

## Purple Nutsedge Control with Imazaquin in Bermudagrass Turf

Bul 408

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Purple nutsedge [*Cyperus rotundus* (L.)] is one of the most difficult weeds to control in bermudagrass (*Cynodon* spp.) after the turf has been established (Coats et al. 1987). This weed is also a severe problem in many other grasses and crops in more than 90 countries of the world (Bendixen and Nandihalli 1987; Holm et al. 1977). In the United States, purple nutsedge is found in the Southeast from Texas to Virginia and in California (U.S. Department of Agriculture 1970). Purple nutsedge is a perennial which rarely reproduces by seed (Thullen and Keeley 1979), but reproduces extensively by rhizomes and tubers (Wills 1987).

Researchers and turfgrass managers have attempted to control purple nutsedge in turfgrasses for nearly three decades. Repeated postemergence applications of arsonate herbicides have given initial control (Hamilton 1971; Long et al. 1962; Sturkie 1967), but regrowth usually occurs. Foliage of purple nutsedge plants were killed by 2,4-D [(2,4-dichlorophenoxy)acetic acid], but new underground tubers began to sprout within three to four weeks (Loustalot et al. 1954). Bentazon {3-(1-methylethyl)-(1H)-2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide} and perfluidone {[1,1,1-trifluoro-N-[2-methyl-4-(phenylsulfonyl)phenyl]-methanesulfonamide]} did not effectively control purple nutsedge in an earlier study in Georgia (Johnson 1975).

Bentazon is used by turfgrass managers for control of yellow nutsedge (*Cyperus esculentus* L.) but not for purple nutsedge. Imazaquin {2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-3-quinolinecarboxylic acid}. The herbicide has shown postemergence activity on purple nutsedge (Coats et al. 1987; Menn and Beard 1989).

Because purple nutsedge is difficult to control when growing with bermudagrass, experiments were initiated with imazaquin applied alone or with MSMA (monosodium salt of MAA) to determine the frequency of treatments needed to obtain effective control.

### Materials and Methods

Three experiments were conducted on purple nutsedge control in an established mixed 'Tifway' (*C. dactylon* x *C. transvaalensis* Burtt-Davy) and common bermudagrass [*C. dactylon* (L.) Pers.] turf with imazaquin applied alone or with MSMA from 1986 through 1988 at the Augusta National Golf Club, Augusta, GA. A fourth experiment was conducted on tolerance of common bermudagrass to imazaquin during 1989 and 1990 at the Georgia Station, Griffin, GA. Table 1 gives the time of treatments and ratings taken.

Table 1. Purple Nutsedge Experiments Conducted on Bermudagrass

Experiment	Type	Location	Date Applied	Date Rated
I	Annual imazaquin treatments	Augusta National Golf Club	1986: July 18 1987: July 17 1988: July 21	August 1,15 Oct. 2 July 13,28 August 12,31 July 21 August 4,15,30
II	Imazaquin formulations	Augusta National Golf Club	1987: July 13 1988: July 21	July 13,28 August 12,31 July 21 August 4,15,30
III	Multiple imazaquin treatments	Augusta National Golf Club	1987: June 1 July 14 1988: June 10 July 21	June 1,15 July 2,13,28 August 12,31 June 24 July 21 August 4,15,30
IV	Tolerance of common bermudagrass	Georgia Station, Griffin	1989: May 31 June 22 1990: May 30 June 22	June 5,14,22 June 29 July 6,12,18 June 5,11,18 June 21,28 July 3,8

### **Augusta National Golf Club**

**Experiment I.** Imazaquin was applied alone and with MSMA as tank mixtures to purple nutsedge at rates given in table 2. Treatments were applied to the same plots on July 18 ± four days for three consecutive years (1986-1988). The purple nutsedge population was uniform with ground cover > 60% when the first treatments were made.

