Benefits of Nitrogen for Corn Production

Nitrogen (N) is a macronutrient for corn, as is phosphorus (P) and potassium (K), and while N is one of the most common elements on earth, N deficiency may be the most common nutrient issue farmers experience. Nitrogen is a major component of amino acids, which function as the building blocks of proteins. Perhaps the major role it plays in all plants is as a component of chlorophyll, the green pigment in plants, that is essential for photosynthesis. Adequate N availability in corn helps the plant to reach its genetic yield potential.

In the soil, N exists in three forms, organic N, ammonium ions (NH_4^+), and nitrate ions (NO_3^-). Organic N is contained in organic matter in the soil, in crop residues, and in the microbial community within the soil. While organic N may make up most of the N in the soil, it is not available to plants until it is converted by microorganisms through a process called mineralization. Mineralization is the process where organic N is converted to ammonium or nitrate ions that can be taken up by the plant. During the growing season, ammonium is quickly converted to nitrate, which is referred to as nitrification. Nitrate is the main form of N taken up by the plant.

Every bushel of corn grain requires about one pound of N; therefore, a 200 bu/acre corn crop would require approximately 200 lb of N/acre. A relatively new concept in N application rates is referred to as maximum return to N. An online tool is available and called the Corn Nitrogen Rate Calculator (http://cnrc.agron.iastate.edu/). While hosted by Iowa State University, data from many states are available on this site. With this tool, production type, rotation, fertilizer product and price, and expected corn price are used to determine the most economical N application rate. This tool is used only for guidance and seasonal adjustments can be made using various in-season tools. Local university extension services, or soil testing laboratories, may also be able to provide suggested fertilizer N rates for your situation.

Nitrogen Sources in Fertilizers[1,2]

There are many available forms of N fertilizer, with urea being the most common. Urea has a high N content at 46% and is very rapidly converted to nitrate. However, a note of caution is that when urea is surface applied, it may be subject to atmospheric loss through volatilization. Therefore, it is recommended to incorporate urea into the soil to minimize the chance of this occurring. Urea ammonium nitrate is a common liquid form with an N content of 28 to 32%; this is commonly utilized in sidedress applications and starter fertilizers. Ammonium sulfate is a soluble form of N that provides both N (21%) and sulfur (24%). Anhydrous ammonia has the highest N content of any of the available products, with 82% N. Ammonium nitrate is a salt that contains 34% N with both ammonium and nitrate forms of N. The volatilization risk is less than that of urea. Mono-ammonium phosphate (MAP) has an analysis of 11% N, 52% P, with a small amount of sulfur, and is often used as a dry starter fertilizer. Di-ammonium phosphate (DAP) is a dry formulation that contains 18% N and 46% P.

The N content in manure can vary from about 0.4 to 0.8% for manure in a liquid and from 0.8 to 2.7% for solid manure. Poultry manure has the highest N content in either liquid or solid forms. As the N content can vary in manure, it is wise to receive an analysis to determine the N content. Incorporating the manure into the soil immediately after application will provide the highest amount of N to the plant from the manure.

Soybean Nitrogen credit in Rotation with Corn[3]

Although soybean plants do not directly contribute N to the soil, a "credit" can be applied for the amount of N fertilizer needed for the following corn crop in the rotation. While it is difficult to estimate a specific amount for the N credit from soybean, as it is dependent on soil type, growing conditions, previous soybean crop yield, and microbial population, the general consensus is that 25 to 45 lb less N is needed for corn following a soybean crop. Since there is quite a bit of variability in the N credit amount, consult with your local university extension office, or soil testing laboratory for the credit amount for your area.

N Uptake in Corn[4]

Nitrogen is taken up by the plant throughout its active growth. However, the uptake accelerates at the vegetative (V6) growth stage, at which time about 25 to 30 lb of N has been taken up by the plant. During the V6 through V12 growth stages, about 25% of the total N is taken up by the plant (Figure 1). From V12 growth stage to the emergence of the tassel (VT), an additional 40% of the total N needed is taken up by the crop. The remaining N needed is taken up from VT until the reproductive stage R3 (milk).

