



FIG. 1. Bentgrass varieties used in this study. Individual plots are 5 x 10 feet.

Phytotoxicity of Preemergence Herbicides

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Crabgrass and annual bluegrass (*Poa annua* L.) are serious weeds which invade putting green turf. Of the two weeds, annual bluegrass is the most difficult to eradicate. Annual bluegrass is a prolific seed producer that can produce seed under putting green height of cut. Annual bluegrass is the main grass component in some putting greens because it persists under many putting green management programs.

H. B. Sprague and Glenn W. Burton³ were among the first researchers to observe that lead arsenate was slightly toxic to annual bluegrass. Lead arsenate has been used to control annual bluegrass on putting greens for many years with

a fair degree of success when applied at the right time and at the right amounts. Calcium arsenate is used to some extent for annual bluegrass control, but control has been somewhat erratic. Injury from calcium arsenate can result from high application rates, excessive buildup of soil toxicity levels, and from applications made during hot weather. V. B. Youngner⁴ states that calcium arsenate is not safe to use on greens under their conditions in the West.

Although several preemergence herbicides give excellent control of crabgrass, there is justifiable concern over potential injury to bentgrass greens. There is also the possibility of injury

from preemergence herbicides applied for annual bluegrass control. Holman M. Griffin¹ reported good control of crabgrass with DCPA (Dacthal) on bentgrass. His findings are supported by field experience that shows this herbicide to have a high degree of safety on all but Cohansey bentgrass greens. A. T. Perkins² reported bensulide as a promising herbicide to eradicate annual bluegrass without injury to 16 bentgrass selections.

The purpose of this study was to determine the phytotoxicity of six preemergence herbicides on several bentgrass varieties.

Bentgrasses and Herbicides

The experiment was set up in 1965 on bentgrass plots sprigged or seeded in 1957. The experimental area included four replications of 5 feet by 10 feet plots planted to the following creeping bentgrass varieties: Arlington, Congressional, Cohansey, Collins, C-52 (Old Orchard®), Metropolitan, Pennncross, Pennlu, Seaside, Washington, and a mixture of Arlington and Congressional (Fig. 1.). Herbicide treatments were applied across the replications in 16 main plots measuring 2½ feet wide and 55 feet long. Three of six herbicides were applied on two of the four bentgrass replications. The bentgrass variety subplots within herbicide treatments were 2½ feet by 5 feet. Herbicides and rates applied were: 1) bensulide, 15 pounds per acre; 2) DMPA, 15 pounds per acre; 3) siduron wettable powder, 12 pounds per acre; 4) DCPA wettable powder, 10 pounds per acre; 5) lead arsenate 96 per cent, five pounds per 1,000

square feet; 6) calcium arsenate 69 per cent, five pounds per 1,000 square feet; and 7) the control plot. Rates of all herbicides were based on active ingredients per acre except lead arsenate and calcium arsenate. All herbicides were applied with a knapsack sprayer, each in one gallon water, except for lead arsenate and calcium arsenate which were mixed with sand and applied with a fertilizer spreader.

Herbicides were applied to the same plots in May for five consecutive years, from 1965 to 1969. Visual phytotoxicity notes were taken in July or August of each year. Injury scores were not obtained in 1968 because of a severe attack of disease just before ratings were to be taken. Injury to the bentgrasses was not evident in 1969.

Results

The amount of injury to bentgrass varieties, averaged over three years, is listed in Table 1. Of the six herbicides used in this study, bensulide was the only one that did not appear to injure any of the bentgrasses tested. A trace of injury was observed from lead arsenate in 1966. There was no obvious injury to bentgrasses from lead arsenate in the other two years.

Appreciable varietal differences are apparent among bentgrasses in reaction to herbicides, with the exception of bensulide and lead arsenate. This is seen in the absence of siduron injury on Pennncross and the appreciable level of damage from this herbicide on the Washington variety. Calcium arsenate injury on C-52 was relatively severe, with only slight injury on Penn-

TABLE 1. Turf injury scores on bentgrass selections (average for 1965-1967)¹

Varieties	Herbicides and Rates					
	DMPA 15 lb/A	Calcium arsenate 5 lb/1000 sq. ft.	Siduron 12 lb/A	Lead arsenate 5 lb/1000 sq. ft.	DCPA 10 lb/A	Bensulide 15 lb/A
Pennlu	1.3	1.0	.7	.17	1.2	0
Arlington	.8	1.0	.7	.17	1.0	0
Pennncross	1.2	.8	0	.3	1.2	0
Arlington Congressional	.3	.3	.8	0	1.2	0
C-52 (Old Orchard®)	.8	2.2	.17	0	1.0	0
Metropolitan	1.0	1.7	.8	0	1.0	0
Washington	1.3	.3	3.3	0	1.7	0
Congressional	.3	.7	.3	0	.8	0
Cohansey	.7	.7	.17	.3	1.8	0
Collins	.8	.17	1.3	0	1.2	0
Seaside	1.3	1.2	1.7	.3	1.5	0

