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Tolerance of Woody Nursery Stock to Classic (chlorimuron) and Harmony (thiameturon)[1]

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Abstract

Classic and Harmony applied at rates ranging from 0.009 kg ai/ha (0.008 lb ai/A) to 0.067 kg/ha (0.06 lb/A) provided excellent preemergence and postemergence control of common groundsel (*Senecio vulgaris* L.) 5 weeks after application to container-grown nursery plants. Classic at 0.034 kg/ha (0.03 lb/A) and 0.067 kg/ha (0.06 lb/A) reduced yellow nutsedge (*Cyperus esculentus* L.) growth by 50 to 77% 5 weeks after preemergence or postemergence treatments. Harmony did not affect yellow nutsedge from either type of application. 'Seagreen' juniper (*Juniperus chinensis* L.), 'Blue Pacific' juniper (*Juniperus conferta* Parl.) and 'Bennetts Compacta' holly (*Ilex crenata* Thunb.) tolerated all rates of Classic and Harmony. 'Girard's Rose' (*Rhododendron kaempferi* Planch.) and 'Coral Bells' azalea (*Rhododendron obtusum* (Lindl.) Planch.), and redtip photinia (*Photinia* × *Fraseri* Dress) were initially injured by these herbicides, but outgrew the foliar damage.

Index words: sulfonylurea herbicides, weed control, woody landscape plants, herbicide

Species used in this study: Azalea (*Rhododendron* × 'Coral Bells', 'Girard's Rose', 'Hinocrimson'); Japanese holly (*Ilex crenata* Thunb. 'Bennetts Compacta'); shore juniper (*Juniperus conferta* Parl. 'Blue Pacific'); Chinese juniper (*Juniperus chinensis* L. 'Sea Green'); redtip photinia (*Photinia* × *Fraseri* Dress); common groundsel (*Senecio vulgaris* L.); yellow nutsedge (*Cyperus esculentus* L.)

Herbicides used in this study: Classic (chlorimuron), 2-[[[[(4-chloro-6-methoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl] benzoic acid; Harmony (thiameturon), 3-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino]sulfonyl]-2-thiophene-carboxylic acid; Surflan (oryzalin), 4-(dipropylamino)-3,5-dinitrobenzenesulfonamide.

Significance to the Nursery Industry

Few selective chemicals are available for control of emerged yellow nutsedge or broadleaf weeds in nursery plantings. Classic at 0.018 kg/ha (0.016 lb/A) suppresses yellow nutsedge when applied either preemergence or postemergence, and provides equivalent control to Pennant, a preemergence herbicide recommended for yellow nutsedge control. Pennant, however, will not control emerged nutsedge, so application timing is critical for this herbicide. Both Classic and Harmony controlled common groundsel, an important container and field nursery weed problem, when applied either preemergence or postemergence at 0.009 kg/ha (0.008 lb/A). Juniper and holly appear to tolerate rates 2 to 4 times the rate of Classic and Harmony recommended for weed control. Azaleas and photinia are temporarily injured by these 2 herbicides, but outgrow the damage. Further research is needed to determine if Classic and Harmony can be utilized for nursery weed control without causing unacceptable injury or growth reduction.

Introduction

Limited herbicides are available for selective control of emerged yellow nutsedge or broadleaf weeds in nursery crops, although chemical controls are available for other crops (9). Available preemergence herbicides must be applied on a timely basis. Nonselective postemergence herbicides may injure desired plants. Development of selective postemergence herbicides would allow nurserymen to treat infested areas and not rely on broadcast treatments of preemergence herbicides applied to the entire nursery. Basagran (bentazon) has been evaluated for postemergence yellow nutsedge control in nursery stock, with injury occurring to some species but not others (3, 4).

The sulfonylureas, a recently-developed class of herbicides, have both preemergence and postemergence activity. Classic (chlorimuron) is utilized as a postemergence herbicide and is a component of several herbicide mixes applied preemergence to soybeans (2, 5, 6). Harmony (thiameturon), initially developed for postemergence control of certain broadleaf weeds and wild garlic in small grains, is a component of the herbicide mixture Harmony Extra, and is being developed under the trade name Pinnacle for soybean weed control (6, 8).

The objectives of this research were to determine if selected woody nursery plants could tolerate Classic and Harmony, and to evaluate these two sulfonylurea herbicides for preemergence and postemergence control of yellow nutsedge and common groundsel, two troublesome weeds in container and field nursery production.