**Experiment II.** Imazaquin was applied as a liquid concentrate (LC) and granular (G) formulations to purple nutsedge on the same plots in 1987 and 1988. A tank-mixture of imazaquin LC plus MSMA was also included. Table 4 gives herbicide rates. Imazaquin G was formulated on a 27-3-3 fertilizer and contained 0.47 lb of imazaquin per 100 pounds of fertilizer. Whenever imazaquin is applied alone or with MSMA and no formulation is given, it will always be the LC formulation. Purple nutsedge population was uniform, with average cover of 37% when the first treatments were made.

**Experiment III.** Imazaquin was applied alone and with MSMA in multiple applications in 1987 and 1988. The first application was made June 5 ± five days, and the second application was made July 18 ± six days. Table 7 gives the rates and frequency of application. Treatments were made to different plots each year. The purple nutsedge population was uniform, with average cover of 47% when the first treatments were made.

**Table 2.** Influence of Imazaquin Applied Alone or with MSMA as a Single Annual Application for Three Consecutive Years on Purple Nutsedge Control in Experiment I at Augusta National Golf Club, Augusta, GA

Treatments <sup>a</sup>		Purple nutsedge control <sup>b</sup>								
		1986			1987			1988		
Herbicide	Rate lb ai/A	AUG 1	AUG 15	OCT 2	JULY 28	AUG 12	AUG 31	AUG 4	AUG 15	AUG 30
Untreated	-	0	0	0	0	0	0	0	0	0
Imazaquin	0.5	92	100	69	88	92	87	98	95	85
Imazaquin + MSMA	0.5 + 2.0	100	97	73	100	98	91	100	99	97
Imazaquin	0.38	82	88	47	80	77	70	95	91	77
Imazaquin + MSMA	0.38 + 2.0	100	99	87	100	98	94	100	100	100
Imazaquin	0.25	82	62	50	77	70	60	93	77	57
Imazaquin + MSMA	0.25 + 2.0	100	90	80	100	94	90	100	100	96
MSMA	2.0	35	42	35	37	38	30	48	30	33
LSD (0.05)		12	18	25	12	14	22	4	13	18

- a. Herbicides were applied to the same plots July 18, 1986, July 14, 1987, and July 21, 1988.
- b. Purple nutsedge control ratings were based on 0 = no control and 100 = complete control.

**Table 3.** Influence of Imazaquin Applied Alone or with MSMA as a Single Annual Application for Three Consecutive Years on Population of Purple Nutsedge in Experiment I at Augusta National Golf Club, Augusta, GA

Treatments <sup>a</sup>		Purple nutsedge cover				
		1986	1987		1988	
Herbicide	Rate	Oct. 2	July 28	Aug 31	July 21	Aug 30
Untreated	-	62	25	62	45	67
Imazaquin	0.5	16	17	9	19	11
Imazaquin + MSMA	0.5 + 2.0	14	0	7	3	2
Imazaquin	0.38	28	23	25	25	17
Imazaquin + MSMA	0.38 + 2.0	6	0	4	3	0
Imazaquin	0.25	28	28	30	18	28
Imazaquin + MSMA	0.25 + 2.0	12	0	6	4	3
MSMA	2.0	30	28	42	33	42
LSD (0.05)		15	25	22	17	15

a. Herbicides were applied to the same plots on July 19, 1986, July 14, 1987, and July 21, 1988.

**Table 4.** Influence of Imazaquin Applied Alone or with MSMA as a Single Annual Application for Two Consecutive Years on Purple Nutsedge Control in Bermudagrass in Experiment II at Augusta National Golf Club, Augusta GA

Treatments <sup>a</sup>		Purple nutsedge control <sup>b</sup>						
		1987			1988			
Herbicide <sup>c</sup>	Rate lb/ai/A	July 28	Aug 12	Aug 31	July 21	Aug 4	Aug 15	Aug 30
Untreated	-	0	0	0	0	0	0	0
Imazaquin LC	0.5	80	73	48	26	93	78	63
Imazaquin LC + MSMA	0.5 + 2.0	98	75	65	53	99	93	86
Imazaquin LC	0.38	73	73	45	26	88	67	50
Imazaquin LC +	0.38 + 2.0	95	78	62	52	100	94	86