¹ Scores: 0 = (no apparent injury) to 10 = (severe injury)

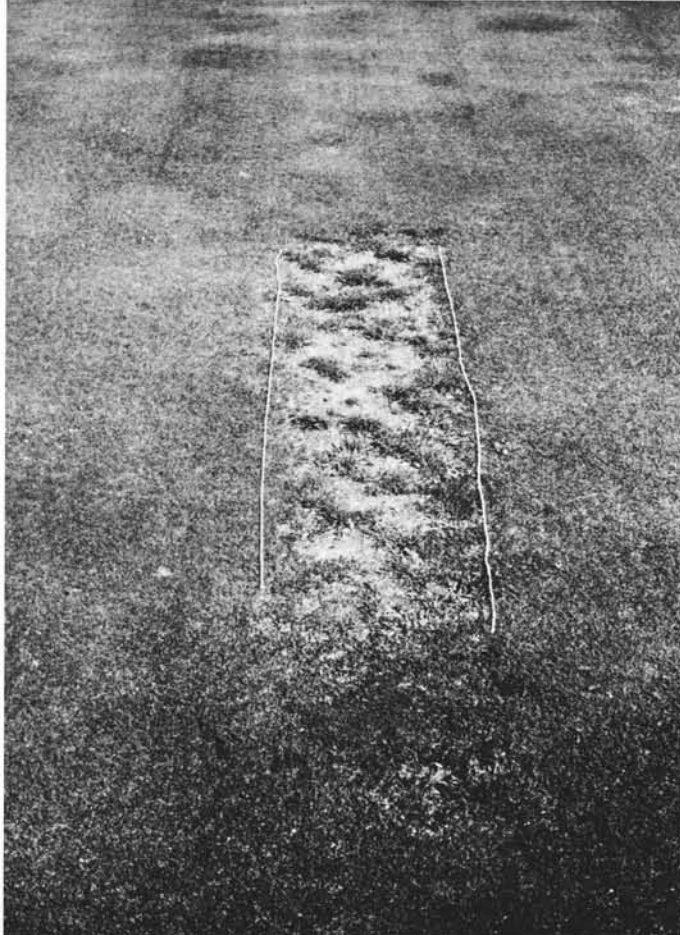


FIG. 2. Turf injury to Washington bentgrass from siduron applied at 12 pounds ai per acre.

cross and Washington bentgrass.

There was variation among years in the amount of herbicide injury on bentgrasses (Table 2). Injury from DCPA rated 2.3 in 1966, compared with .1 in 1965 and .8 in 1967.

DMPA rated 0 in 1965, 2.5 in 1966, and .4 in 1967 while calcium arsenate was rated 1.3 in both 1965 and 1966 but only .2 in 1967.

There was 107 per cent more injury from siduron in 1967 than in 1966. In 1965, siduron injury to Washington bentgrass was 7.5 (Fig. 2) with little or no damage to several other varieties. *Poa annua* largely filled in the injured areas of Washington bentgrass so that very little injury was observed during the next two years.

The higher rate of injury from calcium arsenate in 1965 was due to the susceptibility of C-52, which received an average score of 5.0 (Fig. 3) and to relative high scores assigned to Metropolitan (3.5) and Seaside (3.5). In 1965, all but two bentgrass varieties were slightly injured by the calcium arsenate application.

Injury from DCPA was different from that of the other herbicides in that the turf was not

scorched to form open areas. Stolons from DCPA treated plots failed to root well, the sod was less dense, and the turf had a ragged appearance (Fig. 4).

In 1968, both lead arsenate and calcium arsenate were applied in water with a knapsack sprayer. Within a day or two the calcium arsenate plots showed considerable scorching which disappeared in approximately two to three weeks.

The lack of injury to bentgrass from application of bensulide confirms the findings reported by Perkins². Control of *Poa annua* with bensulide may require annual applications for two or three years to prevent seed germination. Established *Poa annua* may remain in the greens for a number of years because of the favorable conditions for *Poa annua* growth found in most putting green management programs.

