HRI's Mission:

To direct, fund, promote and communicate horticultural research, which increases the quality and value of ornamental plants, improves the productivity and profitability of the nursery and landscape industry, and protects and enhances the environment.

The use of any trade name in this article does not imply an endorsement of the equipment, product or process named, nor any criticism of any similar products that are not mentioned.

Frequency of Drive (Quinclorac) Treatments on Common Bermudagrass Tolerance and on Large Crabgrass Control[1]

B. Jack Johnson[2]
Department of Crop & Soil Sciences
University of Georgia
Georgia Station, Griffin, GA 30223-1797

Abstract

When a postemergence (POST) herbicide is used to control large crabgrass [*Digitaria sanguinalis* (L.) Scop.] in common bermudagrass [*Cynodon dactylon* (L.) Pers.], the herbicide should maintain optimum weed control for 8 to 10 weeks without causing undesirable injury to the turfgrass. A field experiment was conducted during 1993 and 1994 to determine the lowest rate of Drive (quinclorac) needed to control large crabgrass without causing undesirable injury to bermudagrass turf. Drive (quinclorac) applied at 0.28 kg ai/ha (0.25 lb ai/A) initially in early May and repeated at the same rate at a 2-week interval, controlled 85% large crabgrass for 16 weeks in 1993 and 70% for 10 weeks in 1994. The control in 1994 was 96% for 17 weeks when the herbicide was applied at 0.28 kg ai/ha (0.25 lb ai/A) in each of three applications on May 2, May 29, and June 13. The maximum bermudagrass injury in 1993 from Drive (quinclorac) applied at 0.28 kg ai/ha (0.25 lb ai/A) in each of two applications at 2- to 4-week interval was ≤ 27% compared to ≥ 33% when ≥ 0.56 kg ai/ha (≥ 0.5 lb ai/A) was applied as a single application. Bermudagrass treated initially with Drive (quinclorac) at 0.28 kg ai/ha (0.25 lb ai/A) was injured higher in 1994 (≤ 35%) than in 1993 (≤ 14%). Bermudagrass injury was ≥ 40% when the second application was delayed until mid- to late June either year or when the herbicide was applied in three applications during May and June 1994.

Index words: Cynodon dactylon, turfgrass injury, weed control.

Herbicides used in this study: Drive (quinclorac), 3,7-dichloro-8-quinolinecarboxylic acid.

Significance to the Nursery Industry

Large crabgrass control by late August 1993 was similar whether Drive (quinclorac) was applied once in May at 0.84 kg ai/ha (0.75 lb ai/A) (92%) or twice in May at 0.28 kg ai/ha (0.25 lb ai/A) (85%). However, the control was consistently higher in 1994 when the herbicide was applied at 0.28 kg ai/ha (0.25 lb ai/A) in three applications (96%) than when applied once at 0.84 kg ai/ha (0.75 lb ai/A) (69%). Common bermudagrass turf was injured less from the herbicides when the final application was applied in May or early June than when delayed until mid- to late June.

Introduction

When a postemergence (POST) herbicide is used for crabgrass control in warm- and cool-season turfgrasses, the herbicide should provide effective weed control for 8 to 10 weeks with a minimum number of applications. Daconate (MSMA) (monosodium salt of MAA) will control crabgrass, but repeated applications are required (5). Drive (quinclorac) is a new herbicide in the final development stage for POST crabgrass control. It is in the olinecarboxylic acid family.

