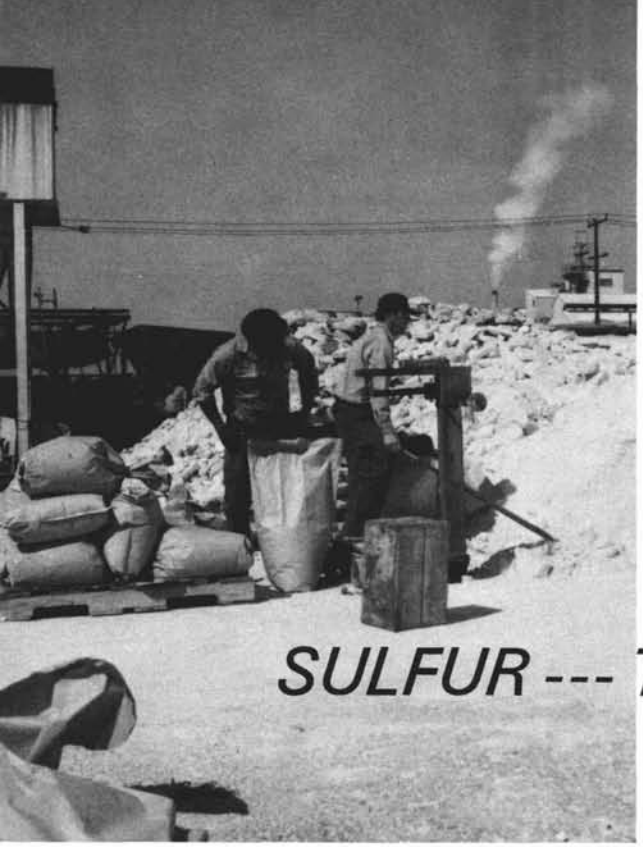

SULFUR --- The Essential Element

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Yellow is a popular color on the golf course. Dandelions prefer it, golfers wear it, and golf course superintendents use it for tee markers and putting green flags.

Turfgrass also has a great preference for yellow. Sulfur plays an important role in turfgrass nutrition. Did you know that the need for sulfur in turfgrass parallels that of nitrogen? It is vital for tissue development, protein synthesis, chlorophyll production, root development and for stimulating the growth and increase of soil micro-organisms!

Recent information has shown that one ton of bluegrass clippings contains about 2.5 pounds of sulfur. Bermudagrass yields even more with 4.3 pounds of sulfur per ton of clippings.

Sulfur is a versatile element. It helps to improve the physical structure of certain soils, thus enabling a better moisture-holding capacity. Where soils are alkaline, it reduces the pH value to a neutral or acid level. This process in turn liberates other elements already present in the soil, such as phosphorus, potassium, calcium and magnesium. This is team work in action because these elements are also important to good turfgrass development.

How Turfgrass Obtains Sulfur

Sulfur availability to plants, and in particular, to turfgrass, is accomplished by numerous means.

1. Through direct absorption from the air.
2. Decomposition of organic sulfur into the available sulfate form in the soil.
3. From water containing sulfur.
4. From fertilizer and chemical materials that contain sulfur.

Nature provides a cycle for conversion of sulfur into the various useable forms needed by plants. Basically, sulfur occurs naturally as a solid crystalline form and as gasses, such as hydrogen sulfide, and sulfur dioxide. These gasses are either carried into the soil by water or absorbed directly into the plant. In the soil, natural inorganic sulfur is converted (oxidized) to sulfurous acid which combines with some of the soil mineral elements to form sulfides of calcium, magnesium, sodium and potassium.

These sulfides are then further oxidized into sulfates such as sulfuric acid.

The importance of this process is appreciated when it is understood that higher plants take up sulfur in the sulfate form. When the plant dies, organic sulfur is released by combustion or putrafaction, and is given off as gasses, or as elemental sulfur, thus completing the cycle.