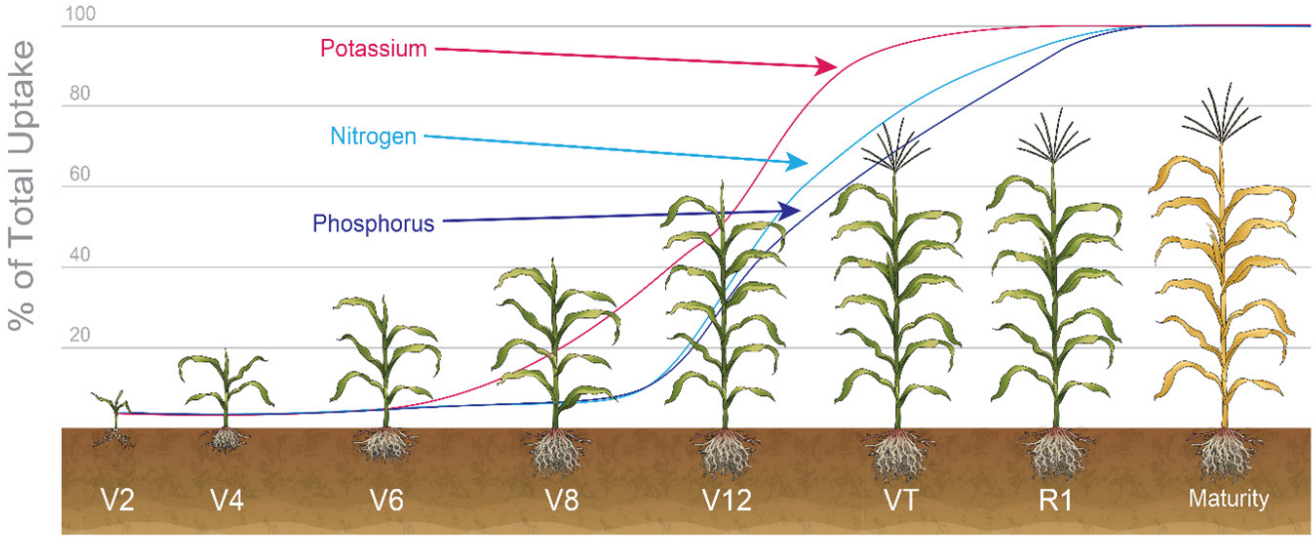

Figure 1. Uptake of nitrogen, phosphorus, and potassium by corn.

Repercussions of N Shortage[4]

The yellowing or chlorosis of the older leaves in a spear point appearance is an indication of a N deficiency (Figure 2). A shortage of N at emergence until V6 growth stage can result in a weaker root system, particularly after V4 growth stage as the plant makes the transition from seed resources to soil-based resources. During V6 to V18 growth stages, when the stem is actively elongating, if adequate N is not available, vigor can be reduced, the root system can be stunted, and the uptake of other nutrients (particularly K) may be reduced. This can have negative consequences for photosynthetic efficiency. A decrease in photosynthetic activity can reduce kernel numbers and, if severe, result in kernel abortion. Kernel row number is determined by V8 growth stage and a N deficiency before this stage will reduce the amount of kernel rows. Additionally, N deficiency during grain fill can result in remobilization of N from the stalks and roots to the developing kernels. This can result in weak stalks leading to infection by stalk rot organisms. Nitrogen is the most important plant

nutrient in determining the final grain yield. A long-term research project conducted by Iowa State University demonstrated that corn yields average about 60 bu/acre in a continuous corn production system and 115 bu/acre in a corn/soybean rotation without the addition of N. Providing adequate N increased yields to over 200 bu/acre.[5]

Figure 2. Corn leaf showing symptoms of N deficiency. Photo is provided courtesy of the International Plant Nutrition Institute (IPNI) and its IPNI Crop Nutrient Deficiency Image Collection.

Sources:

[1]Weiss, J., Bruulsema, T., Hunter, M., Czymmek, K., Lawrence, J., and Ketterings, Q. 2009. Nitrogen fertilizers for field crops. Cornell University Extension. Fact Sheet 44. http://nmsp.cals.cornell.edu/publications/factsheets/factsheet44.pdf

[2]Silva, G. 2017. Nutrient removal rates by grain crops. Michigan State University Extension. https://www.canr.msu.edu/news/nutrient_removal_rates_by_grain_crops

[3]Klinger, G. and Bugeja, S. 2018. Why do we Need a Soybean Nitrogen Credit?. University of Minnesota Extension. https://blog-crop-news.extension.umn.edu/2018/04/why-do-we-need-soybean-nitrogen-credit.html

[4]English, E., Ketterings, Q., Cyzmmek, K., Gabriel, A., Flis, F., and Lawrence, J. 2017. Nitrogen Uptake by Corn. Cornell University Extension. Agronomy Fact Sheet No. 98. http://nmsp.cals.cornell.edu/publications/factsheets/factsheet98.pdf

[5]Sawyer, J. 2018. Nitrogen Use in Iowa Corn Production. Iowa State University Extension. CROP 3073.

Legal Statements

ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. Performance may vary, from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields.

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