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Tolerance of Containerized Landscape Plants to the Postemergence Herbicides Stinger, Manage and Basagran[1]

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Abstract

Stinger (clopyralid), Manage (MON 12051) and Basagran (bentazon) postemergence applications were evaluated for phytotoxicity on five species of landscape plants grown in containers. Stinger (clopyralid) was less injurious than Manage (MON 12051). Crape Myrtle (*Lagerstroemia indica* L. 'Carolina Beauty') was injured from Stinger (clopyralid) application 3 and 6 weeks after treatment (WAT). Manage (MON 12051) caused foliar damage to Crape Myrtle (*Lagerstroemia indica* L. 'Carolina Beauty') (1992), Cotoneaster (*Cotoneaster dammeri* C.K. Schneid. 'Coral Beauty') (1992 and 1993), and Dwarf Japanese Juniper (*Juniperus chinensis procumbens* Endl. 'Nana') (1993) at 3 and 6 WAT. Foliar applications of Basagran (bentazon) injured Crape Myrtle (*Lagerstroemia indica* L. 'Carolina Beauty') in 1992 and Cotoneaster (*Cotoneaster dammeri* C.K. Schneid. 'Coral Beauty') in both years. Manage (MON 12051) reduced the growth of Cotoneaster (*Cotoneaster dammeri* C.K. Schneid. 'Coral Beauty') in both years. Hetzi Blue (*Juniperus chinensis* L. 'Hetzi Glauca') growth index was reduced by Manage (MON 12051) in 1992. Stinger (clopyralid) reduced the growth of Dwarf Japanese Juniper (*Juniperus chinensis procumbens* Endl. 'Nana') at the highest rate in 1992. Parsons (*Juniperus chinensis* L. 'Parsoni') and Blue Pacific (*Juniperus conferta* Parl. 'Blue Pacific') junipers were not affected by these herbicides in this study.

Index words: clopyralid, MON 12000, bentazon, herbicide, post-emerge, container-grown, phytotoxicity, weed control.

Species used in this study: Blue Pacific Shore Juniper (*Juniper conferta* Parl. 'Blue Pacific'); Carolina Beauty Crape Myrtle (*Lagerstroemia indica* L. 'Carolina Beauty'); Coral Beauty Cotoneaster (*Cotoneaster dammeri* C.K. Schneid 'Coral Beauty'); Hetz Blue Chinese Juniper (*Juniper chinensis* L. 'Hetzi Glauca'); Parsons Juniper (*Juniperus chinensis* L. 'Parsoni'); Dwarf Japanese Juniper (*Juniperus chinensis procumbens* Endl. 'Nana').

Herbicides used in this study: Stinger (clopyralid), 3, 6-dichloro-2-pyridinecarboxylic acid; Manage (MON 12051) methyl-3-chloro-5-(4-6-dimethoxypyrimidin-2ylcarbamoylsulfamoyl)-1-methylpyrozole-4-carboxylate; Basagran (bentazon), 3-(1-methylethyl)-1H-2,1, 3-benzothiadiazin-4(3H)-one 2, 2-dioxide.

Significance to the Nursery Industry

Additional selective postemergence herbicides are needed for weed management by the nursery industry. Stinger (clopyralid) and Manage (MON 12051) are new herbicides that will effectively control problem weeds including nutsedge, and information about the tolerance of landscape plants to these postemergent herbicides is needed. The deciduous species, Crape Myrtle and Cotoneaster, were most sensitive to all three herbicides and topical applications should be avoided. The junipers evaluated displayed a higher degree of tolerance, however, there were growth reductions in some cases without accompanying foliar injury. None of the herbicides injured or reduced the growth of Parson's or Blue Pacific juniper. Other investigations, including directed sprays, are needed to ascertain the safety and utility of these herbicides for the nursery and landscape industry.

Introduction

Selectively controlling a wide range of emerged weeds in container grown landscape plants is a goal for many in the nursery industry. Presently there are few postemergence herbicides labeled for use in landscape plants and some of these require directed spray application which is not always possible. There is a need for additional postemergence herbicides and the first phase of development of these herbicides is determining landscape plant tolerance.

