Topdressing Nitrogen in Wheat

- Winter wheat uses about 30 to 40 percent of its total seasonal uptake of nitrogen (N) by the start of stem elongation.
- The topdress application should be timed to provide sufficient N to support the plant when the seed head is initiated in the spring (Feekes growth stages 3 to 4).
- A grain protein response to a topdress N application is usually more reliable in winter wheat than spring wheat.

The growth stage of the crop is the most critical factor for the proper timing of topdress nitrogen (N) applications. The Feekes scale is the most commonly used of several systems (Figure 1).

Nitrogen Uptake in Wheat

Wheat requires approximately 1 to 2 pounds of nitrogen (N) per bushel of yield. For optimum tillering and secondary root development, wheat needs about 20 to 40 pounds per acre of available N in the top 6 inches of soil in the fall. Winter wheat uses about 30 to 40 percent of its total seasonal uptake of N by the start of stem elongation. Rapid N uptake occurs during Feekes growth stages 3 to 4 (leaf sheath erection and stem elongation), when the number of kernels per head is established. In most situations N should be applied at Feekes 3 to 4 to ensure N is moved into the root zone with early spring moisture before an N deficiency occurs and seed head size is determined. Ideally, spring topdress application of N should be completed by first hollow stem stage of development, usually a week or two before jointing. After that time, N is needed to produce sufficient leaf area for optimum yield potential.

Nitrogen uptake during the grain fill period is relatively low compared to uptake during stem elongation. The plant utilizes N from the stems and leaves to support grain development rather than N uptake from the soil. Application of N at or after wheat flowering has not been shown to improve yield potential.

Importance of Application Timing

Ideally, a fertility plan for winter wheat should be based on soil test results and include a split application of a fall preplant or at-seeding application coupled with topdress applications in the spring. The fall N application should provide sufficient available N in the soil to carry the crop through green-up and to support tillering once the crop breaks dormancy. The topdress application should be timed to provide sufficient N to support the plant when the seed head is initiated later in the spring (Figure 2). Feekes 5 is the growth stage when head size is being determined which is about two weeks before jointing. The topdress N application should be moved into the root zone with precipitation or irrigation well before jointing. Nitrogen applied after this stage can positively influence yield potential, but it will be less effective. If wheat will be grazed, 30 to 40 lbs/acre of additional N should be applied for every 100 pounds of beef weight gain removed from the field.

A critical stage of wheat development is jointing, when the first node emerges above the soil line (Feekes 6). Topdressed N should be in the root zone prior to jointing. Jointing is visible evidence that a plant has entered the reproductive stage. At this stage the developing grain head is above ground and more vulnerable to stress and mechanical damage. Scouting for the appearance of the “first hollow stem” (FHS) is a tool growers can use to help time N applications prior to jointing. FHS
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typically occurs 7 to 14 days before jointing.\textsuperscript{5} FHS is the point at which a 1/2-inch of hollow stem can first be identified above the root system and below the developing head. Prior to this stage, the nodes are tightly packed together and hard to see. The maximum potential number of spikelets is determined at FHS.\textsuperscript{5} N should be available in the root zone prior to this stage to positively affect the potential number of seeds per head.

Split N applications. Apply the majority of the N early to take advantage of better moisture conditions. To encourage tillering, the first N application should be made around Feekes 2 to 3 (Figure 2) and should be about 1/4 to 1/3 of the total spring N application.\textsuperscript{6} Use caution to avoid excessive N rates at this time as this can increase the potential for lodging, freeze damage, foliar burn, and loss of N. If stands at this time are thin, a higher N rate can be used. If tiller counts are high (above 70 tillers per square foot), a lower N rate should be used. A second N application can be made in the spring around Feekes 5 if moisture and yield potential are favorable.\textsuperscript{6}

Single N application. When a single N application is the only option, target the N application when wheat starts to grow rapidly, or Feekes 4 to 5. This is the time when wheat requires the most N and the most benefit will be achieved from an N application. The exception to this is when stands are thin and an earlier N application is needed to encourage tillering. Nitrogen applications that are made too early can increase the potential for lodging, disease, foliar burn, loss of N, and damage from a late spring freeze. Nitrogen fertilizer applications that are made at Feekes 6 (when the first joint appears on the main stem) and beyond will have a diminished yield benefit as wheat yield response to N decreases as growth progresses.\textsuperscript{6}

Topdressing to Increase Grain Protein
Topdressing N at the flowering stage of winter and spring wheat development (Feekes 10) has been shown to potentially improve grain protein, but not yield potential.\textsuperscript{7,8} Before applying N at flowering, conduct a flag leaf analysis to help determine if the application will have a high probability of success. Grain protein is likely to increase with late-season N if the flag-leaf N concentration is less than 4.2 percent.\textsuperscript{7} Responses to late N application vary based on annual environmental conditions and wheat seed products. Protein responses have been more reliable in winter wheat than spring wheat primarily because there is a better chance for rainfall to incorporate N into the root zone in winter than in spring wheat.\textsuperscript{8}

Herbicide Application with Topdress N
Many post-emergence herbicides can be applied with topdress foliar N applications.\textsuperscript{9} However, there is some risk of foliar burn to wheat, especially if a non-ionic surfactant or crop oil is used in the tank mixture. Rising air temperatures and new wheat leaf growth increase the potential for leaf burn. The risk also increases during later wheat growth stages because the crop has more leaf area and there is less time for the plant to recover before head initiation, flowering, and grain fill. Observe all product label instructions to reduce the risk of foliar burn potential. To help reduce the potential of foliar nitrogen burn, limit the amount of nitrogen fertilizer in the spray solution to no more than 50 percent by volume when applying herbicides with surfactant or crop oil adjuvant.\textsuperscript{9} When liquid nitrogen in the spray solution exceeds 50 percent by volume, be aware that significant foliar burn may still occur and weed control may also be reduced. Avoid making applications during warm, humid conditions, and before expected periods of freezing temperatures because herbicide metabolism by the crop may be limited and cause injury to the crop.

Best Management Practices

- Determine the right rate for each field at the beginning of the season based on a profile N soil test. Conduct the test before the crop is planted and before any N has been applied. Samples can be taken in late winter or very early spring before the wheat greens up to identify areas of high nitrate availability but results may not be as accurate as when samples taken in the fall.
- The most critical factor for topdress applications is timing. Have sufficient N in the root zone prior to jointing.
- Most topdressing is made as a broadcast application. In high residue situations, it may be advantageous to apply N with dribble streamers spaced approximately 5 inches apart.
- The most commonly used N sources for topdressing are a liquid solution of urea ammonium nitrate (UAN) or dry urea. Dry urea may be the preferred option for no-till or high residue fields. Some of the new controlled-release products such as polyurethane coated urea can be considered on very sandy soils prone to leaching, or poorly drained soils prone to denitrification.\textsuperscript{3}