Tolerance of Nineteen Species of Container Grown Landscape Plants to Postemergence Applications of Basagran[1]

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Abstract

Nineteen container grown landscape species were evaluated for tolerance to postemergence (topical) applications of Basagran (bentazon) at 1.1 and 2.2 kg ai/ha (1 and 2 lb ai/A). Visual injury ratings were made at 14 and 37 days after treatment and growth measurements at the end of the study. Both rates of Basagran were phytotoxic to Amagasa Azalea (*Rhododendron satsuki* 'Amagasa'), Crimson Pygmy Barberry (*Berberis thunbergii* D.C. 'Crimson Pygmy'), Coral Beauty Cotoneaster (*Cotoneaster dammeri* C.K. 'Coral Beauty'), Heavenly Bamboo (*Nandina domestica* Thunb.) and Holmstrup Arbovitae (*Thuja occidentalis* L. 'Homstrup') 14 days after treatment. Azalea and Heavenly Bamboo treated with the low rate recovered from the earlier injury by 37 days after treatment. Sasanqua Camellia (*Camellia sasanqua* Thunb. 'Cleopatra'), Rotunda Holly (*Ilex cornuta* Lindl. and Paxt. 'Rotunda') and Schellings Dwarf Yaupon Holly (*Ilex vomitoria* Ait. 'Schellings'), Hetzi Blue Chinese Juniper (*Juniperus chinensis* L. 'Hetzi I. Glauca'), and Wax-Leaf Privet (*Ligustrum japonicum* Thunb.) exhibited no visual damage or growth reduction. The remaining species were injured to differing degrees.

Index words: herbicide tolerance, phytotoxicity, growth reduction, yellow nutsedge

Species used in this study: Amagasa Azalea (*Rhododendron satsuki* 'Amagasa'); Armstrong Chinese Juniper (*Juniperus chinensis* L. 'Armstrongii'); Blue Pacific Shore Juniper (*Juniperus conferta* Parl. 'Blue Pacific'); Carolina Beauty Crape Myrtle (*Lagerstroemia indica* L. 'Carolina Beauty'); Cleopatra Camellia (*Camellia sasanqua* Thunb. 'Cleopatra'); Coral Beauty Cotoneaster (*Cotoneaster dammeri* C.K. Schneid 'Coral Beauty'); Crimsom Pygmy Barberry (*Berberis thunbergii* D.C. 'Crimson Pygmy'); Dwarf Burford Holly (*Ilex cornuta* Lindl. & Paxt. 'Dwarf Burfordii'); Grey Owl Juniper (*Juniperus virginiana* L. 'Grey Owl'); Heavenly Bamboo (*Nandina domestica* Thunb.); Hellers Japanese Holly (*Ilex crenata* Thunb. 'Helleri'); Hetz Blue Chinese Juniper (*Juniperus chinensis* L. 'Hetzi Glauca'); Holmstrup Arbovitae (*Thuja occidentalis* L. 'Holmstrup'); Japanese Pieris (*Pieris japonica* (Thunb.) D. Don ex G. Don); Japanese Spurge (*Pachysandra terminalis* Siebold & Zucc.); Parsons Juniper (*Juniperus chinensis* L. 'Parsonii'); Rotunda Chinese Holly (*Ilex cornuta* Lindl. & Paxt. 'Rotunda'); Schellings Dwarf Yaupon Holly (*Ilex vomitoria* Ait. 'Schellings'); Wax-Leaf Privet (*Ligustrum japonicum* Thunb.).

Herbicide used in this study: Basagran (bentazon), 3-(1-methylethyl)-(1*H*)-2,1,3-benzothiadiazin-4(3*H*)-one-2,2 dioxide.

Significance to the Nursery Industry

Basagran effectively reduces yellow nutsedge and certain broadleaf weed infestations which interfere in the production and maintenance of landscape plants. Information about the tolerance of landscape plants to postemergence applications of Basagran is needed to utilize this tool with minimum injury to desirable plants. Directed application of Basagran to the base of the plant is labeled for several species. However, some prostrate species are not easily treated with directed applications. This research indicates that Coral Beauty Cotoneaster, Heavenly Bamboo, Crimson Pygmy Barberry, Holmstrup Arbovitae and 'Amagasa' Azalea are very sensitive to Basagran topical applications and caution should be used when directed sprays are made around these plants. Sasanqua Camellia, Burford Holly, Rotunda Holly, Yaupon Holly, Hetzi Juniper and Japanese Spurge were not visibly injured from topical application of Basagran either year.

