SOIL, WATER, AND CLIMATE
PhD DEFENSE SEMINAR

Studies of Economically Optimum Fertilizer Rates and Spatial Variation of Landscape-Scale Experiments

by

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Wednesday, December 5, 2007
1:00 pm
375 Borlaug Hall

ABSTRACT

The key concept of precision agriculture is to apply adapted management practices to specific soils or zones within farm fields that exhibit spatial variability in factors such as: topography, crop productivity, pest populations, soil morphology, and nutrient availability.
The purpose of this project was to study economically optimum nitrogen rates (EOR) in South Central Minnesota and evaluate the influence of within-field spatial variability of large-scale experiments. The study included four parts. The first part consisted in the validation of University of Minnesota nitrogen fertilization guidelines using on-farm experiments. The second part presented methodologies for the estimation of confidence intervals around the EOR from single response functions. Section three introduced a new approach to analyze large-scale experiments which accounted for the spatial variability of soil properties. The last part of the project evaluated the methodology proposed in the third part of the study using multiple fields, and included an assessment of the relationship between spatial variability and EOR.

Results from the first part study showed that the average EOR of the 68 site-years analyzed was within the acceptable range of the University of Minnesota guidelines. The results of the EOR uncertainty analysis showed that the profile-likelihood based, and the bootstrap methodologies for confidence interval estimation provide a superior, computationally viable approach for EOR uncertainty estimation in non-linear fertilizer response models.

In parts three and four, a new approach was presented for estimating EOR from on-farm trials involving different rates of fertilizer applied in long wide strips across the landscape. The new methodology used an iterative spatial modeling approach that is similar to nearest neighbor analysis in many ways. The iterative procedure resulted in adjusted crop yields that can be used along with fertilizer treatment rates to estimate EOR in small blocks across the field. The spatial patterns in EOR can be used as part of a variable rate fertilizer management program to optimize fertilizer inputs in areas where these patterns cannot be easily estimated using soil maps, soil sampling, or remote sensing.

This seminar is in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Soil Science