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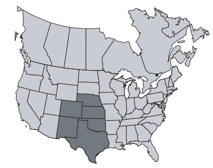

Nutrient Management after Drought

The southern and central Great Plains have been severely affected by drought in 2011. The states of Texas, New Mexico, Oklahoma, and parts of Kansas have seen extreme, and in some cases, record breaking drought conditions (see drought monitor map below—found at http://droughtmonitor.unl.edu/). In some areas crops have failed altogether, while in other areas crops will be harvested with yields that are substantially lower than average. This article covers some fundamental nutrient management considerations following drought.

Where crops failed in 2011 due to drought, farmers are asking questions on the best ways to handle their nutrient management programs for 2012. In most cases, the vast majority of the fertilizer that was applied to unharvested, failed crops should still be there in 2012—either in the soil or in the crop residue. However, farmers will need to do some soil testing to know more about 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 in the field, and how quickly those nutrients will become available to crops.

There are a number of potential sources of nutrients other than applied fertilizers that could contribute to wheat, corn, sorghum, or soybean crops in 2012. These include:

1. Nitrate (NO_3^--N), sulfate (SO_4^{2-}-S), and chloride (Cl^-) in the soil profile
2. Phosphorus (P), potassium (K), and zinc (Zn) in the surface soil layer
3. Nutrients contained in crop residues

The first category consists of **mobile nutrients,** while the second category consists of **immobile nutrients.** The difference is important. Mobile nutrients are able to dissolve in soil water and can move through the soil with water, while immobile nutrients generally stay where applied. Of the 14 essential mineral elements, the common mobile nutrients 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 after a failed crop

A very large portion of those mobile nutrients that were not taken up by the 2011 corn and/or wheat crops are likely still present 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 N will have been lost. The K-State Soil Testing Lab, is already seeing higher-than-normal soil test levels for N, reflecting an accumulation of unused nitrate-N in the soil profile. Any unused 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 his 2012 fertilizer program is a deep profile soil test for N, S, and Cl^-.

Immobile nutrients in the soil after a failed crop

What about P, K, or Zn? Where these nutrients were applied to the 2011 crop, will they still be available for crops in 2012? 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."*

Phosphorus reacts with the clay surfaces and the iron and aluminum coatings found on 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 dissolved into soil solution, replacing the P taken up by plants. This is a buffering system which maintains a small but constant quantity of available P that supplies what is required for good crop growth. This is how

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we store P in the soil and build soil test values, with little worry about 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 pounds of P_2O_5 and it reacts with the soil, becoming sorbed to the clays and other minerals present, the soil test will increase 1 ppm. If we remove 18 pounds P_2O_5 through crop uptake, the soil test value will drop 1 ppm.

So how does this relate to planning for 2012? Any P applied in 2010 or 2011 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 increase the soil test values for P. The higher soil test values will result in a 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 pounds K_2O added will increase the soil test by 1 ppm, and every 4 to 8 pounds removed will lower 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 2011 crop would have been retained on the CEC in the surface soil and remains available for 2012. And, the higher K soil test values will result in lower K fertilizer recommendations for 2012.

With Zn, a third mechanism called chelation occurs, which retains applied Zn. Soil organic matter is a strong natural chelating agent, much like some of the synthetic compounds used 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. In fact, 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 our DTPA soil test. If we add 1 pound 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 nutrients (N, 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.

Measuring nutrient levels on fields after a failed crop

For those planting wheat this fall in these failed crop fields, a profile soil test for N, S, and Cl^- is a must. Applications of P and K 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 that 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 2011 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 of 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. 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 nutrients such as N, S, and Cl^-. But to get a good estimate of the amounts present, a profile soil test to a depth of 24 inches will be required.

Many of the nutrients taken up by this year's crop will also be available, especially the K and Cl^-, which are not incorporated into organic compounds. However 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, which is difficult to estimate. Crop sensors can help take some of the risk out of crediting these mineralized nutrients. ■