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INTRODUCTION

Algae and cyanobacteria can be serious problems on golf putting greens throughout the southeastern United States. Excessive rainfall or irrigation, humidity, and suboptimal mowing heights compound the problem. Cultural practices that maintain healthy turf are often the best way to control these organisms. However, during periods of extended rainfall, pesticides may be beneficial management tools. For many years, fungicides and/or hydrated lime and bleach have been used to combat these organisms on greens. Although some of these products are not labeled for use as algicides, they need to be evaluated for effectiveness under field conditions.

"Algae" on golf greens are often mixtures of different species of algae and cyanobacteria (often called blue-green algae) (Baldwin and Whitton, 1992; Colbaugh et al., 1994b; Maddox and Goatley, 1995; Maddox et al., 1997). These two groups are in separate taxonomic kingdoms (Raven et al., 1981); however, due to ongoing changes in classification within the two kingdoms, the genera in this study are grouped as either eukaryotic or prokaryotic algae. This is a logical grouping due to distinct physiological differences between the groups (Raven et al., 1981). Eukaryotic algae on putting green soils in central Mississippi consist mainly of the divisions Chlorophyta and Chrysophyta (Maddox et al., 1997), whereas prokaryotic algae are cyanobacteria. Both groups consist mostly of photoautotrophic species, similar to higher plants.

Most algicide/cyanobactericide evaluations have used visual ratings to evaluate control (Vargas et al., 1986; Soika and Sanders, 1991; Colbaugh and Williams, 1993; Colbaugh et al., 1994a,c; Elliott, 1994, 1995). Such ratings can be used to evaluate the quality of turf in regard to algal colonization, or the actual reduction in the amount of visible algae on the surface in response to a treatment. The first method is questionable because turf density alone can reduce algal numbers. The second method, direct microscope counts, may be more precise since color similarities among genera may make it difficult to visually determine which genera are being controlled. For example, Chrysophyta and some genera of Cyanobacteria may both appear brown, making them difficult to see in thatch. In addition, the colors of Chlorophyta genera like *Chlamydomonas* and *Hormidium* may appear similar to those of some cyanobacterial genera like *Oscillatoria*. Combinations of different genera of eukaryotic and prokaryotic algae within a study can make accurate chemical evaluations difficult without the use of a microscope.

There were two purposes of this study: (1) to evaluate the efficacy of various algicides using direct microscopic counts of eukaryotic and prokaryotic algae; and (2) to compare direct microscopic counts with subjective visual ratings.

MATERIALS AND METHODS

Sampling Site

This study was conducted on a 'Tifgreen' bermudagrass green [*Cynodon dactylon* (L.) Pers. x *C. transvaalensis* Burtt-Davy] at the Mississippi State University Golf Course, east of Starkville, Mississippi, in the summers of 1992, 1993, and 1994. The green was constructed with native soil (Kipling Silty Clay Loam) and covered with about 15 cm of sand from years of topdressing. A native soil green modified with sand was used for this study since greens of this type often experience algal/cyanobacterial problems. The study area on the green was moved each year to avoid possible residual effects from the previous annual treatments. Turf cover ranged from 90% to 95% throughout the 7-week study each year. Irrigation was used as needed, and the green was mowed to 4 mm daily. Water soluble nitrogen (NH_4NO_3) was applied at 4.9 grams per square meter (g m^{-2}) before the initiation of each study. In each year, soil analyses showed similar levels of phosphorus, 58 to 80 kilograms per hectare (kg ha^{-1}); potassium, 101 to 130 kg ha^{-1}; magnesium, 76 to 77 kg ha^{-1}; and zinc, 9.5 to 11.3 kg ha^{-1}. Calcium levels ranged from 394 to 589 kg ha^{-1} and pH from 5.4 to 6.0.

