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Surface Algae on Golf Course Putting Greens and Tees

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Algae occur in nearly all terrestrial environments on earth, even Antarctica, so it should not be surprising that they are part of the soil microflora on golf courses. A study conducted 20 years ago in the Houston area correlated algal populations and diversity with land usage. The largest populations of algae were associated with a golf course (disturbed/fertilized site) as compared to a woods or a disturbed/unfertilized site in the same area.

As with any naturally occurring group of organisms, algae have the potential to become problems, especially when environmental conditions favor growth of the algae over the turfgrass. Florida's normal rainfall of 60-65 inches, most during the summer, creates such an environment. However, algae is not limited to Florida, since human intervention can create a favorable environment in any climate. In this article, only surface algal problems will be discussed.

Source of Algae

Terrestrial algae are the algae that live in soil and are often referred to as edaphic algae. In general, terrestrial algal species are different from aquatic

Algal Growth Requirements

Conditions that favor surface algal growth are:

1) excessive moisture,
2) soil surface exposure to sunlight,
3) adequate nutrients.

Excessive moisture can be due to rainfall or irrigation. It can also be related to shady areas where the surface remains excessively wet, even under normal rainfall or irrigation patterns. Shade combined with excessive moisture is probably the primary cause of surface algae. Shade does not have to be in the form of trees. A cloudy day results in the entire green being shaded.

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algal species. A study at Mississippi State University has helped to confirm that this is true for golf courses also. This means that the algal species causing your surface algal problems are not coming from your irrigation water source. As noted above, the algae are simply a natural part of the soil microflora. The algae cannot be eliminated, but their growth can be controlled.

A superintendent's concern about irrigation water and algae should be focused on nutrient and pesticide runoff from the golf course and how that effects irrigation water quality, which in turn effects turfgrass and algal growth on greens and tees.

Types of Algae

Most terrestrial algae found on greens and tees can be divided into two groups, the green algae and the blue-green algae. The third group one might encounter are the diatoms and yellow-green algae.

The green and blue-green algae differ not only in color but in some very basic life characteristics. Blue-green algae are actually a type of pigmented bacteria (prokaryote). Green algae are eukaryotes, which means they are more similar to fungi than bacteria. Both algal types have photosynthetic capabilities, just like the turfgrass. Examples of green algae associated with greens and tees surfaces include *Chlamydomonas, Cosmarium*, and *Cylindrocystis*. Blue-green algae often found include *Lyngbya, Nostoc, Oscillatoria* and *Phormidium*.

Of the two groups of algae, the most likely group to be found on **surfaces** of greens and tees are the blue-green algae. Blue-green algae prefer neutral to alkaline conditions whereas green algae prefer acidic conditions. The soil pH does not determine the algal population on the surface; it is the surface soil pH or the soil pH in the thatch that will determine the algal population. If herbicides or fungicides are used on greens and tees, the algal population may shift to green algae. Insecticides do not seem to influence algal growth as extensively.

It is not uncommon to have multiple days, if not an entire week, when the weather pattern results in minimal sunshine and excessive rainfall. Those conditions lead to a weakened turfgrass stand that starts to thin, exposing the algae on the soil surface to light. If the grass was being cut below optimum height (and 1/8 inch is below optimum height for ANY turfgrass species), the grass was already in a stressed state.

Since the algal species are capable of photosynthesis, they do need sunlight. However, they do not need nearly as much sunlight, especially the blue-green algae, as turfgrass requires to thrive. A healthy crop of blue-green algae can be grown in the laboratory under a single fluorescent light bulb; a situation in which turfgrass would become thin and elongated. This means the shady, wet conditions that are detrimental to turfgrass growth are perfect for algal growth. Add in the readily available nutrients on greens and tees, and the algae are set to "bloom".

Crusts and Toxins

A characteristic of blue-green algae that is greatly appreciated by agriculturists and soil conservationists is their ability to hold soil together. On golf course greens and tees, this characteristic develops into the unappreciated crusts and slime that often form. Blue-

green algae also produce toxins. It is currently unknown if the crusts and slimes have any negative effect on turfgrass due to toxin production. The crusts and slimes do prevent the turfgrass from growing back into an area unless they are removed or broken up.

Cultural Controls

Surface algal growth is a secondary problem. A superintendent must solve the original problem of shade and excessive moisture to prevent or cure the problem. If these conditions are not due to weather, then it is essential to initiate a program to correct these conditions. Remove or thin trees and shrubs. Reduce irrigation in problem areas. This may require hand watering non-affected areas until the algal-infested areas are dried out. Install fans to increase air circulation. If the conditions are due to weather, then a proactive approach, that may include the use of pesticides, must be initiated.

