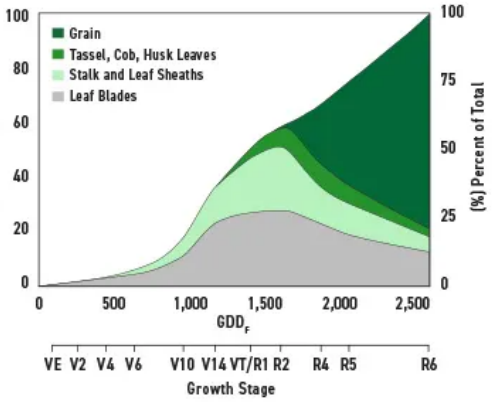
Hello All,

Well how about those temperatures. I am ready to move forward to spring. As a result of the cold air, I have been asked about wheat survival and the answer must be we will have to evaluate after some more seasonal temperatures. On another note, commodity prices have taken a hit after crop report last week. This along with interest rates will make for an interesting year and the focus will need to be on efficiency. Now back to our fertility/nutrition discussion.

Last week I discussed fertilizer reactions in the soil. Continuing with this theme I will again look at Phosphorus fertilizer in the soil. This is by far the second most important nutrient to consider for yield of crops and forage. Physiologically it plays a very important role in plants in energy storage and transfer. What this means, the plant with adequate P levels will have optimal fruiting, flowering and seed production along with increased root growth, winter hardiness and tillering and finally maturity will be hastened.

I spent some time in another update discussing availability and the Ca precipitating with phosphate. I will add that higher OM soils tend to have more mineralized P and thus more available P. Mineralization is governed by the soil microbes as we have talked before this needs heat and moisture and for us the release is normally in August which can be a little later than ideal from a physiological standpoint as illustrated in the chart below.



When considering phosphorus fertilizer there are a few things to consider. P is immobile in the soil due to its highly reactive nature. In addition, our soils are rich in Ca which allows for precipitation of the P fertilizer applied. Consequently, these two known variables have led to the placement of P fertilizers in the soil near the seed to allow for availability early in plant development.

Taking all these things into consideration considering the amount of P needed for the crop see the chart below:

Crop	N removal pounds per bushel	P205 removal pounds per bushel
Corn	0.9	0.37
Soybean	3.8	0.80
Wheat	1.2	0.63

Normally I figure .35#/bu for crop removal. Then base recommendations on soil test levels and crop removal.

Knowing the reactions in the soil is crucial in making proper recommendations. In conclusion, regarding this nutrient soil reactions have been the focus of the industry for some time. Evidence of this is the emphasis of placement near the plant or changed formulations to abate some of these reactions. Suffice it to say that phosphorus management is highly influenced by the reactions in the soil.

The next primary nutrient I will discuss minimally is potassium. I am not going to spend a lot of time here since our soils are high in K levels.
Physiologically it is involved in the movement of water, nutrients and carbohydrates in plant tissues. It is also involved in enzyme regulation and stomatal regulation.

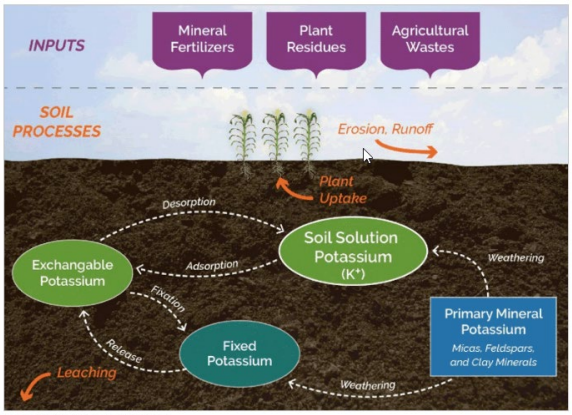


Figure 2. Soil potassium cycle.

While there are a few reactions as illustrated above potassium fixation is probably the most important one. Potassium is positively charged and will attach to clay and be trapped. These would be montmorillonite or vermiculite 2:1 expanding clays. Ideal conditions for this type of fixation would be higher levels of potassium and dry soils and these expanding clays.

Crop removal of potassium is around .30#/bu. That said, potassium levels in our area are not an issue normally. Not a lot of fixation occurs in our area due to the lack of expanding clays. One other thing that could have an impact would be cation exchange sites Ca, Mg. Since we have CEC that are inflated by the number of cations present in the soil one could conclude that exchange sites a more limited. That said, if the Mg levels are higher, they can occupy exchange sites that otherwise would have been occupied by K. While most of our K levels are very high, Mg levels can be very high in areas. Going back to base saturation if the K:Mg ratio is less than .20-.25 then you could some issues with K availability. In conclusion, our K levels typically are at sufficient levels for plant needs. I would contend that there could be certain conditions that would have an impact on availability even at these levels.