Chemical Applications

Treatments were arranged in a randomized complete block design with three replications per treatment. Experimental units were 0.9 x 1.8 m. A 0.6-m alleyway was left between each block to prevent chemical drift and tracking between blocks. All treatments were applied twice at 3-week intervals. The applications were made on July 7 and 29, 1992, July 7 and 28, 1993, July 19, 1994, and August 9, 1994. The following treatments and rates were applied per square meter: Bleach (experimental) (Clorox®, The Clorox Company, Oakland, California) as a 1% solution (0.000525%, or 0.19 g m^{-2}, sodium hypochlorite) in 1992 and 1993; chlorothalonil (tetrachloroisophthalonitrile) (Daconil 2797, ISK Biotech Corp., Mentor, Ohio) at 0.96 g of active ingredient (a.i.) in each year; copper (Hi-Yield Bordeaux Mix Fungicide, Voluntary Purchasing Groups, Inc., Bonham, Texas) at 0.075 g in 1992 and 1993; hydrated lime (experimental) (calcium hydroxide) (Hi-Yield Hydrated Lime, Voluntary Purchasing Groups) at 24.4 g in each year; mancozeb (manganese, zinc, and ethylene bisdithiocarbamate ion) (Dithane WF, Rohm and Haas Company, Philadelphia, Pennsylvania) at 0.92 g a.i. in each year; quaternary ammonium salts (alkyl and dimethyl benzyl ammonium chloride and alkyl and dimethyl ethylbenzyl ammonium chloride) (Consan Triple Action 20, Parkway Research Corporation, Kingwood, Texas) at 0.0024 g a.i. (0.35 mL product) in 1992 and 1993; quaternary ammonium salts (Algaen-X, Grace-Sierra, Milpitas, California) at 0.135 g a.i. (4.0 mL product) in 1994; and an untreated control in each year. The rates for quatenary ammonium salt treatments were changed because of product label differences between Consan Triple Action 20 and Algaen-X. Treatments that were labeled for algae were used at recommended rates. All treatments, except hydrated lime, were applied in a water carrier (359 mL per square meter) by a CO_2-powered boom sprayer with pressure at 1.75 kg cm^{-2}. The hydrated lime was applied by hand and received immediate, thorough watering with a sprinkler can to facilitate soil contact and remove the product from the turf foliage. For the purposes of this study, these treatments were evaluated for both algicidal (using eukaryotic algae numbers) and cyanobactericidal (using prokaryotic algae numbers) activity.

Golf course superintendents typically use 7- to 10-day intervals when applying algicides. However, 21-day intervals were used in this study to allow the organisms more time to recover and to permit some inferences to be made about adequate spray intervals. The spray volumes used in this study are higher than those typically used by golf course superintendents applying some of these products as fungicides. However, higher spray volumes can increase penetration of the turf canopy and are commonly used with algicides. Since the target organisms in this study live on the soil surface, we considered higher spray volumes to be necessary.

Putting Green Sampling

Sampling was initiated on July 7, 1992 and 1993, and July 19, 1994, before treatments were applied. Each week, two soil samples from each experimental unit were taken with a 1.9 cm diameter steel corer to a depth of 2.5 cm. Soil samples were taken from the center of each experimental unit at opposite ends. Each week, soil samples were collected within 2.5 cm of the location of the last soil sample to reduce sampling variation among weeks.

Eukaryotic and prokaryotic algal numbers in soil samples were analyzed under a light microscope (Dynazoom Research Laboratory Microscope, Bausch and Lomb, Rochester, N.Y.). Each soil sample was placed in a 25 x 150-mm test tube, and 25 mL of distilled water was added to each sample and shaken vigorously for 30 seconds. A micropipette (Pipetman 200) was used immediately to collect a sample of the suspension. Two 25-µL drops were placed on a microscope slide at opposite ends, and each drop was covered with a cover slip. Three microscope fields at 200X were analyzed from each drop to determine eukaryotic and prokaryotic algal numbers, resulting in a total of 12 microscope fields for each treatment replication. Genera counted as eukaryotes were *Chlamydomonas* sp., *Cylindrocystis* sp., *Navicula mutica* Kütz., *Hantzschia amphioxys* (Ehr.) Grun., *Hormidium* sp., and *Stichococcus* sp. The cyanobacteria counted were three *Oscillatoria* spp. and a *Nostoc* sp. These eight genera were enumerated since they were found in highest numbers at the time of initiation in 1992. These genera were also the most common on the green in the 1993 and 1994 studies, although the eukaryotic genera were present in low numbers in 1994. Coloration was used to determine viability visually. Only eukaryotic and prokaryotic algal taxa with coloration were counted. Given the difficulty in counting single cells within a trichome and the functioning of trichomes as a single unit, trichomes consisting of more than one cell (*Hormidium* sp., *Oscillatoria* spp., and *Nostoc* sp.) were counted as one unit or observation. Data are presented as the number per microliter of sample solution.