Cultural controls to help reduce surface algae include frequent sand topdressings. These should be heavy enough to cover-up the algal growth. This helps to absorb excess surface moisture and, more importantly, cuts the algae off from the sunlight. If algal crusts are present, aerify, spike, slice or verticut prior to sand topdressing. It is critical to physically break-up the crusts. Raising the height of cut is critical for relieving stress on closely mowed turfgrass. The turf will then be able to grow more vigorously and shade out the algae.

Fertilizer management to control algae is probably difficult to do on greens and tees. If possible, minimize the presence of phosphorus on the soil surface. Again, remember that the concern is not what is present IN the soil but what is present ON the soil surface. Nitrogen may also increase algal growth, especially of those algal species that do not fix nitrogen themselves.

Two fertilizers that are often mentioned for controlling algae are hydrated lime and ferrous sulfate. Both products must be used with extreme caution on closely cut fine turfgrass. Hydrated lime is only a temporary fix and may actually increase the surface algae. The lime initially acts as a dessicant and dries out the soil surface. However, it will instantly raise the surface soil pH which means the blue-green algae will thrive if weather conditions remain favorable for their growth. Also, if the turfgrass has thinned due to one of the root rot patch diseases (examples include take-all patch, summer patch, bermudagrass decline), these diseases may increase dramatically as the soilborne pathogens that cause these diseases also like alkaline soils.

Ferrous sulfate is an acidic fertilizer (due to the ferrous ion and not the sulfate ion) which will inhibit the blue-green algae, but perhaps not the green algae. Also, it will burn the turf if not applied properly or when applied at higher than 2 to 3 ounces per 1000 square feet. Test a small location first to determine if it would be effective on your golf course.

Integrated Surface Algal Control

An integrated approach to surface algal control requires:

- An understanding of why the algae have become a problem.

Establishment of a tree removal or tree thinning program if excessive shade is responsible for algal growth.

- Increasing the height of cut to alleviate stress on the turfgrass and to shade the soil surface to prevent algal growth.
- Development of a cultural program that includes sand topdressing, less irrigation if necessary, and disruption of the algal crusts when present.
- Preventative use of fungicides only when weather conditions warrant their use. They should not be used if the algae develop for reasons that are not related to weather and which can be controlled by reducing shade or altering management practices such as irrigation.

Chemical Controls

Copper sulfate has been reported to control surface algae, but superintendents often note that it burns greens and tees. One reason for this burning is they were using the fertilizer formulation of copper sulfate, $CuSO_4 \cdot 5\ H_2O$, which is hydrated copper sulfate (blue vitriol) and is very soluble in water. The fungicide formulation of copper sulfate, $CuSO_4 \cdot 3\ Cu(OH)_2$, is insoluble or only slightly soluble in water. It is often referred to as basic copper sulfate or tribasic copper. This latter material must be registered for golf course turfgrass use in your state to be legally used as it is a fungicide and not a fertilizer material.

The active ingredient in other fungicides that may be registered for control of algae in your state are mancozeb, chlorothalonil and quaternary ammonium salts. We have examined all three of these products in trials on the research green at the University of Florida's Fort Lauderdale Research and Education Center. The algae that develop on this site are blue-green algae. We provide an ideal environment by irrigating twice daily, whether it rains or not.

Mancozeb and chorothalonil fungicides were most effective when used preventatively, either prior to conducive weather patterns or shortly after they begin. Combined with the cultural controls, they can prevent the development of surface algae. We have not observed any control, preventatively or curatively, of surface blue-green algae using the quaternary ammonium salts. This product must be applied in the specified amount of water to prevent burning of the turf. Research in Texas indicates the material must be drenched to be effective.

The rate evaluated for mancozeb was 4.5 ounces active ingredient per 1000 square feet, the rate that has always been on the label for algal control. Since chlorothalonil had not been evaluated for algal control previously, the rates initially evaluated were 1.5, 3 and 6 ounces active ingredient per 1000 square feet. Applications were made at either 14 or 28 day intervals. The chlorothalonil was not effective at the lowest rate. Mancozeb and the higher chlorothalonil rates were effective in preventing or minimizing development of surface algae under the severe conditions used for evaluation. An application timing interval of 14 days was most effective under severe conditions, but 28 days would be adequate if environmental conditions were not as intense.

If heavy algal growth was already present (>50% surface algae per plot), at least two and usually three applications of these fungicides were required before any curative effect was observed. In other words, fungicides will be effective in preventing or minimizing algal development prior to or during the initial stages of conducive conditions for algal growth, but they will not be effective in eliminating the problem once it has developed.

It has been observed that some fungicides, primarily systemic DMI fungicides, may enhance surface algal development. This simply emphasizes the need to thoroughly understand why you are applying fungicides and what the positive or negative consequences may be of that application.

Biological Controls

There are presently no biological controls available for controlling surface algal growth. Interestingly, plant pathologists are examining algae more closely for use as biological control of plant diseases. Also, pharmaceutical companies are finding previously unknown antibiotics produced by algae, especially blue-green algae.

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