W1339

Nitrogen Application Timings in No-Till Dryland Corn Production System in Tennessee

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Introduction

Nitrogen (N) management is critical for corn yield as well as quality because it is required for several important functions in corn plants including chlorophyll synthesis, an essential requirement for the process of photosynthesis. Nitrogen is also required in amino acid synthesis, which is an integral constituent of proteins. Despite being a costly production input, commonly used N fertilizers are associated with unintended losses through several pathways including ammonia volatilization, denitrification, runoff and leaching. These losses often have economic, production and environmental implications.

Implementing appropriate N management practices such as the 4 R nutrient stewardship principles can minimize N loss, optimize N uptake, maximize productivity and improve farm profitability. Right timing of N applications is one of the practices of the 4 R nutrient stewardship principles. The ultimate goal of timing is to supply adequate amounts to synchronize with the most active period of N uptake to minimize losses. Therefore, a major focus is to avoid over or under applications, which can reduce profits and harm the environment.

Nitrogen uptake throughout the growing season follows a sigmoid shape (Figure 1). Prior to V6 growth stage, the corn plants take up less than 12 percent of the total N during the growing season. Approximately, 60 percent of the total N uptake occurs between V6 to VT growth stage. About one-fourth of the plant N uptake is after tasseling. Considering there is limited N uptake prior to V8, sidedress N fertilizer application is recommended between V4 to V6 growth stage to reduce risk for N loss or delayed N applications.

In Tennessee, the current recommendation is to split apply one-third at planting (shortly after emergence) and then sidedress the remaining N for dryland corn production. Since the update of the current recommendations for N management in dryland corn, there have been newer corn hybrids and N management tools such as enhanced efficiency fertilizers. To address these new developments, trials were conducted to examine 1) the optimal recommended rate to split-apply N, 2) proportions of N to split-apply and 3) sidedress timing of N applications. This publication provides findings of these trials.

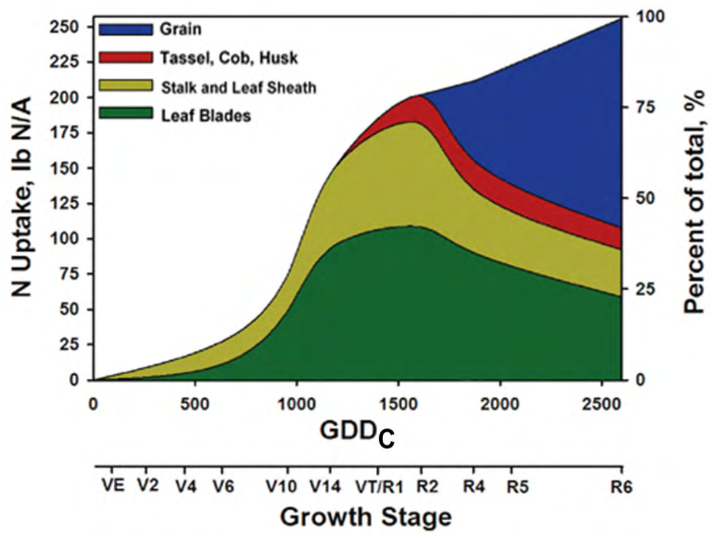

Figure 1: *Cumulative nitrogen (N) uptake by corn on a pound-per-acre basis and percentage from emergence (VE) to physiological maturity (R6). GDDC or growing degree days is the measure of heat accumulation and is used to estimate the growth and development of some agronomic crops (Source: Bender et al., 2013).*

Corn Growth Stages

Confidently and accurately determining corn growth stages throughout the season is critical for a number of reasons. However, it is particularly important with regard to proper sidedress nitrogen application timing.

- VE – Emergence. The shoot or coleoptile has emerged from the soil. No leaf collars are visible at this time.
- V1 – First leaf. The lowest leaf has a visible collar. This first leaf has a rounded tip (Figure 3).
- V2 – Second leaf. The lowest two leaves both have a visible leaf collar. The second and all subsequent leaves have pointed tips.
- This process continues until the final leaf emerges. However, at approximately V4–V6 (4–6 leaf collars visible), the coleoptile and V1 leaf collar is no longer visible, and a beginning or starting point cannot be determined. At this time, the "slicing method" is a useful tool allowing for accurately growth-staging corn throughout the vegetative cycle until VT, or the emergence of the tassel.
- Slicing Method – Carefully remove a plant from the ground without breaking the stalk. With a razor blade or sharp knife, slice the stalk length-wise from the top of the plant all the way through the bottom. Find the pithy triangle. Locate the first internode space above the pithy triangle. The first distinguishable separate stalk node is node number 5. Leaf number 5 (V5) attaches to the plant at this location.

