The Natural Chemistry Lab

Galynn Beer
Senior Sales Account Manager

Fertilizing a crop, any crop, is getting more and more complex; why? To answer this question, we'll do a quick review of the economic side, and then move into why it is important to look at things that haven't traditionally been scrutinized.

Why does it seem like there is more focus on various aspects of crop production? A major reason crop nutrition seems to be getting more complex is due to the swings in commodity prices, which quickly change revenue, input costs and profit margins. A thinning profit margin requires higher levels of management or we fall victim to the cruelty of a capitalistic market. There was a time when fertilizer management only focused on N-P-K. As yields climb, we know that we are having to increase the productivity of N, P and K through the supporting roles of secondary and micro nutrients, such as sulfur and zinc, all the way through molybdenum. To make matters worse, some of those supporting nutrients get pricey, so human tendency is to focus on the cheaper ones. Spending on extra nitrogen and potassium feels better than copper for sure. But what if copper holds the yield of your wheat crop back and the result is the 50 pounds of nitrogen you applied isn't productive because it wasn't supported by $5 worth of copper? Economics and our biases sometimes interfere with our decisions. Be aware of your tendencies and remember: balance is better than abundance in most instances.

Everyone wants a fertile soil, but that alone does nothing. The expectation of a fertile soil is that it will share those nutrients with the crop. The production of a crop is what provides a return and that's why we want nutrition to be associated with crop production. Fertile soils are generally productive, so there is a correlation - but not always. Excesses of some nutrients can interfere with the utilization of good levels of other nutrients. Higher rainfall amounts will cause some nutrients, such as potassium, to move down in the soil. With dry climates, high evaporation rates will keep cations at the surface. In addition, arid areas are often receiving irrigation water. Since the irrigation water generally carries other nutrients, the top of the soil starts acting like a coffee filter and the soil can take on the properties of the water. The result can be a potassium level that may have you gloating over how fertile you soil is, but could actually limit production. These factors matter as we manage crop nutrition. We can manipulate levels some, but then we're back to economics to see if productivity will justify the expense.

Let's get started. I'll go in the order that I look at a soil test analysis.

1. Cation exchange capacity (or CEC, and pronounced like a short phrase: cat-I-on)
The CEC. shows us the nutrient and water holding capacity of the soil. This is the first indicator of the productive capability of a soil. The higher the number, the more water and nutrients it can store. I have seen all types of CEC. soils be productive. Low numbers can be challenging because they need rain or irrigation more often since these sandy soils don't store much water. But crops root down well in a sandy soil and with sufficient water, they will reward you with outstanding yields. Higher CEC. soils hold more nutrients and water, providing a buffer between rain events. A low CEC number would be 1, requiring superb management, and a high number might go as high as 50 if a lot of organic matter exists. Typical soils range between 10 and 30.

2. Calcium (Ca)
Calcium levels heavily influence soil productivity. I like a Ca base saturation range of 60-75%. Higher numbers will tie up, or crowd out, other nutrients. With a number higher than 75, I immediately look to see if it is tying up phosphorus and crowding out the micronutrient cations like zinc, iron and manganese. If it is, I need to make sure to allocate budget for these. This is a case of a low nutrient base saturation, such as phosphorus or one of the micros, and those low levels being related to an excess of something. In this example, it would be because of calcium. Phosphorus is very reactive with calcium and since zinc, iron, manganese and copper are cations, they can be displaced by high levels of calcium. Most commonly, you'd see associated low levels of zinc, iron and manganese. The importance of sulfur is elevated in this situation to counter high calcium levels. You aren't only considering crop needs for sulfur, but also the 'antidote' effect it has on the elevated cation level of calcium. Banding near the root zone is important to limit exposure of the nutrients to reactivity of the high calcium levels. On the other end of the spectrum, at lower than desired calcium levels, below 60%, rhizobia bacteria don't do their job as efficiently, so lime is needed, especially if a legume will be grown.

3. Magnesium (Mg)
I like Mg between 10 and 20%. Over 20, and compaction is more of an issue. An anaerobic condition can develop under heavy rain or even with severe drought. Under 10% and deficiencies begin to occur and applications should be made. Magnesium is central to chlorophyll development, so it is important to have enough of this nutrient available to your crop.

4. Potassium (K)
It should be between 3 and 8%. A low CEC soil should be in the high side of this range to supply ample amounts. If not, then it needs addressed. Rare instances of levels over 8% can exist and can restrict water infiltration. These high levels would most likely be found in low rainfall areas with high applications of manure or with potassium being brought to the soil through irrigation.

5. Hydrogen (H)
Any amount of hydrogen present means we are on the acidic side of the pH scale, meaning under 7. The higher the hydrogen number, the more acidic the soil. You'd like to keep your soil near the neutral level of 7. As soils become acidic, some nutrients are more readily released, such as iron and manganese. Often, you see crops that like high levels of iron and manganese grown in acidic soils, such as blueberries. But many beneficial microbes can't survive in an acidic environment, so generally lime is needed to raise the pH. This is done by adding lime with calcium and/or magnesium, which displaces the hydrogen and brings the pH up. Rain and snow (H_2O) bring H to the environment, so acidity slowly creeps back in. Also, various forms of nitrogen can contribute more than others. NH_3 and the conversion of urea to NH_4, then to NO_3 through the nitrogen cycle, contribute to acidity. Don't panic; these forms of nitrogen don't cause a radical shift in pH, but over-applications do contribute additional hydrogen and creates some acidity.

6. Sodium (Na)
Sodium mostly comes into play in arid areas where irrigation water is being applied, but can be a factor in low areas of fields where water stands and in areas with a shallow water table. Sodium base saturation over 2% can limit production when temperatures rise and water is demanded by the plant to cool itself. Sodium holds on to water and can limit its movement into a plant. Generally, elemental sulfur would be used to counter this situation. Also, winter annuals typically do better if sodium issues are persistent. They are grown when transpiration rates aren't as high, so the competition of sodium for water isn't as critical. The source of sodium should be identified and treated if possible so that production options remain flexible.

The management of cations greatly influences the productive capacity of your soil. Proper balance is important for other nutrient inputs to provide maximum return. Calcium in a range of 60-75%, magnesium between 10-20%, potassium between 3 and 8%, hydrogen less than 10% and sodium less than 2% will provide the most consistent yields through a variety of environmental conditions. Exceptions for specific crop reasons and economic limitations of amending soils can create a to manage around problems in this area. A perfect soil doesn't always make sense. Where possible, it lowers risk of other stresses limiting production, but good production can come from less than ideal soils if they are properly managed.

In the next edition of the AgroLiquid Newsletter, we'll tackle the other nutrients and then look at how all cations and nutrients work together and interact with each other.

"The production of a crop is what provides a return and that's why we want nutrition to be associated with crop production."