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Diclofop for Goosegrass Control in Bermudagrass Putting Greens[1]

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Abstract. **Diclofop (2-(4-(2,4-dichlorophenoxy)phenoxy)propanoic acid) caused little to no injury to common bermudagrass [*Cynodon dactylon* (L.) Pers.] mowed twice weekly at 1.6–2.0 cm at rates of 0.56, 1.12, 2.24, and 4.48 kg/ha or to 'Tifdwarf' bermadagrass *Cyndon dactylon* x *C. transvaalensis* Burtt-Davey, mowed daily at 0.5 cm at rates of 0.56, 1.12, and 2.24 kg/ha. Diclofop at 0.56, 1.12, and 2.24 kg/ha gave good control of mature goosegrass [*Eleusine indica* (L.) Gaertn.] in 'Tifdwarf' turf mowed daily at 0.5 cm, but resulted in inadequate control at 4.48 kg/ha in common bermudagrass turf mowed twice weekly at 1.6 or 2.0 cm.**

Goosegrass is a serious weed of turfgrass, particularly on golf course putting greens if it is not controlled while in an immature stage. Monosodium methanearsonate (MSMA) applications generally do not satisfactorily control mature goosegrass in bermudagrass turf (6, 10). Recently, Johnson (7) reported that methazole [2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione] or metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4H)-one] controlled goosegrass, but caused significant injury. Later, Johnson (8) reported that low rates of methazole or metribuzin plus MSMA controlled goosegrass in 'Tifdwarf' bermudagrass putting greens with only temporary injury. Our unpublished data indicate that metribuzin plus MSMA combinations at rates as low as 0.07 kg/ha metribuzin and 1.12 kg/ha MSMA can sometimes cause severe injury to bermudagrass putting greens in Hawaii.

Diclofop is a relatively new herbicide which provides control of several annual grasses, including goosegrass, but provided no control of several emerged perennial grasses (1). In other studies with diclofop in turf, injury was observed on a turf mixture of red fescue (*Festuca rubra* L.), Kentucky bluegrass (*Poa pratensis* L.) and colonial bentgrass (*Agrostis tenuis* Sibth) which might limit the usefulness of this herbicide (5).

These experiments were conducted to determine the effect of diclofop on goosegrass control and injury to turf in 'Tifdwarf' bermudagrass putting greens and common bermudagrass fairways or roughs. Four separate experiments were conducted on golf courses during 1979–1980 on turf maintained at different cultural intensities. Goosegrass was mature and flowering in all experiments, even when mowed at 0.5 cm daily.

The first experiment was conducted on common bermudagrass mowed twice weekly at about 1.6 cm. Treatments were applied on June 12, 1979. Air temperatures during the experiment ranged from 21 to 28°C. The second experiment was established on Aug. 7, 1979, on common bermudagrass mowed twice weekly at 2.0 cm. Air temperatures during the course of this experiment ranged from 22 to 30°.

The soil for these experiments was a Tropeptic Eutrustox, a silty clay red soil with about 3% organic matter and a pH of 5.5 to 6.0. Mineralogically the soil is mostly kaolin minerals and iron oxides, but the cystalline minerals have coatings of silicon-depleted amorphous materials.

The third experiment was initiated on Aug. 7, 1979, on a 'Tifdwarf' bermudagrass practice putting green mowed daily at 0.5 cm. This green was constructed from soil in the area near that of experiment 1. Air temperature during the experiment ranged from 22 to 30°C.

The fourth experiment was established on April 23, 1980, on a 'Tifdwarf' bermudagrass practice putting green near that used in experiment 3. This green was constructed of coral sand with pH of 7.5–8.0. No organic amendment was included in the original coral medium. Air temperatures throughout the experiment ranged from 18 to 26°C.

Herbicides in all experiments were applied to 1.5 × 3.0-m plots replicated 4 times in a randomized complete block design. Spray volume was 374 liters/ha applied at 2.1 kg/cm^2 pressure. In experiments where MSMA was included, MSMA was reapplied at weekly intervals for a total of 3 applications. MSMA applications included 0.16% v/v of a commercial nonionic surfactant. No surfactant was used with diclofop.

Experiments were evaluated for goosegrass control and phytotoxicity to bermudagrass turf at weekly intervals after application. Goosegrass control and phytotoxicity were rated on a scale of 0 to 100%, with 0% being no control or phytotoxicity and 100% being complete control of goosegrass or killing of the turf. Control is based primarily on established goosegrass, but includes new goosegrass emerging over time. Ratings were made by 2 people at each date and averaged. Data were subjected to analysis of variance. Because significant changes in ratings did not occur weekly, only data from selected dates are given.

Normal golf course use and maintenance practices including irrigation, fertilization, and mowing were carried out on all areas throughout the experimental periods.

Neither diclofop nor MSMA provided satisfactory goosegrass control nor caused serious phytotoxicity to common bermudagrass in the golf driving range or golf rough (Tables 1 and 2). MSMA gave fair control at the 4-week rating in the golf course rough (Table 2), but goosegrass recovered and only about 50% control was observed at the 8-week rating. Weed control was even poorer in the

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Table 1. Influence of diclofop and MSMA on phytotoxicity to common bermudagrass and control of goosegrass in a golf course driving range.

