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Evaluation of Three Imidazolinone Herbicides for Control of Yellow and Purple Nutsedge in Woody and Herbaceous Landscape Plants[1]

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Abstract

Foliar-applications of Pursuit applied at 280 and 560 g/ha (4 and 8 oz/A) provided 97% purple nutsedge and 86% yellow nutsedge control at 560 g/ha (8 oz/A). Foliar-applications of Cadre applied at 70 g/ha (1 oz/A) provided 95% purple nutsedge and 61% yellow nutsedge control. Image provided 70 and 77% yellow nutsedge and 56 and 59% purple nutsedge control applied at 430 g/ha (6 oz/A) and 560 g/ha (8 oz/A), respectively. Azalea 'Macrantha Orange'was not tolerant to any of the imidazolinone herbicides tested. Likewise, shore juniper exhibited 17 to 35% growth reduction from the imidazolinone herbicides 4 WAT. Juniper growth reductions increased to between 25 and 37% 8 WAT. Redtip photinia was tolerant to Image at 430 and 560 g/ha (6 and 8 oz/A) and Cadre applied at 35 g/ha (0.5 oz/A). Pursuit-treated photinia exhibited 26 to 33% growth reductions 4 WAT. Green liriope was tolerant of all herbicide treatments 4 WAT. Of the 13 bedding plant taxa tested only French marigolds were found tolerant of Pursuit.

Index words: imidazolinone herbicides, nutsedge control, herbicide tolerance.

Species used in this study: ageratum (*Ageratum houstonianum* Mill 'Hawaii Blue'); azalea (*Rhododendron indicum* x 'Macrantha Orange'); bronze-leaved begonias (*Begonia semperflorens* Hort.); green-leaved begonias (*B. semperflorens* Hort.); celosia (*Celosia plumosus* Burv.); geranium (*Pelargonium* x *hortorum* Bailey 'Elite Scarlet'); shore juniper (*Juniperus* x *conferta* Parl.); green liriope (*Liriope muscari* Bailey); African marigolds (*Tagetes erecta* L. 'Discovery Orange'); French marigolds (*Tagetes patula* L. 'Dwarf Orange'); purple nutsedge (*Cyperus rotundus* L.); yellow nutsedge (*Cyperus esculentus* L.); lavender petunias (*Petunia* x *hybrida* Juss. 'Orchid Madness'); red petunias (*P.* x *hybrida* Juss. 'Red Madness'); white petunias (*P.* x *hybrida* Juss.); redtip photinia (*Photinia* x *fraseri* Lindl.); purple salvia (*Salvia splendens* L. 'Empire Purple'); red salvia (*S. splendens* L. 'Red Hot Sally'); vinca (*Vinca roseus* L. 'Peppermint Cooler').

Herbicides used in this study: Cadre (AC 263,222), (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid (CA) (±)-2-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)-5-methylnicotinic acid; Image (imazaquin), 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-y1]-3-quinolinecarboxylic acid; Pursuit (imazethapyr), (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid.

Significance to the Nursery Industry

Either rate of Pursuit and the 70 g/ha (1 oz/A) rate of Cadre provided excellent purple nutsedge control (97 and 95%, respectively). The two Image rates (480 and 560 g/ha) (8 and 9 oz/A) rate of Pursuit provided 70, 77, and 86% control of yellow nutsedge, respectively. Theseherbicides and rates also provided suppression of tuber regrowth which is essential for the control of nutsedge. Herbaceous and woody landscape plant tolerance was limited with growth reductions and/or visual injury on all taxa except French marigolds and green liriope. Due to the great potential for injury and growth reductions with the use of Pursuit, Image, or Cadre, an over-the-top application is not feasible. However, additional research is needed evaluating these herbicides in a directed spray and application to landscape plants.

Introduction

Nutsedge is tolerant of the wet soils and high temperatures found in most plant nurseries. Organic or plastic mulches offer limited control because nutsedge penetrates most mulching materials (4, 7). Currently, postemergence herbicide options for nutsedge control in ornamentals are limited (3, 5). Imidazolinones are a new class of herbicides that are effective on a broad spectrum of weeds at low rates. Some imidazolinones such as imazaquin and imazethapyr are labeled for nutsedge control. Imazaquin is used in soybeans as Scepter (2) and in turfgrasses as Image (1). Imazethapyr is used in peanuts and soybeans as Pursuit (2). Imazaquin tolerance has been reported in several landscape taxa such as common boxwood (*Buxus sempervirens* L.) and 'Big Blue' liriope (*Liriope muscari* Bailey) (6), dwarf Burford holly (*Ilex cornuta* Lindl.), 'Bennett's Compacta' holly (*I. crenata* Thunb.), blue rug juniper (*Juniperus horizontalis* Moench), dwarf crimson barberry (*Berberis thunbergii* DC), and redtip photinia (3). Dwarf Burford holly and 'Bennett's Compacta' holly are tolerant to imazethapyr (3). Tolerance of landscape plants to imazaquin has encouraged further studies of imidazolinone use.

