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January 10-11, 1990

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Sulfur and the Black Layer

by Lee Berndt, Joe Vargas, Jr. & Brad Melvin
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Black layer forms in turfgrass soils when metal sulfides precipitate from soil solution and deposit on soil particles and organic matter. Iron sulfide (FeS) is probably the most common metal sulfide in black layer, but it is certain that other forms, such as manganese sulfide, exist.

Metal sulfides form from a bacterial respiratory process known as dissimilatory sulfate or sulfur reduction. This is essentially bacterial respiration in the absence of oxygen. In sulfate reduction, electrons from food burned for energy by the bacteria are passed to sulfur instead of oxygen, forming hydrogen sulfide. Hydrogen sulfide is very poisonous and also very reactive with metals such as iron. Thus, if hydrogen sulfide is produced and iron is present, metal sulfides will be formed. More importantly, if hydrogen sulfide is produced the potential for the decline which frequently accompanies black layer increases. This is because hydrogen sulfide is a respiratory toxin which blocks electron transport.

Hydrogen sulfide is formed only in the absence of oxygen. Thus, conditions which favor oxygen depletion also favor sulfide formation and black layer development. These conditions include waterlogging, high rates of respiration from microorganisms, compaction, and addition of compounds such as elemental sulfur. The chemistry of sulfur is such that its most stable state is sulfate. In order for sulfur to become sulfide it must acquire 4 oxygen atoms for each sulfur atom. When this occurs in turf soils, it happens at the expense of aerobic micro-organisms and turf plants.

Management of black layer lies in prevention. There are several things you can do to prevent the creation of conditions necessary for sulfide production hence black layer formation. Control the amount of irrigation applied to your soil. The easiest way to achieve conditions in soil where oxygen is deficient is by adding an excess of water. There may be nothing you can do about torrential rain but you can control your irrigation regime. Also, control the amount of sulfur applied to your turf. Pay attention to the sulfur content of micro-nutrient solutions, fertilizers, and fungicides. If you must add sulfur add sulfate and not sulfur. Less black layer forms from sulfate sulfur than from mineral sulfur. It is also better to add nutrients such as iron and phosphorus than to attempt to make them more available by lowering soil pH. Why risk black layering by adding large amounts of sulfur when adding these nutrients is so easy?

If black layer has already become a problem do everything you can do to get oxygen into the soil. Core aeration is an effective way to do this. Remove plugs from the turf, and leave core holes open and unfilled. Do not core, however, when your green is overly wet. You will do more damage than good. Allow your soil to dry out as much as possible. This will encourage oxygen diffusion into soil. Syringing is mandatory for maximum black layer control. Adding potassium nitrate or calcium nitrate will also help. These compounds are good oxidizers will allow aerobic respiration in soil using nitrate as an electron acceptor. Nitrate in effect prevents sulfate reduction in environments where oxygen is lacking. The state highway department routinely adds nitrate to stagnant water in roadway ditches to stop the smell (from sulfides) and clear up the scum. Also, if black layering has already become a problem do not add organic N sources. Organic matter will intensify sulfide formation and "feed" black layer. Do, however, spoonfeed nutrients, including P and K, to the turf.

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