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# Tank-Mixed Postemergence Herbicides for Postemergence Goosegrass Control in Bermudagrass Turf[1]

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## Abstract

Goosegrass [*Eleusine indica* (L.) Gaertn.] continues to be a major weed problem in bermudagrass (*Cynodon spp.*) throughout the southern United States. A field experiment was conducted during 1995 and 1996 in Georgia to determine if tank-mixed postemergence herbicides would improve goosegrass control in common bermudagrass [*Cynodon dactylon* (L.) Pers.] turf. Illoxan (diclofop), MSMA plus Sencor (metribuzin), MSMA plus Sencor with Princep (simazine), and selected rates of Illoxan with Princep controlled goosegrass effectively (≥83%) for 8 weeks in 1995. However, the control was ineffective (<80%) for any treatment by 8 weeks in 1996. The higher control in 1995 was probably related to higher air temperature [mean high temperature was 35C (95F) for 14 days after treatment] compared to 1996 [32C (89F) during the same period]. Tank-mixes of Princep with MSMA did not improve goosegrass control compared with Illoxan alone. Addition of Princep to MSMA, MSMA plus Sencor, or Illoxan did not increase bermudagrass injury compared to these treatments applied without Princep.

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

**Herbicides used in this study:** Illoxan (diclofop), (±)-2[4-(2.4-dichlorophenoxy)phenoxy] propanoic acid, MSMA, monosodium methanearsonate, Princep (simazine), 6-chlor-*N*,*N*-diethyl-1,3,5-triazine-2,4-diamine, and Sencor (metribuzin), 4-amino-6(1,1-dimethylethyl)-3-methylthio)-1,2,4-triazin-5(4*H*)-one.]

## Significance to the Nursery Industry

Tank-mixes of Princep (simazine) with MSMA did not improve goosegrass control in bermudagrass compared with Illoxan (diclofop) alone in a single application. The control at 8 weeks with Illoxan at 1.1 kg/ha (1.0 lb/A) was 83% in 1995, but only 48% in 1996. These treatments cannot be applied to cool-season grasses because of severe injury.

## Introduction

Goosegrass continues to be a major weed problem in turfgrasses throughout the southeastern United States. When weeds are not controlled, turfgrass quality is reduced whether the grass is grown on golf courses, athletic fields, home lawns, industrial parks, or other turf areas. However, goosegrass can be controlled with timely use of preemergence (5, 6, 7) and postemergence (8, 9, 12) herbicides. Postemergence herbicides are used in areas not previously treated, or when the preemergence herbicides do not provide full season control.

[1]Received for publication October 21, 1996; in revised form December 11, 1996. Supported by state and Hatch Act funds allocated to the Georgia Agricultural Experiment Stations. The author gratefully acknowledges J. Davis for statistical analysis, and W. Olson, T. Dinkins, and C. Jones for technical assistance.

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When goosegrass control is dependent on postemergence herbicides, multiple applications are often needed to maintain acceptable weed control (≥80%) level (1).

Multiple applications of MSMA plus Sencor (metribuzin) are needed for postemergence control of goosegrass for 6 to 8 weeks (1). (Since MSMA is commonly used and has several trade names, it will be used alone throughout the paper.) Illoxan (diclofop) has postemergence activity on goosegrass, but the control ranges from poor to acceptable (2, 3, 4, 8, 9, 12). The control in Mississippi from 1.1 kg/ha (1.0 lb/A) applied in 1 or 2 applications was 90% on golf greens but was reduced to ≤50% in fairways and roughs (12). The control from the same rate in Florida ranged from 29 to 95% for 3 to 5 weeks over a 2-year period when the herbicide was applied once at the same rate to fairways (9). Goosegrass control in Georgia was consistent for 8 to 9 weeks (85 to 96%) (2, 4, 8), but not (36 to 97%) when rated 14 to 16 weeks after application. In Hawaii, mature goosegrass was controlled 100% for 12 weeks when treated once with Princep at 2.2 kg/ha (2.0 lb/A) and twice with MSMA at 2.2 kg/ha (2.0 lb/A) (10). However, it is desirable to maintain optimum goosegrass control for 8 to 10 weeks with minimum number of applications.

Tank-mixes of Sencor with MSMA controlled goosegrass consistently better in Georgia than when either was applied alone (1). However, tank-mixes of Illoxan with MSMA did not consistently improve the control (4, 9, 12). Goosegrass control was actually reduced from tank-mixing Illoxan with MSMA in 3 of 4 studies in Florida (9) and 2 of 3 studies in Georgia (4). Since multiple MSMA applications combined with a single Princep application controlled goosegrass in Hawaii (10), an experiment was initiated to determine the influence of single tank-mixed applications of Princep with MSMA and other postemergence herbicides for goosegrass control and influence of treatments on bermudagrass tolerance.

