Using the K-State Intensive Management, Multiple Application Sensor Based N Rate Calculator for Winter Wheat

The Intensive Management Multiple Application N rate Calculator has been developed to use active red wavelength crop sensors such as the handheld GreenSeeker or Crop Circle sensors, to provide accurate estimates of yield potential and N needs for hard red or white winter wheat from the Feekes 4 through 9 growth stages. The primary purpose of this calculator is to fine tune N management, to enhance N Use Efficiency and potential crop yield. The Feekes 4 growth stage normally occurs in the spring, 2-3 weeks after green-up, when the leaves of the wheat plants begin to be noticeably upright, rather than laying flat, or prostrate, on the soil surface. Feekes 6 is defined as initial jointing, or stem elongation, and Feekes 9 is when the flag leaf fully extended with the ligule or leaf collar visible. This calculator will not work with amber or green light versions of these sensors, or perform well at earlier or later stages of growth.

The basic objective of the calculator is to use the red NDVI values provided by these active crop sensors to estimate the current yield potential of an unfertilized field or area within a field and compare that to the yield potential of a fertilized reference strip or N Rich strip area. One important addition to this new version of the K-State calculator as compared to earlier versions, is that it includes an adjustment for any reduction in ability of the plant to recover yield potential which may result from earlier N stress. This is a marked improvement since tillering and the number of potential heads per foot of row, and head size, or the number of potential grains per head both strongly impact yield potential, and are significantly influenced by N stress.

The goal of intensive wheat N management should be to avoid significant N stress during the spring, and keep the wheat growing while avoiding excess vegetation. Regular use of the sensor beginning at Feekes 4 and adding less N at early topdressings keeps the amount of mineral N in the soil lower, reducing the potential for N loss from a significant rainfall event, and allowing the bulk field to effectively utilize N mineralized from organic materials in the soil. By planning on a second topdressing if needed, one has the opportunity to add N if mineralization is less than expected, or N loss is greater than expected, or to save that N and those dollars and not add additional N if little N loss occurs, or unusually large flush of mineralization occurs.

What's a reference strip? A reference strip is an area which has been fertilized in the fall or winter, and represents the yield potential of the crop if it all had received the full seasons N early. Reference strips can be established in many ways, but generally are done by applying 100 to 125% of the normal N application rate at planting or during the winter. Ideally at least some of the N would be available to the crop when it emerges to support fall growth and tillering. A combination of 40-50% of the N at or before planting and the balance in late winter before the crop breaks dormancy will provide a good reference area in most situations. Unfortunately, high N loss over winter can cause reference strips to fail. So it is important to check your reference strips and be prepared to add some additional N a month or so prior to sensing.
Why calculate a Response Index? The response index or RI, is simply the ratio of the NDVI measured in the reference strip area, divided by the NDVI of the target field or area to be fertilized. The RI should always be near or greater than 1, and the bigger that number becomes, the more N stress the unfertilized target field is under. This is important since the underlying research has shown that the high levels of N stress reduces the ability of the plant to respond to fertilization. Those areas will likely have fewer tillers, and may have already begun to determine head size. So since using sensors requires delaying topdressing until the plants are actively growing in the spring, applying 20-30 pounds of N per acre at planting will reduce the potential for a large response index, and significant early season N stress, and help ensure the crop can respond well to the topdress fertilizer.

Importance of a realistic yield potential estimate. One of the driving factors in the N recommendation made using this calculator is your estimate of yield potential of the field. Keep in mind that the yield potential estimates made during vegetative growth, especially as early as Feekes 4 are just estimates of potential, and a lot can happen between Feekes 4 and harvest. In Kansas, moisture and heat stress, together with disease pressure, even with fungicide application, prevent us from realizing those potentials in many years. While we can control N stress to a degree, we don’t have control over weather. Putting in higher yield potentials than can be realized will result in unrealistic N recommendations. Conversely, putting in extremely low estimates of yield potential for the area have a way of being self fulfilling. A good guide for estimating normal yield potential values is to take the yield from your last 5 crops, throw out the high and low values and add 5%-10%

What’s NUE and how does that impact the N recommendation? Nitrogen Use Efficiency (NUE) is the portion or fraction of the applied N fertilizer that is actually recovered by the targeted crop. In Kansas, average NUE is approximately 50%, with a range of 40 to 60% normal. We generally use a value of 50% when making fertilizer recommendations. However, a lot of things, including soil drainage, rainfall, tillage and residue, N source and method of application, time of application and the use of nitrification or urease inhibitors can all influence NUE. Some examples to help you determine if your situation would warrant an adjustment:

Location, climate and soils: Poorly drained claypan soils, in a high rainfall area such as SE Kansas. Potential for denitrification is high, and NUE may be reduced through denitrification. NUE may be closer to 40-45% on long-term averages.

