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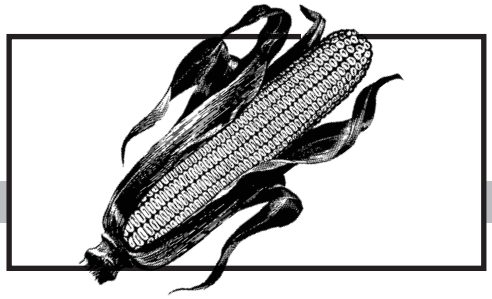

Nitrogen Soil Testing for Corn in Virginia

*G.K. Evanylo and M. M. Alley**

Nitrogen and Corn Production

An adequate supply of plant-available nitrogen (N) is crucial for efficient corn production, and corn N requirements are greater than any other nutrient. For example, a corn crop yielding 150 bushels per acre typically contains about 165 lbs N in the grain and stover, or approximately 1.1 lbs N/bu grain. These calculations are based on actual N uptake, and allowances must be made for actual fertilizer use efficiency and soil N availability.

Nitrogen use efficiency is the percentage of applied N that is actually taken up by the crop. Nitrogen use efficiency is normally 50-60%, but can be as high as 75% with proper N timing and placement. Costs of N fertilizers and environmental concerns about nitrate (NO_3) from fertilizers, manures, and other nutrient sources leaching into groundwater require that new tools be developed and implemented to improve the use of all N sources available to the corn crop.

Many sources of N can be used by a corn crop. Residual N is N that is carried over in the soil from one growing season to the next, and this N source may supply as little as 10% or as much as 100% of the crop's total N need. Residual N is generally low under our climatic conditions because it tends to leach out of the root zone as NO_3-N during the winter and early spring months; however, residual N can meet a significant portion of a subsequent corn crop's need in silty and clayey soils, which retain more N than sandy soils. Most residual N is found in organic forms such as animal manures, legume forage and cover crops, and biosolids (municipal wastewater treatment sewage sludge).

The N that is in the organic forms becomes available to the crop as the organic matter is mineralized (decomposed) by soil organisms. Mineralization of organic matter and release of N increases as soil warms in the spring. When little N is available from animal manure, biosolids or legumes, the majority of the crop N requirement must be supplied by mineral fertilizer sources such as urea ammonium nitrate solution, urea, ammonium nitrate, or ammonium sulfate.

Nitrogen Behavior and Soil Testing

Soil testing has been an economically and environmentally beneficial practice for determining the availability of phosphorus, potassium, and other nutrients. Nitrogen recommendations for corn grown in the middle Atlantic and southeastern states have not been based on traditional soil test calibration methods, in contrast to other nutrients, because: 1) predicting the availability to crops of organic N has not been successful, and 2) the storage of soil mineral N is often too brief due to the winter and spring leaching losses of the mobile NO_3-N form that occur under our high rainfall and moderate soil temperatures. Nitrogen analysis of animal manures, biosolids, and legumes to predict the amounts of N available for crops has been only partly successful, which accentuates the need for a soil N test.

Nitrogen behavior in the soil is difficult to predict because N transformations in soil are very complex (Figure 1). Over 98% of the N in most soils is unavailable for plant uptake at any specific time because it is fixed in soil organic matter or in clay minerals. Nitrogen in organic matter (e.g., plant residue, cover crops, animal manure, biosolids) may undergo microbial transformations that convert it to a plant-available form. The end result of this process is the NO_3 form of N. The transformation rate of organic N to plant-available NO_3 in the spring increases as the soil temperature increases, and much plant-available N can be produced from

*Extension Soil Scientist, Waste Management & Water Quality; Extension Agronomist, Soil Fertility & Cropping Systems, respectively; Virginia Tech

organic N in Virginia, beginning in mid-May in eastern Virginia to mid-June in western Virginia.

The behavior of N in the soil has several important implications for efficient N management of corn. Corn requires only small amounts of N during the first month of growth because the plants are small and root systems are not well-developed (Figure 2). Nitrogen applied preplant or released from organic matter during early spring can be lost by leaching during this time when the plants' N requirements are low and soil moisture is high. Therefore, only small amounts of starter N (25-30 lbs/acre) should be applied prior to or at corn planting to meet the N needs of the crop for the first 30-45 days following emergence. Any additionally-required N can be applied as a sidedressing when the corn is 12 to 24 inches tall.