## Materials and Methods

MSMA, MSMA plus Sencor, and Illoxan were applied alone and with Princep as tank-mixed treatments for postemergence goosegrass control in common bermudagrass during 1995 and 1996. Herbicide application rates are given in Table 1. The experiment was located at Beaver Lake Golf and Country Club, Gay, GA. Postemergence herbicides were applied to mature (four to eight tillers) goosegrass initially on July 11, 1995, and July 17, 1996. A second application was applied 9 ± 2d later. Plots were located on different experimental sites each year. Goosegrass population at time of treatment was 65% cover in 1995 and 41% cover in 1996.

**Table 1. Effect of postemergence herbicides on goosegrass control in common bermudagrass.**

| Treatments[z] | | | Goosegrass control[y] | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Rate | | 1995 | | | 1996 | | |
| Herbicide | kg ai/ha | lb ai/A | 3 Wk | 5 Wk | 8 Wk | 3 Wk | 5 Wk | 8 Wk |
| | | | % | | | | | |
| Untreated | — | — | 0 | 0 | 0 | 0 | 0 | 0 |
| Illoxan | 1.1 | 1.0 | 64 | 74 | 83 | 59 | 61 | 48 |
| (diclofop) | 0.6 | 0.5 | | | | | | |
| | fb0.6 | fb0.5 | 67 | 78 | 94 | 55 | 71 | 64 |
| MSMA | 2.2 | 2.0 | 13 | 5 | 0 | 48 | 26 | 0 |
| | 2.2 | 2.0 | | | | | | |
| | fb2.2 | fb2.0 | 76 | 48 | 54 | 87 | 54 | 19 |
| MSMA + Sencor (metribuzin) | 2.2 + 0.14 | 2.0 + 0.12 | 93 | 83 | 83 | 75 | 51 | 18 |
| | 2.2 + 0.14 | 2.0 + 0.12 | | | | | | |
| | fb2.2 + 0.14 | fb2.0 + 0.12 | 99 | 91 | 100 | 92 | 69 | 42 |
| MSMA + Princep (simazine) | 2.2 + 1.1 | 2.0 + 1.0 | 51 | 31 | 33 | 76 | 22 | 14 |
| | 2.2 + 1.7 | 2.0 + 1.5 | 47 | 38 | 40 | 87 | 68 | 39 |
| | 2.2 + 2.2 | 2.0 + 2.0 | 39 | 38 | 42 | 95 | 74 | 46 |
| | 1.1 + 1.1 | 1.0 + 1.0 | 46 | 35 | 40 | 77 | 70 | 56 |
| | 1.1 + 1.7 | 1.0 + 1.5 | 48 | 35 | 31 | 77 | 42 | 8 |
| | 1.1 + 2.2 | 1.0 + 2.0 | 61 | 55 | 57 | 66 | 22 | 0 |
| MSMA + Sencor + Princep | 2.2 + 0.14 + 1.1 | 2.0 + 0.12 + 1.0 | 99 | 99 | 97 | 92 | 73 | 58 |
| | 2.2 + 0.14 + 1.7 | 2.0 + 0.12 + 1.5 | 96 | 98 | 98 | 94 | 68 | 46 |
| | 2.2 + 0.14 + 2.2 | 2.0 + 0.12 + 2.0 | 99 | 98 | 98 | 98 | 88 | 76 |
| Illoxan + Princep | 1.1 + 1.1 | 1.0 + 1.0 | 45 | 42 | 53 | 42 | 48 | 12 |
| | 1.1 + 2.2 | 1.0 + 2.0 | 86 | 93 | 91 | 88 | 77 | 64 |
| | 0.6 + 1.1 | 0.5 + 1.0 | 82 | 83 | 91 | 66 | 48 | 35 |
| | 0.6 + 2.2 | 0.5 + 2.0 | 83 | 83 | 82 | 77 | 66 | 62 |
| LSD 0.05 | | | 22 | 16 | 18 | 12 | 14 | 15 |

[z]Herbicides were applied initially to 4 to 8 tiller goosegrass on July 11, 1995, and July 17, 1996. fb = followed by a second application 9 ± 2d later.

[y]Goosegrass control ratings were made 3, 5, and 8 weeks after the first treatment and based on 0 = no control to 100 = complete control. On this scale < 80% would be commercially unacceptable.

All herbicides were applied as a broadcast spray in 375 L/ha (40 gal/A) of water.