Introduction

Basagran (bentazon) controls broad-leaved weeds and yellow nutsedge (Cyperus esculentus L.) in turf and other crops when applied postemergence (3, 4). Recently, Basagran's label was expanded to include use around many landscape plant species as a directed spray and on certain ground covers as a topical spray. While there has been much research reported on the use of Basagran in agronomic crops (1), little has been documented about its use around landscape plants.

Landscape plants differ in their tolerance to Basagran. Melton et al (5) observed that Hosta and Daylily were tolerant to topical applications of Basagran. Howell et al (4) also reported Van Houtte Spirea, Rose of Sharon, Mock Orange, Redbud, and Golden Raintree tolerant to Basagran applications. However, Fretz and Sheppard (3) observed severe injury from topical applications of Basagran to uniform liners of Cotoneaster, Privet, Spirea, and Dogwood. Derr and Appleton (2) evaluated eight Azalea cultivars and determined that 'Rosebud' and 'Tradition' Azalea were very tolerant to Basagran with the other cultivars recovering from foliar damage after 40 days.

Plant tolerance to Basagran appears to be related to the ability of certain species to detoxify the herbicide in a relatively short time period. The mode of action of Basagran involves the inhibition of the photosynthetic process. Mine et al. (6, 7) determined that Basagran inhibited the Hill reaction in isolated chloroplasts and rapidly inhibited photosynthetic CO_2 fixation in susceptible *Cyperus serotinus*.

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Table 1. Landscape plant injury from topical application of Basagran at 1.1 and 2.2 kg ai/ha (1 and 2 lb ai/A) 14 days after treatment in 1989 and 1991.

Species	1989 Basagran (lb ai/A) 0	1.0	2.0	LSD	1991 Basagran (lb ai/A) 0	1.0	2.0	LSD
		%Injury				%Injury		
Rhododendron satsuki	0	28	35	12	0	9	26	7
Berberis thunbergii	0	22	40	12	0	31	63	4
Camellia sasanqua	0	0	2	ns[z]	0	0	0	ns
Cotoneaster dammeri	0	2	18	7	0	14	12	9
Ilex cornuta 'Burfordii'	0	2	2	ns	0	0	0	ns
Ilex cornuta 'Rotunda'	0	0	3	ns	0	0	0	ns
Ilex crenata 'Helleri'	0	1	10	7	0	0	0	ns
Ilex vomitoria 'Schellings'	0	7	3	ns	0	0	0	ns
J. chinensis 'Armstrongii'	0	0	0	ns	0	4	11	5
J. chinensis 'Hetzi Glauca'	0	0	2	ns	0	0	4	ns
J. conferta 'Blue Pacific'	0	0	0	ns	0	3	6	ns
J. davurica 'Expansa'	0	0	0	ns	0	4	27	6
J. virginiana 'Grey Owl'	0	0	2	ns	0	1	6	3
Lagerstroemia indica	0	2	17	4	0	0	0	ns
Ligustrum japonicum	0	3	2	ns	0	0	0	ns
Nandina domestica	0	18	28	11	0	40	48	11
Pachysandra terminalis	0	2	3	ns	0	0	0	ns
Pieris japonica	0	0	5	ns	0	21	33	15
T. occidentalis 'Holmstrup'	0	7	20	18	0	13	42	13

[z]not signficantly different at $P = 0.05$.

However, plant species differ in their ability to metabolize Basagran. Mine et al (6) showed that about 80% of the Basagran absorbed by rice was metabolized to nonphytotoxic metabolites within 24 hours whereas 50–75% of parent Basagran remained unchanged in susceptible *C. serotinus* after 7 days. Plant injury caused by Basagran may also be related to the stage of growth at treatment.

There are very few selective postemergence herbicides registered for use with landscape plants. Basagran is one such herbicide that is effective for yellow nutsedge control. Since directed applications of Basagran are not always possible or feasible due to plant density and form, information on species tolerance to topical applications would be very useful. The objective of this study was to evaluate a diverse group of nineteen container-grown landscape species for tolerance to topical applications of Basagran.

Materials and Methods

Experiments were initiated in May, 1989 and repeated in June, 1991. The landscape species were established in #1 containers in an 80% pine bark, 12% peat, and 8% sand media from uniform liners for an average of 3 months before treatment. They were grown in full sun and overhead sprinkler irrigated daily, except for the treatment day, and fertilized with 17N-3P-8.3K a week before starting the experiment.

Basagran was applied at 1.1 and 2.2 kg ai/ha (1 and 2 lb ai/A) with a crop oil concentrate (Dash)[3] at 1.25% (by volume) over-the-top of landscape plants using a CO_2 pressurized sprayer. This sprayer was calibrated to deliver 187 l/ha (20 gpa) at 275 kPa (40 psi) equipped with 11002 flat fan nozzle tips. Herbicide applications were made on May 11, 1989 and on June 12, 1991. The experiment utilized a randomized complete block design with 3 replications in 1989 and 4 replications in 1991.