POST crabgrass control with Drive (quinclorac) varies with plant size. When applied at 1.1 kg ai/ha (1.0 lb ai/A), the control was higher when the herbicide was applied to 2-leaf to 5-tiller plants in the spring (1, 3, 4, 8) than when applied during late summer to mature crabgrass (> 5 tiller) plants (2). Even though Drive (quinclorac) has POST activity on crabgrass, the performance varies when applied in a single application. When applied at 0.84 kg ai/ha (0.75 lb ai/A), large crabgrass control ranged from 73 to 78% for 10 weeks in three cool-season turfgrasses in New Jersey (4) to 67% for 8 weeks in Kentucky bluegrass (*Poa pratensis* L.) in Maryland (3). Dates of Drive (quinclorac) applications influenced large crabgrass control in Georgia (6, 7). When the herbicide was applied at 0.84 kg ai/ha (0.75 lb ai/A), the control over a two-year period was higher when applied during early April to common bermudagrass than during late April or early June (7); but control was higher when applied during early June to tall fescue (*Festuca arundinacea* Schreb.) than when applied in April. However, large crabgrass control was consistent (≥ 83%) in both turfgrass species when the herbicide was applied at 0.56 kg ai/ha (0.5 lb ai/A) in each of two applications (6, 7).

Drive (quinclorac) has generally not injured any of the cool-season grasses (1, 3, 4, 6). However, bermudagrass was severely injured (35 to 40%) immediately after treatment with the herbicide at 0.56 kg ai/ha (0.5 lb ai/A) in 1 of 2 years in Virginia (1) and at 1.1 kg ai/ha (1.0 lb ai/A) in 2 of 3 years in Georgia (8). Dates of treatment at 0.84 kg ai/ha (0.75 lb ai/A) also influenced common bermudagrass injury in Georgia, but was not consistent across years (7). For example, turfgrass injury was 60% when applied April 10, 1991, but the injury was < 30% during the same period in 1992. When treatments were made on June 10, the injury was > 40% both years. Drive (quinclorac) applied at 0.56 kg ai/ha (0.5 lb ai/A) in each of two applications severely injured (> 30%) common bermudagrass after each treatment and required 3 to 4 weeks for recovery.

Drive (quinclorac) applied at ≥ 0.84 kg ai/ha (≥0.75 lb ai/A) has POST activity on crabgrass, but severely injures bermudagrass. Therefore, an experiment was initiated to determine the lowest herbicide rate needed to effectively control large crabgrass without injuring bermudagrass, whether applied as a single or multiple applications.

[1]Received for publication October 24, 1994; in revised form March 6, 1995. Supported by state and Hatch Act funds allocated to the Georgia Agricultural Experiment Stations. The author gratefully acknowledges J. Davis and C. Jones for statistical, and T. Dinkins and W. Olson for technical assistance.

[2]Professor, Department of Crop and Soil Sciences.

Materials and Methods

Mature common bermudagrass was overseeded with large crabgrass seed at 10 kg/ha (9 lb/A) in January for two consecutive years before treatment with Drive (quinclorac) during 1993 and 1994 at Griffin, GA. The population of large crabgrass was excellent with a density of 68 and 95% in untreated plots by late August in 1993 and 1994, respectively. Drive (quinclorac) was applied in single and sequential applications. Herbicide treatments were applied as a broadcast spray in 375 liter/ha (40 gal/A) of water. A surfactant BAS 09002S from BASF Corp., P.O. Box 13528, Research Triangle Park, NC 17709 was applied with Drive (quinclorac) at 0.25% v/v. Treatments are given in Table 1 for 1993 and Table 2 for 1994. Treatments were applied initially on May 5, 1993 and on May 2, 1994 when large crabgrass was in the 3-leaf to 3-tiller growth stage. Different plots were used each year.

The bermudagrass was fertilized each year with 50N-22P-42K kg/ha (45N-20P-38K lb/A) during early April and early September. An additional 50 kg N/ha (45 lb/A) was applied during late May or early June. The turfgrass was irrigated as needed to maintain optimum growth. Actively growing turf was mowed three times per week with a reel mower at a height of 3 cm (1.2 in). The soil type was a Cecil sandy clay loam (clayey, kaolinitic thermic Typic Kanhapludult) with 63% sand, 16% silt, and 21% clay. Organic matter was 2%.

Visual ratings for turfgrass injury and large crabgrass control were made at various times during the spring and summer. Turfgrass injury ratings were made within one week after initial treatment and at 1- to 2-week intervals until late August. The ratings were based on 0 to 100 where 0 = no injury, 1–15 = minor leaf discoloration, 16–30 = moderate leaf discoloration with some plant necrosis, > 30 = moderate to severe leaf discoloration and plant necrosis, and 100 = complete kill. Large crabgrass control ratings were made mid-June and at bi-weekly intervals until late August and based on 0 to 100 where 0 = no control and 100 = complete control.