Common bermudagrass was mowed once per week with a reel mower at 1.9 to 2.5 cm (0.75 to 1.0 in) height. Clippings were returned immediately following each mowing. The turf was fertilized with 50N–22P–42K kg/ha (45N–20P–38K lb/A) in mid-April. Turfgrass was not irrigated. However, goosegrass was actively growing when herbicide treatments were applied both years. Rainfall was adequate to prevent drought stress for 8 weeks after treatment both years.

Visual estimates of turfgrass injury and weed control ratings were made during 1995 and 1996. Turf injury ratings were made initially at 1 week after treatment and at weekly intervals from 1 to 8 weeks and based on 0 to 100 where 0 = no injury and 100 = complete kill. On this scale, 1 to 15% = minor leaf discoloration, 16 to 30% = moderate leaf discoloration with some plant necrosis, and >30% = moderate to severe leaf discoloration and plant necrosis. Turf injury >30% would not be acceptable. Goosegrass control ratings were made initially at 3 weeks after treatment and at weekly intervals from 3 to 8 weeks and based on goosegrass density and converted to percent control where 0 = no control and 100 = complete control. On this scale, ≥90% would be preferred while <80% would not be acceptable.

The experimental design was a randomized block with four replications. Plot size was 1.5 by 3 m (5 by 10 ft). The data were analyzed (ANOVA) within and across years using the General Linear Models Procedure (11).

## Results and Discussion

There were year by herbicide treatment interactions for turf injury and goosegrass control and the data are presented by year.

*Goosegrass control.* The control of goosegrass in common bermudagrass during 1995 was effective (≥83%) for 8 weeks when treated with Illoxan and MSMA plus Sencor (Table 1). The control was 83% when Illoxan was applied once at 1.1 kg/ha (1.0 lb/A) and 94% when applied at 0.6 kg/ha (0.5 lb/A) in each of two applications. MSMA plus Sencor at 2.2 + 0.14 kg/ha (2.0 + 0.12 lb/A) controlled 83% when applied once and 100% when applied in each of two applications. The results for Illoxan and multiple MSMA plus Sencor treatments were similar to earlier studies (1, 2). In the present study, no advantage was found in goosegrass control at 8 weeks after treatment in 1995 when Princep was tank-mixed and applied with Illoxan or MSMA plus Sencor compared

**Table 2. Tolerance of common bermudagrass to postemergence herbicides for goosegrass control.**

| Treatments[z] | | | Turfgrass injury[y] | | | |
|---|---|---|---|---|---|---|
| | Rate | | 1995 | | 1996 | |
| Herbicide | kg ai/ha | lb ai/A | 11d | 18 d | 13d | 20d |
| | | | % | | | |
| Untreated | — | — | 0 | 0 | 0 | 0 |
| Illoxan | 1.1 | 1.0 | 24 | 5 | 11 | 9 |
| (diclofop) | 0.6 | 0.5 | | | | |
| | fb0.6 | fb0.5 | 23[x] | 15 | 6 | 4 |
| MSMA | 2.2 | 2.0 | 26 | 9 | 21 | 11 |
| | 2.2 | 2.0 | | | | |
| | fb2.2 | fb2.0 | 22[x] | 27 | 29 | 24 |
| MSMA + Sencor (metribuzin) | 2.2 + 0.14 | 2.0 + 0.12 | 35 | 23 | 33 | 24 |
| | 2.2 + 0.14 | 2.0 + 0.12 | | | | |
| | fb2.2 + 0.14 | fb2.0 + 0.12 | 35[x] | 33 | 50 | 25 |
| MSMA + Princep (simazine) | 2.2 + 1.1 | 2.0 + 1.0 | 22 | 14 | 38 | 21 |
| | 2.2 + 1.7 | 2.0 + 1.5 | 19 | 8 | 36 | 28 |
| | 2.2 + 2.2 | 2.0 + 2.0 | 13 | 11 | 37 | 23 |
| | 1.1 + 1.1 | 1.0 + 1.0 | 16 | 8 | 23 | 18 |
| | 1.1 + 1.7 | 1.0 + 1.5 | 13 | 8 | 29 | 20 |
| | 1.1 + 2.2 | 1.0 + 2.0 | 16 | 9 | 32 | 29 |
| MSMA + Sencor + Princep | 2.2 + 0.14 + 1.1 | 2.0 + 0.12 + 1.0 | 33 | 25 | 36 | 16 |
| | 2.2 + 0.14 + 1.7 | 2.0 + 0.12 + 1.5 | 39 | 28 | 34 | 29 |
| | 2.2 + 0.14 + 2.2 | 2.0 + 0.12 + 2.0 | 37 | 20 | 37 | 24 |
| Illoxan + Princep | 1.1 + 1.1 | 1.0 + 1.0 | 24 | 16 | 23 | 0 |
| | 1.1 + 2.2 | 1.0 + 2.0 | 29 | 27 | 16 | 11 |
| | 0.6 + 1.1 | 0.5 + 1.0 | 24 | 13 | 9 | 3 |
| | 0.6 + 2.2 | 0.5 + 2.0 | 28 | 26 | 9 | 3 |
| LSD 0.05 | | | 13 | 14 | 17 | 16 |

[z]Herbicides were applied initially on July 11, 1995, and July 17, 1996. fb = followed by a second application 9 ± 2d later.

