PLANT NUTRITION AND SOIL RECOMMENDATIONS

FACT SHEET

Plant nutrition and plant to soil interaction is a complex mechanism with a number of environmental and external conditions effecting the process. There are 16 elements involved in plant nutrition, three that are supplied naturally that we have little control over and 13 that are supplied by soil and or fertilizer application.

These elements are either negatively charged or positively charged and compete with each other for position on soil particles and uptake by plants. The positively charged ions are called cations, Potassium K^{+}, Sodium Na^{+}, Ammonium NH_4^{+}, Hydrogen H^{+}, Calcium Ca^{2+} and Magnesium Mg^{2+}. The negatively charged ions are called anions, Chloride Cl^{-}, Nitrate NO_3^{-}, Sulfate SO_4^{---}, Borate BO_4^{----}, and Phosphate $H_2PO_4^{-}$.

Since soil particles are negatively charged and like charges repel and unlike charges attract it is easy to see the antagonistic relationship that these elements may have or that some elements can enhance the utilization of others.

Therefore it is important when interpreting soil analysis and designing a fertility program to keep balanced nutrition and proper placement of these nutrients in mind.

In production Agriculture today there is a lot of controversy over recommendations and how they are made. I often say that if you put two agronomists in a room together that they will come up with 3 different recommendations. Understand that all three are likely correct but are made with different philosophy or intentions.

When designing a recommendation we must keep in mind that we are not feeding the plant the soil will feed the plant, our inputs are to feed the soil that will in turn feed the plant.

Applications of different elements accomplish different things. Nitrogen that we apply provided that we do an excellent job using all Best Management Practices, we can expect the plant to get approximately 75% of that product in the production year. The rest of this nitrogen will be lost to the atmosphere, leached, tied up in the organic component etc.

Other nutrient such as Phosphorus and Potassium are not as efficient in plant uptake in the production year. In the application year the plant will only take up 15 to 20% of the applied P and K, the rest of the plant requirements will come from soil reserves.

A soil that has well-balanced fertility will be able to supply nutrients to a crop in all kinds of conditions and will remain a strong field or consistent producer. A field that is limited in fertility will not be a strong producer or consistent in all environmental extremes.

The form of nutrient also has an effect on the plant availability and how it will build the soil. An example of this is the different forms of Phosphorus. MAP and triple super are classed as more of a plant feeder in that the plant will take up a larger percentage of these materials in the application year. DAP on the other hand is more of a soil builder and is not taken up as readily as the other sources.

Potassium sources such as Potassium sulfate and Sulfate of Potash Magnesia are more of a plant feeder and Muriate is more of a soil feeder.

In any case however there is a much greater efficiency in uptake of P and K if these materials are banded due to the concentration effect and percentage of uptake by the plant. Generally a broadcast application of P and K will not be as effective in the application year and will become available in subsequent years as the soil releases these materials through diffusion to the root.

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Broadcast treatments usually consist of a greater quantity of fertilizer and should be looked upon as more of a soil maintenance and building program whereas the band program is designed for quicker availability due to concentration and placement.

Band treatments however should be limited in amount due to competition in the band with other elements (ei. P and Zn) and also the problems with excessive salt concentration that can cause root injury.

Designing a Fertilizer Program From Recommendations.

A&L recommendations are based on soil calibration work that has been in existence since 1945 and the latest work from Fisher et al. 1974 where he included C.E.C. in the interpretation to distinguish that difference in soil type.

We can all agree that sands and clays are different and for that matter they will respond differently in their ability to provide nutrients to a crop. Therefore when making a fertilizer recommendation we treat them differently.

A&L recommendations are a two-part recommendation. The first part and the most significant part of the recommendation in amount of fertilizer is the soil-building portion. The second part of the recommendation is the soil maintenance or crop removal portion of the recommendation.

Most agronomists do not disagree with the crop removal portion of the recommendation because it is well documented on how much a crop removes from the soil. The second part of the recommendation however is where there begins to be some disagreement.

The differences here come from two factors A) what is the target nutrient level or optimum level of the nutrient for that soil, and B) how fast can I afford to build that soil to get to that optimum level economically.

In the next decade with the use of GPS and soil audits, yield monitors and custom VRT equipment I believe every grower will have the tools and technology to establish the optimum level for his soil and farming system. The grower will establish what the most economical nutrient level is in a field and in turn determine how fast he wants to get to that point.

At the present time while we build these databases we use formulas such as Fishers' formula for optimum K levels in a soil that is as follows.

$$\mathbf{K_{sl}=(110 + 2.5 \times C.E.C.)}$$

This determines the optimum level of K for that soil type. From here we can develop a K recommendation with the following formula.

(K_{sl}ppm – K soil test value) x2 + crop removal

This first part **"(Ksl – K soil test value)x2"** is the soil build portion.

K_{sl} - from Fishers formula optimum K level for that soil

K soil test value - amount found from the soil test.

The second part **"(+crop removal)"** is the maintenance portion and is usually the amount that we would consider in a band or planter mix application placed in close proximity to the young root system for most efficient uptake by that plant.

When designing a fertilizer program from a soil report you must decide on how much fertilizer investment will go to soil build. If the economics at that time does not support soil building then a band application using crop removal will likely get the job done.

Understand however that at some time it is beneficial to invest in building the soil to optimum nutrient levels as these soils will perform on a more consistent basis in extreme conditions.

The recommendations that are on the A&L soil report are to build soil from one level to the next over a three to five year period. Using more or less in the building portion of your recommendations will only reduce the length of time or increase the length of time reaching these levels.

The charts that are attached give you the information on how much each crop removes by unit of production. This value should always be applied, as it is a soil maintenance value.

If you are looking to band apply fertilizer some agronomist will use this value as the amount to apply, while other will use half this amount, such as in short term rental agreements on land. I however would recommend that you do not go below crop removal.

In some poor fertility situations recommendations in the band may increase as the ppm reading decreases by as much as 50% increments. This is OK to a point but band applications placed close to the seed or developing root can become toxic from salts or even induce deficiencies of other elements such as mentioned early with P and Zn.

In conclusion I must say that fertilizer recommendations can be confusing if you do not understand why they are made or what was the intent. However when you look at the practical approach and consider crop removal, placement for efficient uptake, economics and success of fields or soils that have been identified as in balance with good levels it becomes a little clearer.