



September 2012

Crop Nutrition Following the 2012 Drought: South and Central Great Plains

The summer of 2011 brought a record-breaking drought to much of the Southern and Central Great Plains Region. Thus we released newsletters and other information last summer on the topic of fertilizing after a drought. Unfortunately, this is a relevant topic again in 2012. Last year the Sept. 22 US Drought Monitor Map showed severe to exceptional drought covering the entire states of Texas and Oklahoma, most of New Mexico, eastern Colorado, and southern Kansas, while Nebraska was unaffected. The conditions this year have shifted somewhat (see map) as a low pressure system brought needed rain in July to areas in the southern part of the region, but for the most part conditions are still tough, with the majority of the six state region still affected by some degree of drought. The state of Kansas has been especially hard-hit this year, and as a result KSU Extension faculty have been earnestly addressing drought issues. This newsletter will again focus on basic soil fertility and drought.

Where crops fail or are damaged by drought, questions arise on the best ways to handle nutrient management programs going forward. In most cases, the majority of the fertilizer that was applied to unharvested, failed crops should still be there for the next crop—either in the soil or in the crop residue. Farmers will need to do some soil testing to know with best certainty the nutrient status of fields with failed corn and other crops. Farmers will also want to have some idea of the amount of nutrients present in the residue remaining, and how quickly those nutrients will become available to crops. Scientists at KSU have studied drought-affected fields across Kansas to help producers answer questions about residue (*KSU Agronomy E-updates, July 27 and July 20, 2012, see http://www.agronomy.ksu.edu/extension/p.aspx?tabid=58#july_12*)

There are a number of potential sources of nutrients other than applied fertilizers that could contribute to a 2013 crop. These include:

1. Nitrate ($\text{NO}_3\text{-N}$), sulfate ($\text{SO}_4\text{-S}$), and chloride (Cl) in the soil profile

2. Phosphorus (P), potassium (K), and zinc (Zn) in the surface soil
3. Nutrients in crop residues

The first category consists of mobile nutrient forms, and the second category consists of immobile nutrients. The difference is important. Mobile nutrient forms are found in the soil solution and can move through the soil in water, while immobile nutrients generally stay where applied. Of the 14 essential mineral elements, the common **mobile nutrients** in soils we apply as fertilizer are N, S, and Cl , and the common **immobile nutrients** we apply as fertilizer are P, K, and Zn.

Mobile nutrients in the soil

A very large portion of those mobile nutrients that were not taken up by the 2012 corn and/or wheat crops are likely to remain in the top foot or two of soil. With the low rainfall in most of the southern and central Great Plains, very little of the $\text{NO}_3\text{-N}$ will have been lost. The K-State Soil Testing Lab is seeing higher-than-normal soil test levels for $\text{NO}_3\text{-N}$, reflecting its accumulation in the soil. Any unused $\text{SO}_4\text{-S}$ or Cl would also be present in that top foot or two of the soil profile. Most is still in the top few inches and will remain there until we receive some soaking rains.

So the first tool a farmer should think about when planning a 2013 fertilizer program is a deep profile soil test for $\text{NO}_3\text{-N}$, $\text{SO}_4\text{-S}$, and Cl .

Immobile nutrients in the soil

What about P, K, or Zn? Where these nutrients were applied to the 2012 crop, will they still be available for crops in 2013? When immobile nutrients such as P, K, and Zn are applied to the soil, they interact with different portions of the soil and are retained. Note the word “retained,” not “fixed.”



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Phosphorus reacts with the clay surfaces, and the iron and aluminum coatings found on the soil particles, and is **sorbed** to those surfaces. Sorption reactions occur in stages, and the initial stages are highly reversible. Sorbed P can be desorbed and go into soil solution, replacing the P taken up by plants. This is a buffering system that maintains a constant small quantity of P in the soil solution and supplies the P needed for good crop growth. This is how we store P in the soil and build soil test values, with little worry about that P being lost. Sorbed P is the primary P fraction in soils measured by a soil test. But the soil test only reflects a fraction of the total P present in the soil. For example, most Kansas soils have an 18:1 buffer factor. If we add 18 lbs of P₂O₅ and it reacts with the soil, becoming sorbed to the clays and other minerals present, the soil test will increase 1 ppm.