You may now use this as your new starting point to locate leaf collars as they progress up the plant. This is the only accurate way to determine how many matured leaves are present on a corn plant after the coleoptile and 1st true leaf is no longer visible, and is commonly utilized until corn reaches reproductive status.

Research

University of Tennessee research on recommended rate to split-apply N

Nineteen site-years dryland field trials were conducted from 2021-2024 to determine the recommended rate to split-apply N on corn hybrids at Springfield and Milan, Tennessee, to achieve a final stand of between 30,000–32,000 plants per acre. Corn was planted on a 30-inch row spacing. Trials consisted of single and split applications of 5 N application rates (60, 120, 180, 240, and 300 lb N/A). All of the total recommended N was applied shortly after emergence for the single application. However, with regards to the split application, 60 lb N/A was applied at planting and the remaining N was applied between V4–V6 growth stages. All N applied was dry urea treated with ANVOLTM N stabilizer. The average grain yields from split-applications were significantly higher than the corresponding rate of single-applications from the 120 lb N/A and beyond in 2021 and 2022 (Figure 2). In 2023, significant yield difference was observed between the single and split applications at the 180 lb N/A rates and beyond. In contrast to the previous years, there was no significant difference between single application and split applications in 2024. The response observed in 2024 was mainly due to weather conditions, especially in Middle Tennessee. There was extended period without rainfall after the sidedress application, which impacted nutrient uptake including nitrogen during the period of peak N demand. Even with this hurdle, yield was similar to the single applications. Over the four-year study, split application was beneficial when the total recommended application rate is 120 lb N/A or more. Regardless of the year, split application of 60/120 lb N/A was similar to single application of 300 lb N/A at planting.

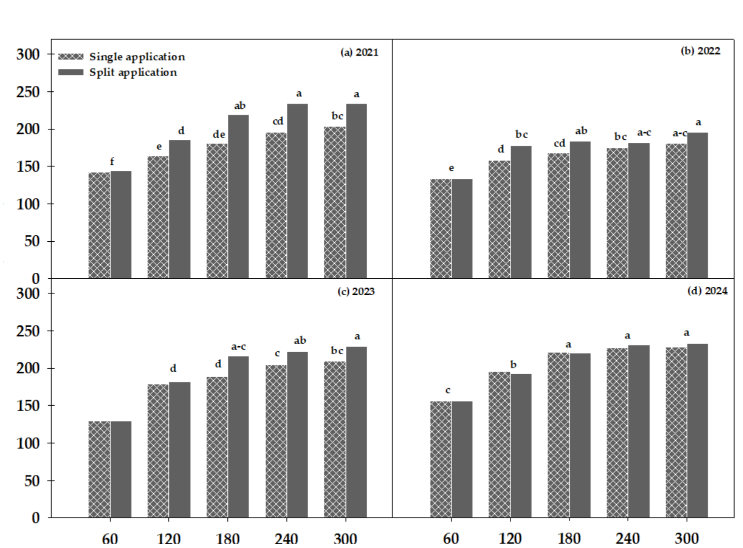

Figure 2: *Average grain yield of corn for single vs split application of treated urea fertilizer at different nitrogen rates in (a) 2021 (6 trials), (b) 2022 (3 trials), (c) 2023 (4 trials), and (d) 2024 (6 trials)*

University of Tennessee research on split- N proportion

A three-year field trial (2022-2024) was conducted in dryland conditions to determine the optimal split proportion for sidedress N. Corn was planted at a 30-inch row spacing to achieve a final stand of between 30,000–32,000 plants per acre. Six N fertilizer proportions (180/0, 120/60, 60/120, 90/90,40/100/40, and 0/180 lb N/A) were tested. In 2022, there were significant differences in the split proportions, with the highest yield occurring at the 60/120 lb N/A (Figure 3). In 2022, there was at least 15 percent yield penalty when 2/3 (120 lb N/A) or more of the total recommended N was applied at planting. There was no significant difference between the split proportion in 2023, however, the highest yield and optimal split proportion occurred at the 60/120 lb N/A. In 2024, the 60/120 lb N/A out-yielded all the other split proportions except 180/0 lb N/A. The excellent growing condition in 2023 may have masked the effect of split proportion and therefore resulted in similar yields. This research and several others conducted in Tennessee show that 60 lb N/A is sufficient for the crop prior to sidedress application. If the total applied N is greater than 120 lb N/A, split application of 60 lb N /A at planting and then apply the remaining N at sidedress is recommended.