[3]Dash, a trademark of BASF Wyandotte Company, Parsippany, NJ

Visual injury ratings were made weekly for 5 weeks after treatment on a scale 0 = no injury and 100 = complete plant death. Growth measurements were taken at the end of the two experiments to determine any differences in growth. A growth index was calculated by measuring the (height + minimum width + maximum width)/3. Analysis of variance was used for data analysis and means were separated using a protected least significant difference at $P = 0.05$. There was a significant year effect so data are presented by years.

Results and Discussion

Species response varied greatly to Basagran applications. Injury symptoms observed included yellowing of the leaf margins, necrosis from the leaf apex towards the base, and stunting. At 14 days after treatment, both rates of Basagran were phytotoxic to Amagasa Azalea (9 to 35% injury), Crimson Pygmy Barberry (22 to 63%) and Heavenly Bamboo (18 to 48%) both years (Table 1). Coral Beauty Cotoneaster (2 to 12%) and Holmstrup Arborvitae (7 to 42%) were also injured by both rates in 1991 and by the high rate (20%) in 1989. Hellers Holly (10%), and Carolina Beauty Crape Myrtle (17%) were injured with the high rate in 1989 while Armstrong Juniper (11%), Parsons Juniper (27%) and Grey Owl Juniper (6%) were injured with only the high rate in 1991. Japanese Pieris was not damaged by any treatment in 1989 but significant injury (21 to 33%) occurred from both rates in 1991. This may be due to the time of application relative to the initiation of new growth for this species. The May treatment date in 1989 could have been prior to new growth while the June application date in 1991 was likely after new growth initiation.

Amagasa Azalea, Crimson Pygmy Barberry, Holmstrup Arborvitae, and Heavenly Bamboo remained stunted and chlorotic 37 days after treatment (Table 2). Visual injury from the 2.2 kg ai/ha (2 lb ai/A) rate was evident on Burford Holly, Hellers Holly, Parsons Juniper, and Japanese Spurge

Table 2. Landscape plant injury from topical application of Basaran at 1.1 and 2.2 kg ai/ha (1 and 2 lb ai/A) 37 days after treatment in 1989 and 1991.

Species	1989 Basagran (lb ai/A) 0	1.0	2.0	LSD	1991 Basagran (lb ai/A) 0	1.0	2.0	LSD
		%Injury				%Injury		
Rhododendron satsuki	0	17	18	5	0	1	14	7
Berberis thunbergii	0	5	5	ns[z]	0	17	22	5
Camellia sasanqua	0	0	0	ns	0	0	0	ns
Cotoneaster dammeri	0	3	7	ns	0	3	2	ns
Ilex cornuta 'Burfordii'	0	3	5	4	0	0	0	ns
Ilex cornuta 'Rotunda'	0	2	5	ns	0	0	0	ns
Ilex crenata 'Helleri'	0	3	13	10	0	0	0	ns
Ilex vomitoria 'Schellings'	0	5	0	ns	0	0	0	ns
J. chinensis 'Armstrongii'	0	0	0	ns	0	0	9	4
J. chinensis 'Hetzi Glauca'	0	0	2	ns	0	0	2	2
J. conferta 'Blue Pacific'	0	0	0	ns	0	0	0	ns
J. davurica 'Expansa'	0	2	10	6	0	1	45	18
J. virginiana 'Grey Owl'	0	0	5	ns	0	2	4	ns
Lagerstroemia indica	0	0	7	ns	0	0	0	ns
Ligustrum japonicum	0	3	2	ns	0	0	0	ns
Nandina domestica	0	27	26	4	0	2	9	8
Pachysandra terminalis	0	3	10	8	0	0	0	ns
Pieris japonica	0	2	5	ns	0	25	66	24
T. occidentalis 'Holmstrup'	0	3	43	41	0	11	33	15

[z] ns = not signficantly at $P=0.05$.

in 1989 and on Armstrong Juniper and Parsons Juniper in 1991. Japanese Pieris also remained damaged from both Basagran rates at the 37 day evaluation in 1991.

Growth measurements taken 37 days after treatment revealed similar results to those of the visual evaluations except for the Junipers (Table 3). Both rates of Basagran reduced the growth of Amagasa Azalea and Crimson Pygmy Barberry both years and Armstrong Juniper, Heavenly Bamboo, and Hellers Holly in 1989. The growth index of Parsons Juniper, Blue Pacific Juniper, Grey Owl Juniper and Japanese Pieris was also reduced by both rates in 1991. The high rate caused stunting of Rotunda Holly, Gray Owl Juniper and Wax-leaf Privet in 1989 and Armstrong Juniper and Wax-leaf Privet in 1991. In general, visual injury was not severe for the junipers. However, when compared to the untreated species, the growth index was reduced for

Table 3. Landscape species growth index 37 days after topical application of Basagran at 1.1 and 2.2 kg ai/ha (1 and 2 lb ai/A) in 1989 and 1991.