The experimental design was a randomized complete block that included three replications with repeated measures (years). Data were analyzed using the general linear models (GLM) procedure across years, since some algicide treatments were not applied during 1994. Since there were no missing data within a given year, the analysis-of-variance (ANOVA) procedure was used within years, within years across weeks, and within years across treatments (SAS Institute, 1988a).

A visual algal cover rating was used for comparison with the numerical counts by using the Pearson product-moment correlation procedure (SAS Institute, 1988b). The visual rating scale ranged from 1 (no visible algae/cyanobacteria) to 6 (complete mat of algae/cyanobacteria).

Results and Discussion

Eukaryotic and Prokaryotic Algal Interactions

A significant year by week interaction ($P \leq 0.05$) was indicated by a GLM analysis of both eukaryotic and prokaryotic algae numbers. Due to these interactions, eukaryotic and prokaryotic algal data were analyzed by year, across weeks, and within weeks. In 1992, eukaryotic and prokaryotic algae numbers generally increased over the course of the study, whereas they generally decreased in 1993 (Tables 1-2). Higher temperatures may have reduced numbers in 1993 (average daily highs of 34.1°C in July 1993). Only numbers of prokaryotic algae are presented for 1994 (Table 3), since numbers of eukaryotic algae were very low.

Table 1. The effects of six algicide treatments on numbers of eukaryotic algae per microliter of sample solution from a bermudagrass green in 1992 and 1993.[1]

Treatment	Rate [2]	Number per microliter (1992) [3]								Number per microliter (1993) [3]							
		0	1	2	3	4	5	6	LSD [4]	0	1	2	3	4	5	6	LSD [4]
Quaternary Ammonium Salts	0.0024	11	14	16	55	58	73	57	26	13	8	6	5	5	10	10	NS
Sodium Hypochlorite	0.19	17	8	19	61	39	27	21	26	31	6	3	6	10	15	10	12
Chlorothalonil	0.96	16	1	7	30	15	24	16	NS	20	7	2	0	2	7	2	6
Copper	0.075	11	7	14	63	28	48	37	21	24	9	6	3	10	10	8	10
Hydrated Lime	24	14	1	15	32	4	8	11	11	20	9	9	6	4	4	2	9
Mancozeb	0.92	22	6	8	42	21	27	36	14	36	10	7	8	2	10	7	11
Control	-	12	14	11	31	39	62	53	31	26	6	7	10	8	12	10	NS
LSD [4]		NS	NS	NS	NS	25	40	29		NS	NS	NS	NS	NS	NS	NS	

[1]Eukaryotic species: *Chlamydomonas* sp., *Cylindrocystis* sp., *Navicula mutica* Kütz., *Hantzschia amphioxys* (Ehr.) Grun., *Hormidium* sp., and *Stichococcus* sp.
[2]Treatments measured in grams of active ingredient per square meter. All treatments except hydrated lime applied with a water carrier in a volume of 359 mL m^{-2}.
[3]Number of algae at 0-6 weeks after initiation. First application (week 0) made on July 7, 1992 and 1993. Second application (week 3) made on July 29, 1992, and July 28, 1993.
[4]Mean separation across weeks within treatment and across treatments within week by Fisher's protected least significant difference ($P \leq 0.05$); NS = nonsignificant.