MSMA								
Imazaquin G	0.38	80	68	53	50	88	81	69
Imazaquin LC	0.25	73	70	43	3	85	53	38
Imazaquin LC + MSMA	0.25 + 2.0	90	70	65	42	98	83	83
Imazaquin G	0.25	54	50	45	8	65	57	25
MSMA	2.0	43	33	50	13	49	13	27
LSD (0.05)		18	19	16	NS	8	20	16

- a. Herbicides were applied to the same plots July 14, 1987 and July 21, 1988.
- b. Purple nutsedge control ratings were based on 0 = no control and 100 = complete control.
- c. LC = liquid concentrate, G = granular.

### **Georgia Station**

**Experiment IV.** A weed-free, common bermudagrass turf was treated with imazaquin at 0.38 and 0.5 lb ai/acre in 1988 and 1990. The treatments were initially applied May 31 and repeated June 22 ± one day to the same plots both years. The normal time period between imazaquin applications for purple nutsedge control is at least a six-week interval. However, the repeated applications were made at three-week intervals in the present study to determine maximum turfgrass injury from imazaquin.

### **General information**

Bermudagrass in all experiments was an established turf that was cut at a height of 1.0-1.25 inches once or twice per week. Purple nutsedge generally had four to six leaves at time of treatment. A normal fertility program for bermudagrass (annual 4 to 6 lb N/1000 ft<sup>2</sup>) was followed in all experiments. This included a balanced fertilizer (N-P-K) in early April and early September, with additional N applied as needed during late spring and summer. Irrigation was applied as needed to maintain a good quality turf.

Herbicides were applied in 25 and 40 gal water/acre at Augusta and Griffin, respectively. A surfactant (Alkylaryl-polyoxyethylene glycols fatty acid isopropanol) was added at 0.25% (v/v) with imazaquin. Extra surfactant was added to increase the surfactant concentration in MSMA treatments to 0.25%. The granular formulation was mixed with sand and applied by hand. The herbicide rates are presented as active ingredient per acre.

Table 5. Influence of Imazaquin Applied Alone or with MSMA as a Single Annual Application for Two Consecutive Years on Population of Purple Nutsedge in Experiment II at Augusta National Golf Club, Augusta, GA

Treatments <sup>a</sup>		Purple nutsedge cover			
		1987		1988	
Herbicide <sup>b</sup>	Rate	July 13	Aug 31	July 21	Aug. 30
Untreated	-	37	48	38	67
Imazaquin LC	0.5	50	32	28	27
Imazaquin LC + MSMA	0.5 + 2.0	53	20	18	10
Imazaquin LC	0.38	55	30	28	35
Imazaquin LC + MSMA	0.38 + 2.0	52	23	17	10
Imazaquin G	0.38	42	28	19	23
Imazaquin LC	0.25	50	37	37	42
Imazaquin LC + MSMA	0.25 + 2.0	43	22	22	15
Imazaquin G	0.25	52	38	35	48
MSMA	2.0	45	33	33	50
LSD (0.05)		NS	13	NS	11

a. Herbicides were applied to the same plots on July 14, 1987 and July 21, 1988.

b. LC = liquid concentrate, G = granular.

Visual estimates of bermudagrass injury, purple nutsedge control, and cover ratings were made at 2- to 3-week intervals as needed to show the maximum response to herbicides. At Griffin, bermudagrass injury ratings were made weekly. Bermudagrass injury ratings were based on 0 to 100, where 0 = no injury, 1-20 = slight injury, 21-30 = moderate injury, > 30 = severe injury and unacceptable, and 100 = complete kill. Purple nutsedge control ratings were based on 0 to 100, where 0 = no control and 100 = complete control. Purple nutsedge cover ratings were based on 0 to 100, where 0 = no purple nutsedge and 100 = complete plot coverage of purple nutsedge plants.

