Assessing Spatial Variability in Soil Mineralizable Nitrogen Levels

Timothy Smith

Abstract (1427)

Nitrogen has been widely studied as a plant nutrient and as an environmental pollutant. The amount of nitrogen that is mineralized in the soil is important for plant growth and therefore when determining proper nitrogen additions to the soil for optimum crop production. Being able to predict soil mineralization could also help to minimize nitrogen loss to the environment. The Illinois Soil N Test has been shown to be a good indicator of nitrogen mineralization and has related directly to crop responses to fertilizer nitrogen. In order to use this test to determine nitrogen use rates, analysis of the spatial variability that exists in producer's fields needs to be studied. This paper looks at the spatial variability of soil mineralizable nitrogen levels as determined by the Illinois N Test using Arview to map and analyze a number of data sets.

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Nitrogen is the most critical nutrient for corn production. In a typical year, Illinois farmers use more than a million tons of fertilizer N, at a current cost in excess of $350/ton. However, a major impediment to N management has been the lack of a soil test that can reliably predict crop yield response to fertilizer N application. For instance, it has been repeatedly shown, and is now widely accepted, that soil nitrate tests are seldom correlated with crop yield response in the eastern Corn Belt. In Illinois, soil testing is rarely performed. Rather, N fertilizer recommendations are often based on a yield goal, with adjustments for prior cropping and management history. Thus, N fertilizer is often applied where and when it is not required, reducing profitability for the producer and promoting environmental pollution (Mulvaney et, al. 2001).

Several field studies in the north-central U.S. have detected sites where corn does not respond to N fertilization or have failed to show a consistent relationship between yield response and N application rate. It has long been postulated that certain organic forms of soil N are readily converted to plant-available forms and account for this lack of response to fertilizer application. Numerous attempts have been made to identify a labile pool of soil organic N, but these have been unsuccessful because of serious defects in methodology. Recent work has implicated the amino sugar fraction in reducing the yield response of corn to N fertilization, and led to a new type of soil test, commonly referred to as the Illinois soil N test (ISNT) that differentiates between responsive and nonresponsive sites (Khan et. al. 2001).

Using this test as an indicator of mineralization of nitrogen at two differing field scales, this study attempts to evaluate the spatial variability present so that it can be used to make meaningful nitrogen recommendations. Preliminary assessment of the spatial variability in small plots (approximately 15 X 20 meters) has been reported to contain spatial structure that would allow relevant maps to be created (Boast et. al., 2003). This paper is looking at scales that might be applicable to production conditions. Ultimately, strategies for dealing with variability at this scale may provide a key component in a management scheme where the Illinois soil N test is used to make decisions for soil nitrogen fertilization amount and spatial distribution. Evaluation of the fields in this study for spatial structure is being done in ongoing related work.

One field was sampled in spring of 2002(South 26A). This continuous corn field was a 26 acre field that had had been under uniform fertility management for at least 34 year. The field was located in an area that was transitional from soils that formed under prairie vegetation (Mollisols) to soils that formed under forest vegetation (Alfisols). This field was sampled on a one-acre square grids with a sample represented by five cores taken to 12 inches deep. The cores were taken on the corners of a two-meter square and in the middle of the square. Two other fields were sample in the spring of 2003. The first (University of Illinois, C. U. Williams Farm) was sampled on approximately one-acre rectangular grids (150 ft. by 290 ft.) with a five-core composite taken to 0-12 inches and 12-24 inches deep taken from evenly spaced locations along the centerline of the grid. The second (Mansfield E of Creek) was sampled with same procedure as the C. U. Williams Farm.

The soil samples were oven dried at 40^{o} C until dried and crushed with a rotary mill to pass through a 2 mm screen and thoroughly homogenized. The samples were analyzed using the N test described by Khan et al. (2001). The results were mapped using Arcview 3.2.

The first years results are shown for the South 26 A. field overlaid on the soil type map (Fig 1). The values show interesting trends when compared to the soil type map. The Drummer and Flanagan are the Mollisols and show tendency to have higher values.

