Precision Nitrogen Management: Evaluating Management Zones & Optimizing Nitrogen Rates in PNW Dryland Winter Wheat

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Introduction

Precision nitrogen (N) management has been proposed as a strategy to improve fertilizer use efficiencies. Current N recommendations for soft white winter wheat (SWWW) in the inland Pacific Northwest (PNW) are based on uniform, whole-field applications. However, uniform N applications result in highly variable site-specific yield response and N use efficiencies (NUE) (Huggins 2010). Low NUE represent a financial loss to the grower, while environmental N losses contribute to air and water quality degradation.

The overall goal of this study is further the development of science-based decision support, monitoring, and evaluation systems for farmers that want to implement precision N management. The data presented here are preliminary analyses of the spatial variability in wheat yield response and NUE.

Objectives

1. **Evaluate the site-specific response of wheat performance (yield, NUE) to N fertilizer**
2. **Begin analyses that will lead to the development of management zones (MZs) based on performance criteria such as maximum yield, NUE, efficiency factor in Mitscherlich equation**

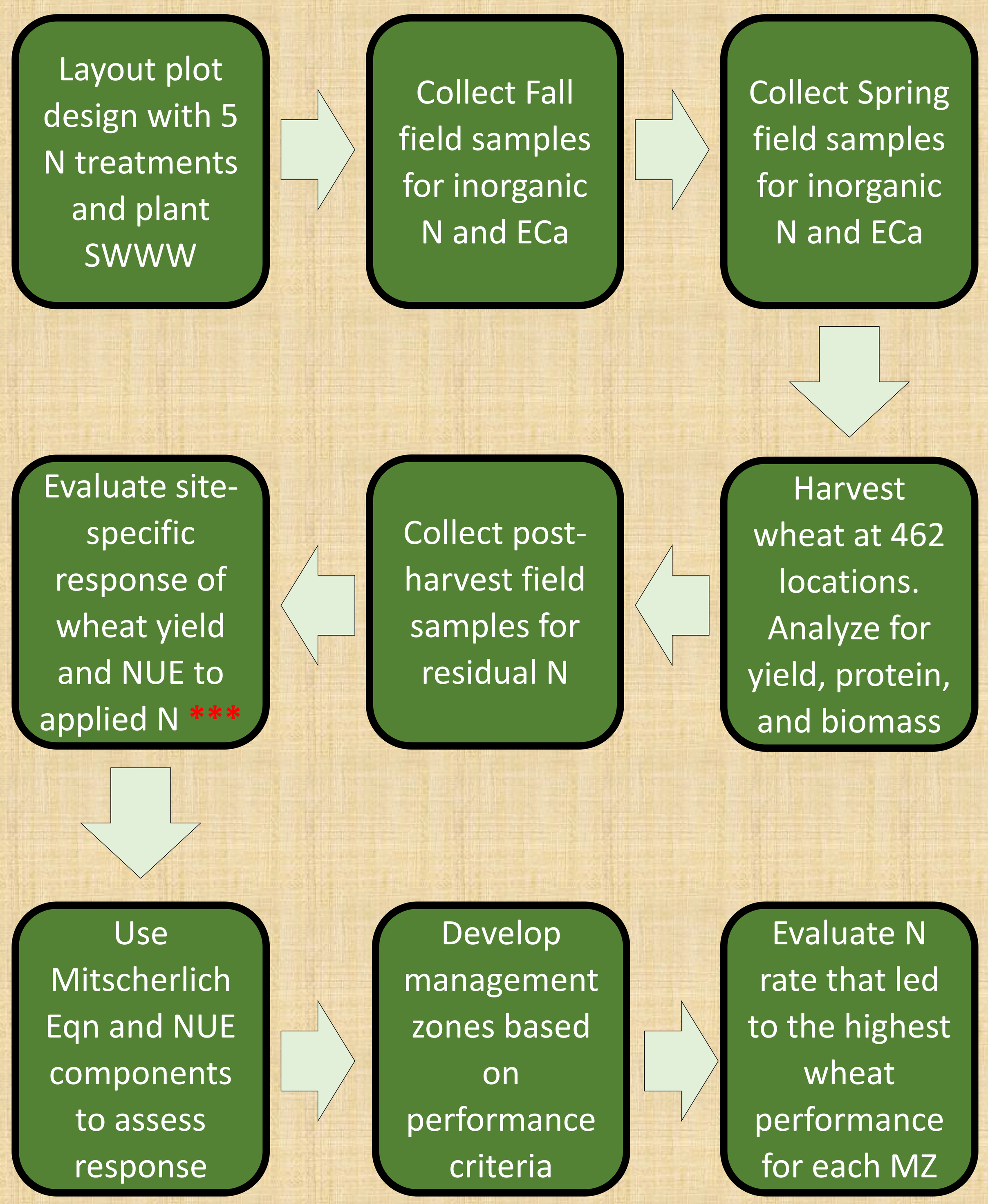


Fig. 1. Work flow for the entire research project. *** marks the current stage of analysis

Methods

- ~50 ha on-farm research plot was identified near Walla Walla, WA