Soil testing in Virginia for available N before the growing season, as is practiced for other nutrients, does not accurately reflect the availability of N when it is most important to the crop (i.e., 30 to 45 days after emergence). The NO_3-N soil test procedure relies on sampling and testing after the crop has emerged and grown for several weeks. The concentrations of soil NO_3-N measured by this procedure are the result of many complex reactions affecting soil N and are more closely related to the need for supplemental N fertilization than any other procedure tested to-date.

Pre-sidedress Soil Nitrate Test

The pre-sidedress soil nitrate test (PSNT) is based on sampling of the surface one foot of soil after the soil has begun to warm and before the corn begins its most rapid growth rate (i.e., corn is 10 to 15 inches tall at the whorl). The amount of NO_3-N in the soil sample is an accurate index of plant-available N, and sidedress fertilizer N recommendations can be modified depending on the concentration of NO_3-N found in the soil.

Data from 47 field research experiments conducted in the Coastal Plain, Piedmont, and Ridge and Valley soil provinces in Virginia during 1990 and 1991 demonstrated that corn grain yields were maximized (i.e., relative yield = 1.0, or 100% of maximum) at soil NO_3-N concentrations above 18 parts per million (ppm) (Figure 3). Enough N was mineralized, or made available from decomposing organic N, at the locations where NO_3-N concentrations were above 18 ppm to supply the seasonal N needs of the corn. Below 18 ppm, most of the relative yields were low, and supplemental N was needed to attain maximum yields. High relative yields occurred primarily where soil had received considerable contributions of organic N, such as from animal manures, biosolids, legume forages, or legume cover crops. Therefore, the PSNT should be utilized primarily on soils that have received significant amounts of organic N.

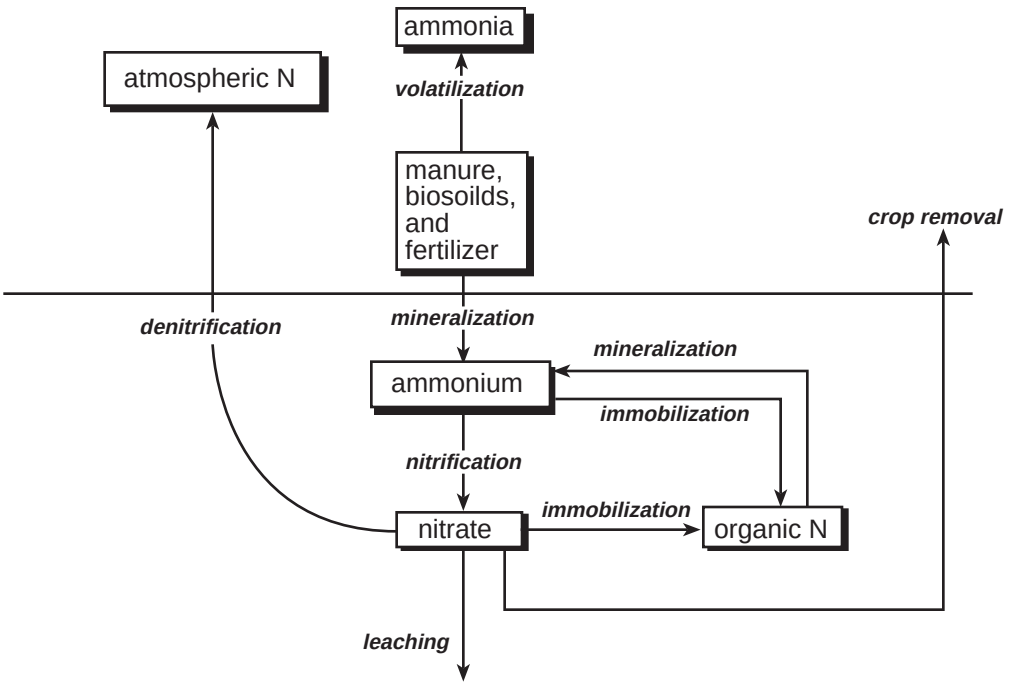

Figure 1. The Nitrogen Cycle in Soil. (Freelance)