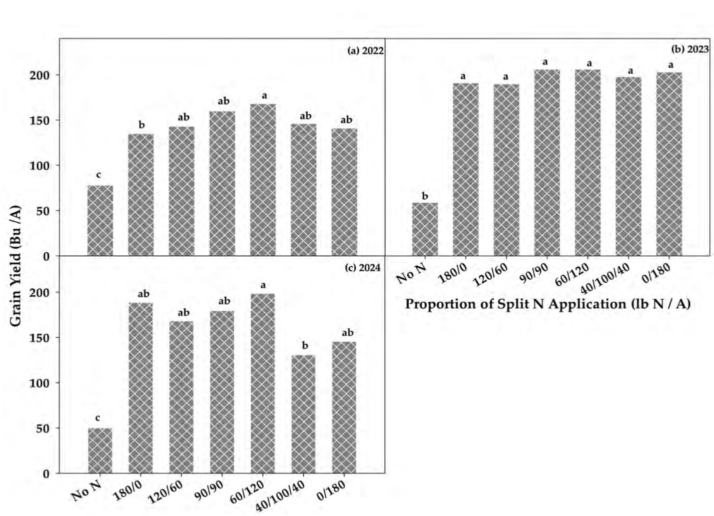

Figure 3: *Average grain yield of corn for different split proportions of sidedress N in (a) 2022, (b) 2023, and (c) 2024*

University of Tennessee research on timing for sidedress N application

Four sidedress N application times (V6, V8, V12, and V14 growth stage) were evaluated in a three-year field trial (2022-2024). Corn was planted at a 30-inch row spacing to achieve a final stand of between 30,000–32,000. The N was applied at planting and/or at sidedress for a total of 180 lb N/A (Figure 4). A control plot, with no nitrogen was included in the trials. The source of nitrogen was ANVOL-treated urea. In 2022, the highest yield was observed when sidedress N was applied at V8, which was similar to the other timings except V14. A 15 percent yield reduction was observed when N was delayed until V14. In 2023, the highest yield was observed when sidedress N was applied at V8, which was similar to the V6 application, but significantly higher than the V10 and V14 applications. A 7 percent and 40 percent yield reduction were observed when N was delayed until the V10 and V14, respectively. In 2024, the highest yield was observed when sidedress N was applied at V6, which was similar to applications at V8 and V10, which were all significantly higher than V14 applications. The V6 is the last time that a producer can safely travel over the top of the corn without damaging plants. In addition, V6 growth stage never results in a yield penalty, and is always a safe time for producers to get equipment in the field. Result suggests the optimal sidedress time would be close to the V6 growth stage.

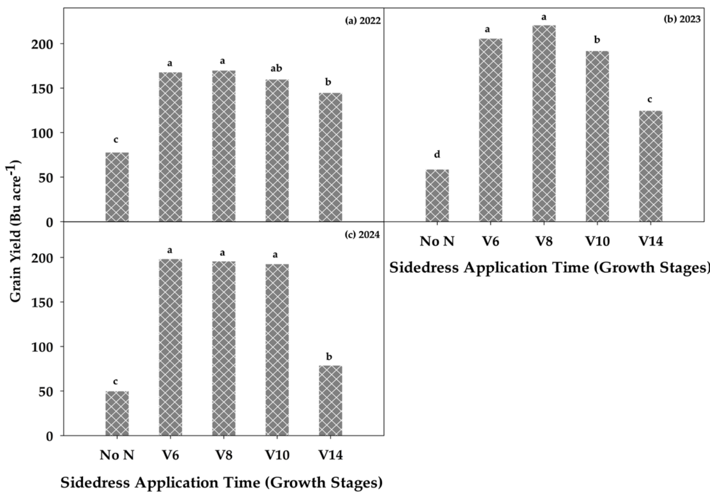

Figure 4: *Average grain yield of corn for sidedress N at different growth stage in (a) 2022 (b) 2023, and (c) 2024*

Summary

Nitrogen (N) management is critical for corn yield as well as quality because it is required for several important functions in corn plants including chlorophyll synthesis, an essential requirement for the process of photosynthesis. Nitrogen also is required in amino acid synthesis, which is an integral constituent of proteins. Despite being a costly production input, commonly used N fertilizers are associated with unintended losses through several pathways including ammonia volatilization, denitrification, runoff and leaching. These losses often have economic, production and environmental implications.

Online Resource

Descriptions with pictures of the various vegetative and reproductive phases of corn are available on the UT Crops News Blog: news.utcrops.com/2025/04/growth-stages-of-corn/

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