Development Of A Multi-Scale Approach To Site-Specific Nitrogen Management

(Interim Report)

Purpose:

The technology is available to variably apply nitrogen to a corn field. To date there has not been a simple inexpensive way to determine how much nitrogen should go in each part of the field. This will evaluate the suitability of using field-strip nitrogen (N) response trials to predict a field based most economic rate of nitrogen (MERN) for grain corn production. The project will also look at the use of a yield stability index and corn grain yield response strips to predict variable N applications. The inter-relationships between remotely sensed imagery, yield stability patterns and soil properties will be examined with respect to N rate prediction. Apart from the potential to reduce nitrate leaching to ground water by applying a nitrogen rate that closely matches crop needs the environmental benefit to the air will be assessed through measurement of N_2O emissions.

Methods:

Field length strips of different nitrogen application rates were used to establish a "field based" N response curve and estimate the most economical rate of N (MERN). All study sites received N rates considered appropriate based on OMAF recommendations. Yield monitor data with global positioning (GPS) was collected for the whole field and a method of determining yield stability was developed and assessed for identifying N management units. Each of the fields had aerial imagery collected in bare soil conditions and in crop. Nitrous oxide emissions (N_2O) were collected along the nitrogen rate strips on two sites.

Results and Summary:

The field MERN estimates indicated that producers were either applying the appropriate nitrogen amount or were over applying fertilizer N. In instances were fertilizer N was over applied, N rates could be reduced by up to 80 kg/ha without yield reductions. Temporal (year to year) variations in MERN values for certain fields did exist, varying by as much as 60-70 kg/ha. These differences could in part be related to the growing season conditions, especially when drought resulted in no profitable response to applied N. As a result data should be collected over several growing seasons before drastically altering N rates.

Management unit delineation has been and remains the greatest challenge in developing site-specific N management systems. Patterns of crop yields often show spatial relationships with slope position and soil type, however, these delineations do not always identify N management units. N management units are defined as areas within a field that have a similar fertilizer N requirement (i.e. similar most economic fertilizer N rates, but may vary by yield). Evaluation of yield response to applied fertilizer N in zones of yield stability gave mixed results. On some sites, the method appears to be promising while for others the response to N within a given management unit was extremely variable and/or did not indicate a significant change in the level of fertilizer required across the field. Although most sites displayed reasonably strong relationships between

slope position and yield, this relationship was influenced by growing season conditions and yield responses to fertilization did not always indicate that this would properly identify the N management units.

Over application of fertilizer N can result in the increase in N_2O emissions from the soil. Yield responses to applied N were variable and differed between slope positions (i.e. significant slope by N rate interaction). The response at the knoll was linear (which is atypical) and quadratic at the mid slope and depression. The MERN for the depression and mid slope was 55 and 78 kg/ha respectively, while a MERN for the knoll could not be calculated although yields did not appear to significantly increase above 100 kg/ha. Fertilizer N recommendations based on the pre-sidedress N tests were 34, 47, and 47 kg/ha for the knoll, mid slope and depression, respectively. Thus the N test under estimated the amount of fertilizer N required for this site. Grain protein content and stover tissue N concentrations indicated that differences between the 100, 150 and 200 kg/ha treatments were small and not significant. Thus, from a yield and N uptake status applications above 100 kg/ha for this site could be considered excessive. The 150 and 200 kg/ha rates also resulted in residual soil nitrate nitrogen levels (fall 2002) in the soil profile (0-70 cm) that were approximately twice as high as the other fertilizer treatments (14.9 mg/kg versus 6.5 mg/kg).

Although fertilizer N application rate affected the N_2O flux from the soil, this effect was limited to the sampling period within 30 days after fertilizer application, and no treatment effect was observed in the later sampling times in the fall or following spring period, even though soil N levels were higher in the greater than 100 kg/ha fertilizer treatments. Application of fertilizer N rates at or slightly above the MERN did not significantly increase N_2O fluxes in the mid slope or depression compared to the 0 kg/ha N treatment. However, all fertilizer treatments increased the N_2O flux relative to the 0 kg/ha N treatment at the knoll. Variable application of N based on the landscape position and crop MERN could significantly reduce the amount of N_2O lost from the soil.

Bare soil imagery reflects differences in soil colour presumably due to differences in texture and soil organic matter content (SOM), while crop imagery may illustrate areas of similar yield and/or N status. Only 25% of the soils from the study sites indicated that there was a useful correlation between SOM level and imagery data. The low percentage may be due to limitations of the camera or to the fact that most SOM levels were in the less than 2% range. Field based relationships between imagery data and SOM contents were poor. This would in part be due to the fact that although there was no crop present at the time of imagery collection, there was surface crop residue as most farm cooperators practiced some form of conservation tillage. Imagery data did not adequately identify regions of yield response to applied N, indicating that it may not be a useful tool for N management. The extremely dry growing seasons may also have limited the applicability of this type of data for delineating N management units. Different methods of image classification may also improve these relationships.

Next Steps:

The data analysis will be completed and a final report of this project will be completed in 2004.

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