Table 2. The effects of six algicide treatments on numbers of prokaryotic algae per microliter of sample solution from a bermudagrass green in 1992 and 1993.[1]

Treatment	Rate [2]	Number per microliter (1992) [3]								Number per microliter (1993) [3]							
		0	1	2	3	4	5	6	LSD [4]	0	1	2	3	4	5	6	LSD [4]
Quaternary Ammonium Salts	0.0024	234	260	358	387	331	183	424	NS	141	191	242	150	152	127	112	NS
Sodium Hypochlorite	0.19	146	219	348	350	238	216	488	NS	186	239	192	167	148	166	115	59
Chlorothalonil	0.96	115	148	228	277	192	124	257	101	145	125	180	179	171	150	141	NS
Copper	0.075	163	234	408	336	173	205	427	NS	167	179	198	141	169	141	107	NS
Hydrated Lime	24	201	184	278	272	147	156	265	NS	148	159	226	137	117	100	102	NS
Mancozeb	0.92	150	222	321	273	226	185	470	NS	151	198	168	192	170	168	112	NS
Control	-	201	312	332	299	256	235	387	NS	191	155	239	154	203	135	148	55
LSD [4]		NS	82	NS	NS	102	NS	NS		NS	NS	NS	30	45	41	NS	

[1]Prokaryotic species: *Oscillatoria* spp. *and Nostoc* sp.
[2]Treatments measured in grams of active ingredient per square meter. All treatments except hydrated lime applied with a water carrier in a volume of 359 mL m^{-2}.
[3]Number of algae at 0-6 weeks after initiation. First application (week 0) made on July 7, 1992 and 1993. Second application (week 3) made on July 29, 1992, and July 28, 1993.
[4]Mean separation across weeks within treatment and across treatments within week by Fisher's protected least significant difference ($P \leq 0.05$); NS = nonsignificant.

Effects on Eukaryotic Algae

At study initiation in 1992 and 1993, numbers of eukaryotic algae were not significantly different among treatments (Table 1). In 1992 and 1993, all treatments reduced the number of algae within 1 week after the first application, except the quaternary ammonium salt and control treatments in 1992. One week after the first application in 1992, the numbers of eukaryotic algae were significantly ($P \leq 0.05$) reduced by hydrated lime and mancozeb. One week after the first application in 1993, reductions were significant in all treatments except the quaternary ammonium salt and control treatments.

Similar trends were observed after the second application in 1992 (Table 1). All treatments except the quaternary ammonium salts and control treatments reduced numbers of eukaryotic algae. After the second application in 1993, no differences within treatments were significant.

In 1992, no effects within weeks were significant until the first week after the second application (Table 1), when numbers in the quaternary ammonium salts treatment were significantly higher than in the chlorothalonil, copper, hydrated lime, and mancozeb treatments. However, only hydrated lime reduced numbers significantly relative to the control. No treatment effects were significant within weeks in 1993 (Table 1).

The quaternary ammonium salt treatment had little effect. In 1992, increases in eukaryotic algae were observed 1 week after each application only in the quaternary ammonium salt and control treatments. Numbers in the quaternary ammonium salt treatment never differed from those in the control.

Trends observed in the chlorothalonil and mancozeb treatments were similar in 1992 and 1993. In 1992, reductions in algal populations in the mancozeb treatment were significant 1 week after both applications. In 1993, reductions were observed after both applications, but they were significant only 1 week after the first application. Numbers did recover by the final week of the study in 1992, but remained low relative to the control. Numbers tended to be lower in the chlorothalonil treatment, although the trends were similar. Using visual ratings, Soika and Sanders (1991) observed some control using the same rate of chlorothalonil. Some control of unidentified algae was observed using mancozeb in two studies conducted by Colbaugh et al. (1994a,c), although the rates were far higher (39.8 and 37.6 g a.i. m^{-2}) than those used in this study (0.92 g a.i. m^{-2}).

Trends in the bleach and copper treatments were similar to those in the chlorothalonil and mancozeb treatments, but the numbers were generally higher. Vargas et al. (1986) observed some control using copper sulfate.

Numbers of eukaryotic algae were reduced 1 week after each application of hydrated lime in 1992 and 1993. All reductions were significant, except for 1 week after the second application in 1993. Note that hydrated lime is not currently labeled as an algicide for use on golf putting greens.

Repeated use of chlorothalonil at a higher labeled rate (1.44 g a.i. m^{-2}) may damage turf, particularly at higher temperatures, although the mechanisms are not fully understood (Maddox and Goatley, 1995). The rate used in this study (0.96 g a.i. m^{-2}) is at the low range of labeled rates. Higher rates of bleach and mancozeb, when mixed with surfactant, can be phytotoxic to bermudagrass (Colbaugh and Williams, 1993; Colbaugh et al., 1994c). However, no turf damage was observed at the rates and intervals used during 1992 and 1993. Eukaryotic algae numbers were low in 1994, and therefore no data are presented.

