Influence of S, N and Soil Depth on Black Layer Formation in a 'Penncross' Creeping Bentgrass Green

Lee Berndt, Joe Vargas, Jr. and Mark Slater
Dept. of Botany and Plant Pathology
Michigan State University

Black layer research at Michigan State University has suggested a causal relationship between the anaerobic chemistry of sulfur and black layer formation. Laboratory research was initiated to determine what effect certain inputs had on intensity of sulfide accumulation in turfgrass soils. It was found that S type and level, organic matter type and level, N type and level and other subtle inputs had a dramatic effect on intensity of sulfide accumulation, hence black layer potential. The objective of this field research was to determine whether these same inputs would effect differences in sulfide accumulation in situ.

Our study originated at the Robert Hancock Turfgrass Research Center in East Lansing. Sulfur plots were established in 1987 but the experimental design was changed in 1988, and again in 1989 as we came to learn more about black layer formation. Thus, only the final experimental design applicable to 1989 data will be discussed. For a more complete discussion of 1987 and 1988 data see Berndt's thesis (in preparation). The experimental site was a sand golf green supporting 'Penncross' creeping bentgrass. Total N content of the soil was 0.07% and total C was 0.80%. Turf was mowed every other day at 1/4 inch with a triplex greens mower.

Experimental design was a split plot with 6 replications. Sulfur treatments constituted the whole plots while N treatments comprised the split. Soil depth was viewed as an additional split. Plot size was 4 x 6 feet. Treatments were arranged factorially and consisted of flowable 52% S applied at rates of 0, 1 or 5 pounds S/M/application every 3 weeks. Nitrogen as organic N (i.e., sewage sludge or bio-organic) or as inorganic nitrate (i.e., the K or Ca salt) was applied weekly at rates of 1/4 pound N/M/application. The plots were irrigated daily for approximately 30 minutes. Irrigation was supplied from an automated system.

During the season visual quality ratings, algae ratings and wilt ratings were taken periodically. In fall, 1989, duplicate samples from each split plot were harvested at depths of 2.5, 5.0 and 10.0 cm for sulfide measurement and determination of pH. Surface thatch pH was also determined.

Turfgrass responded favorably to residual S applications made in 1988, prior to any N application. As the season progressed the response to S began to wane and response to N became apparent. Turf treated with organic N appeared more favorable (i.e., it was darker green) but was somewhat thinned compared to turf treated with nitrate. It was assumed that nitrate added to the turf probably was leached due to excessive irrigation and also probably denitrified under induced anaerobiosis.

Algae appeared in the turf during mid-season. It was very interesting that the algae proliferated in turf treated with S and organic fertilizer while minimal algae was noted in plots receiving nitrate or no S. Perhaps the noted thinning in organic N treated turf allowed for the algae invasion. Wilt also appeared in certain plots during the first part of August. Wilt was most severe in plots treated with S and nitrate while plots receiving no S, or organic N, did not appear to suffer from wilt. It was assumed that an interactive effect from nitrate salt and high levels of S combined to produce the wilt.

Sulfide (as black layer) appeared in every plot beginning several days after initiation of irrigation. Analysis of variance detected differences in sulfide concentration due to increasing levels of S. That is, sulfide concentration was greater in plots receiving the 5# S/M rate than for either the 1 # S/M rate or the no S check plots. Sulfide concentration also differed by depth in soil. More sulfide accumulated at 5 cm than at either 2.5 cm or at 10 cm. However, interactive effects between S application rate and soil depth were detected. What this means is that the sulfide concentration for a given soil depth depended on level of applied S and vice versa. The interaction probably resulted from to high an oxygen tension at 2.5 cm while organic matter was probably limiting for sulfide formation at 10 cm. No differences between fertilizer types was detected, but a trend was noted towards having a slightly higher sulfide concentration in turf fertilized with organic N, especially at the 5.0 cm soil depth.

Subtle differences in the pH of thatch and underlying soils in the experiment were detected. In general, pH declined with soil depth regardless of treatment. Plots treated with higher levels of S had depressed pH compared to plots receiving less S. Also, plots receiving organic N had depressed pH compared to those receiving nitrate fertilizer. Interactive effects between S level and soil depth, and between N carrier type and soil depth were, however, detected by AOV. Thus, differences in the pH due to S level varied with soil depth as did differences in pH due to N source.

In conclusion, we found that turf showed a response to S early in the season and that turf treated with organic N appeared more favorable, in that it had a darker green color. However, we should be reminded that adding reduced sources of N (i.e., organic N) will detract from the available soil oxygen as they begin to nitrify. It is still recommended that if a black layer situation is prevalent nitrate sources of N still be applied. This practice will in essence add oxygen to an otherwise oxygen depleted system.

We found that algae accumulated in response to organic fertilizer especially where S was applied while minimal algae was seen on plots receiving nitrate. This was very interesting in view of the fact that algae are photosynthetic organisms which require light for metabolism. Algae will only proliferate in conditions where light is available (i.e., thin turf). In our study use of nitrate fertilizer prevented the thinning associated with applications of organic N, hence the algae problem. Perhaps more nitrate N, or more frequent applications would have given the greeness desired.

Wilt occurred in response to high levels of S especially where nitrate was applied. Thus, when using high rates of S to attempt pH adjustments care must be taken to avoid problems. Would it not be better to apply the necessary nutrients than to risk problems associated with adjusting pH?

We found that black layer in our study was composed of sulfide and that more sulfide accumulated where high rates of S were applied. It was shown that more formed at 5 cm than at 2.5 or at 10 cm while less sulfide accumulated in plots treated with nitrate.

Lastly, It was also shown that adding S decreased the soil pH but very high rates were needed to accomplish this (i.e., 25 pounds/season). We found that pH decreased with soil depth except at the very high rate of S where greater pH depression occurred nearer the surface. We also found that N source exerted a subtle influence on soil pH.