SITE-SPECIFIC MANAGEMENT OF N FERTILIZATION IN ONTARIO

I.P. O'Halloran[1] and R.G. Kachanoski[2]

Significant within field variability of soil properties, such as soil fertility, and plant growth have been well documented. Standard soil testing practices and fertilizer recommendations which encompass an average soil test value for a field and a constant rate of fertilization will obviously result in certain areas of a field being either over or under fertilized. As indicated by Kachanoski and Fairchild (1995), for a single (constant) rate of fertilizer application, recommendations based on soils with low variability (i.e. small plots) will under predict the optimum economic fertilizer requirement of sites (i.e. farm fields) with higher variability. This in part, may explain why some farmers obtain economical yield increases to fertilizer applications above recommended levels. The use of calibration curves and soil test values for making fertilizer recommendations must take into account the degree of field scale variability if maximum economic benefit of fertilization is to be obtained.

In an attempt to deal with field scale variability, interest has increased in site-specific crop management systems which attempt to manage the different areas within a field to their optimum, rather than to the field average. These site-specific systems may improve economic returns and reduce environmental contamination through a more judicial application of nutrients and a better utilization of the soil's resources. The technological ability to spatially vary fertilizer inputs has been developed and made available to producers for several years. In Ontario, innovative producers have already invested in this technology and have been conducting on-farm field trials in an attempt to increase the economic return of their production systems. However, a critical component of site specific management systems is the creation of the expert map which indicates how to alter the rate of fertilizer applied at different locations within the field. Some commercial soil-testing laboratories are soil sampling fields in a grid pattern to create a soil-fertility map. This method can be fairly expensive and has met with limited success. Soil properties and crop growth often vary with changes in landscape position, and this information may also prove useful in developing expert maps.

The following paper outlines a major research project developed to address the issues of site-specific crop management in Ontario, although the current focus of the project pertains to variable N fertilization. The project, currently in the first year of a five year programme, was initiated by the Ontario Ministry of Agriculture, Food and

---

[1]Research Professor and Associate Professor and Chair, Department of Land Resource Science, University of Guelph, Guelph, Ontario, Canada, N1G 2W1. Presented at the 25th North Central Extension-Industry Soil Fertility Conference, November 15, 1995, St. Louis, MO.

Rural Affairs (OMAFRA) in cooperation with the Department of Land Resource Science at the University of Guelph. The rationale for the approach taken is based on the information gathered in two other major on-farm projects, Tillage 2000 and Partners in Nitrogen, which were conducted in Ontario during the past decade.

PROJECT OBJECTIVES

As indicated earlier, the basic objective of this project is to evaluate the potential of varying crop management factors with the technologies available. The initial stages of the project are devoted to the study of variable rate N applications. Within this context, specific objectives include:

1) Identification of factors which produce within field variability of crop growth and assessing the impact that these factors have on crop fertilizer N requirements. This information will be used to generate the "expert maps" for variable N fertilizer application.

2) An assessment of the ability of current technologies to characterize and manage the variability in the field within a site-specific crop management system. This includes aiding the farmer in assessing what information he may want to collect, and how he might best utilize this information for management decisions.

3) An evaluation of the economical benefits of variable rate application of N fertilizers.

4) To determine the change in potential nitrate loading to ground water from variably applying N fertilizer within a field compared to constant application.

5) To evaluate the consistency of the expert map from year to year and the cumulative effects of successive low or zero N fertilizer applications on the expert map.

METHODOLOGY

Site Selection:

Currently the project involves 24 sites across Ontario. Site selection was based on the following criteria:

1) Each farm co-operator was willing to make a five year commitment to the project in terms of land and labour, and has purchased or has access to a Global Positioning System (GPS) and on-the-go yield monitors.

2) Fields (50-125 acres) were selected which encompassed the typical range in soil variability for a given area including variations in topography and soil types.

3) Cropping systems which were either corn-bean or corn-bean-cereal rotations. Bean refers to either white bean or soybean.

Although no yield data has been collected, field observations indicate that for some sites a significant increase in fertilizer N use efficiency is possible and that variable rate application will be necessary to meet water quality objectives.

Site Characterization and "Expert Map" Generation

For each site, a topographic map will be created. We are currently evaluating the feasibility of using High-Resolution GPS for obtaining this information quickly and accurately, in comparison to a laser theodolite total station survey. Previous work in Ontario has shown landscape position, as determined on a 33' x 33' grid using a laser theodolite total station survey, had a significant impact on crop yields in the absence of fertilizer N inputs (Kachanoski 1994).

Field scale soil maps (texture, topsoil depth, colour etc.) will also be created, as will soil fertility maps (100' x 100' grid) for soil P, K, Mg, organic matter and pH. For each site, three field-length check strips (0 fertilizer N applied) are sampled for soil nitrate levels (1 foot depth, 33 foot sampling interval). This information is used to generate a soil N test fertility map. All soil sampling locations are tagged and located using GPS so they can easily be overlaid upon topography or yield contour maps. On-the-go yield monitors and GPS will be used to generate yield maps of both check strips and areas fertilized to current recommended levels for each field in the study.

These data will be used to generate contour maps of the fields and relationships amongst topographic position, soil properties and crop yield parameters will be used to develop the spatial pattern for crop N requirements. Of particular interest is the proportion of yield variability and N requirement that can be attributed to slope position or landscape classification. These relationships will be used to develop the recommended variable rate fertilization maps for the fields to be planted in corn the following growing season. Spatial variability in yield patterns as related to slope position and fertilizer application will continued to be examined throughout the study to monitor possible changes in the expert map and potential residual effects of variable rate application on subsequent crops in the rotation. An economical analyses of the two systems will be conducted to evaluate the potential savings and net cost/benefit associated with the variable rate system.

At selected sites, more detailed analyses will be conducted to examine cumulative effects of site-specific management on soil properties, movement of fertilizer into the ground water and crop N uptake to obtain a better understanding of the potential year to year variation in the expert maps.

CURRENT PROJECT STATUS

Although much of the soil sampling has been conducted, the field mapping and topography work has yet to be completed. Early response from producers indicate a very keen interest in this project at the farm level, and many cooperators are eager to expand the context of the programme to include other management factors such as variations in population and/or varieties. A similar approach will be used for these additional management variables. We will attempt to first determine how a change in the management factor influences the spatial yield pattern in relation to the spatial patterns in soil or landscape parameters.

REFERENCES

Kachanoski, R.G. 1994. Variable rate technology for N fertilizer application: Annual report submitted to the Agriculture Canada Greenplan Programme.

Kachanoski, R.G. and Fairchild. G.L. 1995. Field scale fertilizer recommendations: The spatial scaling problem. Can. J. Soil Sci. **75:(in press)**.

PROCEEDINGS OF THE TWENTY-FIFTH

NORTH CENTRAL EXTENSION-INDUSTRY

SOIL FERTILITY CONFERENCE

Published for
The North Central Extension-Industry Soil Fertility Conference
by
Potash & Phosphate Institute
2805 Claflin Road, Suite 200
Manhattan, KS 66502
913-776-0273

November 15-16, 1995

St. Louis Westport Holiday Inn
St. Louis, Missouri

Volume 11

Program Chairman and Editor:

Dr. George Rehm
University of Minnesota
Dept. of Soil, Water and Climate
439 Borlaug Hall
1991 Upper Buford Circle
St. Paul, MN 55108-6028