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CURRENT RESEARCH ON SOIL NITRATE TESTING FOR CORN IN KENTUCKY

John H. Grove

Introduction

Concern has been expressed that growers do not have the "site-specific" information they need for more efficient nitrogen (N) fertilizer management on a field-by-field basis. Soil testing has routinely been used to guide recommendations for phosphorus, potassium, and lime additions to individual fields, but effective soil N test procedures have long eluded soil scientists working in warm, humid regions with substantial winter rainfall. Now, recent research suggests that a new soil test procedure has some potential to guide fertilizer N applications for corn. The purpose of this report is to define the concept of soil nitrate testing; to describe how it is conducted for corn; and to review some of our latest research information.

Defining The Concept

Soil testing for "residual" nitrate is now well accepted in the drier portions of the U.S. corn belt. Soil nitrate left over from one season accumulates and is available the next season in these areas. For determining the amount carried over, samples are usually taken to a depth of 2 to 4 feet sometime between fall harvest and spring planting. In contrast to this situation, it is difficult to measure the effectiveness of carryover nitrate in warmer, more humid climates because winter and spring rainfall usually insures that most of this nitrate is lost before spring planting. Warm, wet weather increases the

rate at which soil N processes (mineralization, immobilization, leaching, and denitrification) take place in the soil, which narrows the optimal sampling period and shifts this period closer to the time when the crop's N demand is highest. In humid regions, soil nitrate testing should provide a measure of the soil's ability to mineralize N for a growing crop, a kind of *in-field* assay of net inorganic N release due to biological activity.

Because the test must be timed according to the N demand of the crop, the test/sampling procedure will be crop specific. For example, what works for corn will probably not be the best for wheat. Currently, there is much interest in use of such a test for corn. It is commonly called the pre-sidedress soil nitrate test (PSNT). This test is performed when corn is 6 to 18 inches tall because at this time the rate of N uptake begins to accelerate. This is why delayed N application is associated with improved N fertilizer use efficiency on many Kentucky soils. Sampling earlier (pre-plant or at-planting) has given soil nitrate values that were poorly related to fertilizer N needs. Sidedress sampling synchronizes the growth of young corn plants with the mineralizing activity of soil microbes. Since both corn growth and N mineralization are dependent on temperature, moisture and aeration, what slows one slows the other. The PSNT was designed to measure the combined contribution of all

organic N sources (manure, crop residues, soil organic matter) to the supply of N for the crop.

How Is The PSNT Conducted?

Interpretation of results is totally dependent on proper sampling. Plants should be a minimum of 6 inches tall (to the center of the whorl), but usually not greater than 18 inches. Sampling should avoid any fertilizer banded at-planting and preferably should be exactly in the middle between the rows. The sample should consist of 15-25 cores taken from a uniform area of no more than 10 acres. Samples must be taken to a depth of 1 ft in order to include most of the zone of biological activity. Shallower sampling is not recommended because of depth variation in soil organic matter, crop residues and manure incorporation. After sampling, the 15-25 cores should be thoroughly mixed, spread in a thin layer, and dried.

Laboratory procedures vary somewhat and will not be described here. Most depend on some sort of simple extraction followed by nitrate detection using either colorimetric or potentiometric analysis. So do most of the "kits" being marketed. Hand-held colorimeters (to measure the color due to nitrate in a solution), specific ion electrodes (to measure the concentration of the nitrate ion in the solution), or reflectometers (which measure the intensity of color developed on a strip of nitrate-sensitive paper dipped in the solution) are being used successfully.

A Short Review of PSNT Correlation/Calibration Research

The range in critical nitrate concentration of the PSNT, defined as the concentration at which no response to sidedress N fertilizer is likely to occur and above which no sidedress N fertilizer would be recommended, has been found to vary from state to state, but is about 25 ppm N: Vermont-20 to 30 ppm N, depending on yield goal; Iowa-21 to 26 ppm N; Pennsylvania-20 to 25 ppm N; and Maryland-22 ppm N. A phone survey of states in the southern region found only four (Kentucky, Mississippi, Tennessee and Virginia) with relevant information. In the south, no state's information is based on more than two years of data and only Virginia has offered the test (or an interpretation of test values) to corn growers.