Table 3. The effects of six algicide treatments on prokaryotic algae numbers per microliter of sample solution from a bermudagrass green in 1994.[1]

Treatment	Rate[2]	0[3]	1	2	3	4	5	6	LSD[4]
Quaternary Ammonium Salts	0.0024	179	139	127	101	107	107	97	NS
Chlorothalonil	0.96	146	69	99	65	94	59	74	35
Hydrated Lime	24	157	106	113	74	89	76	142	45
Mancozeb	0.92	128	74	107	43	83	86	61	36
Control	-	168	141	141	89	109	106	103	NS
LSD[4]		NS	NS	NS	NS	NS	21	48	

[1]Prokaryotic species: *Oscillatoria* spp. and *Nostoc* sp.
[2]Treatments measured in grams of active ingredient per square meter. All treatments except hydrated lime applied with a water carrier in a volume of 359 mL m^{-2}.
[3]Number of algae at 0-6 weeks after initiation. First application (week 0) made on July 7, 1992 and 1993. Second application (week 3) made on July 29, 1992, and July 28, 1993.
[4]Mean separation across weeks within treatment and across treatments within week by Fisher's protected least significant difference ($P \leq 0.05$); NS = nonsignificant.

Effects on Prokaryotic Algae

Prokaryotic algae were not as responsive to algicides as were eukaryotic algae in 1992 and 1993. No significant reductions were observed for any treatment 1 week after either application in 1992 and 1993 (Table 2). Reductions of cyanobacteria numbers were observed in all treatments 1 week after the first application in 1994 (Table 3).

The quaternary ammonium salts treatment did not reduce prokaryotic algae populations in 1992 or 1993. Elliott (1994, 1995) observed similar results using quaternary ammonium salts. Elliott used application rates of 1.3 mL m^{-2} in 1994 and 1995, and 4 mL m^{-2} in 1994, similar to the rates used in this study. The lower (203.7 mL m^{-2}) spray volume used in Elliott's (1995) study was phytotoxic to bermudagrass. No phytotoxicity was observed at the rates and higher spray volume (359 mL m^{-2}) used in our study.

Few trends were observed for the bleach, chlorothalonil, copper, and mancozeb treatments (Table 2). These products appear to be more effective for controlling eukaryotic than prokaryotic algae. Our results with prokaryotic algae are similar to those obtained with unidentified algae in other studies. Soika and Sanders (1991) observed no algal and/or cyanobacterial control with chlorothalonil at the same rate. In the Soika and Sanders study, algal control ratings for chlorothalonil did not differ significantly from those for the control.

Prokaryotic algae numbers were reduced at 1 week after all hydrated lime applications in 1992 and 1993, except after the first application in 1993. Numbers were next to the lowest in 1993 and the lowest in 1993 on the last week of the study. Although effects are not as pronounced as those obtained with eukaryotic algae, hydrated lime may also control prokaryotic algae.

Significant reductions in populations of prokaryotic algae were observed in 1994 (Table 3) for chlorothalonil, hydrated lime, and mancozeb 1 week after the first application. In contrast, the numbers in all treatments increased 1 week after the second application. Numbers of cyanobacteria in the quaternary ammonium salt and control treatments remained higher during this period than in other treatments. In contrast, significant reductions were observed in 1994 in the chlorothalonil, hydrated lime, and mancozeb treatments. Only the quaternary ammonium salt treatment had no significant effects. Following the second application, the hydrated lime treatment damaged the turf, resulting in a significant increase in cyanobacteria numbers near to those at initiation. The caustic nature of the hydrated lime is a concern for leaf desiccation. The residual effects of hydrated lime upon prokaryotic algae are brief and the algae quickly recovered, given the additional light created by thinning the turf canopy. Hydrated lime may also elevate soil pH, favoring prokaryotic algae. Frequent application of hydrated lime at lower levels may be necessary to reduce turf damage.