Well drained, silt loam soils in a low rainfall region, Western KS. Potential for loss through denitrification or leaching is low, and NUE may be higher than average, closer to 55-60% on average.

Management practices: Well drained, silt loam soils in a low rain fall area such as West Central Kansas, with no-till continuous wheat, and N applied as anhydrous ammonia prior to planting. N loss potential is low and NUE obtained will likely be higher than average, with 55-60% common.
Well drained, silt loam soils in a low rain fall area such as West Central Kansas, with no-till continuous wheat, and N applied as topdressed N solutions in February. N loss potential from immobilization in this situation is high, and NUE will likely be average, with 50% common.

**Advantages to this approach:** What are the advantages of a sensor based multiple topdress system, compared to a one time rate calculator compared to the traditional soil test based N recommendation system? There are at least two advantages to using any crop sensor compared to a traditional soil test based N recommendation system. First, soil test systems rely on profile N tests which are difficult to take and not commonly done. The sensor can be used in place of the soil test, allowing the plant to estimate N availability from the soil based on the RI. Second, soil tests should be made prior to planting, but don’t consider over winter N loss through mechanisms such as leaching or denitrification. Sensors can provide more current data and consider spring N availability. This can be extremely important in areas where N loss potential is high. By adding the potential for a later second topdressing, one can potentially determine if the rate of N mineralization from crop residues or soil organic matter is above or below normal, and determine if later spring N loss may have created a need for additional N. While a multiple topdressing approach may not increase yield over well planned and executed traditional soil test systems of single application sensor based systems every year, they will likely produce that yield with less N applied in many years.

**Comments on extreme crop conditions:** Some unusual issues related to extremely high or low yield potential and N rate recommendations can occur at extremely high or extremely low levels of growth at early stages of growth. The user needs to be aware of these situations and may need to make some decisions based on field observation.

The first is extremely lush growth, with high levels of biomass and NDVI values of 0.7 or above at Feekes 4. Crops exhibiting these conditions normally will not respond to additional N, and may actually have resulting yields below the potential estimated at Feekes 4 or 5, due to high levels of foliar disease such as leaf rust, stripe rust or mildew, lodging, or water stress late in the growing season. Adding additional N in this situations can reduce yield, and lead to additional lodging and potential disease. This situation has been observed several times during the development of these calculators, and it is important that wheat growers exercise care and judgment when fertilizing these beautiful crops.

The second situation is extremely low levels of growth with NDVI values of the bulk field below 0.3 or 0.35. In many cases these are normal growth patterns of wheat planted late, or wheat planted into wide C:N residues with little or no N added at seeding in a cool spring. Examples would include wheat following high yielding corn with a “maintenance rate” of 50 pounds 11-52-0 applied with the drill at seeding or second year wheat no-tilled or minimum tilled into wheat stubble with a similar rate of 11-52-0 applied with an air seeder. In both cases decomposition of the wide C:N crop residue would create a great demand for soil N, and the wheat could be under N stress. A high
NDVI reference strip would indicate a very N responsive situation, and the calculator will recommend a high rate of N. If the bulk field or target area is relatively uniform, application of these high topdress N rates is justified. Even with modest NDVI readings in the reference strips, N recommendations will be high due to the relatively high potential yield increase from N, and the large amount of N needed per bushel to obtain that response.

But at times, the bulk field may be more variable, and the low NDVI areas may be confined to patches or spots, interspersed in a higher NDVI field. In this situation the user of the calculator needs to determine if the low NDVI values in the spots are due to stand issues, water damage, sulfur deficiency or some other issue which high rates of N fertilizer will not correct. If that is the situation, N may be needed, but caution needs to be used to ensure other potential yield limitations can be corrected.

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