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K-State's New Way to Calculate Nitrogen Rates on Crops

The science of agronomy is always evolving because the very nature of farming is always evolving. Farmers are using more cover crops, more conservation practices, and greater use of precision agriculture. Researchers at K-State and other universities have been improving their recommendations based on this ever changing science. These recommendations are based on years of research and hundreds of fields. However, they do their best to make these recommendations fit as many producers, fields, and crops as possible, though every farmer, field, and season is very different.

One of the biggest updates from K-State Research and Extension fertilizer recommendations come from new guidelines for nitrogen application. The old guidelines were universal of field type and centered around organic matter percentage, previous crop, residual nitrogen if tested, and yield goals. These new guidelines include new soil type factors such as heavy clay vs sand, location factors such as western vs eastern Kansas, and cropping factors such as no-till vs conventional tillage. All of these are what we call nitrogen efficiency factors due to the fact that much of our nitrogen is lost by leaching, denitrification, and volatilization. Let's take a look at these new recommendations and how they compare with the old ones. In this example, we'll use the nitrogen recommendation for no-till corn with a 160 bu per ac yield goal in our heavy clay southeast Kansas soils with 3% organic matter, previous crop of soybeans, and split-applied application.

Nitrogen Recommendations

Corn Nitrogen Recommendations

Fertilizer N Required At Various Yield and Soil Organic Matter Levels Assuming Profile N Test Is Not Used (Includes 30 lb N/A residual default) ¹

$N\ Rec^{2,3} = (Yield\ Goal \times 1.6) - (\% \text{ SOM} \times 20) - Profile\ N - Manure\ N - Other\ N\ Adjustments + Previous\ Crop\ Adjustments$

¹ Total N requirements presented include only Yield Goal and Soil Organic Matter Adjustments assuming profile N test not used. N rate should also be adjusted for Previous Crop, Manure and Other Appropriate N Rate Adjustments [see N rate adjustments for warm-season crops].

² Maximum fertilizer N recommendations are 230 lb N/A for Dryland Corn production and 300 lb N/A for Irrigated Corn production.

³ A minimum fertilizer N application of 30 lb N/A may be appropriate for early crop growth and development.

Older recommendations from K-State's Soil Fertilizer Handbook

Nitrogen Recommendations

Corn

$$N \text{ (lb/a)} = (ie/fe) EY - (se) \text{ Profile N} - (\% \text{ SOM} \times 20) - \text{Manure N} - \text{Other N Adjustments} + \text{Previous Crop Adjustments}$$

ie (corn internal efficiency) lbs/bu		
Irrigated	0.84	
Non-Irrigated	0.88	
fe (fertilizer recovery efficiency)		
High efficiency	0.65	Injected or split applied
Default	0.55	Broadcast, fall-applied pre-plant
se ("soil" NO ₃ efficiency)		
Low risk for N loss	1.0	Medium texture or western KS
High risk for N loss	0.7	Coarse texture or eastern KS

Efficiency factors:

ie: internal crop efficiency
fe: fertilizer efficiency
se: soil nitrate-N efficiency
EY: expected yield (bu/a)
Profile N: profile NO₃ (lb/a)
SOM: soil organic matter (x20 for summer crops) lb N/a
Previous crop adjustment: lb/a (see pages 3 and 4)

- Maximum fertilizer N recommendations are 230 lb N/a for dryland corn production and 300 lb N/a for irrigated corn production.
- A minimum fertilizer N application of 30 lb N/a is recommended for early crop growth and development.

New recommendations from K-State's Soil Fertilizer Handbook

You can see from the new equations that most of the recommendations are the same, with one very important efficiency factor component. The old recommendation used a flat 1.6 lbs N per bushel standard, while the new recommendations let you create your own standard. For non-irrigated the internal efficiency is .88 and the fertilizer recovery is 0.65 (assuming the nitrogen was split applied). In this example the amount is 1.35 lbs N per bushel needed. The next update is a consideration that not all soil retains nitrogen the same. We lose a lot more nitrogen here in eastern Kansas than western Kansas and this largely due to denitrification. By the old calculation we considered the residual N left over from year to year is around 30 lbs N per acre. The new calculation says 30 lbs N times 0.7 efficiency, or 21 lbs N per acre. This is what would be used if there no soil samples taken to give us the real amount of residual N, which is what we always recommend.

Here are the results of our example:

Old recommendations: $(160 \text{ bu} \times 1.6) - (3.0 \text{ O.M.}\% \times 20 \text{ lbs}) - (30 \text{ lbs N residual}) - (40 \text{ lbs N previous soybeans}) = 126 \text{ lbs N per acre}$

New Recommendations: $((0.88/0.65) \times 160 \text{ bu}) - (30 \text{ lbs N} \times 0.7) - (3.0 \text{ O.M.}\% \times 20 \text{ lbs}) - (40 \text{ lbs N previous soybeans}) = 96 \text{ lbs N per acre}$

That's right. The new recommendations ended up with an application less than the old recommendation. The biggest reason for this is the inclusion of the split-applied nitrogen that increased the use efficiency. The old recommendations never considered this possible application difference.

Now there are some caveats. First off both the old and new calculation considered the season to be fairly favorable to nitrogen use. The soil efficiency (se) is only applied to the residual nitrogen, not the full growing season. Some years we lose a lot of nitrogen through denitrification after the pre-plant application and this depends on how much nitrogen was applied pre-plant and how much is being planned in the top-dress. The fertilizer recovery (fe) might not fully equate for all this loss if the split application was actually all pre-plant, and then an attempt to compensate for a high-loss season by applying more nitrogen right before tasseling. It could somewhat be more accurately stated if the pre-plant nitrogen is 55% efficient and the top-dress nitrogen is 65% efficient.

Another factor that is not directly from K-State Research and Extension but my own researched opinion...the 40 lbs N credit from previous crop of soybean can be excessive. It's the best case scenario and is rarely the case in southeast Kansas, which is why some extension and farmer recommendations use the 1 lb N per 1 bu credit. This is vast simplification to overall process of nitrogen tie-up and release, but it could perhaps be a better calculation to use when considering the poor soybean yields of recent years due to drought. Does that mean that soybeans can results in a credit more 40 lbs N if yields are much higher? It does, but we don't really have the research to go beyond a credit of 45 to 50 lbs N. In fact, research has shown that much of the soybean N credit isn't really the nitrogen released from the stems and leaves but the soybean roots. That credit is also from the lack of N tie-up into the high carbon residue of corn or wheat. In the end, this leaves a 1 lb N per 1 bu credit, yet with a minimum of 20 lbs N and a maximum of 50 lbs N credit. Not a lot of specific research to back this up but a combination of research results and making some estimations.

The new recommendations have more than just updates on nitrogen applications as well. There have been some alterations to phosphorus and potassium guidelines. These aren't changes to the rates so much as clarifications and simplifications to the current recommendations. For example, while phosphorus applications are unlikely to have a yield response when Mehlich-3 test P is above 20 ppm, it is advised to apply what can be expected for crop uptake to keep the P levels between 20 to 30 ppm. This is part of the 'Build-Maintain' level of recommendations. Another recommendation is when soil test P is low, it is recommended to band apply at least half of the P application. You'll get better yield response in low P situations if the fertilizer can be concentrated into zones for the roots to find.

Please give me a call if you have any questions about these recommendations or want to see the newer *Soil Test Interpretations and Fertilizer Recommendations in Kansas* handbook

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