The sulfur available in the air is sulfur dioxide, which can be absorbed by plant leaves. Would you believe that there is a benefit from smog! Golf courses in metropolitan areas benefit from sulfur released into the atmosphere by industrial centers. In fact, reports indicate that air pollution contributes upwards of 40 pounds of sulfur per acre per year. This sulfur is carried into the waters, soils and vegetation! By contrast, golf courses in the desert and in semi-arid parts of the United States, may only receive as much as four pounds of sulfur per acre per year. In short, if you breathe fresh air, your soil may have a sulfur deficiency!

Most soils throughout the United States have an adequate supply of sulfur for plant needs. As a natural occurrence in the soil, sulfur content averages .05 per cent, or about 1,000 pounds per acre. In comparison, nitrogen averages .1 per cent, or 2,000 pounds per acre. The ratio of sulfur in the soil to sulfur in the plant is about 1 to 30. Since we are not always blessed with an ideal soil, sulfur deficiency may become a problem. Deficiences arise in soils which exhibit the following: high leachability, low organic content, alkalinity, non-irrigated, and those soils located far from atmospheric pollution.

Sandy and alkaline soils frequently cannot supply sufficient quantities of sulfur for good turfgrass growth. If for instance, you live in a semi-arid climate, chances are you will encounter sulfur-deficient soils. For sandy soils, applications of 50 to 60 pounds of sulfur per acre per season may be necessary. Clay soils exhibit variability with respect to sulfur absorption into their particle surfaces. Soils containing illitic or kaolitic clays exhibit higher absorption rates than those composed of montmorillonite clays. Absorption increases with a decrease in pH.

Applications of calcium sulfate (gypsum) are helpful in reducing the alkaline reaction of clay soils. This process may, however, take from three to six months to accomplish, depending on the degree of good surface and subsurface drainage. As a guide, one pound of sulfur will neutralize three pounds of calcium carbonate. Therefore, only one-third as much sulfur is needed to reduce alkalinity as carbonate is used to reduce acidity. Where alkaline soils are encountered, the use of bermudagrass as a golfing turf is desirable because of its ability to withstand alkaline conditions.

Have you often wondered why sandy soils do not respond well to repeated fertilizer applications? Obviously these nutrients are leached down through the soil profile. A supply of soil organic matter plays an important role in preventing this loss. From the sulfur cycle, we should not forget that organic matter has a direct bearing on the availability of sulfur, as well as many other elements. Elemental sulfur is not readily available to turfgrass where soils of low organic matter content are encountered. One method used to increase organic matter and also to supply needed sulfur is to mix a sulfur-bearing fertilizer with top-dressing. The bacteria present in good decomposed top-dressing will immediately begin to oxidize the sulfur. This method is valuable in regions where soils make it difficult to create acidity by the sole use of acid-forming fertilizers. Generally, most organic fertilizers already contain from five to ten pounds of sulfur per ton.

Have you ever drunk well water that had a very strong taste? It probably contained sulfur. In the western United States the content of sulfur in water supplies varies from three pounds to 2,000 pounds per acre foot. It is reassuring to know that most irrigation waters contain enough free sulfur to prevent deficiencies in turf. Unfortunately, water, while being a supplier, is also a robber of sulfur. Irrigation water constantly leaches large amounts of sulfate sulphur through the soil and into subsurface drainage areas. About one-half of the available sulfur is lost through this process, amounting to nearly 43 pounds per acre per year in highly porous soils.

In nature, sulfur must come from either decomposed organic matter, irrigation and rain water, air sources, or in soils as an element. Unfortunately, these sources cannot always be depended upon to provide an adequate supply of sulfur for turfgrass. The golf course superintendent should therefore supplement this need from time to time with fertilizers containing sulfur.

Sulfur Deficiency

Since we cannot speak to members of the plant world in our language, we must learn to know plant language. As O. J. Noer once said, "Let's ask the grass." Indeed, grass plants speak very loudly to us in the form of coloration and growth habits. A good rule of thumb in detecting sulfur deficiences in turfgrass, is to watch for a general yellowing of young leaves and bud shoots. Sulfur does not readily move from the protein constituents of older leaves into newly developing leaf tissues. In severe deficiency cases however, older leaves may also

become pale green in color. These symptoms are similar to nitrogen deficiency with the main difference being that with nitrogen loss, the older leaves lose color and the entire plant may become chlorotic.