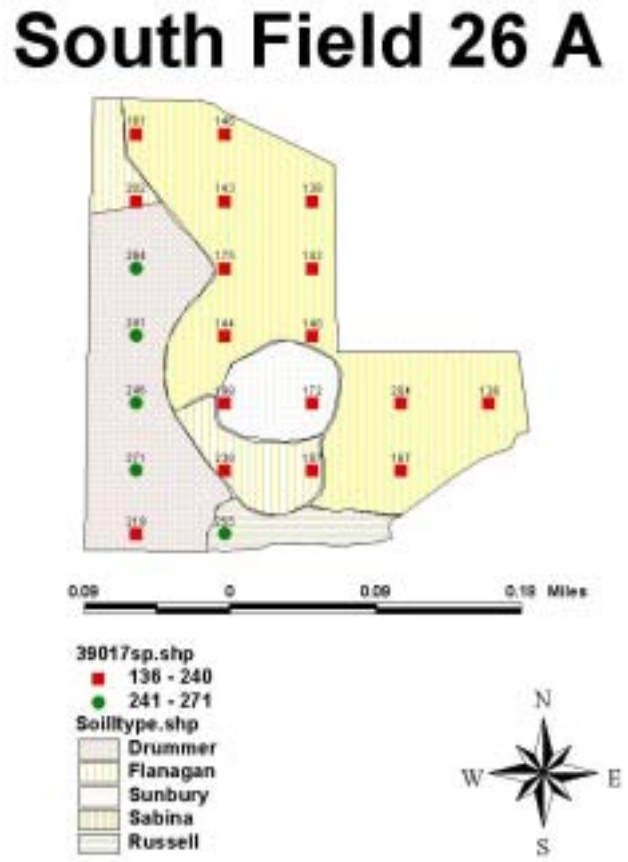

Figure 1

The C. U. Williams field sample in the spring of 2003 is University of Illinois Endowment farm. This field was sampled with the intent of testing nitrogen recommendation based on the ISNT against the current recommendation system. With two sampling depth the ISNT numbers are shown as an index of ISNT with the surface sample having a greater weight (Fig. 2). The recommendations based on the ISNT are 60, 90, 120, 180 lbs of N (Fig.3). From each recommendation area and in a strip in the middle of the field a rate of 150 lbs of N was used as the current N recommendation .

