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Sulfur Its Activity in the Soil and Plants

Roy Flannery and Ralph Engel

Paul DesChamps (right) received the 1984 New Jersey Turfgrass Association Award at last December's Expo Banquet. He is receiving congratulations from Dave McGhee, outgoing president of NJTA. Paul received this award for his enthusiasm, constructive ideas, and never ceasing support of turfgrass and NJTA.

Soil Sulfur

Sulfur constitutes approximately 0.1 percent of the earth's crust. It may be found in the mineral fraction of the soils as elemental sulfur, combined sulfur in metal sulfide ores and as combined sulfur in mineral sulfates. Plants take up the sulfate (SO_4^{-2}) form of sulfur from soils. Therefore, sulfur in lower oxidation states, such as elemental sulfur, must be oxidized before it becomes available to plants. Elemental sulfur is converted to sulfate by biological oxidation. The oxidation of elemental sulfur is affected by its particle size; particles smaller than 60-mesh are oxidized quite rapidly. Soil temperature between 86 and 100° F. favor oxidation of elemental sulfur. Sulfur oxidation is also favored by high soil moisture levels.

Sulfur dioxide is chemically and biologically converted to sulfate in soils. Sulfur dioxide reacts with water to form sulfurous acid which in turn reacts with soil constituents to form sulfite salts. The sulfite salts are oxidized to sulfates either chemically or biologically. Sulfur bacteria, *Thiobacillus*, oxidize elemental sulfur to sulfuric acid. Sulfur dioxide and water in the air are responsible for sulfuric acid that adds to the acidity of the soil and natural waters. This source of sulfur contributes to acid rain which is caused by approximately two parts sulfur dioxide and one part nitrous oxides.

The end product in all sulfur reactions in soils is sulfate. In humid regions sulfate is often leached from the upper part of the soil profile, and it will accumulate in subsurface horizons. Under very high rainfall conditions, soluble sulfate salts can be completely removed from some medium to coarse textured soils.

Many highly weathered soils in regions of high rainfall contain appreciable quantities of absorbed sulfate in their subsoils. The most important conditions favoring this adsorption are: large amounts of clay; presence of hydrous iron and aluminum oxides; low soil pH; high sulfate concentration; slow or impeded movement of soil solution; and the presence of weakly-held anions such as nitrate and chloride. Liming and phosphate fertilization both reduce the soil's ability to adsorb sulfate. Adsorbed sulfate is an important source of sulfur for some plants that have deep root systems and long growing seasons, even though it may be less available than soluble sulfate.

Soil properties can provide helpful clues about plant needs for sulfur fertilization. Sulfur-deficient soils are usually low in organic matter, sandy in texture, and well drained. Total soil nitrogen and organic matter are closely related to total sulfur in soils. High nitrogen fertilization can change the nitrogen to sulfur ratio in soils and may lead to sulfur deficiencies over time.

Plant Needs for Sulfur

In the early sixties, sulfur deficiencies in plants had been identified in 13 states. By the end of the 1970's the number had grown to 36. The problem may be even more widespread today. The northeast is considered to have less sulfur deficiency problems than most other parts of the country.

Three major causes of reduced soil sulfur levels are: the reduction of incidental sulfur in commonly applied fertilizers, such as superphosphate; the reduction in atmospheric sulfur dioxide due to pollution control programs; and more intensive cropping programs which deplete soil sulfur levels more rapidly.

Crop benefit from sulfur received little consideration 25-50 years ago. Until the 1950's, most fertilizers used in this country contained large amounts of sul-

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Comments and Opinions . . Yours and Ours

LETTERS WE ENJOY!

The following are comments from a recent letter written by Lynda Johnson of *Pickseed*.

"Dear Dr. Engel:

A while back you wrote an article on the mixability of ryegrass with Kentucky bluegrass. We found this article to be most useful but unfortunately it has been misplaced in our office.

Would it be possible for use to receive another copy? It would be most appreciated as it was a popular paper for reading and distribution.

Thank you."

The article of reference was written by Gibeault, *et al.* and was reprinted in *Green World* (Vol. II #3 of 1981). The conclusion of the study was "mixes of Kentucky bluegrass and perennial ryegrass (a mixture of Manhattan and Pennfine) practically eliminated 'Fusarium blight' activity". Dr. Reed Funk of Rutgers University and Dr. William Meyer of Turf Seed, inc. have reported this same effect — a nice natural control of a problem!

Dr. Ralph Engel
Consulting Editor,
"Green World"

Dear Ralph,

For sometime now I have intended to write this note letting you know how much I enjoy reading the issues of "Green World." Yours has become one of the few publications that offer raw scientific data or research findings to the turfgrass professional. Most are directly applicable and useful. Your comments are especially appreciated in that further thought is provoked — something that few of us do!

Please express these thoughts and appreciation to powers that be within NJTA.

Sincerely,

Stephen G. Cadenelli, CGCS
New Canan, Conn.
Dec. 1984

Not all those who are aitempting to conduct successful business are profiteers.

C. Coolidge

Enhancing Roundup

Research reports presented at the Northeastern Weed Control Conference in January 1985 indicated that, with the use of FRIGATE surfactant, the rate of ROUNDUP could be reduced considerably and still obtain acceptable control. Ed Beste, University of Maryland, indicated that FRIGATE was the only additive that enhanced ROUNDUP activity at 0.25 Lb AI/A (1/2 pint) adequately to provide full season suppression of bermudagrass. The spring treatment provided 90% Bermudagrass control.

John Ahrens, Connecticut Agricultural Experimentation Station, showed that ROUNDUP activity on rye was enhanced with the surfactant FRIGATE but not with X-77. His data show that rye kill at 0.28 Lb AI/A with 0.5% FRIGATE was equal to 0.56 Lb AI/A with no additive.

