground	Linderman	1994	No injury
5378	Crape Myrtle	<i>Lagerstroemia indica</i>	'Rubra'	Field Container	Beste	1990	Significant growth reduction and foliar injury up to 2 months after treatment. <i>No control of bittercress, carpetweed, prostrate spurge, groundsel</i>
5559	Crape Myrtle	<i>Lagerstroemia indica</i>	'Natchez'	Field In-Ground	Derr	1994	Some injury but plants recovered <i>Excellent control of yellow nutsedge</i>
5378	Crape Myrtle	<i>Lagerstroemia indica</i>		Field Container	Glaze	1990	Generally tolerant. <i>Ineffective control of mares tail, cudweed, brassica species, annual grass, and ragweed.</i>

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
5378	Crape Myrtle	<i>Lagerstroemia indica</i>		Field Container	Linderman	1990	First application resulted in no injury; second application caused light necrosis in center of leaves.
5559	Crape Myrtle	<i>Lagerstroemia indica</i>		Field In-Ground	Linderman	1994	No significant injury
5378	Crape Myrtle	<i>Lagerstroemia indica</i>	'Centennial Spirit'	Field Container	Talbert	1990	Transient yellowing
5378	Crape Myrtle	<i>Lagerstroemia indica</i>	'Tuskegee'	Field Container	Talbert	1990	Transient yellowing
5378	Crape Myrtle	<i>Lagerstroemia indica</i>	'Pecos'	Field Container	Talbert	1990	Transient yellowing
5378	Crape Myrtle	<i>Lagerstroemia indica</i>	'Tuscarora'	Field Container	Talbert	1990	Transient yellowing
20660	Lavender	<i>Lavandula sp.</i>	Provence	Field In-Ground	Boydston	2004	Treated plants saleable
558	Privet	<i>Ligustrum sp.</i>	L. x ibolium	Field In-Ground	Buriff	1995	No injury.
2466	Privet	<i>Ligustrum sp.</i>	L. obtusifolium 'Regelianum'	Field Container	Fretz	1977	Excessive damage increasing with rate (0.75, 1.5, 3, and 6 lb ai per acre)
10844	Privet	<i>Ligustrum sp.</i>	L. sinense	Field Container	Glaze	1992	No injury. <i>Two applications did not control cudweed nor brassica species.</i>
10844	Privet	<i>Ligustrum sp.</i>	L. amurense	Field Container	Schreiber	1991	Slight injury at 1 and 2 lb ai per acre.
10831	Lilyturf, Creeping	<i>Liriope sp.</i>	L. muscari variegata	Field Container	Glaze	1992	No visible injury. <i>Poor control of cudweed and brassica species.</i>
10831	Lilyturf, Creeping	<i>Liriope sp.</i>	L. muscari variegata	Field Container	Glaze	1993	No significant injury. <i>Trifolium control was poor and brassica control increased with number of applications.</i>
26143	Lilyturf, Creeping	<i>Liriope sp.</i>	L. muscari 'Evergreen Giant'	Greenhouse	Norcini	1991	Minimal chlorosis with both younger and older plants; younger plants were more tolerant.
12304	Apple & Crabapple (Non-Bearing)	<i>Malus sp.</i>		Field Container	Fraelich	1997	Slight phytotoxicity after first application; no phytotoxicity after second.
20641	Bee Balm	<i>Monarda didyma</i>	Raspberry Wine	Field In-Ground	Boydston	2004	Slight injury
10841	Wax Myrtle	<i>Myrica cerifera</i>		Field Container	Fraelich	1997	Slight to moderate phytotoxicity increasing with rate, but all plants were marketable.
10841	Wax Myrtle	<i>Myrica cerifera</i>		Field Container	Fraelich	1999	Slight phytotoxicity at all rates, but at end of experiment visible injury only occurred at 4 lb ai per acre.
10841	Wax Myrtle	<i>Myrica cerifera</i>		Field Container	Glaze	1992	No phytotoxicity. <i>Little control of cudweed and brassica species.</i>
10841	Wax Myrtle	<i>Myrica cerifera</i>		Field Container	Glaze	1993	No significant injury. <i>Trifolium control was poor and the brassica control increased with number of applications.</i>