Drive (quinclorac) treatments were applied in a randomized complete block design with four replications. Plot size was 1.5 by 3.0 m (5 by 10 ft). Analysis of variance (ANOVA) using the Statistical Analysis System (General Linear Model Procedure) was conducted within and across years (9), and the means were separated by LSD at the 0.05 level. Herbicide by year interactions were found and means were presented separately by year.

Results and Discussion

Turfgrass injury—1993. The injury to common bermudagrass during 1993 was within an acceptable range (< 30%) when Drive (quinclorac) was applied initially (May 5) at 0.28 kg ai/ha (0.25 lb ai/A) or 0.43 kg ai/ha (0.38 lb ai/A), and followed by 0.28 kg ai/ha (0.25 lb ai/A) at 2 (May 17), or 4 (June 2) weeks later (Table 1). However, the injury was > 30% when the second application was delayed until June 17 (6 weeks). The higher injury from repeated June 17 treatment, compared to repeated treatments on May 17 and June 2 was probably related to higher temperature. The mean low-high temperature for 7 days following the June 17 treatment was 27C (80F), compared to ≤ 24C (≤ 75F) following the earlier dates. The injury from the 0.28 + 0.28 kg ai/ha (0.25 + 0.25 lb ai/A), was lower for two weeks than from the 0.43 + 0.28 kg ai/ha (0.38 + 0.25 lb ai/A). At the lowest rates, the injury was > 20% for only one week, compared to three weeks when treated with the higher rates.

Turfgrass injury in 1993 was ≥ 33% when Drive (quinclorac) was applied alone at ≥ 0.56 kg ai/ha (≥ 0.5 lb ai/A) (Table 1). Therefore, Drive (quinclorac) applied at 0.28

Table 1. Effect of dates and frequency of Drive (quinclorac) treatments on injury of common bermudagrass, Griffin, GA. 1993.

Treatments			Turfgrass injury[z]				
Rates		Date applied	May 17	May 24	June 7	June 21	June 28
kg ai/ha	lb ai/A		%				
Untreated	—	—	0	0	0	0	0
0.84	0.75	May 5	35	29	3	6	13
0.56	0.50	May 5	33	22	10	5	13
0.43	0.38	May 5	25	23	0	0	11
0.28	0.25	May 5	12	10	2	3	12
0.28 + 0.28	0.25 + 0.25	May 5 + May 17	12	27[y]	3	2	8
		May 5 + June 2	11	16	24[y]	7	12
		May 5 + June 17	14	15	3	44[y]	19
0.43 + 0.28	0.38 + 0.25	May 5 + May 17	24	25[y]	24	0	13
		May 5 + June 2	27	20	27[y]	5	23
		May 5 + June 17	30	20	1	43[y]	24
0.43 + 0.43	0.38 + 0.38	May 5 + May 17	30	40[y]	8	9	15
		May 5 + June 2	28	22	35[y]	7	23
		May 5 + June 17	23	16	9	46[y]	18
LSD @ 0.05			8	12	7	7	13

[z]Turfgrass injury ratings were based on 0 to 100 where 0 = no injury, 1–15 = minor leaf discoloration, 16–30 = moderate leaf discoloration with some plant necrosis, > 30 = moderate to severe leaf discoloration and plant necrosis, and 100 = complete kill.

[y]Indicates injury from a second herbicide application.

kg ai/ha (0.25 lb ai/A) in each of two applications offers an advantage of less turfgrass injury during the recovery period than when application was made at ≥ 0.56 kg ai/ha (≥ 0.5 lb ai/A).

Turfgrass injury—1994. The initial common bermudagrass injury from Drive (quinclorac) applied at 0.28 kg ai/ha (0.25 lb ai/A) was consistently higher in 1994 (≤ 35%) (Table 2), than in 1993 (≤ 14%) (Table 1). At 10 days after treatment in 1994, no difference was detected in turfgrass injury, whether the herbicide was applied at any rate from 0.28 to 0.84 kg ai/ha (0.25 to 0.75 lb ai/A).

