Overview

- Improving the efficiency of N fertilizer use without compromising yield will be necessary to address rising levels of reactive N including nitrous oxide, a potent greenhouse gas, while feeding an increasing world population.
- Increasing N use efficiency (NUE) with precision technologies (e.g. GPS, remote sensing, yield monitors, VRT) will require increased scientific understanding of landscape-scale processes and their impacts on decision-making (Fig. 1).

Objectives

- Developing precision N management strategies are key goals of two complementary USDA NIFA projects: Site-Specific Climate Friendly Farming (SCF) and Regional Approaches to Climate Change for Pacific Northwest Agriculture (REACCH).
- Yield-water-NUE relationships are being assessed to elucidate site-specific processes that regulate environmental and economic performance of wheat.
- Specific objectives are to: (1) measure site-specific cropping system performance (yield, protein, economic return, N status, N use efficiency, soil organic matter and inorganic N) required for precision N management decisions; and (2) develop and test site- and time-specific decision-aid and evaluation tools including an economic assessment required by growers to formulate and assess science-based precision N recommendations.
- Involves integration of crop (e.g. yield monitoring), soil (e.g. apparent electrical conductivity), remote sensed (e.g. Rapideye satellite imagery) and economic data using studies at WSU Wilke Farm, WSU Cook Agronomy Farm and on-farm locations (Fig. 2).

Fig. 1. Successful application of precision farming requires that advanced field diagnostics and precision application technologies are coupled with science-based decision support systems at field scales.

Fig. 2. Field diagnostics for developing precision Nitrogen management strategies.

Objective 1: Measure site-specific performance

- Study site: WSU Cook Agronomy Farm near Pullman, WA under long-term no-tillage
- Experimental Design: N Rate x Wheat Density in Split-Plot with Randomized Complete Block Design; Winter wheat (Triticum aestivum) portion of rotation; three landscape positions
- Measurements: Available water; NUE and NUE components during growing season (i.e., plant and soil sampling at pre-plant, tillering, jointing, anthesis, and post-harvest); Yield and yield components

Fig. 3. WSU Cook Agronomy Farm study locations and the N Rate map for Field C study.

- In Field C, precision N management resulted in applying 45 kg ha\(^{-1}\) less N while improving yield by 794 kg ha\(^{-1}\) compared to conventional uniform N management (112 kg N ha\(^{-1}\)) (Fig. 4). Southern aspects exhibited an inverse relationship between spike density and yield with the same N supply (112 kg N ha\(^{-1}\)) indicating that N and seeding rates that stimulate vegetative growth can reduce wheat grain yield (Fig. 4).

Fig. 4. Spatial field variability in: (a) N required to achieve the greatest yield (field average of 66 kg N ha\(^{-1}\)) and (b) yield obtained at the optimum N rate (average yield increased 794 kg ha\(^{-1}\), 12 bu ac\(^{-1}\)); (c) relationship between spike density and grain yield at N and S facing slope.

Objective 2: Develop decision support systems

- A 26-ac strip at the Wilke Farm was used for a precision N study. Yield monitor (1 year) and apparent EC (Geonics EM-38) date were used to establish three N management zones with low, medium and high yield goals for spring wheat (Fig. 5).

- Overall field averages for variable rate (VRT) and uniform (Uni) applied N were very similar (Fig. 6). The N balance index (N removed in harvested grain - N applied) was greater for VRT (0.89) as compared to Uni (0.82) treatment.
- Preliminary economic analyses show that the VRT strategy was more economical on 3 of 4 “high” zones and 2 of 3 “low” zones.
- Other data still under assessment include field soil water and inorganic N from comparative point samples as well as satellite imagery.

Fig. 5. Yield monitor and apparent electrical conductivity (ECa) data used to create N management zones (right) with high (green), medium (yellow) and low (red) yield goals. Control strips with uniform applications of N depicted in gray.

Fig. 6. Yield goals, applied N and resultant yield and grain protein concentration. Actual yield and protein for field zones on far right with a comparison between Uni and VRT N application.

- These data will be used to further assess N and water use efficiency as well as the effectiveness of defining VRT zones. Precision farming strategies are also being evaluated on four on-farm locations as part of SCF.

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