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
25189	Aztec Grass, lillyturf	<i>Ophiopogon jaburan</i>		Greenhouse	Norcini	1991	Injury (tip chlorosis and necrosis) was rate dependent, exhibited faster on younger plants, but was less severe on younger plants.
10836	Petunia	<i>Petunia sp.</i>		Field Container	Schreiber	1991	No injury
10836	Petunia	<i>Petunia sp.</i>		Field Container	Schreiber	1992	No injury.
10822	Petunia	<i>Petunia sp.</i>	'Madness Plum'	Field In-Ground	Senesac	1991	No damage with single application
20633	Phlox, Perennial	<i>Phlox paniculata</i>	Orange Perfection	Field In-Ground	Boydston	2004	Slight, moderate and high injury at 1X, 2X and 4X rates
1591	Photinia	<i>Photinia sp.</i>	P. x fraseri	Field In-Ground	Derr	1993	Bentazon plus crop oil caused severe injury. <i>Good yellow nutsedge control.</i>
10845	Photinia	<i>Photinia sp.</i>	P. serrulata	Field Container	Glaze	1992	No injury. <i>Fair control of cudweed and brassica species.</i>
1591	Photinia	<i>Photinia sp.</i>	P. x fraseri	Field In-Ground	Linderman	1994	No injury.
2464	Pine	<i>Pinus sp.</i>	P. strobus	Field In-Ground	Ahrens	1977	No damage at 1 or 2 lb ai per acre
227	Pine	<i>Pinus sp.</i>	P. strobus	Field Container	Derr	1990	Moderate injury increasing with subsequent applications.
227	Pine	<i>Pinus sp.</i>	P. strobus	Field Container	Glaze	1990	Slight phytotoxicity.
227	Pine	<i>Pinus sp.</i>	P. mugo 'Mugo'	Field Container	Linderman	1990	No phyto with single application; two applications at 1 lb ai/acre caused significant damage
227	Pine	<i>Pinus sp.</i>	P. strobus	Field Container	Schreiber	1991	No injury.
10842	Pittosporum, Japanese	<i>Pittosporum tobira</i>		Field Container	Fraelich	1997	Slight injury increasing with rate, but all plants still marketable.
10842	Pittosporum, Japanese	<i>Pittosporum tobira</i>		Field Container	Fraelich	1999	Slight phytotoxicity at 1 lb ai per acre, moderate at 4 lb ai per acre.
10842	Pittosporum, Japanese	<i>Pittosporum tobira</i>		Field Container	Glaze	1993	No injury. <i>Fair control of cudweed and brassica.</i>
10842	Pittosporum, Japanese	<i>Pittosporum tobira</i>	'Compacta Green'	Field Container	Norcini	1991	Variable response from slight chlorosis to plant death.
10843	Southern Yew	<i>Podocarpus macrophyllus</i>	D. Don	Field Container	Fraelich	1996	Slight injury at 1 and 2 lb ai per acre; moderate at 4 lb ai per acre.
10843	Southern Yew	<i>Podocarpus macrophyllus</i>	D. Don	Field Container	Fraelich	1999	Slight phytotoxicity at 2 and 4 lb ai per acre.
10843	Southern Yew	<i>Podocarpus macrophyllus</i>		Field Container	Glaze	1992	No injury. <i>Marginal control of cudweed and brassica.</i>
10843	Southern Yew	<i>Podocarpus macrophyllus</i>		Field Container	Glaze	1993	Minimal injury, but marketability was poor in two of the reps - possibly due to disease. <i>Trifolium control was poor, brassica control increased with number of applications.</i>
7819	Firethorn	<i>Pyracantha sp.</i>	'Lalandei'	Field In-Ground	Buriff	1995	No significant injury