The objective of this research was to evaluate the efficacy of Pursuit (imazethapyr), Image (imazaquin), and Cadre (AC263,222) for yellow and purple nutsedge control in four container-grown landscape and bedding species.

Materials and Methods

Plant materials were potted in ground pine bark amended with 1.4 kg (3.1 lb) gypsum lime, 5.5 kg (12.1 lb) dolomitic limestone, and 3.7 kg (8.2 lb) Sierrablend 8 to 9 month slow release fertilizer 17N-6P-10K (1.5% Ca, 1.0% Mg, 4.0% S, 0.02% B, 0.05% Cu, 0.4% Fe, 0.1% Mn, 0.001% Mo, and 0.05% Zn) per cubic meter. Yellow and purple nutsedge tubers were obtained from Azlin Seed Service (Azlin, MS)

[1]Received for publication November 3, 1993; and in revised form, March 23, 1994.

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and were germinated in moist potting soil in an open flat. The germinated tubers were transplanted (one tuber per cup) into 473 ml (16 oz) styrofoam cups with drain-holes. Landscape, bedding, and nutsedge plants were grown in a controlled environment greenhouse at 32/24°C (90/75°F) with 12 hours supplemental lighting (1500 μE/m²/s). Azaleas were purchased in #1 (3.8 l) (1 gal) containers. Juniper and photinia liners were transplanted into #1 (3.8 l) (1 gal) containers containing the amended pine bark medium used for the landscape plants. Bedding plants were purchased in cell packs and transplanted into 0.5 l (0.13 gal) containers containing pine bark medium. Nutsedge plants were treated at an average plant height of 10 to 15 cm (4 to 6 in). All landscape and nursery crops were treated after root establishment and active growth was observed (8 weeks for azalea and 12 weeks after transplanting for juniper and photinia). The average height of the landscape plants at the time of treatment was: 30 cm (12.0 in) azalea, 35 cm (14.0 in) photinia, 20 cm (8.0 in) (length) juniper, and 25 cm (10.0 in) (length) liriope. Herbicide treatments were: Pursuit (imazethapyr) at 280 and 560 g/a.i. ha (4 and 8 oz a.i./A), Image (imazaquin) at 430 and 560 ga.i./ha (6 and 8 oz a.i./A), and Cadre (AC 263,222) at 35 and 70 g a.i./ha (0.5 and 1 oz a.i./A). All spray mixtures included a non-ionic surfactant, X-77 (Valent U. S. A. Corp., Walnut Creek, CA 94596-8025) (0.25% v to v). The herbicides were sprayed in an enclosed spray chamber calibrated for 187 l water/ha (20 gal/A) at 138 kPa (20 PSI) and a 8004E TeeJet even flat-fan nozzle tip (TeeJet, Spraying Systems Co., Wheaton, IL 60188). Pursuit was applied to several selected bedding plant taxa to determine tolerance: 8 cm (3.2 in) French marigolds, 10 cm (4.0 in) African marigolds, 14 cm (5.6 in) white petunias, 9 cm (3.6 in) red petunias, 18 cm (7.2 in) lavender petunias, 9 cm (3.6 in) ageratum, 10 cm (4.0 in) celosia, 11 cm (4.4 in) vinca, 8 cm (3.2 in) bronze-leaved begonias, 7 cm (2.8 in) green-leaved begonias, 17 cm (6.8 in) purple salvia, 12 cm (4.8 in) red salvia, and 11 cm (4.4 in) geraniums. Pursuit treatments included a 32% nitrogen solution at 1.4 kg N/ha (3 lb N/A). The treated plants and controls were returned to the glasshouse after application and watered daily beginning no sooner than 12 hr after treatment. Yellow and purple nutsedge control is based on fresh shoot weight reduction compared to the control mean. Nutsedge fresh shoot weight was taken 4 weeks after treatment (WAT).

Table 1. Nutsedge fresh shoot weight and tuber regrowth reduction with Pursuit, Image, and Cadre.

Treatment[x]	Rate		Yellow nutsedge		Purple nutsedge	
			Fresh weight 4 WAT[y]	Regrowth[z] 5 WAT	Fresh weight 4 WAT	Regrowth 5 WAT
	(g/ha)	(oz/A)	(% reduction)			
Check	—	—	0	0	0	0
Pursuit	280	4	55	58	97	99
Pursuit	560	8	86	89	97	93
Image	430	6	70	72	56	50
Image	560	8	77	79	69	62
Cadre	35	0.5	26	39	56	44
Cadre	70	1	61	67	95	93
LSD (0.05)			19	19	18	22

[z]Plants were allowed to grow for 7 days following the 4 WAT harvest.