Stinger (clopyralid) is extensively used in turf, Christmas trees, and agronomic crops. It controls broadleaf weeds with little effect on grasses. Stinger (clopyralid) moves throughout the plant after being absorbed by both roots and shoots accumulating in the meristematic regions and interfering with cell differentiation in susceptible plants. Stinger (clopyralid) has shown no adverse affects on the brassicaceae family. No observable phytotoxcity was reported on cauliflower (3) or cabbage (6) from Stinger (clopyralid) application.

In a study evaluating the effects of turf herbicides on landscape plants, greatest injury from Stinger (clopyralid) occurred in the absence of mulch at the base of deciduous trees (10). Bradford callery pear (*Pyrus calleryana* 'Bradford') and red maple (*Acer rubrum*) were moderately sensitive with mulch present with 8% and 26% injury, respectively, from 0.28 kg ai/ha (0.25 lb ai/A) Stinger (clopyralid). Redbud (*Cercis canadensis*) was very sensitive (89% injury) without mulch.

Over the top application of Stinger (clopyralid), up to 0.56 kg ai/ha (0.5 lb ai/A), in early and or late summer caused no observable injury to yew (*Taxus cuspidata*), arborvitae (*Thuja nigra* 'Dark American'), juniper (*Juniperus horizontalis*) or rhododendron (*Rhododendron* 'Roseum Elegans') (1). Slight injury was observed on fraser fir (*Abies fraseri*) and

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hemlock (*Tsuga canadensis*) in the form of curled needles on new growth (9).

Manage (MON 12000) is being developed for the control of purple nutsedge (*Cyperus rotundus*) and yellow nutsedge (*Cyperus esculentus*) in turfgrass and agronomic crops. Nutsedge control in a variety of warm and cool season turfgrasses at rates up to 0.071 kg ai/ha (0.063 lb ai/A) was greater than 85% with no turf phytotoxicity or growth reduction (8). Manage (MON 12051) was also evaluated for yellow and purple nutsedge control in container grown landscape plants. Over the top applications caused no observable damage to green liriope (*Liriope muscari*) 28 days after treatment (DAT) with rates up to 0.018 kg ai/ha (0.016 lb ai/A) (4). However, new growth of 'Macrantha Orange' azalea (*Rhododendron* x *hybrida*) was injured at rates of 0.009 and 0.018 kg ai/ha (0.008 and 0.016 lb ai/A) 24% and 44% respectively 28 DAT.

Basagran (bentazon) controls yellow nutsedge and broadleaf weeds with postemergence applications and is labeled as a directed spray around many landscape plants. However, tolerance to Basagran (bentazon) is variable among landscape plant species (11) with azalea (*Rhododendron satsuki* 'Amargasa'), nandina (*Nandina domestica*), barberry (*Berberis thunbergii* 'Crimson Pygmy') and pieris (*Pieris japonica*) injured at rates of 1.12 and 2.24 kg ai/ha (1 and 2 lb ai/A) and cotoneaster (*Cotoneaster dammeri* 'Coral Beauty') at 2.24 kg ai/ha (2 lb ai/A). No significant injury was observed from topical application to camellia (Camellia sasanqua), juniper (*Juniperus conferta* 'Blue Pacific' and *J. virginiana* 'Grey Owl'), crape myrtle (*Lagerstroemia indica*) and holly (*Ilex vomitoria* 'Schellings' and *I. crenata* 'Helleri').

The objective for this experiment was to determine tolerance of container grown landscape plants to Stinger (clopyralid) and Manage (MON 12051) postemergence herbicides. Basagran (bentazon) was included for comparison purposes.