Caution: Avoid Extremes

Because sulfur is a strong acid-forming element, care should be used when applying it to turf. Avoidance of high temperatures (90° F. plus) and overfertilization are important. Closely clipped grasses can be severely injured when sulfur materials (including pesticides) are improperly used. Light and frequent applications of sulfur fertilizers are certainly more beneficial than large quantities applied all at once.

For example, ammonium sulfate can be very caustic if applied to creeping bent at 5 pounds per 1,000 square feet during the summer. When this rate is reduced to approximately two pounds per 1,000 square feet, chances of injury are greatly reduced. Remember always to water in this type of fertilizer immediately following application.

New Information

Research in the Northwest indicates that sulfur is very beneficial for cool season grasses. Applications of sulfur have greatly improved the vigor of bentgrass under these soil conditions. In addition, disease damage was minimized and invasion by *Poa annua* into good turf was reduced. Application of sulfur at the rate of 3.4 pounds per 1,000 square feet per year is recommended by Washington State University.

Work in Florida also indicates that warm season grasses exhibit greater resistance to dollar spot when sulfur is included as part of a regular fertilizer program. Sulfur-containing fungicides like Thiram contribute to the control of brown patch and dollar spot.

Obtaining a Supply

Commercially, sulfur is available in the fertilizer form either as a simple element, or in combination with other elements. The following fertilizer materials are listed as some of the more important sources of inorganic sulfur showing their percentage content:

DRY

Elemental sulfur (33-99S)
Ammonium sulfate (21-0-0-24S)
Ammonium phosphate-sulfate (16-20-0-14S)
Ammonium sulfate-nitrate (26-0-0-12S)
Potassium sulfate (0-0-52-18S)
Potassium-magnesium sulfate (0-0-26-15S)
Calcium sulfate (gypsum, CA 21-S17)
Copper sulfate (CU 24-S12)
Zinc sulfate (ZN 45-S44)
Magnesium sulfate (MG 10-S14)
Manganese sulfate (MN 25-S14)
Iron sulfate (FE 19-S32-70) (Fe 19-S30 to 70)
Activated Sewerage Sludge

LIQUID

Sulfuric acid (23S)
Calcium polysulfide (lime-sulfur 32S)
Ammonium polysulfide (20-0-0-32S)
Ammonium thiosulfate (18-0-0-43S)

Sulfur is usually present in pesticides as part of the carrier for wettable powders and dusts. The most prominent pesticide group containing sulfur includes the dithiocarbamate fungicides such as Thiram, Ferbam, Ziram, Nabam and Zineb.

IN CONCLUSION: The benefits of sulfur in turfgrass management should be quite obvious. It is probably the one element that is most overlooked in turfgrass nutrition today.

Our society is becoming more conscious of the natural environment and its needs every day. Championship golf turf also demands that the turf grass manager "let the grass speak to him" and observe its changing needs in a dynamic environment. Do not take for granted that you have an ample supply of nutrients available to grow fine golf turf! Check your turf, have a soil test taken. It may tell you things that you hadn't realized before.

Let sulfur strengthen your hand in turfgrass management. Include it in your fertilization program. It is not as priceless as gold, but it fulfills a priceless need to fine golf turf.

The Triplex Putting Green Mower

In the January, 1970, issue of the Green Section Record, mention was made that a nationwide report on triplex putting green mowers by the Green Section Staff would appear in our May, 1970, issue. This created a great deal of interest. Then last February, two different manufacturers introduced two new triplex mowers at the Golf Course Superintendents Association International Turfgrass Conference in Houston, Texas. Because three such mowers are now available, the Green Section Staff has decided to recaucus and review the matter once more. A report will be forthcoming this year, but we felt it in the best interest of all to put it off for another issue or two.