Agronomists have stated that soil sampling and analysis provides one of the highest returns on investments for agricultural operations. Soil testing is not a new agronomic practice. One of the first true soil testing laboratories was established in the late 1930s. It was not until the 1950s that most of the procedures for soil analysis originated. Although, the chemical principles have not significantly changed, the procedures for measuring soil nutrients have been revised to take advantage of new instrumentation that allows for more accurate, efficient processing, and minimize expense of soil test analysis. However, it is important to understand how the nutrient cycles can affect measurement and availability of sulphur.

NUTRIENT CYCLES: SULPHUR AND NITROGEN

Sulphur (S, a secondary nutrient) and nitrogen (N, a macronutrient) are both required for proper plant growth and development. Both S and N cycles resemble each other in several respects. One of the similarities is that the plant availability of both nutrients is dependent on soil microorganisms. Most of the plant available S comes from the soil organic matter. As such, most of the S will be concentrated in the upper 6 inches of the soil profile (plow layer). For S to be used by the plant, it must be mineralized from the organic matter to sulfate-sulphur (SO₄²⁻). Soil microbes are the primary catalysts for this process. If the soil microbes are not actively respiring (in a warm, oxygenated soil with adequate moisture), this process will not occur. The ability of the soil microbes to break down (mineralize) the organic matter is directly related to the amount of S available to the plant. Application of sulphur bentonite in fall post-harvest or preplant in the spring helps to ensure plants have sufficient S.
throughout the growing season. Sulphur is not mobile in the plant and as such, the plant requires a constant source of \( \text{SO}_4^{2-} \) through the growing season.

The \( \text{SO}_4^{2-} \) form of sulphur and the nitrate \( \text{NO}_3^- \) form of nitrogen are both anions (negative charge). Soil is also negative charged; therefore, it will not attract the anions. Both are leachable through the soil profile. When comparing \( \text{SO}_4^{2-} \) and \( \text{NO}_3^- \), \( \text{SO}_4^{2-} \) tends to leach through the soil profile about half as fast as \( \text{NO}_3^- \). Should the soil have a restrictive layer such as hardpan, fragipan, etc., the \( \text{SO}_4^{2-} \) will be leached to the top of that layer and be available to the roots as they intersect this region of the soil.

**MEASURING AVAILABILITY: SOIL TEST SULPHUR**

For agronomists, soil testing is the foundation of crop fertility recommendations. While it may sound almost heretical, soil testing is not without difficulties. Most of these difficulties can be narrowed down to three main challenges:

1. Type of chemical extractant used to remove the elements from the submitted soil sample
2. Measurement of the element in the extracted solution by different instruments
3. Calibration of results with yield response

While the problems may sound different, they are often impossible to separate. A combination of these problems is more the rule than the exception.

There are many methods for determining the S content in both plant and soil samples. Various chemical extractants and methods for soil testing have been developed over the years. Unfortunately, each extractant and testing method has a peer-reviewed article that questions its respective precision, accuracy, and reliability. It is important to understand that soil test S may show both plant available \( \text{SO}_4^{2-} \) as well as elemental sulphur (S). This is due to the chemical extractant(s) used and the laboratory procedures. Soil testing can only provide a general reference of the amount of sulphur in the soil; however, it is not a good determination of plant available \( \text{SO}_4^{2-} \). Plant tissue sampling is the best method of assessing plant uptake of \( \text{SO}_4^{2-} \).
Land-grant university soil testing laboratories have no "sulphur standard" that is used for soil testing. The western, north central, southeast, and northeast United States each have different laboratory procedures calling for differing extractants and methods for determining the amount of sulphur in the soil (Anonymous, 1995; Brown, 2011; McFarland et al., 2005; Miller et al., 2013; Sikora et al., 2014). Even among these groups of states, some will modify their laboratory procedures to fit their individualized situations. Some laboratories use a weak-salt with temperature (e.g., monocalcium phosphate extraction procedure), some use variations of the Melich III extractant (sometimes referred to as a "universal" soil extractant), and others have used de-ionized water and potassium chloride (KCl) (Esmel et al., 2010). The utilization of various instruments to determine the extracted S can add an error factor when comparisons are made between laboratories. In the end, the method chosen by a laboratory reflects a compromise of cost, speed, accuracy, and yield calibrations. Differing chemical extractants and testing methods remove differing quantities of nutrients from the soil. For example, differences in each laboratory's procedures (i.e., different dilution and shaking rates, extraction time, and even filter paper) may affect the results. These subsequent differences in the soil test results can and will occur, even if the laboratories use the same testing methods. As such, it is imperative that soil tests from various laboratories are not compared directly with each other unless the strengths and weaknesses are well understood.

Soil tests are not well correlated with plant growth due to S interactions with soil microorganisms. Plant analysis, especially utilizing a nitrogen-sulphur (N:S) ratio, is useful for diagnosing a sulphur deficiency. The utilization of the N:S ratio to recommend a fertilizer blend has not been proven through research.
IMPORTANT SOIL TESTING

Always consult with your soil testing laboratory regarding the chemical analyses of agricultural soils. Follow the general recommendation for typical soil analyses for surface (0-15 cm or 0-6 inch in depth) agricultural soils. Analysis should include soil tests for nitrate-nitrogen, available phosphorus, available potassium, and extractable S, plus soil pH and electrical conductivity (EC). If possible, the NO$_3^-$ and SO$_4^{2-}$ analysis should be completed for subsurface soil samples (15-60 cm or 6-24 inches in depth). Additional analyses for micronutrients (boron, chlorine, copper, iron, manganese or zinc) or organic matter for the surface soil samples may be requested. Some laboratories may provide additional analyses as part of the routine analyses package that they may use to improve interpretations and recommendations. If in doubt, consult with the laboratory on how they calibrate their results with crop yields.

Sulphur is a key ingredient in amino acids, proteins, and chlorophyll. Should S levels be low, plants will not be able to efficiently utilize available nitrogen. If SO$_4^{2-}$ is not provided to the plant, it can result in excess nitrogen being left in the soil — a recipe for leaching, runoff, or volatilization. With today’s high-yielding crops removing more S from the soil, it is important to supplement S as needed. The TIGER portfolio of products is an excellent source for additional S to meet crop production requirements. Micronutrient needs can be met with TIGER micronutrient products or TIGER crop mixes. Further information on TIGER products may be obtained from a local account manager or our website, tigersul.com.

REFERENCES:

Copyright© Tiger-Sul Products, LLC 2017. All Rights Reserved.