The experimental design was a randomized complete block with three replications. Plot size varied but was  $\geq 5$  by 10 ft in all experiments. Analysis of variance using the Statistical Analysis System (General Linear Model Procedure) (SAS Institute 1982) was conducted. Due to year interactions, mean data are reported for each year. Means are separated by LSD at the 0.05 level.

Table 6. Influence of Sequential Imazaquin Treatments Applied Alone or with MSMA for Purple Nutsedge Control in Bermudagrass in Experiment III in 1987 at Augusta National Golf Club, Augusta, GA

Treatments <sup>a</sup>		Purple nutsedge control <sup>b</sup>				Bermudagrass injury <sup>c</sup>		
Herbicide	Rate lb ai/A	Application No.	Jun 15	July 13	July 28	Aug 31	Jun 15	July 28
Untreated			0	0	0	0	0	0
Imazaquin	0.25	1	75	55	10	27	5	0
		2	73	58	82	72	5	0
Imazaquin + MSMA	0.25 + 2.0	1	100	78	72	73	8	0
		2	100	72	95	91	10	0
Imazaquin	0.38	1	85	79	42	50	8	0
		2	83	81	95	86	8	5
Imazaquin + MSMA	0.38 + 2.0	1	100	87	72	80	11	0
		2	100	90	98	97	10	4
MSMA	2.0	1	41	12	20	30	0	0
		2	45	13	58	65	0	0
LSD (0.05)			8	14	22	22	3	NS

a. Herbicides were applied June 1, 1987 to all plots and July 14 to plots receiving a second application. The herbicides were applied at the given rates at each application.

b. Purple nutsedge control ratings were based on 0 = no control and 100 = complete control. Nutsedge population averaged 30% ground cover at the time first herbicide application was made and population in untreated plots increased to 47% when final ratings were made.

c. Bermudagrass injury ratings were based on 0 = no injury, 1-20 = slight injury, 21-30 = moderate injury, > 30 = severe injury and unacceptable, and 100 = complete kill.

Table 7. Influence of Sequential Imazaquin Treatments Applied Alone or with MSMA for Purple Nutsedge Control in Bermudagrass in Experiment III in 1988 at Augusta National Golf Club, Augusta, GA

Treatments <sup>a</sup>			Purple nutsedge control <sup>b</sup>				Bermudagrass injury <sup>c</sup>	
Herbicide	Rate	Application	Jun	July	Aug	Aug	Jun 24	Aug 8

	lb ai/A	no.	24	21	4	30		
Untreated	-	-	0	0	0	0	0	0
Imazaquin	0.25	1	86	47	10	18	3	0
		2	93	72	99	87	5	10
Imazaquin + MSMA	0.25 + 2.0	1	100	88	63	68	4	2
		2	100	94	100	98	2	3
Imazaquin	0.38	1	100	84	55	48	4	0
		2	100	87	100	99	7	12
Imazaquin + MSMA	0.38 + 2.0	1	100	97	87	69	3	0
		2	100	99	100	100	7	7
MSMA	2.0	1	23	33	20	17	0	0
		2	34	40	77	53	0	0
LSD (0.05)			16	19	22	24	5	5

- a. Herbicides were applied June 10, 1987 to all plots and July 21 to plots receiving a second application. The herbicides were applied at the given rates at each application.
- b. Purple nutsedge control ratings were based on 0 = no control and 100 = complete control. Nutsedge population averaged 17% ground cover at the time first herbicide application was made and population in untreated plots increased to 47% when final ratings were made.
- c. Bermudagrass injury ratings were based on 0 = no injury, 1-20 = slight injury, 21-30 = moderate injury, > 30 = severe injury and unacceptable, and 100 = complete kill.

