N MANAGEMENT ZONES USING A VARIETY OF DELINEATION METHODS

D. W. Franzen
North Dakota State University
Fargo, North Dakota

INTRODUCTION

In the northern plains, soil testing is most often used for N management. Fall or spring soil sampling is used to detect residual nitrate-N in the rooting zone of the subsequent crop, which is subtracted from a formula based on yield goal to determine the amount of N fertilizer a grower should apply to reach that goal (Franzen and Cihacek, 1996). To apply this principle site-specifically, some sort of method to detect variations of residual nitrate in the soil must be employed.

Grid sampling at the scale necessary to consistently detect N fertility patterns within fields would be cost-prohibitive in this region, even for high-value crops (Franzen and Cihacek, 1998). However, zone sampling, which is based on the premise that fertility patterns exist because of some logical reason, has been shown effective in revealing these zones (Franzen et al., 1998A and Franzen et al., 1998B). It is often difficult to determine where to delineate zone boundaries. For example, if elevation in a field were measured and a topography map developed, where does “hilltop” end and “slope” begin, or “slope” end and “depression” begin. These transitional areas could constitute considerable area, and relying on only one delineation method could result in larger than acceptable errors (Franzen et al., 1999). Other zone delineation methods have been offered, such as electrical conductivity sensors, satellite imagery, aerial photographs, yield mapping, and more detailed soil surveys (Franzen and Kitchen, 1999). The use of these other methods, along with topography, or possibly without topographic information, may be useful in helping to draw boundaries of N management zones with less error than one method alone.

MATERIALS AND METHODS

The Valley City field is relatively square 40 acre field southeast of Valley City, ND about 5 miles. It is located on a glacial till structure called the LaVerne end moraine. This field has been sampled in a 110 foot grid since 1994, with the exception of year 2000, as part of various site-specific projects. Previous work has been published in several sources. Sample results are available for nitrate-N at a 0-2 foot depth from all years. The crop sequence is given in Table 1. Veris EC readings were made in 1998 and 2001. EM-38 EC readings were made in 1998. Satellite imaging was available in 1998. Aerial photographs were taken in 2001. Yield maps were made in 1996 and 2001.
Table 1. Crop sequence, Valley City, 1994-2001

<table>
<thead>
<tr>
<th>Year</th>
<th>Crop</th>
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<tbody>
<tr>
<td>1994</td>
<td>spring wheat</td>
</tr>
<tr>
<td>1995</td>
<td>sunflower</td>
</tr>
<tr>
<td>1996</td>
<td>spring wheat</td>
</tr>
<tr>
<td>1997</td>
<td>barley</td>
</tr>
<tr>
<td>1998</td>
<td>spring wheat</td>
</tr>
<tr>
<td>1999</td>
<td>sunflower</td>
</tr>
<tr>
<td>2000</td>
<td>spring wheat</td>
</tr>
<tr>
<td>2001</td>
<td>barley</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

The nitrate-N maps are given in Figure 1. Similar patterns are seen in most years, except those, such as 1998 and 2001, where poor yields from factors other than nitrate-N contributed to lower yields and higher residual N levels than in most years.

Figure 1. Nitrate-N levels, 1994-1998, and 2000-2001. Fall samples to 2 feet in depth.
The pattern most often described by the nitrate-N map in years of depletion due to good yields and moisture is described by the 1994-1995 nitrate map in Figure 2.

Figure 2. Most common nitrate patterns illustrated by the 1995 nitrate-N map.

Figure 3. Overlay on nitrate-N on topography, 1995.
Other zone delineation methods reflect this basic pattern of nitrate-N, including Veris and EM-38 EC measurements (Figure 4), aerial photography and satellite imagery (Figure 5) and one of the yield maps.

![Veris, EM-38 images]

**Figure 4. Veris 1998, Veris 2001, EM-38, 1998.**

![Landsat satellite image, Ektochrome aerial photo]

**Figure 5. Landsat satellite image, 1998 (left) and Ektochrome aerial photo (2001).**

Oddly, the electrical conductivity in areas of medium nitrate levels are the lowest in the field. Through extensive coring for determination of soil types at an Order 1 level and finer scale, it was revealed that these areas often were underlain with an argillie horizon at 18 inches to 3 feet in depth, which is a feature not regularly described in glacial till surveys in the area, but may be more common than previously thought. The argillie horizon provides a platform, above which water moves in response to topography. It is reasonable to see that these areas are both leached more than others due to shallow lateral water movement, and at the same time contain considerable nitrate-N in that lateral water movement at any given time. An exception to this is an area in the very north-central part of the field, relatively circular in shape, which is a loamy sand, eroded hill-top, very unlike the soil in the rest of the low-EC pattern.

Both the aerial photo and the satellite imagery, taken in different years, still reflect a similar pattern to soil nitrate levels in most years and patterns seen in EC measurements.
Figure 6. Yield, spring wheat, 1996 (left) and barley 2001 (right)

The yield map of the spring wheat in 1996 does not reflect the dominant pattern in the field, however, the 2001 barley yield map does reflect prominent features of the N fertility patterns, with higher yields in the central and southeast parts of the field, and lower yields on the sandier soils to the southwest and north.

Comparison of zone delineation methods is in its early stages. The data from one year for several possible methods has been collected, along with similar data from other sites. This information will be compared to soil test nitrate-N data to determine whether one method of delineation is best, or whether a combination of cheaply obtained sets of data are more effective in delineating and describing soil test N levels in fields of the northern Great Plains.

ACKNOWLEDGMENTS

Initial work was conducted thanks to an EPA-319 water quality grant and support from Agrium. Current research is funded by IFAFS, Precision agriculture grant. All funding is greatly appreciated.

REFERENCES