So how does this relate to planning for 2013? Any P applied in 2012 for this year's crop that was not taken up was sorbed onto clays and other minerals. This creates a new equilibrium in the soil, and will to some degree increase the soil test values for P. How much P in the soil increases depends on how much P fertilizer was applied and how much, if any, P was taken up by the 2012 crop. Higher soil test values will result in a somewhat lower P fertilizer recommendation.

Potassium is a charged cation, K⁺, which is attracted to, and retained on, the soil's cation exchange capacity (CEC). Like sorbed P, exchangeable K maintains a constant supply of K in the soil solution to support plant growth. Also like P, this exchangeable K can be measured by a soil test, and it is a highly buffered system. With K, every 4 to 8 lbs of K₂O added will increase the soil test by 1 ppm. The buffer factor is a function of CEC and soil minerals present. On low-CEC sandy soils this factor is closer to 4, while on high-CEC silty clay loams the value will be closer to 8. Any K applied and not taken up by the 2012 crop would have been retained on the CEC in the surface soil and remains available for 2013. And, the higher K soil test values will result in lower K fertilizer recommendations for 2013.

With Zn, a third mechanism, chelation, helps to retain applied forms of Zn fertilizer. Soil organic matter is a strong natural chelating agent, much like some of the synthetic compounds we buy as fertilizer sources. Zinc sulfate added to soil slowly dissolves. A portion reacts with the organic matter and is retained in soluble, natural organic matter chelates. The vast majority of the Zn that moves to plant roots for uptake is present as a natural soil organic matter chelate. Again, this can be measured by a soil test, and there is a common buffer factor of about 10:1 with the DTPA soil test. If we add 1 lb of Zn, the DTPA soil test value will increase by about 0.1 ppm.

Testing for soil nutrients

The bottom line for soil nutrients is that any N, P, K, S, Zn, and Cl⁻ added as fertilizer and not taken up by crops is still likely there, and can be measured by soil tests. The mobile nutrient forms (NO₃⁻-N, SO₄²⁻-S, and Cl⁻) will need to be measured using a deep profile test, while the immobile nutrients (P, K, and Zn) can be measured using a surface sample.

For those planting wheat this fall in these failed crop fields, a profile soil test for NO₃⁻-N, SO₄²⁻-S, and Cl⁻ is a must. Phosphorus and K applications should also be made based on a surface soil sample. For those planting corn or sorghum next spring, it would be best to wait until late winter or early spring to take the profile sample to get a better feel for the amount of the residual N which will be remaining in the soil. Mobile N can be moved below the root zone, especially in sandy soils if we get a wet winter.

Another potentially valuable tool to consider is the use of a crop sensor to help estimate the amount of the N being mineralized from the 2012 crop residues. Kansas has good recommendation systems for both wheat and sorghum to help interpret sensor data. The rate of mineralization will depend greatly on soil moisture and soil temperatures during March through June. A sensor-based N management system can help take some of the risk out trying to take credit for mineralized N.

Summary

A significant amount of residual nutrients will be present in many fields where this year's crops failed or were otherwise affected by drought. In severe situations, only a fraction of the nutrients applied were actually taken up by this year's crop. Many of the nutrients remain in the soil and can be measured using soil tests. This is especially true for the mobile nutrient forms such as NO₃⁻-N, SO₄²⁻-S, and Cl⁻. But to get a good estimate of the amounts present, a profile soil test to a depth of 24 in. will be required.

In some cases plant biomass accumulation was significant, but no grain was produced. Where this occurred many of the nutrients taken up by the crop will also be available, especially the K and Cl⁻, which are not incorporated into organic compounds in the residue. However the N, P, and S must be mineralized as the vegetation decays. This process will likely be faster than normal, and will increase the availability of these nutrients. But the exact rate of mineralization will depend on the weather, and is difficult to estimate. Crop sensors can help take some of the risk out of crediting these mineralized nutrients. ■