## Results and Discussion

### Purple nutsedge control

**Experiment I--annual treatments for three years.** Imazaquin applied alone or tank-mixed with MSMA controlled a higher percentage of purple nutsedge than did MSMA alone when ratings were made August 1 at two weeks after treatment (WAT) in 1986 (table 2). The control was 10% greater in plots treated with imazaquin at 0.5 lb/acre than at  $\leq 0.38$  lb/acre. Purple nutsedge control was 100% at two WAT with imazaquin plus MSMA, regardless of imazaquin rate. By August 15 or four WAT, the control from each treatment was similar to that obtained on August 1, except in plots treated with imazaquin at 0.25 lb/acre. The control of purple nutsedge treated with 0.25 lb/acre decreased from 82% to 62% from two to four WAT.

Although a single application of imazaquin provided acceptable purple nutsedge control initially, control decreased to an unacceptable level (47% to 69%) by October 2 or 10 WAT (table 2). There was no difference at 10 weeks when imazaquin at 0.5 lb/acre was

applied alone or with MSMA. However, control was greater from the combination of imazaquin plus MSMA when imazaquin was applied at  $\leq 0.38$  lb/acre than with imazaquin applied alone at the same rate. These data, in regards to improved purple nutsedge control with imazaquin plus MSMA compared with imazaquin alone, agree with the report by Coats et al. (1987). These results show that a single herbicide application at rates used in this study will not completely control purple nutsedge after one annual treatment, whether imazaquin was applied alone or with MSMA.

When imazaquin was applied alone or with MSMA in 1987 to plots previously treated in 1986, purple nutsedge control on August 12 or four WAT was similar to the previous year (table 2). In both years, imazaquin at 0.5 lb/acre was more effective than at 0.25 lb/acre in controlling purple nutsedge at four WAT. Imazaquin plus MSMA applied in 1986 and 1987 controlled  $\geq 90\%$  purple nutsedge, regardless of imazaquin rate when the final rating was made in 1987. MSMA applied once both years resulted in poor and unacceptable purple nutsedge control.

Imazaquin applied for three consecutive years at 0.25 lb/acre did not effectively control purple nutsedge (57%) when final ratings were made August 30, 1988 (table 2). As imazaquin rates increased from 0.25 to 0.5 lb/acre, control also increased (57% to 85%). However, the control was  $\geq 96\%$  when imazaquin plus MSMA was applied to the same plots for three consecutive years.

Imazaquin plus MSMA is more effective in controlling purple nutsedge than imazaquin alone. The control of purple nutsedge from imazaquin plus MSMA gradually improved after each consecutive annual application. Therefore, for complete control, it will be necessary to apply these herbicides to the same turfgrass area for up to three years. This is further shown by the decrease in purple nutsedge cover that occurred during the same three-year period as a result of annual imazaquin plus MSMA applications (table 3).

**Experiment II--Imazaquin formulations.** When imazaquin LC and imazaquin G were applied at 0.38 lb/acre, there was no difference until after two annual treatments when final ratings were made August 30, 1988. At this time, the control was greater in plots treated with the G formulation than with the LC formulation. When comparisons were made between the formulations at the 0.25 lb/acre rate, the control was initially greater each year when treated with the LC formulation than with the G formulation, but no difference was noted when final ratings were made August 30, 1988. This was related to faster activity from the LC formulation than from the G formulation.

Even though differences occurred between imazaquin formulations, neither effectively controlled purple nutsedge at rates included in this study. After two annual treatments, purple nutsedge control with imazaquin LC plus MSMA was consistently greater than with imazaquin LC or G alone (table 4). However, the combination of imazaquin LC plus MSMA applied for two consecutive years did not completely control purple nutsedge. These results are also confirmed by cover ratings in table 5. The 10% to 15% purple nutsedge cover after annual treatment with imazaquin plus MSMA for two years in the present study generally agrees with the results (4% to 7% cover) obtained after two years

in Experiment I (table 3). Therefore, as reported in Experiment I, it will be necessary to apply imazaquin plus MSMA for three consecutive years to effectively control and reduce purple nutsedge plant populations.