When Drive (quinclorac) was applied at 0.28 kg ai/ha (0.25 lb ai/A) or 0.43 kg ai/ha (0.38 lb ai/A) on May 2, 1994, and followed by 0.28 kg ai/ha two weeks later, the maximum turfgrass injury was 22% (Table 2). However, the injury was severe (> 40%) when the May 2 treatment was followed by an additional application at 0.28 kg ai/ha (0.25 lb ai/A) on June 22, or when followed by two additional applications at 0.28 kg ai/ha (0.25 lb ai/A) on May 29 and June 13.

These results show that Drive (quinclorac) will cause varying degrees of bermudagrass injury immediately following treatment. During 1993, the turfgrass injury was less when 0.28 kg ai/ha (0.25 lb ai/A) was applied in each of two applications at a 2-week interval than when applied once at ≥ 0.56 kg ai/ha (≥ 0.5 lb ai/A). All Drive (quinclorac) treatments injured common bermudagrass > 30% in 1994. However, the maximum injury from repeated application was less when either 0.28 or 0.43 kg ai/ha (0.25 or 0.38 lb ai/A) was applied as an initial treatment in early May and followed by 0.28 kg ai/ha (0.25 lb ai/A) at a 2-week interval (17 to 22%) than when the repeat treatment was delayed until late June (42 to 44%).

Large crabgrass control—1993. Drive (quinclorac) applied at ≥ 0.56 kg ai/ha (≥ 0.5 lb ai/A) controlled large crabgrass effectively (86%) throughout the growing season during 1993 (Table 3). The control was similar from 0.43 kg ai/ha (0.38 lb ai/A) through mid-July, but declined to an unacceptable level (67%) by late August. A single application at 0.28 kg ai/ha (0.25 lb ai/A) did not control large crabgrass at any time during the spring or summer (≤ 41%).

When Drive (quinclorac) was applied at 0.28 kg ai/ha (0.25 lb ai/A) in each of two applications on May 5 and May 17, large crabgrass was controlled 85% when final ratings were made on August 23, 1993 (Table 3). No difference was found in control when the herbicide was applied at 0.28 kg ai/ha (0.25 lb ai/A) in each of two applications or at 0.56 kg ai/ha (0.5 lb ai/A) in a single application (86%). Large crabgrass control during 1993 was similar when the second 0.28 kg ai/ha (0.25 lb ai/A) application of Drive (quinclorac) was made at a 2, 4, or 6-week interval.

Large crabgrass control—1994. Drive (quinclorac) did not control large crabgrass as effectively during 1994 (Table 4) as during 1993 (Table 3). In 1994, large crabgrass control from a single application of the herbicide was 86% with 0.28 kg ai/ha (0.25 lb ai/A) at 7 weeks (June 21), 72% with either 0.43 or 0.56 kg ai/ha (0.38 or 0.5 lb ai/A) at 8 weeks (June 28), and 88% with 0.84 kg ai/ha (0.75 lb ai/A) at 10 weeks (July 11). Large crabgrass control was unacceptable (< 70%) from any of the single treatments after these dates. Drive (quinclorac) applied at 0.28 kg ai/ha (0.25 lb ai/A) on May 2 and followed by the same rate on May 29 and June 13 controlled large crabgrass higher (96%) by late August than when the herbicide was applied once in May at 0.84 kg ai/ha (0.75 lb ai/A) (69%). Large crabgrass control was poor (< 70%) by late August when Drive (quinclorac) was ap-

Table 2. Effect of dates and frequency of Drive (quinclorac) treatments on injury of common bermudagrass, Griffin, GA. 1994.