Materials and Methods

Plants were grown in black plastic pots (3.8 (#1), 7.6 (#2) or 11.4 l (#3)). Media for the first two studies was pine bark : sand (19:1 by vol) with plants fertilized through the irrigation water (11). Media for the remaining studies was pine bark : sand (4:1 by vol) with plants fertilized with a slow-release, 17N-2.6P-9.9K (17-6-12) fertilizer containing micronutrients. The study design was a randomized complete block with four replications, with one or two plants per pot and one or two pots per replication. Herbicides were

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applied with a CO_2-pressurized backpack sprayer delivering 230 L/ha (25 gal/A) using 8003 flat fan nozzles (TeeJet, Spraying Systems Co., Wheaton, IL 60188). All applications were made overtop the newly-planted nursery liners. Data were subjected to analysis of variance, with mean separation using the Least Significant Difference test at the 0.05 level.

1987 preemergence study. Nursery species used and height at treatment were: 'Bennetts Compacta' holly, 23 cm (9 in), 'Sea Green' juniper, 20 cm (8 in), 'Hinocrimson' azalea, 20 cm (8 in), and redtip photinia 45.7 cm (18 in). Common groundsel was seeded immediately prior to herbicide application. Classic was applied at 0.009, 0.018, 0.067 and 0.13 kg/ha (0.008, 0.016, 0.06 and 0.12 lb/A) in combination with 1.12 kg/ha (1.0 lb/A) Surflan (oryzalin). Surflan was included because Classic is ineffective on annual grassy weeds (7). Surflan was also applied alone at 1.12 kg/ha. Air temperature at application was 16°C (60°F) with 100% cloud cover. Plants were irrigated 4 hr after herbicide application.

1988 postemergence study. Plant species used and height at treatment were: 'Bennetts Compacta' holly, 20 cm, (8 in), 'Sea Green' juniper, 13 cm (5 in), 'Coral Bells' azalea 28 cm (11 in) and redtip photinia 30 cm (12 in). Common groundsel was 3 cm (1 in) tall at treatment. Air temperature at treatment was 24°C (75°F) with 0% cloud cover. Classic was applied at 0.009 and 0.034 kg/ha (0.008 and 0.03 lb/A) while Harmony was applied at 0.018 and 0.067 kg/ha (0.016 and 0.06 lb/A). Basagran was applied alone at 1.12 kg/ha (1.0 lb/A) for comparison. Plants were irrigated one day after treatment.

1988 Classic study. Plant species used and size at treatment were: 'Bennetts Compacta' holly, 10 cm (4 in), 'Blue Pacific' juniper, 8 cm (3 in), redtip photinia, 46 cm (18 in), and yellow nutsedge, 20 cm (8 in). Common groundsel and yellow nutsedge tubers were planted immediately prior to herbicide application to record preemergence control. Air temperature was 26°C (78°F) with 10% cloud cover. Classic was applied at 0.009, 0.018, 0.034 and 0.067 kg/ha (0.008, 0.016, 0.03 and 0.06 lb/A), while Pennant (metolachlor) was applied at 2.24 kg/ha (2 lb/A) for comparison. The nonionic surfactant X-77 (Valent, Walnut Creek, CA 94596-8025) was included in all Classic treatments. At 5 weeks after herbicide application, common groundsel numbers and yellow nutsedge shoot fresh weight were recorded. Yellow nutsedge plants treated postemergence were allowed to regrow for 5 weeks when shoot weight was again recorded. Nursery crop shoot weight was also recorded at this time. Plants were irrigated one day after treatment.

1988 Harmony study. Conditions were identical to the previous study, with the exception that 'Girald's Rose' azalea (23 cm (9 in) tall at treatment) was included and yellow nutsedge was excluded. Harmony was applied at the same rates used for Classic in the previous study. Basagran (bentazon) was included for comparison at 1.12 kg/ha (1.0 lb/A).

1989 study. The treatments evaluated in the 1988 Classic and Harmony studies were combined into one experiment. Plant size at treatment was: 'Girald's Rose' azalea, 18 cm (7 in), 'Bennetts Compacta' holly, 13 cm (5 in), 'Blue Pacific' juniper, 15 cm (6 in) and redtip photinia 39 cm (15 in). Air temperature was 19°C (66°F) with 25% cloud cover. The nonionic surfactant X-77 was added to all treatments. Plants were irrigated 1 day after herbicide application. Yellow nutsedge shoot fresh weight was recorded 5 weeks after treatment. Yellow nutsedge plants treated postemergence were allowed to regrow for 4 weeks when shoot weight was again recorded. Plants were retreated 9 weeks after the first application. Nursery crop shoot fresh weight was determined 10 weeks after the second herbicide application.