**Experiment III--Multiple imazaquin treatments.** Imazaquin applied alone in two applications controlled a greater percentage of purple nutsedge than did a single application when final ratings were made August 31, 1987 (table 6). However, the control was initially higher and lasted longer from tank mixtures of imazaquin plus MSMA than from imazaquin alone. At equivalent imazaquin rates, a single application of imazaquin plus MSMA performed as well or better throughout the summer than two applications of imazaquin applied alone. Two applications of imazaquin plus MSMA (June 1 + July 14) controlled > 90% purple nutsedge by August 31. This was 17% to 18% greater than obtained from a single application of imazaquin plus MSMA applied June 1 and rated August 31. MSMA did not effectively control purple nutsedge at any time, regardless of the number of applications.

The initial purple nutsedge control was similar, whether imazaquin was applied alone or with MSMA in 1988 (table 7), but not in 1987 (table 6). However, the control from a single application in 1988 did not last any longer than in 1987. The control in plots from a single application of imazaquin plus MSMA at 0.25 + 2.0 lb/acre in 1988 was reduced to 63% by August 4, compared to 73% when rated August 31, 1987. The control in 1988 was reduced similarly when imazaquin plus MSMA was applied once at 0.38 + 2.0 lb/acre when final ratings were made in August. Purple nutsedge control was similar throughout the summer for two applications of imazaquin plus MSMA and for imazaquin applied alone. Additionally, two applications of imazaquin at 0.25 lb/acre applied alone or with MSMA was as effective as imazaquin at 0.38 lb/acre applied alone or with MSMA in controlling purple nutsedge.

These results indicate that two annual applications of imazaquin controlled a higher percentage of purple nutsedge than did a single application. The control from imazaquin plus MSMA was generally better throughout the summer than with imazaquin alone. MSMA alone did not control purple nutsedge effectively.

### **Bermudagrass tolerance**

#### **Mixture of 'Tifway' and common bermudagrass--Augusta National Golf Club.**

When imazaquin at 0.5 lb/acre was applied to bermudagrass in Experiment I, a maximum injury of 23% occurred two WAT (table 8). The injury symptom was leaf yellowing with some leaf necrosis, but no stand loss. However, the injury was temporary, as the turf exhibited only 2% injury by four weeks. Turf injury was slight (< 20%) when treated with any other herbicide in 1986 or with any herbicide treatment in 1987 or 1988.

Table 8. Influence of Imazaquin Applied Alone or with MSMA as Single Annual Applications to Bermudagrass in Experiment I at Augusta National Golf Club, Augusta, GA

Treatments <sup>a</sup>		Bermudagrass injury <sup>b</sup>					
		1986		1987		1988	
HERBICIDE	RATE	AUG 1	AUG 15	JULY 28	AUG 12	AUG 4	AUG 15
Untreated	-	0	0	0	0	0	0
Imazaquin	0.5	23	2	18	10	13	0
Imazaquin + MSMA	0.5 + 2.0	13	2	5	3	10	0
Imazaquin	0.38	10	0	7	2	3	0
Imazaquin + MSMA	0.38 + 2.0	10	0	7	5	5	0
Imazaquin	0.25	7	0	5	0	7	0
Imazaquin + MSMA	0.25 + 2.0	5	2	7	5	5	0
MSMA	2.0	5	0	0	0	0	0
LSD (0.05)		5	NS	6	4	6	NS

a. Herbicides were applied to the same plots on July 18, 1986, July 14, 1987, and July 21, 1988.

b. Bermudagrass injury ratings were based on 0 = no injury, 1-20 = slight injury, 21-30 = moderate injury, > 30 = severe injury and unacceptable, and 100 = complete kill.

There was no difference in bermudagrass injury between imazaquin formulations (LC or G) in Experiment II, regardless of herbicide rate, when ratings were made four WAT in 1987 and 1988 (data not given). It is possible that injury occurred, but recovered by the time ratings were made.

Bermudagrass treated with imazaquin in Experiment II injured the turf only slightly ( $\leq$  12%) when ratings were made two WAT in 1987 (table 6) and 1988 (table 7). Therefore, imazaquin was safe to apply to mixed 'Tifway' and common bermudagrass.