Preliminary research testing the validity of the PSNT in Kentucky was begun in 1990. I thank Mr. J. Potts and Drs. M.J. Bitzer, R.L. Blevins, C.G. Poneleit and K.L. Wells for their help getting these data. Figure 1 indicates that there is a strong

relationship between PSNT values resulting from a wide range in at-planting N rates and relative (within a tillage system for a given year) corn yields. The sampling procedures took tillage differences into account and the fit of the data obtained to a single curve was rather good. In Figure 2, where yields were expressed on a relative basis (% of the highest yield observed at each location), and then combined for the 1990 crop year, considerably more scatter is apparent. Figures 3 and 4 use only PSNT values and relative yields from the unfertilized control plots at each location in order to better focus on the nitrate-N supplied by native soil organic matter, crop residues and manure (if any).

The data from Kentucky (16 site-years, Fig. 3) and from Virginia (41 site-years, Fig. 4) are quite comparable at low PSNT values, where a large number of sites responded to fertilizer N addition. There are too few sites in Kentucky where unfertilized soils gave PSNT values greater than 15 ppm N. The only site in Kentucky that did not respond to added fertilizer was a manured one. More data on manured and somewhat poorly to poorly drained soils is needed. The Virginia results, courtesy of Drs. M. Alley and G.K. Evanylo, contain about 20 locations that did not respond to added fertilizer N, and suggest that the critical PSNT value should be about 15 ppm N. This value is consistent with the limited Kentucky data set, but we lack information in the critical range of interest. *The 15 ppm N value is considerably lower than the range of 20 to 30 ppm N that contains most of the critical PSNT values reported from more northern states.*

Conclusions

Our preliminary results in Kentucky resemble past reports and current information coming from other states, and our research is continuing. This approach may improve our ability to make more site-specific fertilizer N recommendations for corn. In fields where use of the test reduces unneeded fertilizer N applications, post-harvest residual soil nitrate concentrations will likely be lower and the potential for water quality degradation by excess nitrate will be diminished. However, we do not yet have enough information to interpret PSNT values for Kentucky corn growers with confidence.


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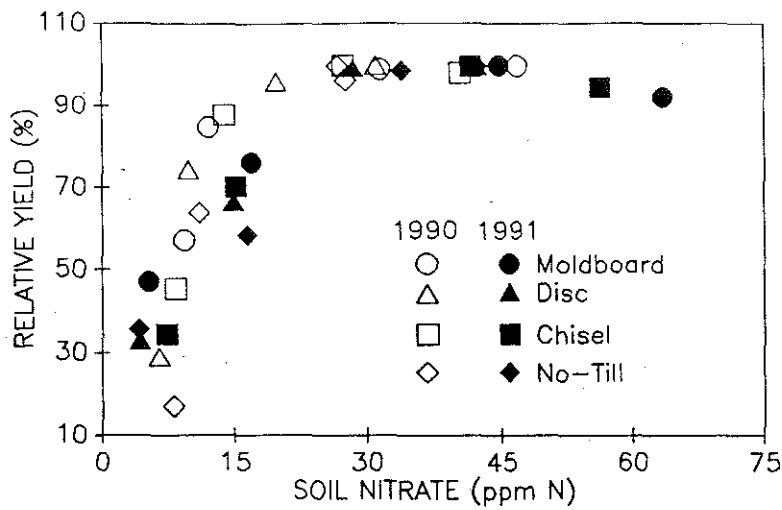


Fig. 1. Relative yield versus PSNT nitrate concentration for four tillage systems applied to a Maury silt loam soil under continuous corn production over two years.

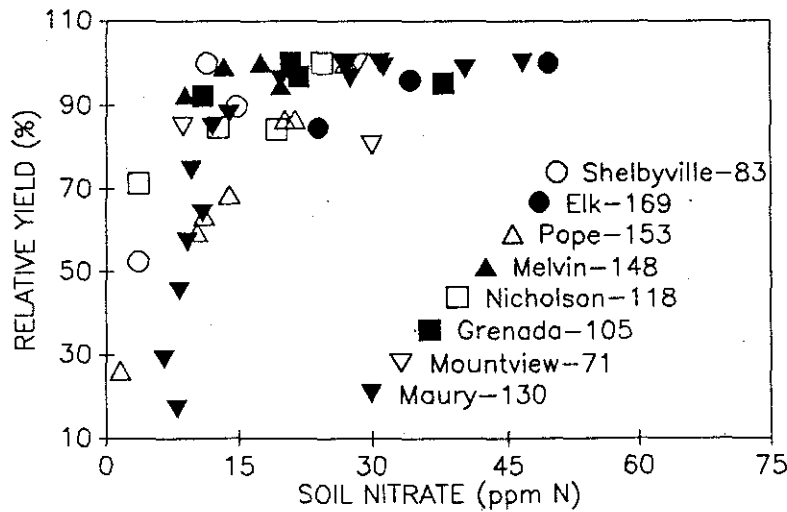


Fig. 2. Relative corn grain yield versus PSNT nitrate concentration for eight Kentucky locations in 1990. Soil series name and maximum treatment mean yield found at each location indicated next to appropriate symbol in body of figure.