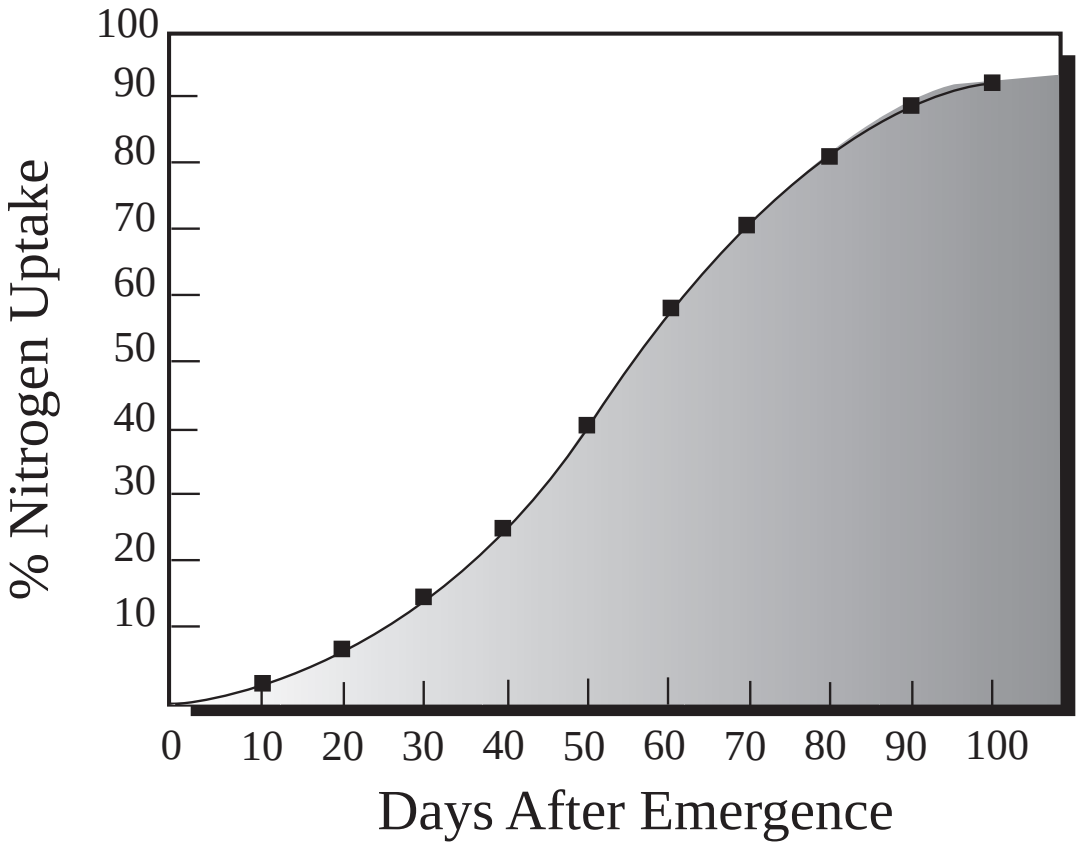

Figure 2. Nitrogen Uptake by Corn. (Origin)

Nitrogen Soil Test Procedure

1. The test is primarily designed to be conducted on soils that have received no more N than a starter N fertilizer application (25-30 lbs/acre); however, the test has been shown to be accurate in some situations where high rates of pre-plant fertilizer N have been applied. Fields that have received manure can and should be tested prior to making any supplemental N fertilizer applications at sidedress time.

2. Take soil samples at corn height of 10 to 15 inches at the whorl, not with an upper leaf extended.

3. Sample soil by taking 10 to 20 cores across the field to a depth of 12 inches, if possible, or as deep as possible. Sample between rows to avoid starter fertilizer bands and areas where roots have depleted soil N.

4. Combine, mix, crumble, and dry samples as quickly as possible by spreading the mixed soil in a thin layer on newspaper in a warm place. Samples can also be dried in an oven at low heat (200 to 225 °F) or in a microwave for 5 to 8 minutes at the high power setting.

5. Use a reliable field test kit to determine soil NO_3-N concentration. The Nitrate Quick Test developed at The Pennsylvania State University and marketed by Hawk Creek Laboratory, Inc. has performed well during 2 years of field testing in Virginia. Other kits that have provided reliable results include N-Trak, developed at Iowa State University and marketed by Hach Co., and the Cardy Nitrate Meter from Spectrum Technologies. All field kits must be carefully calibrated and maintained in order to obtain consistently reliable results.