Date of preemergence herbicide application may be an important factor in amount of injury that may occur. Applications made in the Mid-Atlantic States in May, when temperatures are high, may be responsible for more severe injury to the bentgrasses, particularly from DCPA and calcium arsenate. Preemergence herbicide treatments for control of crabgrass and annual bluegrass can create problems in reseeding damaged greens. Residues from treatments can reduce the successful establishment of bentgrass seedlings. If herbicide injury is a problem, damaged areas should be sodded rather than seeded.

Summary

Phytotoxicity of 6 herbicides on 11 bentgrass varieties was observed in the field from 1965-1969. Herbicides were applied in strips 2½ feet wide and 55 feet long across plots of the 11 bentgrass varieties.

TABLE 2. Injury to bentgrasses from herbicides as it varied from year to year (average for all bentgrass varieties)¹

	1965	1966	1967
Siduron	.7	.6	1.3
DMPA	.0	2.5	.4
Calcium arsenate 69% ai	1.3	1.3	.2
Lead arsenate 96% ai	.0	.3	.0
DCPA	.1	2.3	.8
Bensulide	.0	.0	.0

¹ Scores: .0 (no apparent injury) to 10 (severe injury)

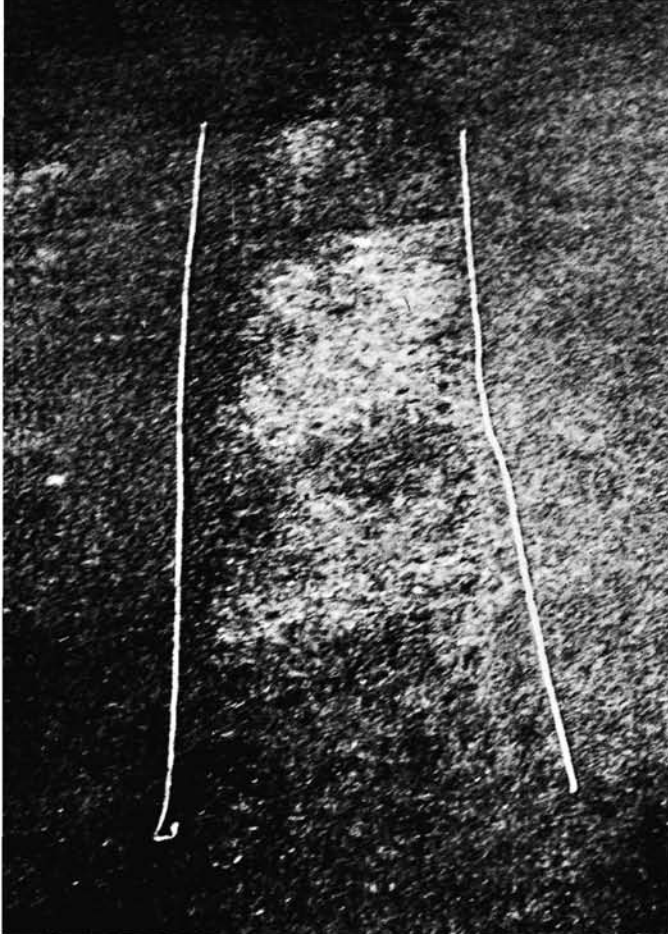


FIG. 3. Turf injury to Old Orchard bentgrass from calcium arsenate applied at 215 pounds per acre.

Washington bentgrass was severely injured in 1965 by an application of siduron, but there was only a trace of injury on two other selections. DMPA did not cause any injury in 1965 but quite severe injury occurred in 1966. Old Orchard®, Seaside, and Metropolitan were most sensitive to calcium arsenate injury in 1965. There was some injury from calcium arsenate on all but two strains in 1966. Bentgrasses were discolored in 1968 when calcium arsenate was applied in liquid form. Injury from lead arsenate was negligible. Bentgrass stolons failed to root readily from applications of DCPA. Bensulide caused no noticeable injury.

FIG. 4 Congressional bentgrass stolons failing to root properly. DCPA applied at 10 pounds ai per acre.

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APPENDIX

LIST OF HERBICIDES REFERRED TO IN THIS PUBLICATION

Common name	Chemical name	Trade name	Manufacturer's name
DMPA	0-(2,4-dichlorophenyl) 0-methyl isopropylphosphoramidothioate	* Zytron	* Dow Chemical
siduron	1-(2-methylcyclohexyl)-3-phenylurea	* Tupersan	* E. I. duPont
DCPA	dimethyl tetrachloroterephthalate	* Dacthal	* Diamond Shamrock
bensulide	0,0-diisopropyl phosphorodithioate S-ester with N-(2-mercaptoethyl) benzene-sulfonamide	* Betasan	* Stauffer
calcium arsenate	calcium arsenate	several names	various companies
lead arsenate	lead arsenate	several names	various companies

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