



## Nitrogen Uptake by Corn

Nitrogen (N) is a very critical nutrient for corn production and it is also the most difficult to manage. In many situations, profitable corn production requires supplemental N but with narrow profit margins, it is also important to closely manage costs. N application in excess to what a corn plant can utilize results in N loss to the environment. In addition to the knowledge of N sources (fertilizer, manure, soil organic matter, crop residues, etc.), an understanding of how corn grows and how much N is taken up in each of the growth stages can help growers and advisors make sound N management decisions (Figure 1). This knowledge is crucial for selecting the right fertilizer source and applying it at the right rate, time, and place (4R concept adopted by the fertilizer industry). In this factsheet, we present information on N uptake of corn during the growing season, and implications for crop N management.

the seed itself. This is not a true leaf and will not form a collar. The second leaf to form on the plant is the first true leaf, and this is "V1". Starting with V1, each new leaf forms at a node. As the plants grow, new leaves are added and the distance between nodes extends.

**V1-V3:** From V1 onwards, the seedling will continue adding leaves for a few weeks. At V3, the corn plant is typically 4 to 6 inches tall and three 3 collared leaves are present. The corn plant transitions away from seed energy and nutrient reserves to making energy through photosynthesis. This energy source fuels the process where the roots begin to take up nutrients from the surrounding soil. Between V1 and V3, plant need for N is minimal; V1-V3 N uptake is estimated at about 5% of the season total, typically amounting to no more than 10-15 lbs actual N per acre. It is recommended to place 20-30 lbs N per acre in the fertilizer band (2 inches below and 2 inches to the side of the seed), where soil N supply is low.

**V3-V6:** Plants continue to add leaves and by V6 (six collared leaves), the growing point is now out of the ground. At this point, the crop can be fatally damaged by a late frost or hail storm. Stem elongation begins to take place and plant growth accelerates. Ear shoots also begin to form in the nodes of the plant. By V6, about 25-30 lbs of N/acre is taken up by the plants. Early sidedress applications can be made if the soil does not have sufficient N supply to meet crop needs. Recommended fertilizer rates will vary depending on soil N supply, soil type, drainage, crop rotation, yield potential and manure history. Agronomy Factsheet #35 (Nitrogen guidelines for corn) gives more information on determination of N application rates.

**V6-V12:** Corn will typically grow to head height in the course of just a few weeks. At V9 plants have nine collared leaves and will develop a new leaf every 2-3 days. The tassel is rapidly developing and brace roots are establishing. At V12 nodes are fully elongated. About 25% of

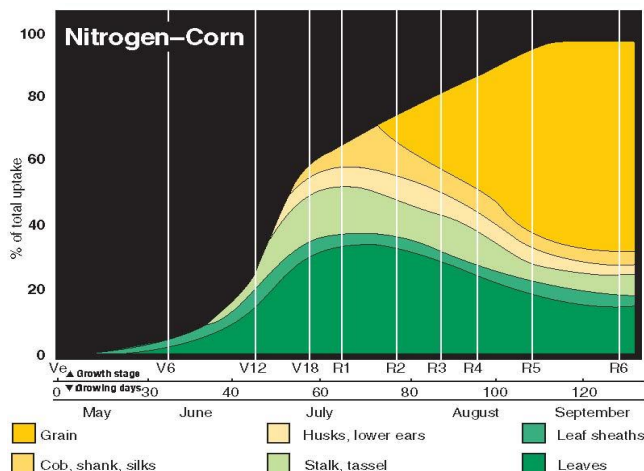


Figure 1: Corn growth stages and relative N uptake. Credit: Iowa State University Extension.

**Seed Germination-V1:** The "V" stands for vegetative stage. The growing point of the corn plant remains 1.5 to 2 inches below the soil and in close vicinity to where the seed was originally placed. The above ground portion of the plant is one inch or less in height and total biomass is very small. The corn plant can survive for up to two weeks on N reserves provided by the seed. The first leaf out of the ground originates from

the total N uptake occurs between V6 and V12 in just a short two-week period. Nitrogen is now being allocated to ear development; N status of the crop will influence kernel number.

**V12-VT:** The plant has reached maximum height and the tassel is now visible. The tassel will begin shedding pollen and fertilizing silks of surrounding corn plants. From V12 to VT about 40% of N uptake will occur.

**R1-R6:** The "R" signifies the plant is in the reproductive stage. At R3, kernels begin to accumulate dry matter. They are in milk stage and can be easily popped, as they are still 80% moisture. Starch accumulation is occurring rapidly in the kernels, however, and abortion can occur if N status is low. From VT-R3, about 20% of the total N uptake takes place. Nitrogen uptake is slowing down now. Physiological maturity is reached at R6 and a black layer has formed at the tip of the kernels. At this stage, kernel moisture content is approaching 35% and under ideal conditions moisture will decrease steadily at 0.5-0.75% per day from this point onwards until the corn reaches about 20% moisture. From R3-R6, some N uptake continues to occur but at a much lower rate (typically no more than 25 lbs per acre).

### Implications of N Shortage

At the beginning growth stages (emergence to V6), it is essential to have a small pool of available N to support the development of a strong root system. While modern hybrids are more resilient than previous generations, N shortages during stem elongation (V6-V18), can cause the plant to lose vigor, root systems can be stunted, and uptake of other nutrients may be restricted. These factors can impact photosynthesis and ultimately crop yield. A decrease in the plant's ability to photosynthesize can result in a decrease in kernel set or an increase in kernel abortion and negatively impact grain fill; N deficiency before V8 will decrease kernel row numbers and subsequently crop yield. It should be noted that crop yield is influenced by many other factors (weed control, general fertility, etc.).

### Implications: Putting it All Together

As corn N needs vary throughout the growing season, there are several options for meeting corn N demands. Before making any decisions on N management, it is important to estimate

what is in the soil already and what may become available over the growing season. Nitrogen credits from both soil organic matter and past manure applications reduce N fertilizer needs (see Agronomy Factsheets #4 and #67). If fertilizer is needed, apply 20-30 lbs N per acre as a starter application at planting followed by N sidedressing at V6-V8. Starter N application can support the crop until sidedressing with low risk of N loss. Sidedress applications are typically done at V6 to V8 to supply the crop with N during the rapid growth period. A very few operators will split sidedress treatments and apply two or even three applications up to tasseling if the equipment is available. Growers should test rates and application timing to be sure they are getting a payback.

### Summary

The majority of crop N uptake occurs during the rapid growth phase of corn, from V6 to V18, but uptake continues into VT and the R stages. Given the dynamic nature of the nitrate form of N that is most needed by plants, matching N supply with N needs allows for greatest N use efficiency and reduces the risk of loss to the environment.

### Additional Resources

- Nitrogen fertilization in corn. D. Beegle. Penn State University. Updated August 2017. <https://extension.psu.edu/nitrogen-fertilization-of-corn>.
- Cornell Nutrient Management Spear Program Agronomy Factsheets #4: Nitrogen credits from manure and #67: Can manure replace the need for starter N? <http://nmsp.cals.cornell.edu/guidelines/factsheets.html>.
- The 4R nutrient stewardship. The Fertilizer Institute. <http://www.nutrientstewardship.org/4rs/>.

### Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information



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