Species	1989 Basagran (lb ai/A) 0	1.0	2.0	LSD	1991 Basagran (lb ai/A) 0	1.0	2.0	LSD
		Growth Index				Growth Index		
Rhododendron satsuki	31	27	25	4	43	38	38	5
Berberis thunbergii	26	22	21	4	46	41	36	3
Camellia sasanqua	19	22	22	ns[y]	40	40	48	ns
Cotoneaster dammeri	64	63	60	ns	26	27	27	ns
Ilex cornuta 'Burfordii'	28	29	30	ns	66	69	68	ns
Ilex cornuta 'Rotunda'	26	25	21	4	36	36	33	ns
Ilex crenata 'Helleri'	27	22	24	3	38	36	36	ns
Ilex vomitoria 'Schellings'	25	24	28	ns	36	36	38	ns
J. chinensis 'Armstrongii'	41	38	36	2	41	41	36	2
J. chinensis 'Hetzi Glauca'	52	50	40	8	51	48	48	ns
J. conferta 'Blue Pacific'	50	55	48	ns	30	28	25	3
J. davurica 'Expansa'	35	32	30	ns	31	28	28	3
J. virginiana 'Grey Owl'	48	40	35	13	46	41	38	5
Lagerstroemia indica	53	43	42	ns	53	56	56	ns
Ligustrum japonicum	34	37	32	5	58	58	56	ns
Nandina domestica	53	26	26	11	78	66	53	11
Pachysandra terminalis	25	23	22	ns	30	30	30	ns
Pieris japonica	26	23	24	ns	38	30	38	3
T. occidentalis 'Holmstrup'	18	21	15	5	28	28	28	ns

[y] not signficantly different at $P=0.05$.

Armstrong (12% by high rate both years and 9% by low rate 1987), Blue Pacific (16.7% by high rate in 1991), Hetz Blue (23.1% by high rate in 1987), and Grey Owl (27.1% by high rate in 1987 and 10.9 and 17.4% by the low and high rates respectively in 1991) junipers indicating that visual ratings may not be the best measure of Basagran's effect on these species.

Sasanqua Camellia, Burford Holly, Rotunda Holly, Yaupon Holly, Hetz Blue Chinese Juniper, Blue Pacific Juniper and Japanese Spurge were not visually injured by either rate any year. However, growth was reduced with the high rate for Rotunda Holly and Blue Pacific Juniper one of the two years. It appears that growth can be slowed by Basagran applications even though injury may not be obvious for some species. This growth reduction may be more critical in container production of landscape plants than when the plants are in the landscape. Variable results were obtained for the remaining species in the two studies.

Several species in this study were tolerant to topical applications of Basagran without damage or only temporary injury symptoms. Basagran is considered a contact herbicide with little translocation in plants. Therefore, when applied as a directed spray Basagran may cause minimal injury for most of the species evaluated. *Cotoneaster dammeri*, *Juniperus conferta* 'Blue Pacific', *Nandina domestica*, and *Rhododendron satsuki* 'Amagasa' are registered for applications of Basagran T/O as a directed spray. However, caution should be used when directed applications are made to these very sensitive plants or in areas where visible damage can not be tolerated.

(*Ed. note*: This paper reports the results of research only and does not imply registration of a pesticide under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities).

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Use of Single-Primer DNA Amplifications for the Identification of Red Maple (*Acer rubrum* L.) Cultivars[1]

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Abstract

Positive cultivar identification is often difficult or impossible based solely on morphological traits. A technique ensuring reliable, repeatable, and unique cultivar identification is needed. The use of molecular markers offers such a technique, allowing assessment of fine levels of variation directly at the DNA level. In this study, RAPD (Random Amplified Polymorphic DNA) markers were investigated for their utility to identify red maple cultivars. Three out of nineteen primers tested resulted in unique banding patterns for all the maples tested, including 9 red maple clones, 5 silver maple seedlings, and 4 purported interspecific cultivars. The red maple cultivars 'Red Sunset' and 'October Glory', which are almost indistinguishable morphologically as young trees, were clearly distinguished using RAPD markers. RAPD markers provide a consistently reliable technique for red maple cultivar identification.

Index words: RAPD (Random Amplified Polymorphic DNA) markers, cultivar identification, patent, trademark, and royalty protection.

Species used in this study: Red maple (*Acer rubrum* L.); silver maple (*Acer saccharinum* L.); *Acer* × *freemanii*.

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