Materials and Methods

Phytotoxic evaluation on container grown species was determined during 1992 at the South Carolina Botanical Gardens, Clemson, SC and in 1993 at Carolina Nurseries, Monck's Corner, SC. Plant species evaluated both years were *Juniperus chinensis* L. 'Hetzi Glauca', *Juniperus chinensis* L. 'Parsoni', *Juniperus conferta* Parl. 'Blue Pacific', *Juniperus chinensis procumbens* Endl. 'Nana', *Cotoneaster dammeri* C.K. Schneid 'Coral Beauty'. *Lagerstroemia indica* L. 'Carolina Beauty' was evaluated only in 1992. Plants were grown in pine bark:sand (17:3 by vol) medium in 1 gal containers. *Lagerstroemia*, *Cotoneaster*, and *Juniperus chinensis* 'Hetzi Glauca' were pruned to uniform heights 2 weeks prior to treatment. All plants were fertilized 4 weeks before herbicide application in 1992 and 1 week before treatment in 1993.

The herbicides were applied with a CO_2 backpack sprayer delivering 25 gpa at 20 psi through a single 9504E flat fan spray tip in 1992 and two 8002 flat fan spray tips in 1993. Treatments included a control (untreated), Manage (MON 12051) at 0.71, 0.14, and 0.28 kg ai/ha (0.063, 0.125, 0.25 lb ai/A), Stinger (clopyralid) at 0.14, 0.28, and 0.56 kg ai/ha (0.125, 0.25, 0.50 lb ai/A), and Basagran (bentazon) at 1.12 kg ai/ha (1 lb ai/A). A surfactant (New Balance Ionic Adjuster and Surfactant) was added to the Manage (MON 12051) treatments at 2.5 ml/liter in 1993. The treatments were applied on August 25, 1992, and September 15, 1993. Experimental design consisted of a randomized complete block design with 4 single plant replicates per herbicide treatment.

Phytotoxicity was visually evaluated at 1, 2, 3 and 6 weeks after treatment (WAT) on a scale of 0–100 with 0 representing no damage and 100 dead plants. Growth index was determined at 6 WAT using the following formula, (maximum width + width perpendicular to maximum width + height)/3. Data were analyzed using analysis of variance and least significant difference determined if F-test was significant at $P= 0.05$.

Results and Discussion

Stinger (clopyralid) at all three rates [0.14, 0.28, and 0.56 kg ai/ha (0.125, 0.25, 0.50 lb ai/A)], injured the Crape Myrtle in 1992 with symptoms observed as leaf discoloration. There was no visual injury associated with Stinger (clopyralid) applications on any of the other landscape plants evaluated in this study. Although there were no visual injury symptoms on three of the junipers, however plant growth was

Table 1. Phytotoxicity of Stinger (clopyralid), Manage (MON12051) and Basagran (bentazon) to landscape plants 3 weeks after treatment in 1992 and 1993[z].

		1992						1993				
Herbicide	kg/ha	JCH[y]	JSP	JCB	JPN	LIC	CDC	JCH	JSP	JCB	JPN	CDC
Stinger (clopyralid)	0.14	0	0	0	0	16	0	0	0	0	0	9
Stinger (clopyralid)	0.280	0	0	0	0	15	0	0	0	0	0	5
Stinger (clopyralid)	0.560	0	0	0	0	15	0	0	0	0	0	9
Manage (MON12051)	0.071	0	0	0	0	15	14	0	0	0	11	19
Manage (MON12051)	0.14	0	0	0	0	14	23	0	0	0	19	24
Manage (MON12051)	0.28	0	0	0	0	6	16	0	0	0	10	15
Basagran (bentazon)	1.12	0	0	0	0	15	19	0	0	0	1	35
Untreated	—	0	0	0	0	0	0	0	0	0	0	0
LSD P=0.05		ns	ns	ns	ns	13	10	ns	ns	ns	12	19

[z]Phytotoxicity was visually evaluated using a percent scale where 0 = no damage and 100 = dead plants. Data represent means of four single plant replicates.

