In February, 1986, Midwest Laboratories began analyzing soils for sulfur using ICAP (Inductively Coupled Argon Plasma) rather than turbidmetrically. Whereas colorimetrically we were measuring degree of turbidity (cloudiness of solution extract) to determine plant available SO$_4$-S only, with the ICAP we are actually burning the sample to determine SO$_4$-S and some organic fractions of sulfur. Determining slowly released organic sulfur, plus more accurately analyzing for SO$_4$-S analysis by ICAP, has in some cases given our clients elevated sulfur readings when compared to previous samples from the same field analyzed turbidmetrically.

The analytical procedure of using the ICAP has improved the accuracy and repeatability of the sulfur analysis which has been a problem with other laboratory methods.

In comparing soil samples from a particular grower differences are usually explainable. With sulfur analysis by ICAP we find a wider range of levels and a greater need to explain the differences. To understand these variances one must first understand the sulfur cycle illustrated below.

**SULFUR CYCLE**

Why do soils differ in their sulfur levels?

1. Difference in organic matter levels. Soils with higher organic matter will generally have higher sulfur levels since analysis by ICAP does determine some of the organic sulfur.
2. Differences in soil texture. Soils of coarser texture will allow more leaching of SO$_4$-S. These sandier soils due to better aeration also usually have lower organic matter levels.

3. Differences in irrigation water. Irrigation water does contain some sulfur usually in a precipitated form with calcium (CaSO$_4$·2H$_2$O). Wells differ in the amount of this sulfur they contain. Fields irrigated by different wells could cause soil sulfur tests to differ.

4. Type of irrigation. Typically flood irrigated fields will contain lower levels of sulfur than center pivot irrigated fields, because the higher rates of water flush the sulfur through the soil profile. With the saturated soil conditions greater reduction of sulfate sulfur to unavailable forms occur also.

5. Differences in soil drainage. This may be due to the type of soil or soil classification. On the Midwest Laboratories soil test a % Mg > 20% generally will indicate a soil of poor internal drainage. If water does not move well through the soil, the SO$_4$-S will not leach as readily giving you higher sulfur readings. Compaction is often a problem on these types of soils. Compacted layers may also reduce SO$_4$-S leaching.

6. Differences in sodium levels. High sodium levels (% NA > 5%) will usually indicate an alkali soil condition. Under these conditions SO$_4$-S will accumulate in the upper soil profile due to the dispersed soil structure causing a very high sulfur level.

7. Dry soil conditions. With dry conditions over several weeks soil moisture will evaporate from the soil surface. As this occurs, water moves up through soil profile. This will create higher SO$_4$-S readings in your surface sample as they accumulate when the water evaporates. Usually nitrates will accumulate as well.

8. Differences in history of sulfur fertilization. Although sulfur leaches and can't be built up in the soil, it does appear that where growers have been applying sulfur for a number of years, analysis by ICAP is detecting higher amounts of slowly available sulfur.

Midwest sulfur values would be rated as follows:

<table>
<thead>
<tr>
<th>Rating</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low (VL)</td>
<td>0-6 ppm</td>
</tr>
<tr>
<td>Low (L)</td>
<td>7-12 ppm</td>
</tr>
<tr>
<td>Medium (M)</td>
<td>13-18 ppm</td>
</tr>
<tr>
<td>High (H)</td>
<td>19-24 ppm</td>
</tr>
<tr>
<td>Very High (VH)</td>
<td>Greater than 24 ppm</td>
</tr>
</tbody>
</table>

The higher the rating the less probability of getting a response from sulfur as a plant food.

There can also be a response to sulfur fertilization which may be more directly related to the affect of acid condition created by the sulfur and not by the need of sulfur as a plant food. This determination for sulfur for this reason will need to be based on soil pH, free lime, sodium, and the wide range of P$_1$ to P$_2$ phosphorus readings.

Sulfur fertilization is becoming increasingly common among growers. Sulfur analysis by ICAP can be very useful in predicting where your best odds of response to plant food sulfur will occur.