Morrow of University of Maine showed that FRIGATE improved ROUNDUP efficacy in the control of quackgrass and may have increased the yield of the oat crop following treatment.

Bill Duke of Cornell University, however, indicated that there were some slight differences from adding FRIGATE but they were insignificant.

How to find out if FRIGATE really does enhance ROUNDUP activity? Try it yourself. Cut the rate of ROUNDUP in half and add 0.5% v/v of FRIGATE to the spray tank. That's 65 1/2 ounces of FRIGATE/gallon of water (don't forget to put the ROUNDUP in!).

John A. Meade
Extension Specialist in
Weed Science

Imagination was given to man to compensate him for what he is not; a sense of humor to console him for what he is.

Frances Bacon

It is not hard to find the truth; what is hard is not to run away from it once you have found it."

Etienne Gilson

It is well to think well; it is divine to act well.

Horace Mann

ABSTRACT: Effect of Acidity and N Source on the Growth and Thatch Accumulation of Tifgreen Bermudagrass in Florida from J. B. Saratin's Study — *Agron. Journal* 77:33-36, 1985.

Treatments were applied on a five-year-old Tifgreen bermudagrass turf growing on a loamy fine sand. Three N sources (Ammonium sulfate (Amm S), Isobutylidene diurea (IBDU) and activated sewage sludge (SS) were applied. Clippings were collected every 45 days for growth rate and N uptake estimates and cores for thatch accumulation estimates were collected after each of three growing seasons. Maximum growth rates occurred at pH less than 4.0. Overall turfgrass quality was not significantly influenced by N source or frequency of application. Acidity promoted thatch accumulation, except in the presence of applied Ca. A higher pH and lower thatch readings occurred with IBDU. Thatch accumulation was greater on plots receiving (Amm S).

Editor's Comment: *This supports findings on cool-season grasses and shows a role for lime.*

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Sulfur Activity
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fur as impurities. Superphosphate and ammonium sulfate which contained 12 and 24 percent sulfur, respectively, were two of the most widely used nutrient sources of nitrogen and phosphorus in N-P-K fertilizers. When either or both of these fertilizers were used, sufficient amounts of sulfur were supplied at the same time to meet the crop's sulfur need. These older fertilizer sources have been mostly replaced by more concentrated fertilizer sources containing much less sulfur. For example, concentrated superphosphate contains less than two percent sulfur and ammonium phosphates less than three percent. Ammonium nitrate, urea and nitrogen solutions normally contain very little or no sulfur.

Plants need sulfur because it is a constituent of several amino acids including methionone and cystine which are essential components of plant and animal proteins. Sulfur is important in the formation of chlorophyll, even though sulfur does not occur in this substance.

Visual symptoms may be used to defect sulfur deficiency, but there are limitations in using this approach. By the time sulfur-deficiency symptoms are evident, the yield and quality of crops may be seriously affected. Sulfur deficiency shows as a yellowing similar to nitrogen deficiency, but in contrast to nitrogen, it is more evident in the new or top growth of the plant. Visually, it may be confused with iron and zinc deficiencies.

Most plants should contain one unit of sulfur for every 12 to 15 units of nitrogen. Some experts suggest applying a five to one ratio of nitrogen to sulfur to maintain this balance. Plants need approximately as much sulfur as either phosphorus or magnesium. Many plants need 15 to 30 pounds per acre of sulfur per year for normal growth. This needed sulfur may be derived from plant residue decomposition, soil organic matter, atmospheric deposits and/or from various fertilizer sources.

* * *

Editorial Comment:
Dr. Flannery's comments on sulfur in the soil and its role with plants are basic to better understanding of this element for turf and agriculture. The next issue of ***Green World*** *will discuss effects of this element on the turfgrass plant and the sources that are available.* REE

Can You Tell The Difference?

Reprinted from ***Green World*** *1982.*

These insects have similar size, movement and appearance. The big-eyed bug is a chinchbug predator. Look carefully at any populations before you treat for this pest either this month or next year. **Lou Vasvary**

Predator

Big-Eyed Bug
Geocoris sp.

Chinch Bugs

1 Immature | 2 Immature | 3 Adult | 4 Adult

Golf's Hardest Shot — A mashie at 90 yards from the green — The ball was played against an oak tree, bounces back into a sand trap, hits a rock, bounces in the green and rolls into the cup. That shot was so difficult that I made it only once. *Zeppo Marx*

Agriculture is America's Oil.
Monsanto

Editorial Comment — This chinch bug item is a repeat of three years ago. Dry weather has caused some spots in turf to show an early and great abundance of the reddish young at the base of the plant. Their sucking weakens or can kill spots of turf. Worse is their potential for producing larger populations later in the season. Do not let the big-eyed bug trick you into treatment.
REE.

Sustaining Members
April 1985

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Of Ecology And Thistles

I have been on a kick against Canada thistle. It started several years ago when the highway departments omitted mowing or delayed mowing until seed had set and scattered in the wind. I wrote letters of compaint on this which did not receive much understanding or concerned action.

Canada thistle and other thistles are becoming more frequent terrors on landscape sites. Canada thistle is not persistent in closely-mowed, good turf cover. With higher cuts one well-timed mowing per season will control seedheads efficiently. However, this plant will persist and spread by rhizomes in higher cut, utility-type turf. Dr. Reed Funk found spring applications over several seasons of our standard broadleaf herbicides for dandelions did not give control. Our grandparents' generations fought this weed relentlessly. It is a costly nuisance to agricultural production. Further increase of this or other thistles makes a bigger and more painful problem for the future. REE

One of the greatest obstacles to success is man's inability to put first things first.

Charles Roth