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
224	Oak	<i>Quercus sp.</i>	Q. agrifolia	Field Container	Glaze	1992	No injury. <i>Some reduction of weed populations of cudweed, brassica, and black willow.</i>
224	Oak	<i>Quercus sp.</i>	Q. rubra	Field Container	Linderman	1990	Single app caused no damage; second app caused moderate damage
224	Oak	<i>Quercus sp.</i>	Q. nigra	Field Container	Schreiber	1990	Some damage with both single and double applications
224	Oak	<i>Quercus sp.</i>	Q. nigra	Field Container	Schreiber	1991	Some damage with 1 and 2 lb ai per acre
10838	Indian Hawthorn	<i>Raphiolepis indica</i>	Alba	Field Container	Norcini	1991	No injury in recently transplanted or established plants.
10838	Indian Hawthorn	<i>Raphiolepis indica</i>		Field Container	Glaze	1993	No injury. <i>Trifolium control was poor and the Brassica control increased with number of applications.</i>
2473	Rhododendron	<i>Rhododendron sp.</i>	'Roseum Elegans'	Field In-Ground	Beste	1990	Significant foliar injury with single and two applications of 1 lb ai per acre.
11291	Azalea	<i>Rhododendron sp.</i>	R. obtusum 'Hino Crimson'	Field Container	Beste	1993	Injury made plants unsaleable
2472	Azalea	<i>Rhododendron sp.</i>	R. obtusum 'Blaaus Pink'	Field In-Ground	Beste	1993	No significant injury <i>Effective suppression of weeds</i>
2472	Azalea	<i>Rhododendron sp.</i>	R. obtusum 'Blaaus Pink'	Field In-Ground	Beste	1994	No phytotoxicity
2472	Azalea	<i>Rhododendron sp.</i>	R. obtusum 'Delaware Valley White'	Field In-Ground	Beste	1994	Transient necrosis, but plants were saleable at end of experiment <i>Excellent control of yellow nutsedge; no control of prostrate spurge and carpetweed</i>
11291	Azalea	<i>Rhododendron sp.</i>	R. obtusum 'Delaware Valley White'	Field Container	Beste	1994	Some injury but plants recovered <i>Some control of yellow woodsorrel but bittercress and spurge not controlled</i>
2472	Azalea	<i>Rhododendron sp.</i>	R. obtusum 'Hino Crimson'	Field In-Ground	Beste	1995	Bentazon plus crop oil caused noticeable but transient phytotoxicity
2472	Azalea	<i>Rhododendron sp.</i>	R. obtusum 'Girard Fuschia	Field In-Ground	Beste	1995	Slight injury but all plants were saleable <i>Controlled chickweed completely</i>
2472	Azalea	<i>Rhododendron sp.</i>	R. obtusum 'Hino Crimson'	Field In-Ground	Beste	1995	Some injury at the 4 lb ai per acre rate but all plants were saleable <i>Effective control of yellow nutsedge</i>
2472	Azalea	<i>Rhododendron sp.</i>	R. obtusum 'Pleasant White'	Field In-Ground	Beste	1995	Some injury but plants were saleable <i>Excellent chickweed control</i>
2472	Azalea	<i>Rhododendron sp.</i>	R. obtusum 'Delaware Valley White'	Field In-Ground	Beste	1995	Slight injury but plants were saleable
11291	Azalea	<i>Rhododendron sp.</i>	R. obtusum 'Girard Rose'	Field Container	Buriff	1995	Some injury at the 2.0 and 4.0 lb ai per acre rate. Plants recovered
2472	Azalea	<i>Rhododendron sp.</i>	R. X 'Hershey Red'	Field In-Ground	Derr	1993	Extensive injury at both rates <i>Excellent yellow nutsedge control</i>