The 1994 study indicated that chlorothalonil, hydrated lime, and mancozeb may have cyanobactericidal effects upon prokaryotic algae. However, these products had little effect during the previous 2 years. Similar results with mancozeb and chlorothalonil were observed by Elliott (1994, 1995) in two studies using

the same rate of mancozeb and a similar rate of chlorothalonil (1.04 g a.i. m^{-2}). More work with prokaryotic algal controls is needed since responses were variable between years in this study. What conditions enhanced the effectiveness of these products on prokaryotic algae in 1994 are not known. Many factors influence algal growth. As indicated with the second application of hydrated lime in 1994, loss of turf from excessive rates of algicide may result in no control, or even elevated numbers of algae. Results from this study indicate that reductions from these chemicals could be short term unless cultural practices that are conducive to algal proliferation are corrected. There may also be a risk of developing resistance in algal populations to certain products. The use of algicides and/or cyanobactericides does not replace good cultural practices like proper fertility (Vargas et al., 1986) and irrigation management.

Application Intervals

The 3-week interval between applications was used to make some inferences regarding adequate intervals between applications. Based upon eukaryotic algal numbers in 1992 (Table 1), the 7- to 14-day application intervals currently recommended for mancozeb and chlorothalonil may be adequate. Eukaryotic algae had recovered by the second week in these treatments. Bleach, copper, and hydrated lime showed similar results in 1992. The algae did not recover in most treatments in 1993, making it difficult to make inferences regarding application intervals.

In 1992 and 1993, no trends in prokaryotic algae numbers were observed in regard to proper application intervals. Prokaryotic algae did not recover between the 3-week application intervals in 1994 except in the hydrated lime treatment, which damaged the turf. Elliott (1995) noted that 28-day application intervals were less effective than 14-day intervals in preventing prokaryotic algal proliferation. Our results did not permit us to determine the proper application interval for curative control of prokaryotic algae.

Evaluation of Visual Ratings

Numbers of eukaryotic and prokaryotic algae (Tables 1-2) were significantly correlated only in 1992 (Table 4). Although significant, this *r* value was low. The lack of correlation between the numbers of these two groups may be a reflection of their differences. Variable responses to controls and other factors between the two groups might be expected.

Correlations between eukaryotic and prokaryotic algae numbers (Tables 1-2) and visual algal cover ratings (Table 5) were not significant in 1992. This may imply that visual ratings were not as effective in estimating population dynamics of either group of organisms. The lack of correlation between eukaryotic algae numbers and visual ratings might be expected. This may be partially explained by the fact that some of the more common algae enumerated during the study were of the Chrysophyta division (*Navicula* and *Hantzschia*). These genera are golden-brown and may blend with the soil or thatch. In addition, turf cover on the green ranged from 90% to 95% each year. Some algal activity beneath the turf canopy may have been missed during visual evaluations.

During 1993 and 1994, correlations (Table 4) between prokaryotic algal numbers (Tables 2-3) and visual ratings (Table 6) were highly significant, implying that prokaryotic algae were the main group being observed. This is expected since the organisms observed in this study tend to be black.

Table 4. Correlation coefficients (*r*) between eukaryotic and prokaryotic algal numbers and visual ratings, 1992-94.[1]

Variables	1992[2]	1993[2]	1994[2]
No. Eukaryotic Algae vs. No. Prokaryotic Algae	0.176*	0.031NS	N/A[3]
No. Eukaryotic Algal vs. Visual Ratings	0.138NS	-0.049NS	N/A
No. Prokaryotic Algae vs. Visual Ratings	0.092NS	0.340**	0.443**

[1]Based on Pearson correlation analysis.
[2]NS = Nonsignificant; * = significant at P ≤ 0.05;and ** = significant at P ≤ 0.0001.
[3]N/A = Not applicable; eukaryotic algae numbers too low for correlations.

Despite these positive correlations, some discrepancies remain. Visual algal cover ratings may not have accurately depicted eukaryotic algal dynamics during 1992 and 1993, or prokaryotic algal dynamics during 1992. This could indicate that these groups were not accurately separated visually and raise questions regarding the use of such ratings. For this reason, the type of organism(s) should be a consideration when comparing algal visual ratings data from different studies. Although this study does not address the effects of algicides upon individual species, many species of algae and cyanobacteria inhabit putting greens. Colonies of different species may look the same but respond differently to algicides. Nonvisual population changes within algal and/or cyanobacterial colonies could be overlooked and lead to misinterpretation of data from visual ratings. Visual ratings could be adequate as a quick assessment of algicidal activity, but precautions should be taken to identify the taxonomic group or species of algae or cyanobacteria when using visual ratings to evaluate algicidal or cyanobactericidal control.