[y]Turfgrass injury ratings were based on 0 to 100 where 0 = no injury ≥30% commercially unacceptable, and 100 = complete kill.

[x]Second herbicide application not applied at this date.

with Illoxan or MSMA plus Sencor alone. The higher control from Illoxan alone at 1.1 kg/ha (1.0 lb/A) than when tank-mixed with Princep at 2.2 kg/ha (1.0 lb/A) was probably antagonistic as reported in earlier studies (4, 9). Antagonism was not observed from the tank-mixes when Illoxan was applied at 0.6 kg/ha (0.5 lb/A) with Princep at any rate or when Illoxan was applied at 1.1 kg/ha (1.0 lb/A) with Princep at 2.2 kg/ha (2.0 lb/A). Tank-mixes of MSMA plus Princep did not control goosegrass effectively (≤61%) at anytime during the 8 week period in 1995.

Postemergence herbicides did not control goosegrass as effectively in 1996 as in 1995 (Table 1). Two applications of MSMA plus Sencor provided 92% control of goosegrass at 3 weeks, but the control was only 69% by 5 weeks. The poor control was related to treated plants outgrowing the damage caused by herbicide treatments. The control was similar at 3 weeks from tank-mixes of MSMA at 2.2 kg/ha (2.0 lb/A) with Princep at ≥1.7 kg/ha (≥1.5 lb/A), MSMA plus Sencor at 2.2 + 0.14 kg/ha (2.0 + 0.12 lb/A) with Princep at ≥1.1 kg/ha (≥1.0 lb/A), and Illoxan at 1.1 kg/ha (1.0 lb/A) with Princep at 2.2 kg/ha (2.0 lb/A). By 5 weeks, the control in all treated plots was <80% except for 88% in plots treated with combinations of MSMA plus Sencor and Princep, but reduced to 76% by 8 weeks. The poor control from tank-mixes of MSMA and Princep differs from those observed in Hawaii (10). The difference in response was probable to the extra MSMA application made to plots treated initially with MSMA and Princep in Hawaii, but not in Georgia.

The higher goosegrass control for Illoxan and MSMA plus Sencor alone or with Princep in 1995 than in 1996 was probably related to air temperature. The mean high air temperature for 14 days after treatment was 35C (95F) in 1995 compared to 32C (89F) in 1996. Rainfall during the 14 day period was 2.3 cm (0.9 in) in 1995 and 8.0 cm (3.1 in) in 1996. When weeds are actively growing at time of postemergence herbicide treatments and followed by dry and above-normal temperatures as in 1995, the herbicides were more active in controlling weeds.

Goosegrass control was consistent with Illoxan in earlier studies (2, 7), but not in the present study (Table 1). The difference was probably related to size of goosegrass plants when treatments were made. Treatments in the present study were applied to mature goosegrass plants with 4 to 8 tillers in mid-July, while treatments in previous studies were applied during late-May when goosegrass plants had 2 to 4 tillers (2, 7).

These results revealed that tank-mixes of MSMA and Princep applied in a single application did not effectively control goosegrass. Additional studies are needed to determine if these treatments would improve the control of small goosegrass plants and whether additional MSMA treatments would improve the control of mature goosegrass plants. Tank-mixes of Illoxan and Princep were not advantageous when compared with Illoxan alone.

*Turfgrass injury*. The initial injury to common bermudagrass in 1995 and 1996 was moderate (<30%) when treated with MSMA, Illoxan, and Illoxan plus Princep and severe (>30%) when treated with MSMA plus Sencor, MSMA plus Sencor with Princep and MSMA plus Princep (Table 2.). Of the herbicides evaluated in this study, MSMA plus Sencor applied in two applications caused the highest injury, which was similar to injury reported in earlier studies (2, 3). Bermudagrass injury was not increased from combinations of Illoxan and Princep compared with Illoxan, combinations of MSMA plus Sencor with Princep compared with MSMA plus Sencor, and combinations of MSMA and Princep compared with MSMA. However, regardless of initial injury level, the turfgrass recovered rapidly, usually within 3 to 4 weeks after treatment (data not shown).

These results showed that Illoxan, MSMA, and MSMA plus Sencor will cause various degrees of injury within a few days after treatment. However, the injury was not permanent and did not increase when any of these herbicides were tank-mixed with Princep.

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