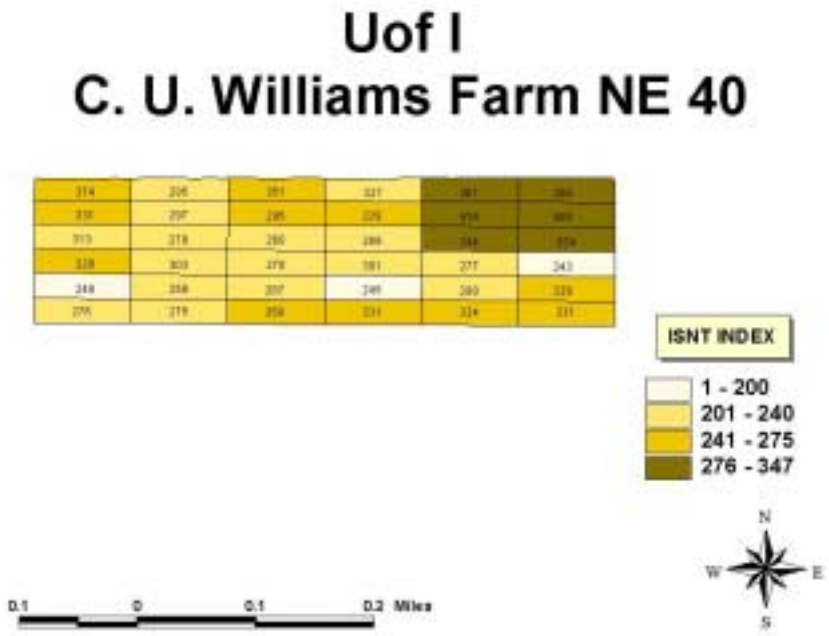

Figure 2

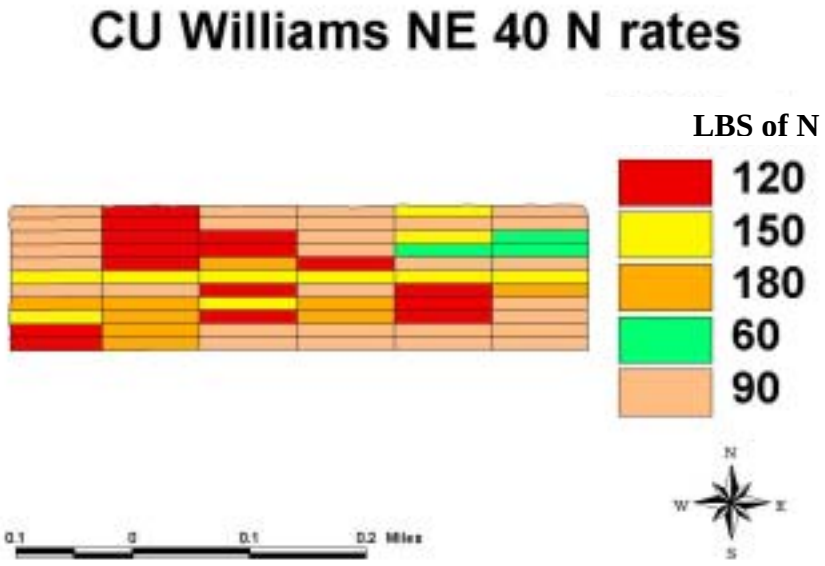

Figure 3

The second field sample in 2003 was the Mansfield E of Creek field. This field was sampled as a production field with the intent of using ISNT to guide our nitrogen recommendation. This field had manure applied, after spring sampling, in the area

indicated in the bold outline (Fig. 4). In the areas without manure application, based on ISNT, rates applied to this field were generally lower than the currently recommended rates. (Fig. 5). In the area where the manure was applied, the rates are higher than what the current recommendation because of the amount of manure applied.

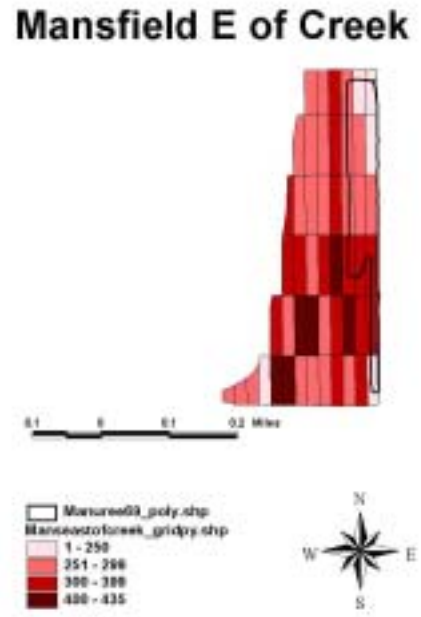

Figure 4

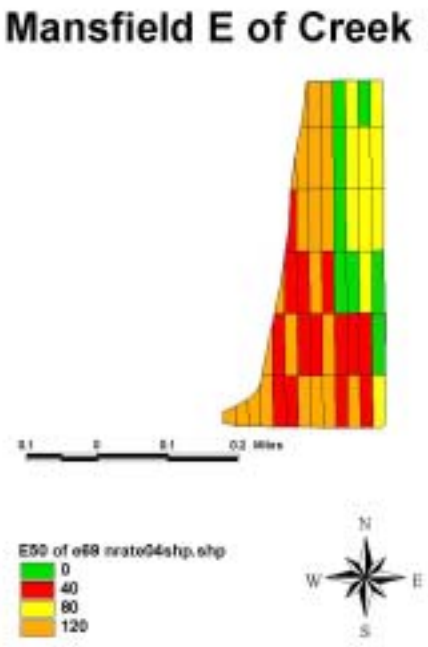

Figure 5

All fields will be harvested with combines equipped with yield monitors with GPS so that harvest maps can be evaluated. The development of the ISNT for measuring potential mineralization of nitrogen makes it possible to create maps of this spatial variable and use it as a basis for making better nitrogen fertilizer recommendations. If this method compares favorable with the current recommendation system, it will be a great advancement in the application method of nitrogen fertilizer for crops.

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Acknowledgements

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