Herbicide[z]	Rate (kg/ha)	Common bermudagrass phytotoxicity[y] 2 wk	4 wk	6 wk	Goosegrass control[y] 2 wk	4 wk	10 wk
Control	0	0a[x]	0b	0	0c	0d	0b
MSMA	2.24	3a	13a	0	30b	43ab	35a
Diclofop	0.56	0a	0b	0	5c	5d	0b
Diclofop	1.12	5a	3b	0	13c	25c	0b
Diclofop	2.24	1a	0b	0	28b	33bc	8b
Diclofop	4.48	0a	0b	0	50a	55a	33a

[z]Herbicides were first applied on June 12, 1979; MSMA was reapplied on June 19, 1979, and on June 27, 1979.
[y]Phytotoxicity and control were noted on a scale of 0–100%, with 0% being no phytotoxicity or control and 100% being complete turf kill or complete goosegrass control. Visual ratings are presented for different weeks after the first herbicide application.
[x]Mean separation in columns by the Bayesian LSD test, 5% level.

Table 2. Influence of diclofop and MSMA on phytotoxicity to common bermudagrass and control of goosegrass in a golf course rough.

Herbicide[z]	Rate (kg/ha)	Common bermudagrass phytotoxicity[y] 2 wk	4 wk	Goosegrass control[y] 2 wk	4 wk	8 wk
Control	0	0b[x]	0c	0d	0e	0b
MSMA	2.24	15a	5b	40b	84a	58a
Diclofop	0.56	8b	8a	18c	5de	20b
Diclofop	1.12	0b	4b	23c	15cd	10b
Diclofop	2.24	3b	0c	25c	25c	30ab
Diclofop	4.48	5b	4b	55a	63b	30ab

[z]Herbicides were applied on Aug. 7, 1979; MSMA was reapplied on Aug. 14, 1979, and on Aug. 21, 1979.
[y]Phytotoxicity and control were rated on a scale of 0–100%, with 0% being no phytotoxicity or control and 100% being complete turf kill or complete goosegrass control. Visual ratings are presented for different weeks after the first herbicide application.
[x]Mean separation in columns by the Bayesian LSD test, 5% level.

Table 3. Influence of diclofop on phytotoxicity to 'Tifdwarf' bermudagrass and control of goosegrass in a golf putting green of soil construction.

Diclofop rate[z] (kg/ha)	Tifdwarf bermudagrass phytotoxicity[y] 2 wk	4 wk	10 wk	Goosegrass control[y] 2 wk	6 wk	10 wk
0	0	0c[x]	0	0b	0c	0d
0.56	0	5bc	0	81a	51b	55c
1.12	0	13a	0	93a	93a	83b
2.24	3	10ab	0	95a	99a	95a

[z]Diclofop applied on Aug. 7, 1979.
[y]Phytotoxicity and control were rated on a scale of 0–100%, with 0% being no phytotoxicity or control and 100% being complete turf kill or complete goosegrass control. Visual ratings are presented for different weeks after diclofop application.
[x]Mean separation in columns by the Bayesian LSD test, 5% level.

Table 4. Influence of diclofop on phytotoxicity to 'Tifdwarf' bermudagrass and control of goosegrass in a golf putting green of coral sand construction.

Diclofop rate[z] (kg/ha)	Tifdwarf bermudagrass phytotoxicity[y] 2 wk	4 wk	Goosegrass control[y] 1 wk	4 wk	6 wk
0	0	0	0b[x]	0c	0c
0.56	0	0	82a	88b	73b
1.12	0	0	85a	90b	76b
2.24	0	0	89a	100a	91a

[z]Diclofop applied on April 23, 1980.
[y]Phytotoxicity and control were rated on a scale of 0–100%, with 0% being no phytotoxicity or control and 100% being complete turf kill or complete goosegrass control. Visual ratings are presented for different weeks after diclofop application.
[x]Mean separation in columns by the Bayesian LSD test, 5% level.

golf driving range, perhaps because the goosegrass was larger, and also the air temperature was slightly lower during this experiment.

In the 2 experiments on practice putting greens, diclofop provided good control of goosegrass and caused slight to no phytotoxicity to 'Tifdwarf' bermudagrass greens (Tables 3 and 4). Control was observed as early as 1 week after application (Table 4) and was evident as late as 10 weeks after application (Table 3). Diclofop appeared to be slightly more active on the green built on coral sand (Table 4) than on the green built on soil (Table 3).

These data show that diclofop is very effective for closely mowed goosegrass control in putting green turf, but is ineffective on larger goosegrass. It is unclear why diclofop controls goosegrass under closely mowed putting green conditions and not under taller, less frequently mowed conditions. Postemergence activity from applications of diclofop can result from absorption by foliar tissues (2) and roots (2, 3). Perhaps the more frequent mowing of greens resulted in a shallower root system of goosegrass, and thus a greater percentage of the absorbing area was exposed to diclofop in the soil. Furthermore, it has been established that optimum soil moisture at application will increase diclofop activity (4, 9), a condition that is more associated with putting greens than fairways or roughs. Finally, the stress created by close and frequent mowing might increase the susceptibility of goosegrass to diclofop.

The excellent tolerance of bermudagrass to diclofop coupled with the susceptibility of goosegrass under putting green conditions indicates its potential for use in bermudagrass putting greens.

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