[y]WAT = Weeks after treatment.

[x]X-77 non-ionic surfactant added to all treatments at 0.25% v per v.

After evaluation 4 WAT, shoots were cut off and regrowth was evaluated 5 weeks later (control plants were 4–8 cm (2–3 in) tall). Ornamental height and new growth measurements were taken at 2 week intervals. Ornamental injury was based on reduction of shoot growth as compared to control mean. Flowering habits of the treated azaleas were monitored for a 13 week period beginning with the onset of flowering. Visual injury of selected bedding plant taxa from Pursuit was taken 4 WAT. The study utilized a randomized complete block design with four replications repeated twice in time. Data were subjected to an analysis of variance and means were separated by Fisher's Protected Least Significance Difference test at the 0.05 level. Flowering data will bereported as means with standard error of the mean.

Results and Discussion

Pursuit provided >95% purple nutsedge control at both rates and 86% yellow nutsedge control at 560 g/ha (8 oz/A) (Table 1). This is in contrast to other research conducted with Pursuit in which less than 50% purple nutsedge control occurred (3). The addition of a 32% nitrogen solution to our Pursuit treatments may be responsible for the increased

Table 2. Growth reduction of woody and herbaceous ornamentals treated with Pursuit, Image, and Cadre.

Treatment[z]	Rate		Azalea 'Macrantha Orange'			Photinia x fraseri			Juniper 'Conferta Shore'			Liriope muscari
			Weeks after treatment									
			4	8	12	4	8	12	4	8	12	4
	(g/ha)	(oz/A)	(% reduction)									
Check	—	—	0	0	0	0	0	0	0	0	0	0
Pursuit	280	4	19	33	35	26	32	49	35	37	16	0
Pursuit	560	8	20	33	36	33	37	50	17	25	9	0
Image	430	6	19	33	36	3	0	6	29	32	15	3
Image	560	8	16	28	34	0	0	0	28	32	18	9
Cadre	35	0.5	13	23	24	12	0	1	24	31	24	12
Cadre	70	1	17	27	30	23	4	16	27	33	21	1
LSD (0.05)			4	9	11	13	15	17	16	15	17	ns

[z]X-77 non-ionic surfactant added to all treatments at 0.25% v per v.

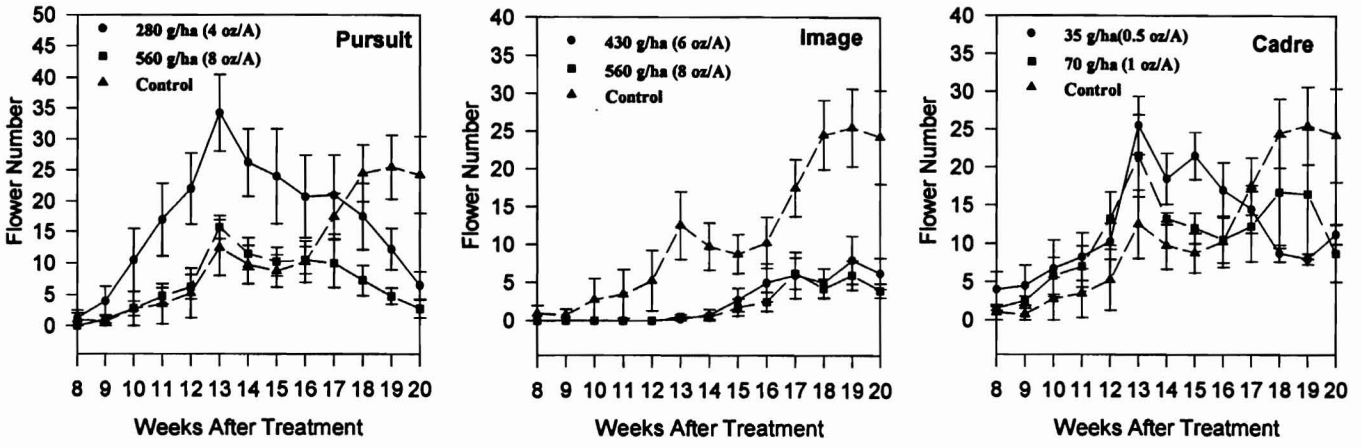

Fig. 1. Effect of Pursuit, Image, and Cadre on the flower production of azalea.

efficacy. Cadre provided 95% purple nutsedge control at 70 g/ha (1 oz/A) but only 61% yellow nutsedge control. Image controlled yellow nutsedge 70 and 77% and purple nutsedge 56 and 68%at 430 and 560 g/ha (6 and 8 oz/A), respectively. However, Image provided less than 70% purple nutsedge control at the same rate. Derr and Wilcut (3) have reported similar results with Image.