**Common bermudagrass--Georgia Station** A single application of imazaquin at  $\geq$  0.38 lb/acre injured common bermudagrass  $\geq$  30% when ratings were made one WAT in 1989 and 1990 (table 9). Turf injury was greater with imazaquin at 0.5 lb/acre than at 0.38 lb/acre in 1989, but not in 1990. However, regardless of rate, the turf completely recovered by three weeks after the first application. Coats et al. (1987) reported a maximum injury of 25% to 32% to common bermudagrass at two and three weeks after treatment over a two-year period with imazaquin at 0.75 lb/acre. The injury was  $\leq$  15% during the same period when treated at 0.5 lb/acre. These data indicate that the maximum bermudagrass injury from imazaquin occurred within a one-week period after treatment.

Since the turf had recovered by three weeks, the tolerance data obtained in experiments conducted at Augusta National Golf Club recorded at two WAT or later probably was not the maximum injury.

Table 9. Tolerance of Common Bermudagrass to Imazaquin Treatments in Experiment IV, Griffin, GA

Turf ratings (WAT)								
Applications number								
Rates <sup>a</sup> lb ai/A	1				2			
	1989		1990		1989		1990	
	1 wk	3 wk	1 wk	3 wk	1 wk	3 wk	1 wk	3 wk
<i>% Turf injury<sup>b</sup></i>								
0	0	0	0	0	0	0	0	0
0.38	48	8	30	8	63	12	60	16
0.5	53	1	30	14	64	19	64	24
LSD (0.05)	3	NS	3	NS	4	11	7	10
<i>Turf density<sup>c</sup></i>								
0	8.8	9.2	9.3	8.6	8.3	8.8	8.5	8.4
0.38	8.3	9.3	8.5	8.7	8.5	9.1	7.8	8.9
0.5	8.3	9.0	8.5	8.3	8.5	8.3	7.6	9.1
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS

a. Treatments were applied May 31 and June 22 ± 1 day to the same plots during 1989 and 1990.

b. Turf injury ratings were made 1 and 3 weeks after the last application and based on 0 = no injury, 1-20 = slight injury, 21-30 = moderate injury, > 30 = severe injury and unacceptable, and 100 = complete kill.

c. Turf density ratings were made weeks after treatment and based on 1 = no grass cover and 10 = complete uniform cover.

When the imazaquin application was repeated at a three-week interval to common bermudagrass, the injury was severe (≥ 60%) when ratings were made one week after the second application in 1989 and 1990 (table 9). It should be emphasized that a repeat imazaquin application for purple nutsedge control is normally made at a six-week interval. The severe injury from a repeat application at a three-week interval may be higher than expected from normal applications at a six-week interval. However, the severity of the injury from repeated applications in this experiment indicates that

imazaquin can severely injure common bermudagrass. Although common bermudagrass treated twice with imazaquin did not completely recover by three weeks after the second application, turf density was unaffected (table 9). The density of common bermudagrass was not reduced by any rate of imazaquin, regardless of application number, throughout the two-year period. Therefore, the severe discoloration of the turf from initial imazaquin treatments was temporary, as the turf fully recovered with no stand loss.

### **Summary and Conclusions**

Imazaquin was applied alone or with MSMA for purple nutsedge and bermudagrass tolerance. The major findings are as follows:

1. Imazaquin applied with MSMA generally controlled a higher percentage of purple nutsedge than when applied alone.
2. When imazaquin plus MSMA was applied as a single annual application, three years were required to obtain complete purple nutsedge control.
3. A higher percentage of purple nutsedge control was obtained when imazaquin was applied alone or with MSMA in two annual applications than was obtained from a single application.
4. There was generally no difference in purple nutsedge control, whether imazaquin was applied as a sprayable (LC) or as a granular (G) formulation.
5. Imazaquin severely injured common bermudagrass when tolerance ratings were made within one week of application. The injury increased from applications repeated at a three-week interval. However, the injury was temporary with no stand loss.

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