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Tolerance of 5 Warm-season Turfgrasses and 36 Ornamental Plant Species to Asulam¹

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Abstract. Methyl sulfanylcarbamate (asulam) was effective for the selective control of several grassy weeds in established st. augustinegrass (*Stenotaphrum secundatum* (Walt.) Kuntze), 'Tifway' bermudagrass (*Cynodon dactylon* L.), and 'Emerald' zoysiagrass (*Zoysia matrella* Merr.). Bahiagrass (*Paspalum notatum* Flugge) and centipedegrass (*Eremochloa ophuroides* (Munro) Hack.) were severely injured when asulam was used at a rate of 2.24 kg ai/ha. Thirty-six species of ornamental plants were relatively tolerant to foliage applications of asulam at rates of 2.24 and 4.48 kg ai/ha with growth normal on all but 4 ornamental species 22 weeks following treatment.

Selective weed control in turf is necessary in the production of high quality weed-free sod as well as in turf maintenance. Several types of selective herbicides are presently available for use on turf grass but no single material will control the wide spectrum of weedy grasses and broadleaf plants which commonly invade turf during initial establishment, or when under stress. Healthy, vigorous turf is still the best defense against invading weeds (1).

St. augustine comprises 46% of home lawns in Florida, and is also used extensively in other southeastern states (2). Grassy weeds, however, become a problem in st. augustinegrass when atrazine has been used repeatedly, and control is difficult. Until 1977, there was no practical means of postemergence control

of monocots in st. augustinegrass turf. Recently a 24C Florida state label was granted for the use of asulam on st. augustinegrass and on 'Tifway' bermudagrass.

Woody and other herbaceous ornamental plants are grown in close proximity to turf. Thus tolerance of some commonly used ornamentals to asulam was determined as part of the study.

Materials and Methods

Several field experiments with asulam were initiated during the fall of 1975 at Fort Lauderdale on 5 species of warm-season turfgrasses: bahiagrass, bermudagrass, centipedegrass, st. augustinegrass, and zoysiagrass. In each experiment asulam was applied to the turf plots at rates of 1.1, 2.2, and 4.5 kg ai/ha in a volume equivalent to 411 liters/ha. These rates were 1/2, 1, and 2 times the label rate for weed control in sugarcane in Florida. Plot size varied depending on the size of the available turf area from 0.5 x 3 m to 1 x 10 m. A randomized complete block design with 3 replications was used in each experiment. Asulam was applied with compressed air spray tank fitted with a No. 8003 Tee Jet nozzle. Turf injury ratings were made by visually estimating the amount of turf discoloration. The evaluations were made at 2, 4, 8, and 12 weeks following treatment by 2 individuals. In most cases maximum development of phyto-

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toxic symptoms had occurred by 4 weeks. If turf thinning was apparent, the % stand reduction at 12 weeks following treatment was evaluated and reported.

In 1976 further tests with asulam were conducted on the same turf species and also on 36 species of ornamental plants. These ornamentals are frequently used for landscaping in close proximity to turf and therefore might be affected by the use of asulam on adjacent turf. Rates used in 1976 testing were 2.2, 4.5 and 9.0 kg ai/ha. Foliage of containerized ornamentals growing under 57% shade was sprayed. Treatments were replicated 3 times. The types and degree of severity of phytotoxicity symptoms were recorded at 3, 6, 10 and 22 weeks following treatment.

Results and Discussion

Turfgrasses. Bahiagrass, centipedegrass, and the 2 fine-textured bermudagrasses ('Tifgreen' and 'Tifdwarf') were very sensitive to asulam, being severely damaged even at the 2.2 kg rate, while some grass plants were killed at the higher rates (Table 1). 'Tifway' and 'Ormond' bermudagrasses, st. augustinegrass, and zoysiagrass were discolored 2 week after treatment at the 2.2 kg rate, but in most cases recovered by 8 weeks. Injury symptoms of asulam on each turfgrass began with a slowdown or cessation of growth within 3 to 5 days of application, followed by a gradually increasing chlorosis beginning 7 to 10 days later. Chlorosis was fully developed by 4 weeks. The chlorosis was similar in appearance to severely N deficient turf or to yellowing which occurs normally from applications of the organic arsenicals. Injury symptoms from the latter are fully developed within a week, while with asulam symptoms are not comparably developed for about a month. Within 8 weeks the tolerant turfgrasses had regained almost all of their vigor and color. The non-tolerant turfgrasses continued to decline after 4 weeks, with a 10 to 40% kill of the grass plants observed 8 weeks following treatment. By 12 weeks that part of the turf which was not killed had recovered and appeared normal.