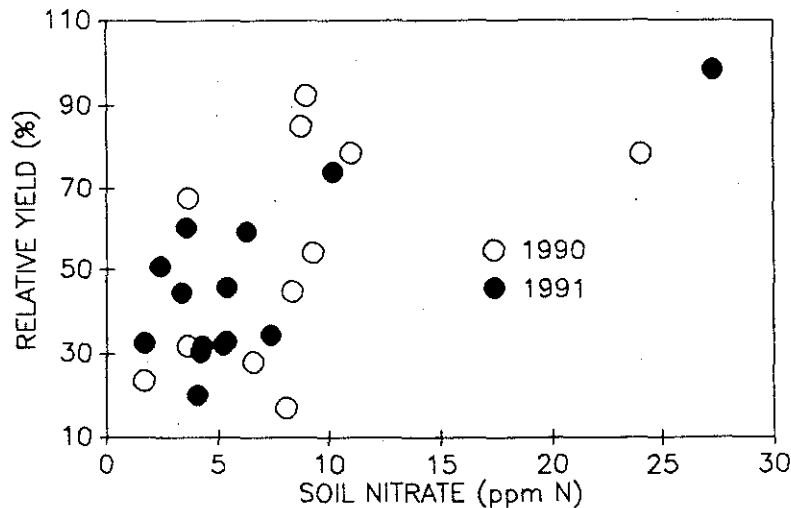


Fig. 3. Relative corn grain yield versus PSNT nitrate concentration for unfertilized controls at 16 Kentucky locations in 1990 and 1991. Some locations are represented more than once due to several tillage or rotation treatments not receiving fertilizer N.

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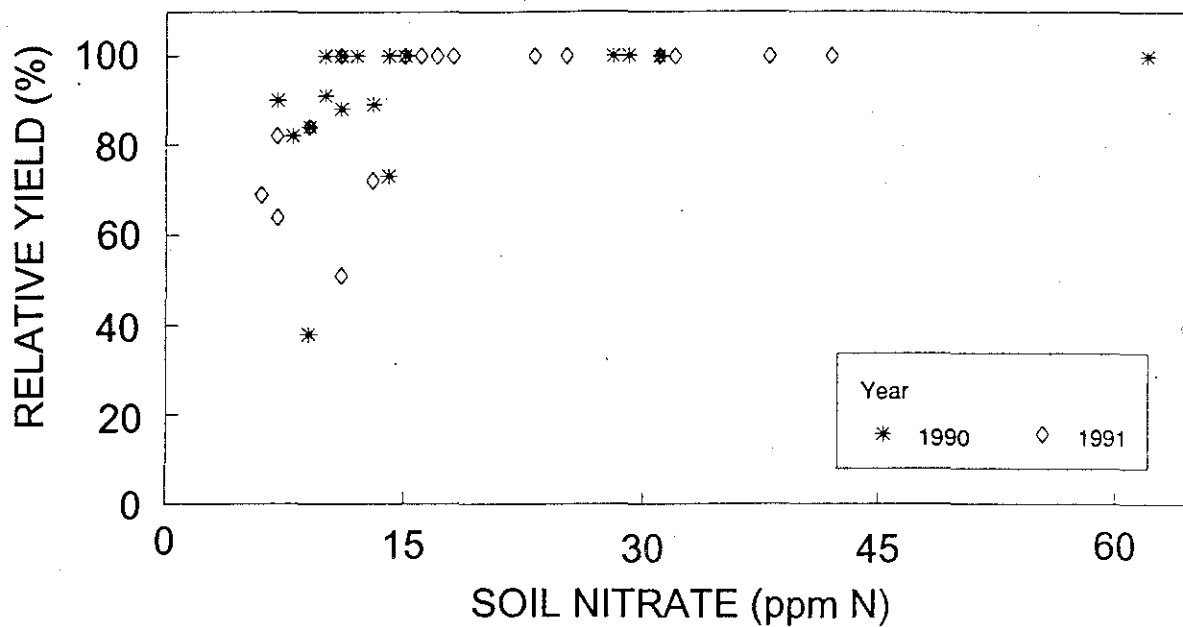


Fig. 4. Relative corn yield versus PSNT nitrate concentration for unfertilized controls at 41 Virginia locations in 1990 and 1991 (Evanylo and Alley, 1991). Used with permission.