k-state extension
Agronomy e-Updates

Number 66
January 26, 2007

1. Late topdressing of wheat

The heavy dose of precipitation in Kansas during late December and January may mean that soils will stay wet through at least late winter or early spring. Producers who were planning to topdress nitrogen (N) on their wheat during this time period may have to wait longer than they'd like for soils to dry out enough to make the application. This could mean that the N will go on later than usual. How late can producers topdress their wheat and still get a yield benefit?

Unless wheat is not severely deficient in N at the boot stage, it's unlikely that an N application at that time will increase yields. If the wheat is severely deficient in N at that time, then an application of N can increase yields.

In almost all situations, N has to be in the root zone of wheat by the jointing stage to have a significant effect on yields. After that stage of growth, additional N has much less, if any, yield benefit. Nitrogen that is surface-applied just prior to or at jointing has less chance of moving into the root zone than N applied in fall or winter. That's why we recommend applying topdress N as early as possible on medium- to fine-textured soils where the chances of losses from either leaching or denitrification are low. Nitrogen applied on the surface at or after jointing has little chance of increasing yields much, unless the wheat is severely deficient in N.

A three-year study conducted by Barney Gordon at the North Central Experiment Field has tested different N rates and application timing on wheat, and demonstrates a typical response on medium- to fine-textured soils.

Spring applications were made in mid-February to mid-March each year. The soil N level in the top 24 inches in 2003 was 26 ppm; 6.2 ppm in 2004; and 10.2 ppm in 2006. The variety was 2145 and the previous crop each year was soybeans.

When part or all of the N was surface-applied at F6 (jointing), it had only half the effect on yield as where it had been applied earlier. When part or all of the N was surface-applied at F8 (flag leaf emergence), it had little or no effect on yield.

In contrast, a treatment of 80 lbs/A N resulted in wheat yields of about 90 bu/A whether it was applied all in the fall, split between fall and early spring, or all in early spring. In each of these years, there was enough moisture after the early spring applications to move the N into the root zone of wheat.

The wheat in these tests was not severely deficient in N at the time of the applications made at jointing or flag leaf. If that had been the case, there could have been more of a yield benefit from the flag leaf application of N.

Nitrogen Timing and Rates on Wheat: North Central Experiment Field					
		Yield (bu/A)			
Timing	N Rate (lbs/A)	2003	2004	2006	Average
None	--	49	42	46	46
All Fall	40	68	71	74	71
	80	92	88	90	90
	120	91	88	91	90
Fall-Spring	20-20	69	73	76	73
	40-40	94	89	87	90
	60-60	95	87	93	92
All Spring	40	69	75	72	72
	80	95	88	89	91
	120	96	89	88	92
Split Spring-F6	40-40	68	73	70	71
Split Spring-F8	40-40	70	70	68	70
F6	80	67	70	65	68
F8	80	51	58	52	54
LSD		4	5	4.2	

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2. Sulfur deficiencies in Kansas

Deficiencies of sulfur (S) have increased in Kansas, most of North America, and worldwide. The incidence of S-deficient soils has increased over the years, and is likely due to one or more of the following:

* Much higher crop yields
* More intensive cropping systems that result in greater S removal
* Erosion of surface soil and organic matter over the years
* Less S deposition from the atmosphere
* Continued use of fertilizers that contain little or no S

Sulfur deficiency on growing crops is often mistaken for nitrogen (N) deficiency. With S deficiency, many crops become uniformly chlorotic. The pale yellow symptom of S deficiency often appears first on the younger or uppermost leaves, while N deficiency initially appears on the older, lower leaves. Deficiencies of S are often difficult to identify because the paling in crop color is not always obvious. Crops lacking S also may be stunted, thin-stemmed, and spindly. In the case of wheat and other cereal grains, maturity is delayed. On legume crops, nodulation may be reduced. In some crops, a reddish color may first appear on the underside of leaves and on stems.

Sulfur is usually present in relatively small amounts in soils, and a majority is in organic forms. Sulfur-deficient soils are often low in organic matter, coarse-textured, well-drained, and subject to leaching. In recent years, an increasing number of finer-textured soils have shown S deficiency, however. Much like N, S tends to cycle in the soil.

Soil organic matter is an excellent source of S. Since organic-S is not plant available, sulfate must be released from reserves of organic matter through microbial mineralization. Nitrogen and S mirror each other closely in terms of the transformations and reactions that occur in the soil. Mineralization of sulfate from soil organic matter is controlled by organic matter levels, temperature, and moisture. Generally, environmental factors that favor plant growth enhance S release from organic matter.

Sulfate is an anion, and as such is mobile in the soil, though not as free moving as nitrate or chloride. In well-drained, coarse-textured soils, sulfate-S can be leached below the root zone, especially in high-rainfall areas or under irrigations. Supply of sulfate in soils can vary greatly from year to year, based on crop removal, environmental conditions, and the amount of S deposition from the atmosphere.

The total S concentration of soil varies widely from about 50 to 50,000 ppm. As is the case with many other nutrients, however, total S is not necessarily a good predictor of a soil's ability to supply this nutrient. A soil test for available sulfate-S has been developed. For proper interpretation of this test, soil organic matter, soil texture, the crop to be grown, and the expected yield level also need to be factored in to accurately assess S needs.