Because of the tolerance of st. augustinegrass and 'Tifway' bermudagrass to asulam, this material has been labeled for post-emergence weed control on these turfgrasses in the State of Florida. 'Ormond' bermudagrass and 'Emerald' zoysiagrass were also tolerant to asulam but were not included on the label, because of inadequate data at the time.

Ornamentals. Of the 36 ornamental species, 11 exhibited no injury symptoms, and were tolerant to asulam (Table 2). Of the 25 species exhibiting asulam injury symptoms, 11 were slightly sensitive, 8 moderately sensitive, and 6 very sensitive.

As in turf, injury symptoms on ornamentals developed slowly, and 10 weeks or more were required for full expression, although initially acute symptoms such as chlorosis and various types of leaf burn (tip, blade, or margin) or shoot tip necrosis developed 3 weeks following treatment. Subsequent phytotoxicity (6 to 10 week observations) was characterized by shoot tip death, slower than normal growth, deformed leaves, chlorosis and leaf fall. Leaf burn incurred initially continued to detract from the appearance of the plants and therefore affected the visual rating of phytotoxicity. Sprouting of lateral buds below killed or injured shoot tips was delayed in comparison to expectations if shoot tips had been pruned. However, once sprouting did occur, more sprouts appeared than expected as a result of pruning.

After 22 weeks all species except weeping fig, Boston fern, Brazilian pepper, and copperleaf had completely recovered and grew normally. The sensitivity of Brazilian pepper to asulam is of interest here because this plant is a weedy shrub and covers large areas of south Florida, necessitating brush removal practices in many instances along canals, fence rows, and utility rights-of-way. These results suggest that asulam might be useful in its control.

Table 1. Tolerance of 5 warm-season turfgrasses to asulam.

Species	Asulam (kg/ha)	Turf injury ratings ^z			Stand reduction
		2 weeks	4 weeks	8 weeks	%
<i>St. Augustine</i>					
Bitter Blue	1.1	0.0	0.2	0.0	0
	2.2	0.3	1.0	0.3	0
	4.5	0.6	1.7	0.7	0
Floratom	1.1	0.0	0.0	0.0	0
	2.2	0.1	0.0	0.0	0
	4.5	0.0	0.8	0.2	0
Floratine	1.1	0.0	0.0	0.0	0
	2.2	0.1	0.8	0.2	0
	4.5	0.8	1.5	0.7	0
Scotts 1081	1.1	0.6	1.2	0.0	0
	2.2	1.2	1.8	1.0	0
	4.5	2.0	2.5	1.4	0
Common	1.1	0.0	0.5	0.0	0
	2.2	0.5	1.2	0.7	0
	4.5	1.0	2.0	1.2	0
<i>Bermudagrass</i>					
Tifway	1.1	0.8	1.2	2.0	0
	2.2	1.3	1.8	0.7	0
	4.5	1.6	2.5	1.5	0
Ormond	1.1	1.0	1.7	0.5	0
	2.2	1.5	1.9	1.0	0
	4.5	2.0	2.6	2.0	12
Tifgreen	1.1	1.7	1.7	0.4	0
	2.2	3.0	4.9	3.8	13
	4.5	4.5	7.8	7.0	41
Tifdwarf	1.1	2.2	4.7	2.6	15
	2.2	3.8	5.0	3.5	32
	4.5	5.2	9.1	6.8	48
<i>Zoysiagrass</i>					
Emerald	1.1	0.0	0.0	0.0	0
	2.2	0.0	1.7	0.2	0
	4.5	0.6	2.3	1.2	0
<i>Centipedegrass</i>					
Common	1.1	1.9	3.2	4.0	11
	2.2	5.9	7.8	8.6	24
	4.5	7.2	9.2	9.6	39
<i>Bahiagrass</i>					
Pensacola	1.1	1.6	2.9	2.6	18
	2.2	3.0	5.0	4.0	26
	4.5	4.3	6.5	5.6	38
Argentine	1.1	1.6	2.8	3.3	16
	2.2	2.7	4.8	3.9	27
	4.5	4.2	6.3	5.2	33

^zTurf injury ratings were visual estimates of turf discoloration by 2 individuals, based on a scale of 0 to 10 with 0 equal to no injury and 10 complete discoloration (yellowing and/or browning). A rating of 1.0 indicated slight, temporary discoloration. Ratings above 4.0 were too severe for commercial acceptance.

The fact that 61% of the treated ornamental species were either unaffected or only slightly affected by over-the-top foliar sprays of asulam at rates equivalent to, or higher than, the label rate of turf justifies the use of asulam on st. augustinegrass and 'Tifway' bermudagrass turf adjacent to ornamental plantings.