Results and Discussion

1987 study. All rates of Classic controlled common groundsel at the 98% level or greater when applied preemergence (Table 1). Surflan did not control this weed. No visual injury was observed in juniper or holly. Slight injury (2 to 20%) was noted in photinia, while moderate to severe injury (27 to 55%) was noted in azalea following the Classic plus Surflan treatments. Surflan alone also appeared to injure these 2 species, suggesting that combining Surflan with Classic may synergistically increase damage to sensitive species.

Table 1. Preemergence common groundsel control and crop injury 4 and 7 weeks following application of Classic (chlorimuron), 1987 study.

			4 weeks after treatment					7 weeks after treatment				
	Rate		Preemergence common groundsel	Visual injury				Preemergence common groundsel	Visual injury			
Herbicide	kg/ha	lb/A	control	juniper	holly	azalea	photina	control	juniper	holly	azalea	photina
Untreated	0	0	7	0	0	0	2	0	0	0	0	0
Classic	0.009	0.008	100	0	0	27	2	98	0	0	11	7
Surflan	1.12	1.0										
Classic	0.018	0.016	100	0	0	35	10	100	0	0	18	2
Surflan	1.12	1.0										
Classic	0.067	0.06	100	0	0	47	12	100	0	0	21	0
Surflan	1.12	1.0										
Classic	0.13	0.12	100	0	0	55	20	100	0	0	27	7
Surflan	1.12	1.0										
Surflan	1.12	1.0	12	0	0	5	10	8	0	0	15	0
LSD (0.05)			12	NS	NS	17	11	9	NS	NS	16	NS

Table 2. Postemergence common groundsel control 3 weeks and crop injury 3 and 7 weeks following application of Classic (chlorimuron) and Harmony (thiameturon), 1988 study.

Herbicide[z]	Rate kg/ha	Rate lb/A	common groundsel control 3 wk	Crop injury 3 week juniper	3 week holly	3 week azalea	3 week photinia	7 week juniper	7 week holly	7 week azalea	7 week photinia
			%								
Untreated	0	0	0	0	0	0	0	0	0	0	0
Classic	0.009	0.008	99	1	0	9	10	0	3	10	3
Classic	0.034	0.03	100	0	0	13	8	0	0	11	6
Harmony	0.018	0.016	100	0	3	6	8	0	0	10	10
Harmony	0.067	0.06	100	0	0	5	6	0	0	14	9
Basagran	1.12	1.0	100	13	31	14	11	20	8	9	8
	LSD (0.05)		2	4	7	5	4	20	4	7	6

[z] X-77 was added to Classic and Harmony at 0.6 L/HA (1/2 pint/A) while Agridex crop oil was added at 2.3 L/Ha (1 qt/A) to Basagran.

1988 postemergence study. Both Classic and Harmony completely controlled common groundsel (Table 2). As in the previous study, no visual injury was seen in juniper or holly following Classic application, and Harmony also did not injure these 2 species. Slight injury (5 to 14%) was noted in photinia and azalea following application of Classic and Harmony. Basagran injured all 4 species.

In another study, chlorimuron applied at rates ranging from 0.036 to 0.28 kg/ha did not cause greater than 8% visual injury to 'Merritt Supreme' hydrangea or 'Gloria' azalea (7). Classic did not control large crabgrass but controlled Pennsylvania bittercress in a peat media in that study. Classic applied at 0.035 and 0.07 kg/ha (0.03 and 0.06 lb/A) controlled *Eclipta alba* without injury to dwarf yaupon (*Ilex vomitoria* Ait. 'Nana'), 'Pink Gumpo' azalea, 'Coral Bells' azalea or *Liriope muscari* L. 'Big Blue' (1).

1988 Classic study. All rates of Classic gave 99% or better control of common groundsel (Table 3). Only the 2 higher rates of Classic (0.03 and 0.06 lb/A) caused a significant reduction in yellow nutsedge shoot weight (51 and 46% reduction, respectively), when applied preemergence. Classic appeared to be more effective as a postemergence herbicide, where the same rates caused a 60 to 77% reduction in initial yellow nutsedge shoot weight. Pennant, registered for yellow nutsedge control in nursery production, applied preemergence at 2.24 kg/ha (2 lb/A) caused a reduction in yellow nutsedge growth equivalent to Classic at 0.016 lb/A. Higher rates of Pennant would be expected to provide greater yellow nutsedge control, since labeled use rates range from 2.24 to 4.48 kg ai/ha (2.0 to 4.0 lb ai/A) in nursery crops. Pennant applied postemergence to yellow nutsedge had no effect on growth.