As with nitrate-N, soil samples should be collected from a deeper depth than for normal soil samples if the soil test is to be used. Since sulfate-S is mobile, sampling to a 24-inch depth is suggested for best results.

Significant amounts of plant-available sulfate-S can be added to the soil via irrigation water. In Kansas, S content of irrigation water varies, but in some cases enough S could be added through irrigation to meet crop needs. The S content of irrigation water should be determined by testing and factored into S applications. The timing of irrigation may not coincide with plant S needs, however. If it is well into the growing season before the first irrigation is made, the plant may be S deficient early, even though more than enough S will eventually be applied during the growing season.

There are many S-containing fertilizer materials available.

* Ammonium sulfate (21-0-0-24S) is one of the oldest sources of ammoniacal N, and is often blended with other dry materials. Ammonium sulfate is a good source of both N and S, has low hygroscopicity, and is chemically stable. Its use may be undesirable on acidic soils, due to the acid-forming potential.

* Ammonium thiosulfate (12-0-0-26S) is a clear liquid material with no appreciable vapor pressure. Ammonium thiosulfate is the most popular S-containing product used in the fluid fertilizer industry, as it is compatible with N solutions and other complete liquid products. When ammonium thiosulfate is applied to the soil, it decomposes to form colloidal elemental S and ammonium sulfate.

* Potassium magnesium sulfate (0-0-22-22S-11Mg) is sometimes referred to as K-Mag. It is marketed as a dry material that is used in mixed fertilizers, or sometimes applied alone to supply S and magnesium on soils deficient in both these two elements.

* Elemental S (typically 90-95 percent S) is marketed by several manufacturers. These products are usually 90 percent or higher S content, with a small amount of binding material and/or bentonite clay to facilitate blending, application, and soil reaction. Concern exists about the availability of elemental sulfur during the year of applications. Before it becomes available for plant uptake, elemental S must first be oxidized by soil microorganisms to sulfate-S and this can be a slow process when surface-applied.

* Gypsum (analysis varies) is calcium sulfate, and is commonly available in a hydrated form containing 18.6 percent S. This material is generally applied in a dry form and is available in a granulated form that can be blended with other materials.

Potassium thiosulfate (0-0-17-17S) is a relatively new product that is a clear liquid. Potassium thiosulfate can be mixed with other liquid fertilizers and has potential for use in starter fertilizer mixes where both K and S are needed. This material should not be placed in direct seed contact. Potassium thiosulfate is not a commonly used product.

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3. Effect of heat and drought timing on grain sorghum

Although grain sorghum withstands heat and drought better than most row crops in Kansas, these environmental stresses end up causing yield losses in grain sorghum somewhere in the state almost every year. The effect on yield depends greatly on when the stresses occur.

At K-State's Center for Sorghum Improvement, we conducted two separate studies over the past year to get a better idea of what stage of grain sorghum growth is most sensitive to short periods of heat and drought stress.

* Heat stress. Grain sorghum was subjected to 10-day periods of high temperatures (104 degrees F high and 86 degrees F low) and compared to plants under optimum temperatures (90 degrees high and 72 degrees low). Moisture was kept at optimum levels. Exposure to 10 days of heat stress significantly decreased percent seed set and seed weight. The maximum effect occurred when the plants were exposed to heat stress during flowering and 10 days prior to flowering. Seed weights were decreased with both pre- and post-flowering heat stress.

Grain yields were decreased to a greater extent when under heat stress at early stages of grain fill, compared to later stages. Heat stress during pre-flowering and flowering stages of growth reduced yields by reducing seed set. Heat stress during post-flowering stages reduced yields by decreasing seed size.

* Drought stress. Plants were exposed to four treatments:

-- Fully watered
-- Drought stress from boot to flowering
-- Drought stress from flowering to seed set
-- Drought stress from seed set to mid-grain fill

The periods of drought stress lasted 15 days, after which the plants were fully watered. Drought stress during flowering to seed set caused the greatest reduction in percent seed set. Drought stress during the other two growth stages tested did not reduce seed set.

Seed weights were reduced by drought stress at each of the three growth stages, but again most severely at the flowering to seed set stage.

Effect of Drought Stress on Grain Sorghum Seed Weight	
Stage of growth during drought stress	Percent reduction in seed weight
Boot to flowering	14%
Flowering to seed set	63%
Seed set to mid-grain fill	43%

In addition to the effects of drought on seed set and seed weight, drought during boot or flowering also reduced plant height. The overall weight of the plants was reduced by drought stress during the boot stage and grain fill. But when the plants were under drought stress from flowering to seed set, the weight of the plants actually increased. This may seem unusual at first glance, but it is probably due to the fact that drought stress at this time reduced seed set and seed weight more than drought stress at other growth stages. Because the plants stressed at this time had fewer seeds to fill, they put more of their energy into plant growth.

In summary, short periods of heat stress during pre-flowering or flowering reduced seed set significantly. Short periods of heat stress during grain fill reduced seed size and grain yields, especially if the stress occurred at early grain fill. A short period of drought stress during the flowering to seed set stage of growth reduced yields more than drought stress occurring either before or after that period.

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These e-Updates are a regular weekly item from K-State Extension Agronomy. All of the Research and Extension faculty in Agronomy will be involved as sources from time to time. If you have any questions or suggestions for topics you'd like to have us address in this weekly update, contact Jim Shroyer, Research and Extension Crop Production Specialist and State Extension Agronomy Leader
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