The last nutrient I would like to discuss has moved from a secondary nutrient to a primary nutrient in a lot of ways. In fact, many in the industry call in the 4th major nutrient. There are several reasons why this nutrient has become more yield limiting. These include higher yields, less impurities in fertilizer, less use of S containing herbicides and most importantly lower S emissions resulting in less atmospheric deposition.

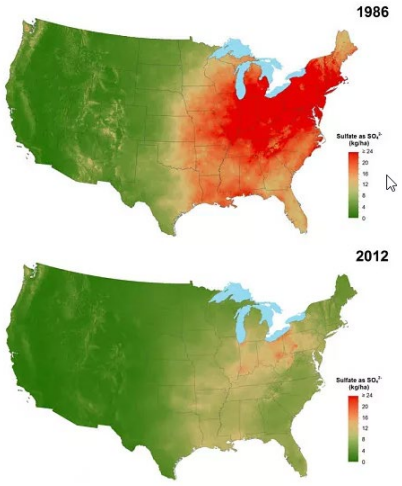


Figure 1. Average annual sulfate deposition from precipitation, 1986 (top) compared to 2012 (above). (Source: National Atmospheric Deposition Program.)

Over the past several years I typically see that more deficiency symptoms from this nutrient than any other. Physiologically sulfur serves many functions in the plant it is used in the formation of amino acids, proteins and oils. It is necessary for chlorophyll formation, helps develop and activate enzymes and vitamins, and it is a structural component of two of the 21 amino acids that form proteins. One other thing I want you to realize is that the crops need for S is closely related its need for N. They are both components of chlorophyll and proteins. In addition, Sulfur must be present in the plant to convert nitrate to amino acids. If the plant has higher N demands, then normally it also has higher S demands. I normally use .15#/bu as when looking at the crop removal. See chart below:

Crop	Yield		S (lbs/acre)
Alfalfa	10 tons/acre		54
Canola	60 bu/acre		20
Corn	200 bu/acre	grain	16
		stalks	14
Soybeans	70 bu/acre	grain	13
		stover	12
Wheat	80 bu/acre	grain	8
		straw	11

Table 3. Sulfur requirements of selected crops. (Source: The Mosaic Company)

Most of the S in the soils is contained in the Organic Matter. This organic sulfur must be mineralized to sulfate for plant uptake. As with phosphorus and nitrogen mineralization release is favored by warm soils and moisture. That said, this sulfur would not be made available until later in the season.

When considering sulfur fertilizers, we normally utilize dry formulations (90% S, 21-0-0-0-24, 12-40-0-6.5) and liquid formulations (12-0-0-26). All these other than the 90% S would provide sulfur in the sulfate form. This is the preferred form for plant uptake. The 90% S, however, must go through biological oxidation before it would be plant available.

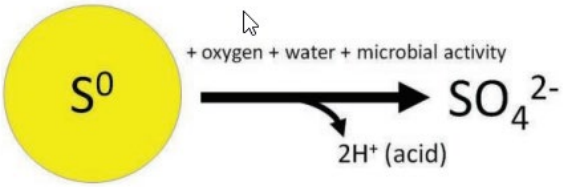


Figure 1. The reaction of elemental S (S^0) oxidation in soils to sulfate (SO_4^{2-}).

The reaction is pictured above. Notice the reaction will result in a release of two hydrogen ions and this will have an immediate impact on the pH of the soil in the area of the reaction. Consequently, with the amount of $CaCO_3$ we have in our soils this will be buffered relatively soon. In the interim however, nutrient availability will be impacted normally for the benefit of the crop. Remember this controlled by soil microbes and is impacted by moisture, temperature, aeration and particle size. Taking this into consideration the use of this product in the spring for the current crop is not the best fit. When the sulfur is oxidized, or you utilize a fertilizer product that contains sulfate understand that this ion is mobile in the soil and can leach out of the rooting zone with the right conditions. In conclusion, sulfur is a very important piece of a balance crop nutrition especially when we are considering higher yield environments.

Well, I better stop here. I get involved and then have a tough time finding a stopping point. We are still just a few short months from corn planting. We need to be evaluating wheat stands soon to make some management decisions. I would like to encourage you to analyze data now. We can always learn something or even confirm something we know. Perhaps we insert this knowledge into our transition to management execution which will happen within a few short weeks. Again, my goal continues to be to provide you some fundamentals and hopefully provided some context to help you understand fertilizer recommendations, soil reactions and finally nutrition. Remember **Agronomy** is an **Art** particularly when you farm in a desert 3,000 ft above sea level. If you have any questions, feel free to reach out.

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