Virginia Cooperative Extension

Crop & Soil Environmental Sciences

REPRINTED 1998

PUBLICATION 418-016

Nitrogen Soil Testing for Corn in Virginia

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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

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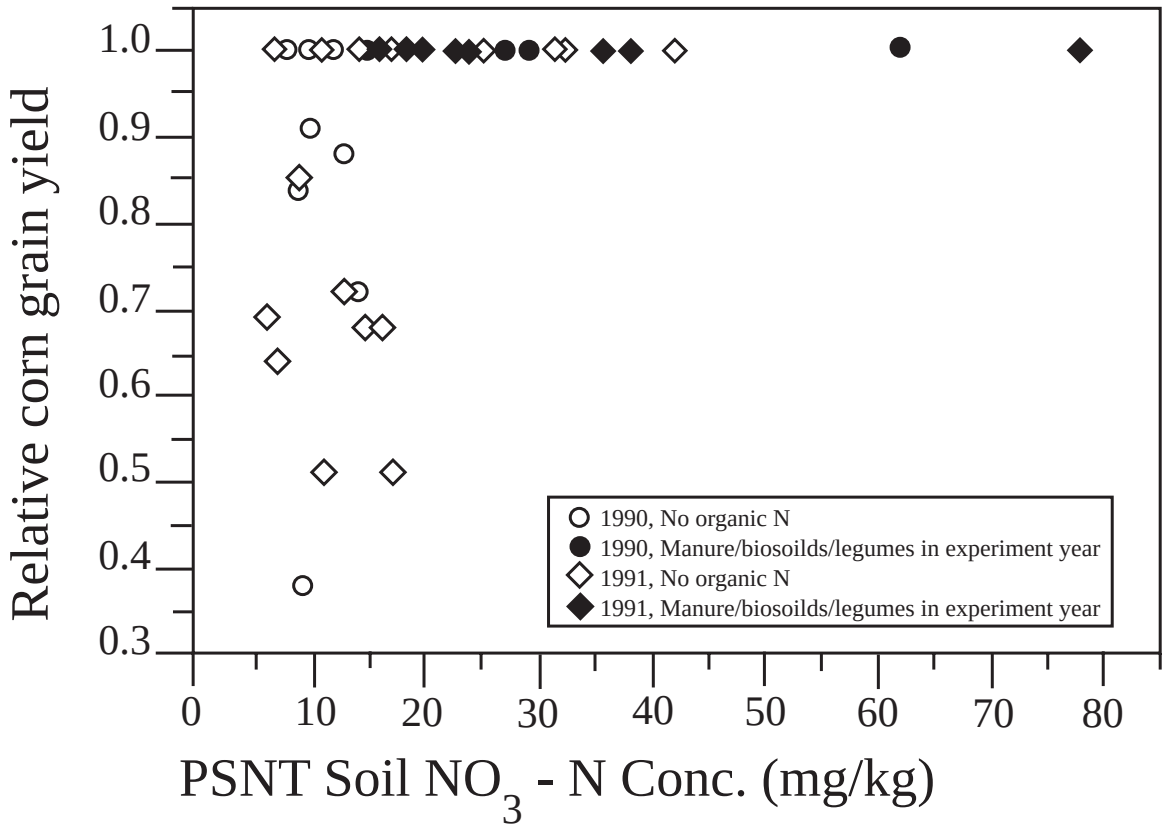

Figure 3. Relation between relative grain yield and Soil NO_3-N concentration. (Origin)

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.