Table 2. Phytotoxicity symptoms of 36 species of ornamental plants 3, 6, 10, and 22 weeks posttreatment with asulam postemergence herbicide applied to the foliage at rates 2.2, 4.5, and 9.0 kg ai/ha.

Species	Visual rating ^z and phytotoxicity symptoms																Overall sensitivity ^y
	3 weeks				6 weeks				10 weeks				22 weeks				
	asulam (kg/ha)			symp-toms ^y	asulam (kg/ha)			symp-toms	asulam (kg/ha)			symp-toms	asulam (kg/ha)			symp-toms	
2.2	4.5	9.0	2.2		4.5	9.0	2.2		4.5	9.0	2.2		4.5	9.0			
<i>Acalypha wilkesiana</i> Muell. Arg. 'Godseffiana' (Green copperleaf)	3.9 ^x	3.0	3.7	b,c ^y	3.7	4.0	4.0	b,c,d, f	3.0	3.3	3.7	a,b,c, d,f	0.0	0.0	0.0	—	V ^w
<i>Acalypha wilkesiana</i> Muell. Arg. (Copperleaf)	2.7	3.0	3.0	a,d,t	4.0	4.0	4.0	b,c,d	4.0	4.0	4.0	a,b,d, f	0.0	2.0	5.0a	—	V
<i>Araucaria heterophylla</i> Franco. (Norfolk Island pine)	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	O
<i>Asparagus densiflorus</i> Jessop 'Sprengeri' (Asparagus fern)	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	O
<i>Bischofia javanica</i> Blume (Bischofia)	2.0	2.3	2.3	b,c,d, f	4.0	4.0	4.0	b,c,d	0.0	3.0	3.0	f	0.0	0.0	0.0	—	V
<i>Brassaia actinophylla</i> Endl. (Schefflera)	0.3	0.3	1.3	b	0.0	0.3	0.3	c	1.3	1.0	1.0	c	0.0	0.0	0.0	—	S
<i>Carissa grandiflora</i> A. DC. 'Emerald Blanket' (Emerald Blanket Carissa)	0.0	0.3	0.0	d	0.3	1.0	0.7	d	1.0	2.7	2.7	a,b,c	0.0	0.0	0.0	—	M
<i>Caryota maxima</i> L. (Fishtail palm)	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	O
<i>Chrysalidocarpus lutescens</i> Wendl. (Areca palm)	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	O
<i>Coccoloba uvifera</i> L. (Sea grape)	0.3	0.3	1.0	b,c	2.7	3.0	3.3	b,c,d	1.7	2.7	3.3	b,c,d	0.0	0.0	0.0	—	M
<i>Codiaeum variegatum</i> Blume 'Bravo' (Bravo croton)	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	O
<i>Codiaeum variegatum</i> Blume 'Gold Dust' (Gold dust croton)	1.0	1.0	1.3	c,d	2.7	3.0	3.0	c,d	1.7	2.7	3.0	a,c,d, f	0.0	0.0	0.0	—	V
<i>Dracaena marginata</i> Lam. (Red edge dracaena)	0.0	0.3	0.0	c	0.0	1.0	1.0	c,d	0.0	0.7	4.0	b,c,d, f	0.0	0.0	0.0	—	S
<i>Eribotrya japonica</i> Lindl. (Loquat)	0.7	0.7	1.0	c,d	0.7	2.0	2.3	c,d,m	0.7	2.0	2.7	c,d,m	0.0	0.0	0.0	—	S
<i>Eugenia uniflora</i> L. (Surinam cherry)	2.3	2.7	2.7	a,b,t	2.0	2.0	4.0	a	0.3	0.3	0.7	c,d,t	0.0	0.0	0.0	—	M
<i>Ficus benjamina</i> L. (Weeping fig)	0.7	0.7	0.7	d,f	2.3	2.0	2.3	a,c,d, f	2.7	2.3	3.3	a,d,d, f	0.0	0.0	0.3	a	M
<i>Ficus lyrata</i> Warb. (Fiddle leaf fig)	0.3	1.7	2.3	a,b	2.3	3.7	4.0	a,b,c, d	1.0	3.0	3.3	a,b,d, f	0.0	0.0	0.0	—	S
<i>Ficus retusa</i> L. 'Nitida' (Cuban laurel)	2.7	1.7	1.7	a,c,d, f	3.0	2.7	2.3	a,d,d	1.7	2.3	2.3	a,c,d, f	0.0	0.0	0.0	—	S
<i>Gardenia jasminoides</i> Ellis (Gardenia)	2.0	2.0	2.0	c,f	0.7	1.0	1.0	c,d,t	1.3	1.7	2.3	c,f,t	0.0	0.0	0.0	—	M
<i>Hemerocallis aurantica</i> Baker 'Aztec Gold' (Aztec gold daylily)	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	O
<i>Hibiscus calphyllus</i> Cav. (Yellow hibiscus)	0.0	0.0	0.7	c	0.0	0.0	0.0	—	0.7	1.3	1.3	c,f,d	0.0	0.0	0.0	—	S
<i>Hibiscus roas-sinensis</i> (Red hibiscus)	1.0	1.7	1.7	c,d	1.0	1.0	1.3	a,c,d	2.3	2.7	2.7	a,c,f	0.0	0.0	0.0	—	M