[y]JCH, *Juniperus chinensis* L. 'Hetzi Glauca'; JSP, *Juniperus chinensis* L. 'Parsoni'; JCB, *Juniperus conferta* Parl. 'Blue Pacific'; JPN, *Juniperus chinensis procumbens* Endl. 'Nana'; LIC, *Lagerstroemia indica* L. 'Carolina Beauty'; CDC, *Cotoneaster dammeri* C.K. Schneid 'Coral Beauty'.

Table 2. Phytotoxicity of Stinger (clopyralid), Manage (MON12051) and Basagran (bentazon) to landscape plants 6 weeks after treatment in 1992 and 1993[z].

		1992						1993				
Herbicide	kg/ha	JCH[y]	JSP	JCB	JPN	LIC	CDC	JCH	JSP	JCB	JPN	CDC
Stinger (clopyralid)	0.14	0	0	0	1	14	0	0	0	0	3	3
Stinger (clopyralid)	0.28	0	0	0	0	10	0	0	0	0	0	0
Stinger (clopyralid)	0.56	0	0	0	0	16	0	0	0	0	3	1
Manage (MON12051)	0.071	0	0	3	3	10	13	1	0	0	9	6
Manage (MON12051)	0.14	1	0	5	8	11	13	1	0	0	10	8
Manage (MON12051)	0.28	0	0	5	4	11	13	1	0	0	6	6
Basagran (bentazon)	1.12	0	0	0	0	34	20	0	0	0	3	6
Untreated	—	0	0	0	0	0	0	0	0	0	0	0
LSD P=0.05		1	ns	5	4	23	5	2	ns	ns	7	8

[z]Phytotoxicity was visually evaluated using a percent scale where 0 = no damage and 100 = dead plants. Data represent means of four single plant replicates.

[y]JCH, *Juniperus chinensis* L. 'Hetzi Glauca'; JSP, *Juniperus chinensis* L. 'Parsoni'; JCB, *Juniperus conferta* Parl. 'Blue Pacific'; JPN, *Juniperus chinensis procumbens* Endl. 'Nana'; LIC, *Lagerstroemia indica* L. 'Carolina Beauty'; CDC,*Cotoneaster dammeri* C.K. Schneid 'Coral Beauty'.

influenced (Tables 1 and 2). Stinger (clopyralid) reduced the growth index of Dwarf Japanese Juniper at the highest rate 0.56 kg ai/ha (0.50 lb ai/A) in 1992 (19.4%) (Table 3). Parson's juniper growth index actually increased with the 0.28 kg ai/ha (0.25 lb ai/A) rate in 1993.

Symptoms of phytotoxicity caused by topical application of Manage (MON 12051) included leaf discoloration followed by necrosis of the new shoot tips. Visual injury was observed on the cotoneaster 1 week after treatment (WAT) for all three rates of Manage (MON 12051) in 1992 and 1993 (Table 1). Due to similarity of results only 3 and 6 WAT data will be presented. At 6 WAT injury was less apparent as the plants were beginning to recover from the damage by generating new lateral growth below the killed shoot tip (Table 2). The Crape Myrtle also had foliar discoloration from all three Manage (MON 12051) treatments in 1992. Dwarf Japanese juniper was injured on the new shoot growth. These symptoms were observed 6 WAT (Table 2) and 3 WAT (Table 1) in 1992 and 1993, respectively. The other juniper species did not have any observable foliar injury at 6 WAT when treated with Manage (MON 12051).

Manage (MON 12051) reduced the growth of Cotoneaster with 0.071 and 0.28 kg ai/ha (0.063 and 0.25 lb ai/A) in 1992 and 0.14 kg ai/ha (0.125 lb ai/A) in 1993 (Table 3). Hetzi Glauca growth was reduced in 1992 for all three rates of Manage (MON 12051). Wilson and Whitwell (11) observed reduced plant growth without visual injury on several landscape plants treated with Basagran (bentazon). Though this may not be of concern once plants are planted in the landscape, it is essential for commercial nurseries that containerized plants achieve maximum growth.

