Soil-Specific Nitrogen Management on Mid-Atlantic Coastal Plain Soils

By R. Khosla and M.M. Alley

Application of nutrients such as N on farmlands is essential for profitable and sustainable crop production. Establishing nutrient rates for improving crop yield and profit, while minimizing environment risk, is challenging. The technology to assist in managing the inherent variability in fertility levels in farm fields has not been available until the recent development of variable-rate computer controllers that can be linked to the global positioning system (GPS). The potential exists to optimize nutrients with variable rate application according to the productivity potential and inherent fertility status of each soil type that exists in each individual field.

Fields with highly variable soil types are typical of the mid-Atlantic Coastal Plain. Based on this pilot study, soil-specific nitrogen (N) application has the potential to optimize N application rates for corn production on variable soil types.

One of the impediments in variable rate fertilizer application is intensive grid soil sampling. It involves skilled labor, time and money in procuring and analyzing substantial numbers of soil samples from individual fields. Techniques of soil sampling and their comparison have been discussed by soil scientists for years. Regardless of the technique, grid soil sampling on small grids (i.e. 1 acre or less) is time consuming and cost intensive. There is a need for an alternative mechanism for making variable rate fertilizer applications that does not involve extensive soil sampling, especially for nutrients such as N that are highly mobile in the soil system.

In the mid-Atlantic Coastal Plain, corn grain yield response to N depends to a large extent on soil textural class and water holding capacity. In general, the coarser the soil, the lower the water holding capacity and the lower the yield potential. It was hypothesized that applying different (variable) rates of N fertilizer based on the soil types that exist in any given field may help to optimize the N fertilization program.

Depending on the field size, we have

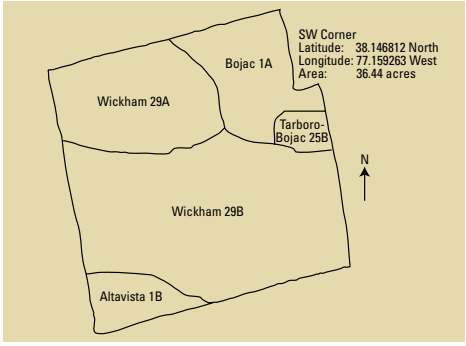

Figure 1. Geo-referenced soil map for a 36-acre test field, based on soil survey order II.

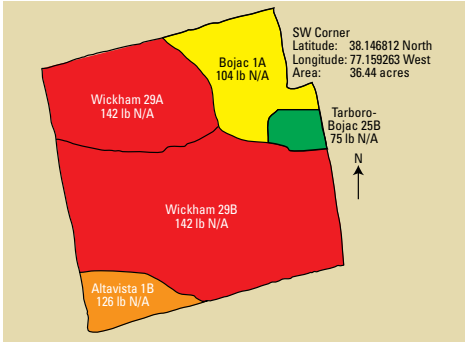

Figure 2. Soil-specific variable rate N application for side-dress corn on a 36-acre test field.

observed between two and 12 different soil types within a field, indicating the amount of soil variability that growers need to manage. Conventionally, farmers have been applying uniform rates of N fertilizer on the fields, usually based on the most productive area of the field.

The potential for soil-specific N applications to optimize N fertilization and increase field-average yields and profits was tested in a pilot study in Virginia in 1998. A 36-acre farm field planted to no-till corn that has five different soil types was chosen as a test field. The field boundary was mapped and a detailed soil map (1:12,000) for that location was obtained from the National Resources Conservation Service (NRCS) office in Virginia. The soils map was digitized, geo-rectified, and underlain with the real-time field boundary for delineating soil type boundaries as polygons (**Figure 1**).

Each polygon in the map representing different soil types was coded alpha-numerically using MAPINFO™ software. The rate of N to be applied in each polygon was determined in consultation with the farmer based on the yield goal for each soil type. A variable rate application map was prepared using the SGIS™ suite of software (**Figure 2**). No soil sampling was performed in the field. Variable-rate N fertilizer was applied on the 36 acres using a model 854 RoGator™ equipped with the Falcon™ control system (Ag-Chem Equipment Inc.). Grain yields were determined with a GreenStar™ yield monitor system on a John Deere 9610 combine.

Table 1 presents the soil types, corresponding land area, total N applied on each soil type, yield goal, actual grain yields, and the N use-efficiency for each soil type. The soil types in the 36-acre field (**Figure 1**) ranged from the Tarboro-Bojac, which is primarily sand with no argillic horizon, to Wickham soil that is highly productive with loamy surface horizon to clay and clay loam in the sub-surface. The grain yield goal varied from 100 bu/A to over 175 bu/A on Tarboro-Bojac and Wickham soil, respectively (**Table 1**). The range of N fertilizer application for side-dressing varied from 75 lb N/A to 142 lb N/A, in addition to 50 lb N/A applied as starter banded at planting (**Table 1**). The total variable rate N application on the test field was 4,463 lb. Current practice for the field would have utilized 5,173 lb N (142 lb N/A rate) for the side-dress application based on the N recommendation for the most productive soil in the field. The variable rate side-dress application utilized in the field reduced N loading by a total of 711 lb (19.5 lb N/A), but increased the N applied to the more productive soils. The grain yield varied from 49 bu/A to 185 bu/A on Tarboro-Bojac and Wickham soil, respectively (**Table 1**). The average grain yield for the test field was 172 bu/A. The overall N use efficiency for the whole test field was very high. The variable rate N application produced a ratio of 1:1...pounds of N applied per bushel grain produced. If the current practice had been utilized to obtain the 172 bu/A yield, the ratio of N to yield (bu/A) would have been 1.12 (**Table 1**). Nitrogen use efficiency was increased with the variable rate application. BC

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TABLE 1. Soil type, land area, rates of N fertilization at planting and side-dressing, total N applied, grain yield, yield goal, and apparent N use efficiency for corresponding soil types in the 36-acre test field, 1998.

Soil type	Area, acres	Starter-band N	Side-dress N	Total N	Grain yield	Yield goal	Apparent N use efficiency
		lb N/A			bu/A		lb N/bu of grain
Tarboro-Bojac 25B	0.9	50	75	125	49	100	2.55
Bojac 1A	5.8	50	104	154	146	140	1.05
Altavista 1B	4.6	50	126	176	176	160	1.00
Wickham 29A & 29B	24.7	50	142	185	185	175	1.04
Total acres	**36.0**						