In another study, Classic at 0.02 kg/ha (0.018 lb/A) provided 84% foliar injury to yellow nutsedge 4 weeks after application in a greenhouse, while rates as low 0.005 kg/ha injured yellow nutsedge (10). Classic at 0.01 to 0.03 kg/ha (0.009 to 0.027 lb/A) totally inhibited secondary shoot production of treated plants in that study.

No visible injury was observed in holly or juniper, although temporary foliar injury was seen in photinia (data not shown). No reduction in shoot weight was observed for these 3 nursery species following Classic application, although juniper weight appeared to decrease at the two highest rates.

1988 Harmony study. Harmony at 0.009 kg/ha (0.008 lb/A) provided excellent, but not complete, preemergence control of common groundsel (Table 4). Harmony has shorter soil residual than Classic, which could explain the slightly

Table 3. Common groundsel and yellow nutsedge control and nursery crop shoot fresh weight 5 and 10 weeks after preemergence (Pre) and postemergence (Post) herbicide treatment, 1988 study.

Herbicide	Rate Kg/ha	Rate lb/A	common groundsel 5 Wat	Shoot fresh weight yellow nutsedge Pre 5 Wat	yellow nutsedge Post 5 Wat	yellow nutsedge Post 10 Wat	juniper 10 Wat	holly 10 Wat	photina 10 Wat
			No. per pot	(g)					
Untreated	0	0	12	151	124	83	34	44	104
Classic[z]	0.009	0.008	0	106	72	53	33	48	133
Classic	0.018	0.016	0	117	57	39	26	51	113
Classic	0.034	0.03	0	74	50	32	27	43	156
Classic	0.067	0.06	0	82	29	10	23	44	110
Pennant	2.24	2.0	2	109	126	91	24	45	78
	LSD (0.05)		4	66	45	40	NS	NS	67

[z] X-77 nonionic surfactant added to all Classic treatments at 0.6 L/HA (0.5 pt/A).

Table 4. Preemergence common groundsel control 5 weeks after and crop shoot weight 10 weeks after herbicide application, 1988 study.

Herbicide	Rate Kg/ha	Rate lb/A	common groundsel 5 WAT	Shoot fresh weight 10 WAT juniper	holly	azalea	photina
			No. per pot	(g)			
Untreated	0	0	14	34	33	72	104
Harmony	0.009	0.008	1	32	48	76	162
Harmony	0.018	0.016	0	36	53	47	103
Harmony	0.034	0.03	1	34	59	76	85
Harmony	0.067	0.06	0	27	29	56	86
Basagran	1.12	1.0	13	33	29	67	127
		LSD (0.05)	5	NS	NS	NS	NS

[z]X-77 added to all treatments at 0.6 L/Ha (1/2 pt/A).

lower control observed. Basagran, a postemergence herbicide, did not affect common groundsel growth when applied preemergence. No herbicide treatment reduced shoot weight of any nursery species. Harmony did cause temporary tip chlorosis in azalea and distorted new growth of photinia, but both species outgrew this injury (data not shown) within three months of treatment.

1989 study. When evaluated 5 weeks after application, Classic at 0.034 kg/ha (0.03 lb/A) reduced yellow nutsedge shoot fresh weight approximately 60%, and approximately 75% at 0.067 kg/ha (0.06 lb/A) when applied either preemergence or postemergence (Table 5). At the 2 lower rates, Classic appeared to provide greater control when applied postemergence rather than preemergence. Classic at 0.034 and 0.067 kg/ha (0.03 and 0.06 lb/A) gave equivalent preemergence suppression of yellow nutsedge shoot growth as Pennant at 2.24 kg/ha (2 lb/A). Harmony had little to no effect on yellow nutsedge when applied either preemergence or postemergence.

No reduction in nursery crop growth was noted for any rate of Classic or Harmony 10 weeks after the second herbicide application. As in the 1988 studies, visual injury was observed in azalea and photinia but both species outgrew injury caused by Classic or Harmony.

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Table 5. Yellow nutsedge shoot weight 5 and 9 weeks after the first preemergence (Pre) or postemergence (Post) herbicide application and crop shoot weight 10 weeks after the second herbicide application, 1989 study.