At 5 WAT, purple nutsedge regrowth was reduced by greater than 93% with either rate of Pursuit or Cadre applied at 70 g/ha (1 oz/A). Image applied at 430 and 560 g/ha (6 and 8 oz/A) reduced yellow nutsedge regrowth 72 and 79%, respectively. Pursuit applied at 560 g/ha (8 oz/A) reduced yellow nutsedge regrowth by 89%.

Azaleas were injured by all imidazolinone herbicides and rates tested. This is consistent with previous research with Image (3, 6, 7) and Pursuit (3, 6). Chlorosis and leaf-tip necrosis was evident 4 WAT on the new growth of the Image and Cadre-treated azaleas. A loss of apical dominance was observed with the formation of many lateral buds in all imidazolinone treatments. New growth was underdeveloped and chlorotic. Mature leaves of the Pursuit- and Cadre-treated azaleas were a darker shade of green as compared to the control. Growth reductions were detected 4 WAT with all treatments (13 to 20%) and increased 12 WAT (24–36%) (Table 2). Azaleas treated with Pursuit applied at 280 g/ha (4 oz/A) displayed more open flowers per week from 11 to 16 WAT than the control (Fig. 1). However, a slight loss of color and flower size also occurred. By 19 WAT, the number of opened flowers decreased to less than those of the control. Both rates of Image suppressed the number of open flowers 12 WAT through 20 WAT. Cadre did not affect azalea flowering.

The three imidazolinone herbicides reduced shore juniper growth 17 to 35% 4 WAT. By 8 WAT juniper growth reductions had increased to between 25 and 37%. However, by 14 WAT, the Pursuit- and Image-treated juniper had recovered. The Cadre-treated juniper continued to exhibit 21 to 24% reduction 14 WAT. Visual injury from all three treatments were not detected on juniper.

Pursuit reduced photinia growth 26 to 33% 4 WAT and by 12 WAT the Pursuit-treated photinia was half the size of the nontreated plants. Derr and Wilcut (3) reported similar reductions in photinia growth from Pursuit application. A loss of apical dominance was observed in the Pursuit-treated photinia with multiple lateral buds breaking immediately below the terminal bud. Photinia tolerated both rates of Image and the 35 g/ha (0.5 oz/A) rate of Cadre. Cadre applied at 70 g /a (1 oz/A) reduced growth by 23% 4 WAT but differences were not present 8 WAT.

The imidazolinone herbicides did not reduce green liriope growth 4 WAT, or cause any visual injury (data not shown).

Of the 13 bedding plant taxa tested for Pursuit tolerance, only French marigolds were Pursuit tolerant. Growth reductions (≥ 16%) were seen in the Pursuit-treated lavender petunias, vinca, bronze-leaved begonias, green-leaved begonias, and geraniums (Table 3). Pursuit applied at 280g/ha

Table 3. Growth reduction of selected bedding plant taxa treated with Pursuit.

Treatment[z]	Rate		African Marigold	White Petunia	Red Petunia	Lavendar Petunia	Ageratum	Celosia	Vinca	Bronze-lf Begonia	Green-leaved	Purple Salvia	Red Salvia	Geranium
	(g/ha)	(oz/A)	(% reduction)											
Check	—	—	0	0	0	0	0	0	0	0	0	0	0	0
Pursuit	280	4	37	15	49	29	0	26	61	6	70	0	3	36
Pursuit	560	8	33	0	41	16	8	4	35	56	85	4	34	71
LSD (0.05)			ns	ns	ns	14	ns	ns	20	48	39	ns	ns	45

[z]X-77 non-ionic surfactant added to all treatments at 0.25% v per v.

Table 4. Visual Injury of Bedding Plants to Pursuit.

Treatment[z]	Rate		African Marigold	White Petunia	Red Petunia	Lavendar Petunia	Ageratum	Celosia	Vinca	Bronze-lf Begonia	Green-leaved	Purple Salvia	Red Salvia	Geranium
	(g/ha)	(oz/A)	(% reduction)											
Check	—	—	0	0	0	0	0	0	0	0	0	0	0	0
Pursuit	280	4	85	43	88	73	40	20	75	65	88	85	78	88
Pursuit	560	8	80	45	73	65	58	13	70	85	95	88	78	93
LSD (0.05)			22	18	26	17	21	10	11	24	12	9	20	21

[z]X-77 non-ionic surfactant added to all treatments at 0.25% v per v.

(4 oz/A) and 560 g/ha (8 oz/A) caused greater than 40% visual injury to African marigolds, white petunias, red petunias, lavender petunias, ageratum, vinca, bronze-leaved begonias, green-leaved begonias, purple salvia, red salvia, and geraniums 4 WAT (Table 4). In addition, Pursuit caused 20 and 13% visual injury to celosia when applied at 280 g/ha (4 oz/A) and 560 g/ha (8 oz/A), respectively.

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