Treatments			Turfgrass injury[z]				
Rates		Date applied	May 12	May 30	June 6	June 21	June 28
kg ai/ha	lb ai/A		%				
Untreated	—	—	0	0	0	0	0
0.84	0.75	May 2	32	15	11	17	10
0.56	0.50	May 2	30	20	18	18	18
0.43	0.38	May 2	33	19	20	18	16
0.28	0.25	May 2	31	16	18	18	14
0.28 + 0.28	0.25 + 0.25	May 2 + May 15	35	17[y]	6	14	12
0.28 + 0.28 + 0.28	0.25 + 0.25 + 0.25	May 2 + May 29 + June 13	35	25	22[y]	40[w]	30
0.28 + 0.28	0.25 + 0.25	May 2 + June 22	31	23	20	14	44[y]
0.43 + 0.28	0.38 + 0.25	May 2 + May 15	29	22[y]	9	15	16
0.43 + 0.28 + 0.28	0.38 + 0.25 + 0.25	May 2 + May 29 + June 13	31	15	21[y]	41[w]	34
0.43 + 0.28	0.38 + 0.25	May 2 + June 22	36	27	26	18	42[y]
0.43 + 0.43	0.38 + 0.38	May 2 + May 15	36	30	14	27	20
0.43 + 0.43 + 0.43	0.38 + 0.38 + 0.38	May 2 + May 29 + June 13	33	22	28[y]	43[w]	26
0.43 + 0.43	0.38 + 0.38	May 2 + June 22	36	24	22	21	47
LSD @ 0.05			12	14	13	15	16

[z]Turfgrass injury ratings were based on 0 to 100 where 0 = no injury, 1–15 = minor leaf discoloration, 16–30 = moderate leaf discoloration with some plant necrosis, > 30 = moderate to severe leaf discoloration and plant necrosis, and 100 = complete kill.

[y]Indicates injury from a second herbicide application.

[w]Indicates injury from a third herbicide application.

Table 3. Effect of dates and frequency of Drive (quinclorac) treatments on large crabgrass control in common bermudagrass. Griffin, GA. 1993.

Treatments			Large crabgrass control[z]			
Rates		Date				
kg ai/ha	lb ai/A	applied	June 14	June 28	July 15	Aug 23
			%			
Untreated	—	—	0	0	0	0
0.84	0.75	May 5	99	99	97	92
0.56	0.50	May 5	98	99	81	86
0.43	0.38	May 5	96	97	83	67
0.28	0.25	May 5	41	33	20	13
0.28 + 0.28	0.25 + 0.25	May 5 + May 17	98	98	96	85
		May 5 + June 2	99	99	93	79
		May 5 + June 17	66	98	98	88
0.43 + 0.28	0.38 + 0.25	May 5 + May 17	99	100	99	96
		May 5 + June 2	96	97	94	77
		May 5 + June 17	97	100	98	96
0.43 + 0.43	0.38 + 0.38	May 5 + May 17	98	100	100	96
		May 5 + June 2	99	100	99	97
		May 5 + June 17	93	100	98	99
LSD @ 0.05			8	7	8	13

[z]Large crabgrass control ratings were based on 0 to 100 where 0 = no control and 100 = complete control.

plied in one or two applications. An exception occurred when 0.43 kg ai/ha (0.38 lb ai/A) was applied twice (May 2 and May 15). The poorer large crabgrass control from Drive (quinclorac) during 1994 (Table 4) than during 1993 (Table 3) was probably related to excessive rainfall. Total rainfall during June and July 1994 was 73.1 cm (28.8 in), with 34.7 cm (13.7 in) occurring over a 2-day period on July 5 and 6.

These results indicate that Drive (quinclorac) will control large crabgrass in common bermudagrass turf. During 1993, the control was effective for 16 weeks (85%) when the herbicide was applied initially at 0.28 kg ai/ha (0.25 lb ai/A) on May 5, and repeated at the same rate on May 17. Common bermudagrass treated with the sequential Drive (quinclorac) treatments had minor leaf discoloration symptoms for one week after the initial application (12% injury), and moderate leaf discoloration with some plant necrosis symptoms for one week after the second application (27% injury). The injury was temporary, and the turfgrass fully recovered within one week after each application. When the 0.28 kg ai/ha (0.25 lb ai/A) was applied in each of two ap-

Table 4. Effect of dates and frequency of Drive (quinclorac) treatments on large crabgrass control in common bermudagrass. Griffin, GA. 1994.