Basagran (bentazon) application caused foliar injury on Crape Myrtle in 1992, however, there was not an accompanying reduction in growth index. Cotoneaster was injured by Basagran (bentazon) in 1992 and 1993. Wilson and Whitwell (11) made similar observations for both Crape Myrtle and Cotoneaster. The injury was similar to that of the Manage (MON 12051) with new shoots discolored and killed on the Cotoneaster. In this study Basagran (bentazon) did not effect growth index of these species.

Parsons and Blue Pacific junipers were the only species in the study that were not injured or had reduced growth index. The two deciduous species, Lagerstroemia and Cotoneaster, were the most susceptible to foliar discoloration and necrosis when compared to the evergreen Juniperus species. This could be possibly due to the thicker cuticle of the juni-

Table 3. Effects of Stinger (clopyralid), Manage (MON12051) and Basagran (bentazon) on plant growth index 6 weeks after treatment of landscape plants in 1992 and 1993[z].

		1992						1993				
Herbicide	kg/ha	JCH[y]	JSP	JCB	JPN	LIC	CDC	JCH	JSP	JCB	JPN	CDC
Stinger (clopyralid)	0.14	34.9	30.1	24.4	27.0	49.2	36.8	41.4	56.3	21.3	31.2	36.3
Stinger (clopyralid)	0.28	34.9	27.2	29.1	25.8	44.6	36.8	44.2	58.4	22.9	32.5	35.3
Stinger (clopyralid)	0.56	34.5	28.5	26.3	20.4	48.5	34.4	36.6	54.1	21.3	28.2	34.3
Manage (MON12051)	0.071	30.7	29.5	23.2	23.7	49.4	31.0	44.4	53.6	26.3	29.2	30.7
Manage (MON12051)	0.14	30.8	28.2	27.2	25.3	48.2	34.9	42.4	54.3	21.3	32.3	26.7
Manage (MON12051)	0.28	30.7	26.7	27.6	24.6	45.4	32.2	42.4	56.6	19.6	29.2	30.5
Basagran (bentazon)	1.12	35.3	26.7	22.2	27.7	48.4	39.7	37.6	55.6	21.6	30.2	32.3
Untreated	—	34.2	27.7	24.6	25.3	50.1	41.2	42.2	49.0	20.8	32.3	40.1
LSD P=0.05		2.8	3.5	6.1	3.8	31.8	8.1	7.1	9.1	3.3	21.1	11.2

[z]Plant growth index was determined using the formula, (height + maximum width + width perpendicular to maximum width)/3. Data represent means of four single plant replicates.

[y]JCH, *Juniperus chinensis* L. 'Hetzi Glauca'; JSP, *Juniperus chinensis* L. 'Parsoni'; JCB, *Juniperus conferta* Parl. 'Blue Pacific'; JPN, *Juniperus chinensis procumbens* Endl. 'Nana'; LIC, *Lagerstroemia indica* L. 'Carolina Beauty'; CDC,*Cotoneaster dammeri* C.K. Schneid 'Coral Beauty'.

pers and thus having more of a physical barrier to the absorption of the herbicides.

Cuticle thickness has been shown to be an effective barrier to foliar absorption of herbicides. Reduced absorption of Roundup (glyphosate) when compared to 2,4-D, in hemp dogbane was a result of cuticle thickness (7). Green *et al.* (2) demonstrated that thick cuticles were responsible for low absorption of [^{14}C]glyphosate. Seven days after treatment red maple and white oak absorbed significantly greater amounts of herbicide than did yaupon holly and loblolly pine. Neal et al. (5) also showed cuticle thickness as being important to herbicide absorption. Junipers absorbed little Roundup (glyphosate) during dormancy, budbreak or elongation. However newly formed leaves of *Ligustrum japonicum* absorbed significantly greater amounts of Roundup (glyphosate than did analogous leaves that had overwintered.

Our data has shown that some landscape plants are tolerant or may have only temporary phytotoxicity symptoms to topical applications of the postemergence herbicides Stinger (clopyralid), Manage (MON 12051) and Basagran (bentazon).

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