Table 2 continued

Species	Visual rating ^X and phytotoxicity symptoms																Overall sensitivity ^Z
	3 weeks				6 weeks				10 weeks				22 weeks				
	asulam (kg/ha)			symp-toms ^Y	asulam (kg/ha)			symp-toms	asulam (kg/ha)			symp-toms	asulam (kg/ha)			symp-toms	
	2.2	4.5	9.0		2.2	4.5	9.0		2.2	4.5	9.0		2.2	4.5	9.0		
<i>Ixora coccinia</i> L. (Red ixora)	0.0	0.3	0.3	d	2.0	2.0	2.0	d,d	2.7	2.7	3.3	a,b,c	0.0	0.0	0.0	—	M
<i>Ixora coccinia</i> L. 'Super King' (Super king ixora)	0.0	0.0	1.0	b	2.0	2.7	3.3	a,c,d,	2.3	3.0	3.0	a,c,d, f	0.0	0.0	0.0	—	M
<i>Jasminum volubile</i> Jacq. (Wax jasmine)	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.3	c	0.0	0.0	0.0	—	O
<i>Livistona chinensis</i> R. Br. (Chinese fan palm)	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	O
<i>Murraya paniculata</i> Jack (Orange jasmine)	0.3	1.3	1.7	a,c,f	0.0	0.3	1.0	c,f	0.0	0.3	0.3	c	0.0	0.0	0.0	—	S
<i>Nephrolepis exaltata</i> Schott. (Boston fern)	2.3	2.3	2.3	b,d,f, t	2.0	3.0	3.0	b,c,f, t	4.0	4.0	4.0	b,c,f, t	3.0	4.0	4.3	f	V
<i>Nerium oleander</i> L. (Oleander)	0.0	0.3	0.7	c,d	0.0	0.0	1.0	c,d,t	0.0	0.0	0.7	c,t	0.0	0.0	0.0	—	S
<i>Pimenta dioica</i> Merr. (Allspice)	0.0	0.7	0.1	b,t	0.0	1.3	2.3	c,f,t	1.0	1.3	2.7	b,c,d, t,m	0.0	0.0	0.0	—	S
<i>Pittosporum ferrugineum</i> Ait	0.7	1.0	2.0	c,d	0.0	0.3	1.0	c,f	0.0	0.7	0.7	t,d	0.0	0.0	0.0	—	S
<i>Pittosporum tobira</i> Ait 'Variegata' (Variegated Japanese Pitto- sporum)	0.7	1.0	1.0	c,d	0.7	1.3	1.7	c,f,d	0.0	0.0	0.0	—	0.0	0.0	0.0	—	S
<i>Podocarpus marcophylla</i> D. Don (Podocarpus)	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	O
<i>Schinus terebinthifolius</i> Raddi (Brazilian pepper tree)	2.0	1.3	2.3	a	3.0	3.0	3.0	a,f	3.3	3.3	3.3	a,f	3.5	4.5	5.0	—	V
<i>Viburnum suspensum</i> Lindl. (Sandankwa viburnum)	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	O
<i>Veitchia merrillii</i> (Becc.) Moore (Christmas or Manila palm)	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	0.0	0.0	0.0	—	O
Avg/Phytotoxicity of the 25 sensitive plants	1.0	1.1	1.5		1.6	1.9	2.2		1.5	2.0	2.8						

^Zvisual ratings: 0 = none (injury symptoms not visible)
 1 = slight (close inspection necessary to determine injury)
 2 = moderate (injury noticeable from 0.5m but does not significantly detract from appearance)
 3 = strong (injury very obvious from several m away, detracts noticeably from appearance)
 4 = severe (plants badly stunted, deformed, discolored or defoliated)
 5 = dead

^YPhytotoxicity symptoms: a = shoot apex killed; b = blade burn; c = chlorosis; d = distorted growth; f = leaf fall; m = margin or leaf burned; t = tip of leaf burned.

^WOverall sensitivity: V = very; M = moderately; S = slightly; O = not sensitive.

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