Herbicide[z]	Rate Kg/ha	Rate lb/A	Shoot fresh weight (g) yellow nutsedge Pre 5 wk	Post 5 wk	Post 9 wk	juniper	holly	azalea 10 wk	photinia
Untreated	0	0	184	173	50	37	53	46	71
Classic	0.009	0.008	122	74	41	48	53	43	70
Classic	0.018	0.016	101	65	32	47	54	44	58
Classic	0.034	0.03	70	67	26	39	45	42	59
Classic	0.067	0.06	47	40	20	44	44	42	83
Pennant	2.24	2.0	62	166	53	40	48	42	48
Basagran	1.12	1.0	172	102	40	33	35	37	55
Harmony	0.009	0.008	137	180	51	36	43	41	46
Harmony	0.018	0.016	132	174	50	46	42	50	73
Harmony	0.034	0.03	129	159	53	27	40	49	61
Harmony	0.067	0.06	155	175	56	34	45	47	46
		LSD (0.05)	39	30	13	15	17	9	24

[z]X-77 added to all herbicide treatments at 0.6 L/HA (0.5 pt/A).

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Desiccation Tolerance in Bare-rooted Apple Trees Prior to Transplanting[1]

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Abstract

Ten types of apple (*Malus domestica* L.) trees (six different scions on M.7 rootstock and four 'Red Delicious' scions on M.7, MM.111, MM.106 and seedling rootstocks) were subjected to air drying for periods of 0 to 48 hr with or without 3 months of cold storage at 0°C (32°F). The kinetics of water loss during drying treatment and the transplanting survival and regrowth vigor were recorded. Both the scions and rootstocks influenced the tolerance of apple trees to desiccation stress. Among the plant materials tested, 'Red Delicious' on MM.111 rootstock had the highest level of tolerance to desiccation. Three months of cold storage at 0°C (32°F) resulted in the considerable loss of tissue water, but the grafted trees survived if no further desiccation occurred prior to planting. Only 'Red Delicious'/MM.111 tolerated desiccation from the combination of three months of cold storage followed by a 48 hr exposure to air drying, while other scion/rootstock compound systems seldom survived. The analyses of water loss from apple trees indicated that the loss did not follow a simple first order reaction. However, there were two distinct first order water loss slopes suggesting that the loss was from two fractions of water inside plant tissues. One fraction of tissue lost water at a faster rate than the following second fraction which was slowly released from the plant tissues. There was no difference in the critical water content and rate of water loss between the tolerant trees, (i.e., 'Red Delicious' on MM.111) and the others. Therefore it is suggested that trees on MM.111 are more tolerant to desiccation because of the tolerance to water loss in the tissue.

Index words: *Malus domestica*, postharvest storage, transplanting survival, drying stress

Significance to the Nursery Industry

Sensitivity to desiccation stress during nursery handling is one of the main reasons for poor regrowth of bare-rooted nursery stocks. Plants subjected to desiccation during any phase of nursery production will have reduced growth potential and poor quality. This study analyzed the effect of desiccation tolerance on various scion/rootstock combinations of bare-rooted apple trees. It appears that both the scion and rootstock influence the post-stress regrowth and survival. Scions grafted on MM.111 rootstocks had the highest level of tolerance to desiccation. The results also suggested that trees on MM.111 are more tolerant to desiccation because of the tolerance to water loss in the tissue.

Introduction

It is common nursery production practice to dig nursery grown fruit trees in the fall/winter season and stored bare-rooted in cold storage or heeled in sawdust until ready for shipping or planting. Desiccation stress is one of the factors impacting the survival and performance of these cold stored bare-root trees.

Desiccation stress during post harvest handling is a major problem in some plant species (1, 4, 6). Woody plants lose water immediately when lifted from the ground, and a prolonged period of exposure to the air during post harvest handling and cold storage results in decreased survival and growth rates (1, 3, 6). Desiccation damage could not be reversed by rewetting once dried below a critical level (4, 5). Unfortunately, desiccated deciduous and evergreen plants are not easily distinguishable visually (1, 4–7). There is a wide variation among plant species (1, 3–5, 7), growth stage (3, 6), and plant tissue (4) in desiccation tolerance. Because there is no reliable method for measuring the desiccation tolerance of shoot and root tissue separately, the role of roots in the survival after desiccation is unclear.

In apples, various combinations of scion and rootstocks are widely used. The availability of the wide spectra of scion/rootstock combinations make it possible to study the influence of shoots and roots on the stress tolerance of the bare-rooted trees.

The objectives of this study were to compare the desiccation tolerance among apple trees of various scion/rootstock combinations and to analyze the kinetics of water loss from plant tissues in relation to their desiccation tolerances.

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