Soil and Nutrient Management for Wheat

- Soil tests are the foundation of fertility management.
- Wheat needs nitrogen in the fall to promote tillering and in the spring to promote growth along with high yield and protein content potential.
- An irrigated wheat crop will require higher rates of nutrients, especially nitrogen.

Growth Stages

The growth stage of the crop dictates the timing of many agronomic decisions. Several different scales are used to describe wheat growth stages with the Feekes scale being the most commonly used in the United States (Figure 1).

Soils and Tillage

Wheat needs well-drained soils for optimal growth. Yields and stands are likely to be reduced when the crop is grown in fields prone to ponding and flooding. Waterlogged soils can lead to increased pest and disease issues and may result in restricted root growth which can make the crop more prone to winterkill.

Managing wheat in a long-term no-till system may result in higher yields and/or economic benefits depending on location and management practices such as crop rotation. For example, no-till may be more economical when wheat is double cropped and/or rotated with other crops such as corn, soybean, sorghum or fallow as this can break disease and weed cycles and reduce dependence on pesticides. Numerous studies have shown that the economic advantages (soil water retention, reduced soil erosion, reduced labor and fuel costs) and disadvantages (costs of weed control, planting equipment costs) of no-till may be farm specific.1,5

Soil Fertility

Soil testing. Applications of phosphorus (P), potassium (K) and lime should be based on soil test results taken as soon as possible after harvest of the previous crop and before seeding wheat. Use caution in drought years as soil tests taken from very dry soils can result in soil pH and K test values that are artificially low.

Soil pH. A soil pH between 6.0 and 7.0, with a target pH of 6.4, should be optimal for micronutrient availability and wheat growth. If lime is needed to correct soil pH it should be applied in the fall prior to planting.

Nitrogen. Nitrogen (N) is the most yield limiting nutrient in wheat.7 Proper N management is important for optimum stands and maximum yield potential. While N deficiency can lead to lost yield potential, too much N can also lead to yield-reducing problems. Too much N can favor excessive vegetative growth which can increase plant susceptibility to diseases, lodging and spring freeze damage. Grain protein content can indicate the N status of the field. Wheat grain with a protein content of 11% or less may be an indication of N deficiency in the field.7

Fall fertilization. A small amount of N is required in the fall for proper tillering. This requirement may be met with the residual N from the previous corn or soybean crop. If N levels in the soil are suspected to be low, such as when the yield of a previous corn crop exceeded expectations, then a fall N application of 15 to 30 lb/acre should be added at or near planting.2,4 If stands are thin, N can be applied during the tillering growth stages (Feekes 2-3) to enhance tillering. To reduce the potential for diseases, lodging, freeze damage and N-loss, total fall-applied N should not exceed 30 to 40 lb/acre.1,4

Spring fertilization. The rapid growth stages of wheat in the spring (Feekes 4-5) is the critical time for N applications for maximizing yield potential. Nitrogen can be applied in the spring as either a single application or a split application. When time and equipment permit, a split N application is recommended as this may increase yields and reduce lodging potential.1,4 Base spring N fertilizer rates on the expected yield. Account for the N supplied or used by the previous crop, residual soil nitrates (determined by soil nitrate tests) and expected N mineralization from organic matter. Nitrogen rates will also be dependant on other factors such as the amount of tillering that occurred in the fall, desired protein content of the grain, irrigation, economics.
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![Seasonal Nitrogen Uptake](image)

Figure 2. Seasonal nitrogen uptake in wheat in Kentucky. Figure modified from Lee, C., Herbek, J. (editors), Bruening, W., et al. 2009. A comprehensive guide to wheat management in Kentucky. ID-125. University of Kentucky Extension.

and weather conditions. Contact your local agronomist or refer to local recommendations for specific rates.

**Split N applications.** To encourage tillering the first N application should be made around Feekes growth stages 2-3 (Figure 2) and should amount to about 1/4 to 1/3 of the total spring application. Use caution to avoid excessive N rates at this time as this can increase the potential for lodging, freeze damage and N-loss. If stands at this time are thin a higher N rate can be used; if tiller counts are high (above 70 tillers per sq ft), a lower N rate should be used. The second N application should be made in the spring around Feekes 5.1

**Single N application.** When a single N application is the only option, target the N application to the stage when wheat starts to grow rapidly (Feekes 4-5) (Figure 2). This is the time when wheat requires the most N and the most benefit will be achieved from an 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, N-loss 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.1

**Fertilizer sources.** Common N fertilizer sources for wheat include ammonium nitrate (33-34% N), urea (45-46% N) and urea-ammonium nitrate (28-32% N). Uniform application is critical to achieve even stand development and optimal yield potential. Regardless of the form of N, when properly applied, all are equally effective for wheat.

**Soil and tissue sampling.** If the amount of spring N to apply is in question, consider having leaf samples tested at a laboratory or in the field with a hand-held chlorophyll meter. Leaf samples taken at Feekes 5 are the most reliable. In some areas, soil nitrate tests conducted prior to seeding the wheat crop are a useful tool for determining the amount of N fertilizer to apply. Soils nitrate tests should be taken to a depth of 3 to 4 feet because most soil N that will affect yield will be within this zone.

**P, K and other nutrients.** Because P is essential for root development, tillering and winterkill resistance, it should be applied in the fall, prior to seeding. Potassium fertilizer should also be applied in the fall, but can be applied in the spring if necessary by broadcasting. Nutrient deficiencies will generally occur when the soil pH is too high or too low. When proper soil pH is maintained using agricultural lime, nutrients such as calcium and magnesium will generally be adequate. Sulfur (S) deficiency can be determined from laboratory analysis of plant tissue around the Feekes 5 growth stage. If the N:S ratio is greater than 15:1, S in the form of sulfate (SO₄⁻) should be added. Nitrogen fertilizer sources such as ammonium sulfate (21% N) and ammonium thiosulfate (12% N) can also be utilized as part of a total N management plan to provide supplemental S fertility.

**Managing Irrigated Wheat**

Adequate water is required for germination and establishment during the early growth stages in the fall. If the soil is extremely dry, an irrigation may be needed before planting. Fall and winter precipitation usually provides adequate moisture for wheat throughout the early stages and through dormancy, and spring growth coincides with abundant precipitation in some growing areas. Use caution with early-spring irrigations as these could bring the crop out of dormancy prematurely, and increase the potential for lodging, freeze damage, and pest and disease issues. Adequate water needs to be available as wheat enters the boot and heading growth stages (Feekes 10). Irrigation may be required at this time for optimal grain development.

An irrigated wheat crop can require higher rates of applied nutrients due to a higher yield potential. Nitrogen rates in particular may need to be adjusted upwards to meet the increased demand of a potentially higher yielding crop and to maintain acceptable grain protein levels.

**Sources:**


For additional agronomic information, please contact your local seed representative. Developed in partnership with Technology, Development & Agronomy by Monsanto.

Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible.

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