Treatments			Large crabgrass control[z]			
Rates		Date				
kg ai/ha	lb ai/A	applied	June 21	June 28	July 11	Aug 29
			%			
Untreated	—	—	0	0	0	0
0.84	0.75	May 2	95	92	88	69
0.56	0.50	May 2	89	72	67	38
0.43	0.38	May 2	83	72	60	39
0.28	0.25	May 2	86	61	46	41
0.28 + 0.28	0.25 + 0.25	May 2 + May 15	98	95	70	51
0.28 + 0.28 + 0.28	0.25 + 0.25 + 0.25	May 2 + May 29 + June 13	100	100	100	96
0.28 + 0.28	0.25 + 0.25	May 2 + June 22	85	97	79	40
0.43 + 0.28	0.38 + 0.25	May 2 + May 15	98	97	93	65
0.43 + 0.28 + 0.28	0.38 + 0.25 + 0.25	May 2 + May 29 + June 13	100	100	100	99
0.43 + 0.28	0.38 + 0.25	May 2 + June 22	83	98	91	57
0.43 + 0.43	0.38 + 0.38	May 2 + May 15	98	100	96	79
0.43 + 0.43 + 0.43	0.38 + 0.38 + 0.38	May 2 + May 29 + June 13	100	100	100	99
0.43 + 0.43	0.38 + 0.38	May 2 + June 22	85	91	91	61
LSD @ 0.05			11	11	12	18

[z]Large crabgrass control ratings were based on 0 to 100 where 0 = no control and 100 = complete control.

plications in 1994, large crabgrass control was excellent for 8 weeks (95%), but declined rapidly thereafter (70% by 10 weeks; 51% by 17 weeks) from heavy rainfall during June and July. Drive (quinclorac) applied at 0.28 kg ai/ha (0.25 lb ai/A) on May 2 and repeated at the same rate on May 29 and June 13 controlled large crabgrass effectively (96%) for 17 weeks. However, these treatments caused moderate to severe leaf discoloration during May (25 to 35%) and June (22 to 40%). Common bermudagrass required approximately four weeks to recover fully from the sequential treatments. Therefore, multiple applications of Drive (quinclorac) improved large crabgrass control in 1 of 2 years, but generally injured the bermudagrass. When bermudagrass injury occurred from the herbicide treatment, the turf fully recovered within 2 to 4 weeks after each application with no stand loss.

Literature Cited

1. Chism, W.J. and S.W. Bingham. 1991. Postemergence control of large crabgrass (*Digitaria sanguinalis*) with herbicides. Weed Sci. 39:62–66.

2. Coats, G.E., J.W. Scruggs, D.H. Anderson, D.C. Heering and R.F. Munoz. 1986. Herbicide screening studies in warm-season turfgrasses. 1985. Mississippi Agric. and For. Exp. Bul. 945.

3. Dernoeden, P.H. and J.M. Krouse. 1991. Selected crabgrass control evaluations for Maryland in 1990. Proc. Northeast. Weed Sci. Soc. 45:117–118.

4. Enache, A.J. and R.D. Ilnicki. 1991. BAS 514 and dithiopyr for Weed Control in cool-season turfgrasses. Weed Technol. 5:616–621.

5. Johnson, B.J. 1975. Postemergence control of large crabgrass and goosegrass in turf. Weed. Sci. 23:404–409.

6. Johnson, B.J. 1994. Influence of dates and frequency of Drive treatments on large crabgrass control in tall fescue turf. J. Environ. Hort. 12:83–86.

7. Johnson, B.J. 1995. Frequency of quinclorac treatments on bermudagrass tolerance and large crabgrass control. J. Turfgrass Management 1:49–59.

8. Johnson, B.J. and T.R. Murphy. 1989. Summer annual weed control in turfgrass. Georgia Agric. Res. Bul. 388.

9. SAS Institute. 1982. SAS User's Guide. Cary, NC.