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
2473	Rhododendron	<i>Rhododendron sp.</i>	'Hershey Red'	Field In-Ground	Derr	1993	Bentazon plus crop oil caused significant damage. <i>Good control of yellow nutsedge</i>
11291	Azalea	<i>Rhododendron sp.</i>	R. indicum 'Sweet'	Field Container	Fraelich	1996	No injury after second application at 1 and 2 lb ai per acre; moderate at 4 lb ai per acre. <i>Good control of oxalis; no observable impact on carolina geranium, crabgrass, cudweed, pine or spurge.</i>
2472	Azalea	<i>Rhododendron sp.</i>	'Hong Kong'	Field In-Ground	Linderman	1994	No injury.
11291	Azalea	<i>Rhododendron sp.</i>	R. macrophylla	Field Container	Linderman	1994	No injury
11291	Azalea	<i>Rhododendron sp.</i>	Azalea 'Coral Bells'	Field Container	Senesac	1990	No visible injury, but reduction in vigor and fresh weight.
2472	Azalea	<i>Rhododendron sp.</i>	R. obtusum 'Hino Crimson'	Field In-Ground	Talbert	1990	<i>Poor control of yellow nutsedge</i>
25194	Rose	<i>Rosa sp.</i>	'Mediland'	Field Container	Senesac	1990	No visible injury, but there was a reduction in vigor and fresh weight.
20658	Sage, Scarlet	<i>Salvia splendens</i>	Caradonna	Field In-Ground	Boydston	2004	Slight injury at 1X, moderate at 2X and 4X rates
20649	Stonecrop	<i>Sedum sp.</i>	<i>Sedum spurium</i> 'Tricolor'	Field In-Ground	Boydston	2004	No injury at 1X and 2X rates, slight at 4X
10834	Marigold	<i>Tagetes sp.</i>	'Inka Orange'	Field Container	Linderman	1991	No injury.
10820	Marigold	<i>Tagetes sp.</i>	'Bolero'	Field In-Ground	Linderman	1994	No phytotoxicity.
10834	Marigold	<i>Tagetes sp.</i>	T. erecta 'Inca Yellow'	Field Container	Norcini	1993	Trial 1 (newly transplanted): moderate to severe necrosis with some mortality. Trial 2 (established plants): some necrosis at 1 and 2 lb ai per acre seven days after first application.
10834	Marigold	<i>Tagetes sp.</i>		Field Container	Schreiber	1991	No injury.
10820	Marigold	<i>Tagetes sp.</i>	'Aurora Gold'	Field In-Ground	Senesac	1991	Slight injury with single application of 1 lb ai per acre; moderate damage with two consecutive applications of 1 lb ai per acre.
10820	Marigold	<i>Tagetes sp.</i>	T. erecta	Field In-Ground	Talbert	1994	No injury with one application at 1 and 2 lb ai per acre rate; slight with the 4 lb ai per acre rate. The second application caused slight to moderate injury increasing with rate. <i>Excellent control of smooth pigweed, common purslane, yellow nutsedge, and common lambsquarters.</i>
10827	Bald Cypress	<i>Taxodium distichum</i>		Field Container	Buriff	1995	No significant injury
10813	Bald Cypress	<i>Taxodium distichum</i>		Field In-Ground	Buriff	1996	No injury
10827	Bald Cypress	<i>Taxodium distichum</i>		Field Container	Glaze	1993	No significant injury
10827	Bald Cypress	<i>Taxodium distichum</i>		Field Container	Schreiber	1991	Slight to moderate injury.