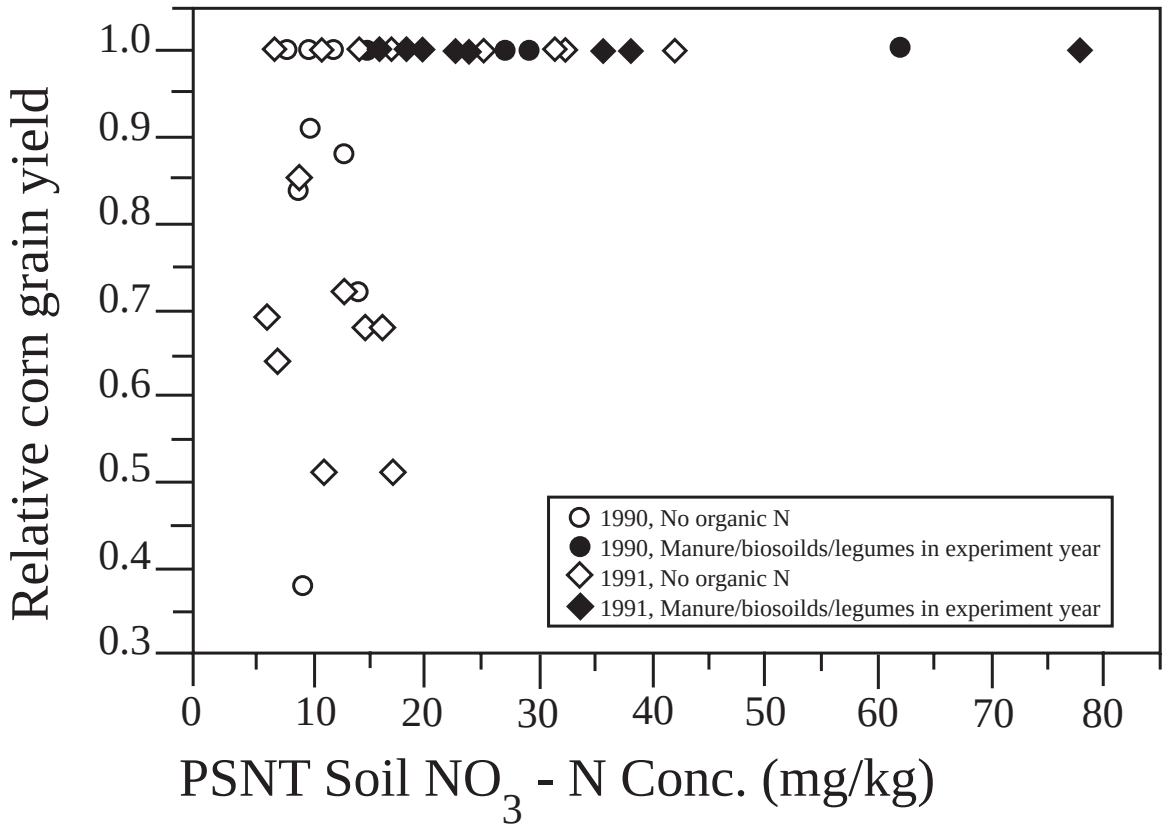

Figure 3. Relation between relative grain yield and Soil NO_3-N concentration. (Origin)

Nitrogen Recommendations

Nitrogen recommendations for corn should be calculated from the Virginia Agronomic Land Use Evaluation System (VALUES) (Simpson, et al., 1993) with adjustments from the results of the PSNT as outlined below.

These recommendations should not substitute for common sense and an understanding of the effects of soil properties and management practices on N availability to corn.

References

Simpson, T.W., S.J. Donohue, G.W. Hawkins, M.M. Monnett, and J.C. Baker. 1993. The development and implementation of the Virginia agronomic land use evaluation system. Dep. of Crop and Soil Environmental Sci., Virginia Tech, Blacksburg, Virginia. 83 p.

NO_3-N concentration	N rate recommendation
< 10 ppm	Apply full rate of sidedress N that is needed for the realistic yield goal for the particular soil as specified by calculations from VALUES.
10-20 ppm	Possible reduction of the normal sidedress N application by 25-50%. The decision to reduce the recommended N rate must be made on a site-by-site basis and should take into account previous field history, organic N additions, and management practices.
> 20 ppm	No sidedress N is needed.