Table 5. The effects of six algicide treatments on eukaryotic and/or prokaryotic algae on a bermudagrass putting green in 1992 and 1993 as determined by visual ratings.

Treatment	Rate [1]	Visual rating (1992) [2]								Visual rating (1993) [2]							
		0	1	2	3	4	5	6	LSD [3]	0	1	2	3	4	5	6	LSD [3]
Quaternary Ammonium Salts	0.0024	1.7	2.3	2.3	2.7	2.0	1.3	1.3	NS	1.3	2.7	2.3	1.7	1.0	1.3	1.3	NS
Sodium Hypochlorite	0.19	1.7	2.3	1.7	2.7	1.0	1.3	1.3	0.91	1.7	2.7	2.0	1.7	1.7	1.0	1.0	0.82
Chlorothalonil	0.96	1.7	1.0	1.3	2.0	1.3	1.7	1.3	NS	1.3	2.0	1.7	1.3	1.3	1.3	1.0	NS
Copper	0.075	1.3	2.0	1.7	3.3	1.7	2.0	1.3	0.79	1.3	3.0	2.3	1.3	1.7	1.7	1.3	0.85
Hydrated Lime	24	1.3	1.7	1.3	2.7	1.3	1.3	1.0	0.94	1.7	1.7	1.7	1.3	1.0	1.3	1.0	NS
Mancozeb	0.92	1.7	1.7	1.3	2.3	1.7	1.3	1.3	0.55	1.7	2.0	1.7	2.0	1.3	1.0	1.3	NS
Control	-	2.0	2.3	1.7	2.7	1.7	1.7	1.7	0.53	1.7	2.0	2.0	2.3	1.3	1.7	1.3	NS
LSD [3]		NS	NS	NS	NS	NS	NS	NS		NS	NS	NS	NS	NS	NS	NS	

[1]Treatments measured in grams of active ingredient per square meter. All treatments except hydrated lime applied with a water carrier in a volume of 359 mL m^{-2}.
[2]Visual ratings at 0-6 weeks after initiation. First application (week 0) made on July 7, 1992 and 1993. Second application (week 3) made on July 29, 1992, and July 28, 1993. Visual Rating Scale: 1 = no visible algal colonies; 6 = total plot covered with algal colonies.
[3]Mean separation across weeks within treatment and across treatments within week by Fisher's protected least significant difference ($P \leq 0.05$); NS = nonsignificant.

Table 6. The effects of six algicide treatments on eukaryotic and/or prokaryotic algae on a bermudagrass green in 1994 as determined by visual ratings.

Treatment	Rate [1]	0 [2]	1	2	3	4	5	6	LSD [3]
Quaternary Ammonium Salts	0.0024	4.3	4.0	3.7	3.3	2.3	2.0	2.3	0.76
Chlorothalonil	0.96	4.0	3.7	4.0	3.0	2.0	1.7	2.7	0.95
Hydrated Lime	24	5.0	4.3	4.3	4.0	3.7	3.3	3.7	NS
Mancozeb	0.92	5.0	4.0	5.0	3.3	2.3	2.3	2.0	1.03
Control	-	4.3	4.3.	4.7	3.7	3.0	3.0	3.3	0.84
LSD [3]		NS	NS	NS	NS	NS	1.09	NS	

[1]Treatments measured in grams of active ingredient per square meter. All treatments except hydrated lime applied with a water carrier in a volume of 359 mL m^{-2}.
[2]Visual ratings at 0-6 weeks after initiation. First application (week 0) made on July 7, 1992 and 1993. Second application (week 3) made on July 29, 1992, and July 28, 1993. Visual Rating Scale: 1 = no visible algal colonies; 6 = total plot covered with algal colonies.
[3]Mean separation across weeks within treatment and across treatments within week by Fisher's protected least significant difference ($P \leq 0.05$); NS = nonsignificant.

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