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
986	Yew	<i>Taxus sp.</i>	T. cuspidata	Field In-Ground	Ahrens	1977	No damage at 1 or 2 lb ai per acre
986	Yew	<i>Taxus sp.</i>	T. cuspidata densiformis	Field In-Ground	Ahrens	1977	No damage at 1 or 2 lb ai per acre
986	Yew	<i>Taxus sp.</i>	T. cuspidata densiformis	Field In-Ground	Ahrens	1978	No damage at 1 or 2 lb ai per acre
986	Yew	<i>Taxus sp.</i>	T. cuspidata	Field In-Ground	Ahrens	1978	No damage at 1 or 2 lb ai per acre
10666	Yew	<i>Taxus sp.</i>	T. media 'Hicksi'	Field Container	Beste	1990	No injury.
10666	Yew	<i>Taxus sp.</i>	T. media 'Hicksi'	Field Container	Beste	1991	No injury. <i>Good initial control of prostrate spurge, no control of PA bittercress or yellow woodsorrel</i>
10666	Yew	<i>Taxus sp.</i>	T. media 'Densiformis'	Field Container	Beste	1993	No injury. <i>Good common sowthistle control; no effect on prostrate spurge; necrosis on Eclipta, but no control; perfect sowthistle was controlled with two applications.</i>
10666	Yew	<i>Taxus sp.</i>	T. media 'Hicksi'	Field Container	Glaze	1993	No significant injury. <i>Trifolium control was poor and brassica control increased with number of applications.</i>
10666	Yew	<i>Taxus sp.</i>	T. cuspidata 'Densiformis'	Field Container	Linderman	1991	No injury.
10666	Yew	<i>Taxus sp.</i>		Field Container	Schreiber	1991	No injury.
986	Yew	<i>Taxus sp.</i>	T. media 'Hatfieldii'	Field In-Ground	Senesac	1990	No injury. <i>About 30% control of nutsedge</i>
986	Yew	<i>Taxus sp.</i>		Field In-Ground	Williams (IL)	1977	No injury noted <i>Acceptable nutsedge control</i>
549	Arborvitae	<i>Thuja sp.</i>	T. occidentalis	Field In-Ground	Senesac	1990	No injury. <i>About 30% control of nutsedge</i>
25190	Jasmine, Asian	<i>Trachelospermum asiaticum</i>	'Aslo'	Field Container	Norcini	1991	Slight to moderate chlorosis and necrosis increasing with rate.
25190	Jasmine, Asian	<i>Trachelospermum asiaticum</i>	T. jasiminoides	Field Container	Norcini	1993	Trial 1 (recently transplanted): slight injury at 1 lb ai per acre and lasting injury at 2 lb ai per acre. Trial 2 (established plants): moderate to lasting injury at 1 lb ai per acre; nearly complete mortality at 2 lb ai per acre.
26132	Hemlock, Canada	<i>Tsuga canadensis</i>		Field In-Ground	Ahrens	1978	Moderate injury with 1 and 2 lb ai per acre
20642	Vervain	<i>Verbena sp.</i>	Homestead Purple	Field In-Ground	Boydston	2004	Slight injury at 1X, high at 2X and 4X rates
10840	Arrowwood	<i>Viburnum sp.</i>	V. odoratissimum	Field Container	Glaze	1993	Minor injury. <i>Trifolium control was poor and brassica control increased with number of applications.</i>
10840	Arrowwood	<i>Viburnum sp.</i>	V. opulus	Field Container	Linderman	1991	Control plants performed poorly; no conclusions can be reached from this trial

PR #	Crop			Production Site	Researcher(s)	Year	Results Summary
	Common Name	Latin Name	Cultivar				
10840	Arrowwood	<i>Viburnum sp.</i>	V. carlesi	Field Container	Schreiber	1991	Moderate injury with both 1 and 2 lb ai per acre.
20657	Pansy	<i>Viola sp.</i>	Masim Sherbet	Field In-Ground	Senesac	1991	Two applications of 1lb ai/acre cause significant damage; one application has slight phytotoxicity
559	Weigela	<i>Weigela sp.</i>	W. florida 'Java Red'	Field In-Ground	Buriff	1995	No injury with directed applications.
559	Weigela	<i>Weigela sp.</i>	'Red Prince'	Field In-Ground	Linderman	1994	Necrosis at 1, 2, and 4 lb ai per acre. Most susceptible tissue were young leaves. Damage became masked within 3 weeks so that by end of experiment plant were saleable.
25192	Zinnia	<i>Zinnia sp.</i>	Shortstuff Mix	Field In-Ground	Senesac	1991	Two applications at 1 lb ai/acre caused significant damage; with one application the plant recovered somewhat over time

Label Suggestions

It is suggested based upon data accumulated over the past 30 years, the following species be added to the Basagran T/O label for over the top applications with single application for those crops with asterisks:

<i>Berberis thunbergii</i>	<i>Jasminum sp.</i>
<i>Buddleia davidii</i>	<i>Koelreuteria bipinnata</i>
<i>Buxus sp.</i>	<i>Lagerstroemia indica</i> (See Beste)
<i>Caryopteris sp.</i> (See Fretz)	<i>Malus sp.</i>
<i>Cotoneaster sp.</i> *	<i>Myrica cerifera</i>
<i>Cynodon dactylon</i>	<i>Pinus sp.</i> *
<i>Euonymus japonicus</i>	<i>Pittosporum tobira</i>
<i>Gardenia sp.</i>	<i>Podocarpus macrophyllus</i>
<i>Hedera canariensis</i>	<i>Raphiolepis indica</i>
<i>Hemerocallis sp.</i> (See Norcini)	<i>Tagetes sp.</i> *
<i>Heuchera sp.</i>	<i>Taxodium distichum</i>
<i>Hosta fortunei</i>	<i>Taxus sp.</i>
<i>Hydrangea sp.</i>	<i>Viola sp.</i> *
<i>Ilex sp.</i> *	

Figure 6. Excerpt from Basagran T/O Label

Table 3. Ornamental Species for Over-the-Top Applications

Common Name	Scientific Name
Ajuga	<i>Ajuga sp.</i>
Arborvitae*	<i>Thuja occidentalis</i>
Boxwood "Winter Gem"	<i>Buxus japonica</i>
Dusty Miller	<i>Centaurea cineraria</i>
Holly, Burford "Burfordii"	<i>Ilex cornuta</i>
Holly, "Compacta"	<i>Ilex crenata</i>
Holly, "Dwarf Burford"	<i>Ilex cornuta</i>
Impatiens "Accent Carmine"*	<i>Impatiens sp.</i>
Impatiens "Balsam"	<i>Impatiens balsamina</i>
Ivy, English	<i>Hedera helix</i>
Liriope, Green	<i>Liriope muscari</i>
Liriope	<i>Liriope spicata</i>
Marigold, "Aurora Gold"	<i>Tagete erecta</i>
Mugo pine*	<i>Pinus mugo mugo</i>
Oak, red*	<i>Quercus rubra</i>
Ornamental cabbage pansy	<i>Brassica sp.</i>
Ornamental cabbage "colorup"	<i>Brassica oleracea</i>
Pachysandra	<i>Pachysandra terminalis</i>
Petunia "Madness Plum"	<i>Petunia hybrida</i>
Petunia "Ultra White"	<i>Petunia hybrida</i>
Snapdragon "L. Scarlet"*	<i>Antirrhinum majus</i>
Yew, Japanese "Densifomis"	<i>Taxus cuspidata</i>
Yew "Hatfieldii"*	<i>Taxus media</i>
Yew "Hicks"	<i>Taxus media</i>

*Make no more than one application per season or per crop.

Appendix 1: Protocol

PHYTOTOXICITY PROTOCOL FOR CLEARING BENTAZON ON ORNAMENTALS

Date: 10/04

Ornamental Protocol Number: 641

General label directions: Refer to Product Label

Research program:

Site (species, variety, etc.) - As Attached

Pest(s) - As Attached

Pesticide (common name and trade name) - Bentazon (Basagran T/O®)

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

BASF, Kathie Kalmowitz, (800) 669-1770, (919) 547-2642, FAX# 919-547-2410; e-mail: kalmowk@basf.com

Formulation: Use only EPA registered product

Experimental design:

Plot size (must be adequate to reflect actual use condition)

Replicates Minimum of 4 Treatment Units

Controls (untreated controls to be included in all experiments)

Application:

Dosages - 1x 1 lb. ai/A

2x 2 lbs. ai/A

4x 4 lbs. ai/A

Volume - 20 to 100 gal./A

Timing - 14 to 21 days (Interval)

Number Applications: 2

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.

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.

If appropriate also include a rating for: Chlorosis, Percent of Defoliation (0-10 scale) and stunting (0-10). Indicate if marketable or not.

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

Appendix 2: Contributing Researchers

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Dr. David Williams	University of Illinois 100 Orn Hort Bldg Urbana, IL 61801

Appendix 3: Submitted Data

Data on following pages are those reports from Drs. Ahrens, Norcini, Senesac, and Williams 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 two separate binders.