- 7 repetitions of 5 N treatments were used in 4.57 m bands across the entire plot. N rates range from 19 kg/ha to 170 kg/ha (Figure 2)
- 85 harvest locations were created using spatial inhibition process in "R"
- At 85 harvest locations, each N fertilizer treatment was harvested at least once for a total 462 harvested points (Figure 3)
- Harvested grain was weighed for yield and analyzed using NIRS to obtain levels of protein, moisture, and test weights
- Yield response curves were created to compare response to N at different site-specific field locations
- Inverse Distance Weighted (IDW) interpolations were used to compare spatial variability in treatment yield minus the control ($Yield_{treatment} - Yield_{control}$) as well as the N balance index: N in grain (Ng) divided by total N applied (Nf); (Ng/Nf)

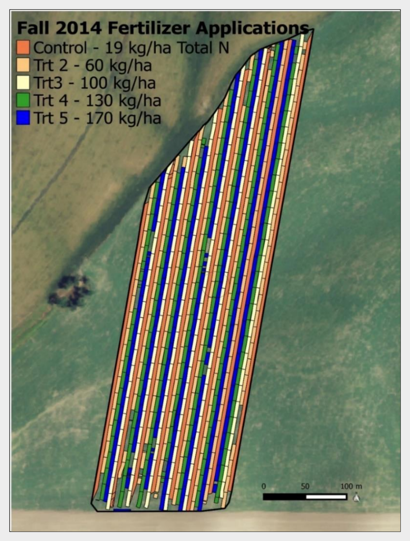


Fig. 2. Plot design with 5 N fertilizer rates

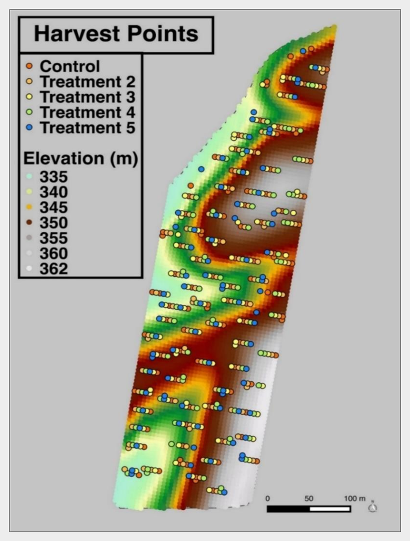


Fig. 3. Harvest locations and field elevations

Results

- Yield response to N at 9 different field locations varied from positive to negative (Figure 4)
- Yield across all N treatments ranged from 3360 – 9390 kg/ha. Average yields ranged from 5703 kg/ha for control (19 kg/ha) to 6319 kg/ha for treatment 3 (100 kg/ha) (Table 1)
- N balance index decreased with increasing N fertilizer (Figure 5)
- Spatial variation of Ng/Nf for largest N rate ranged from 0.40 to 0.87 (Figure 6)
- ($Yield_{treatment} - Yield_{control}$) maps show areas of the field with both negative and positive yield responses to applied N treatments compared to the control (Figure 7)

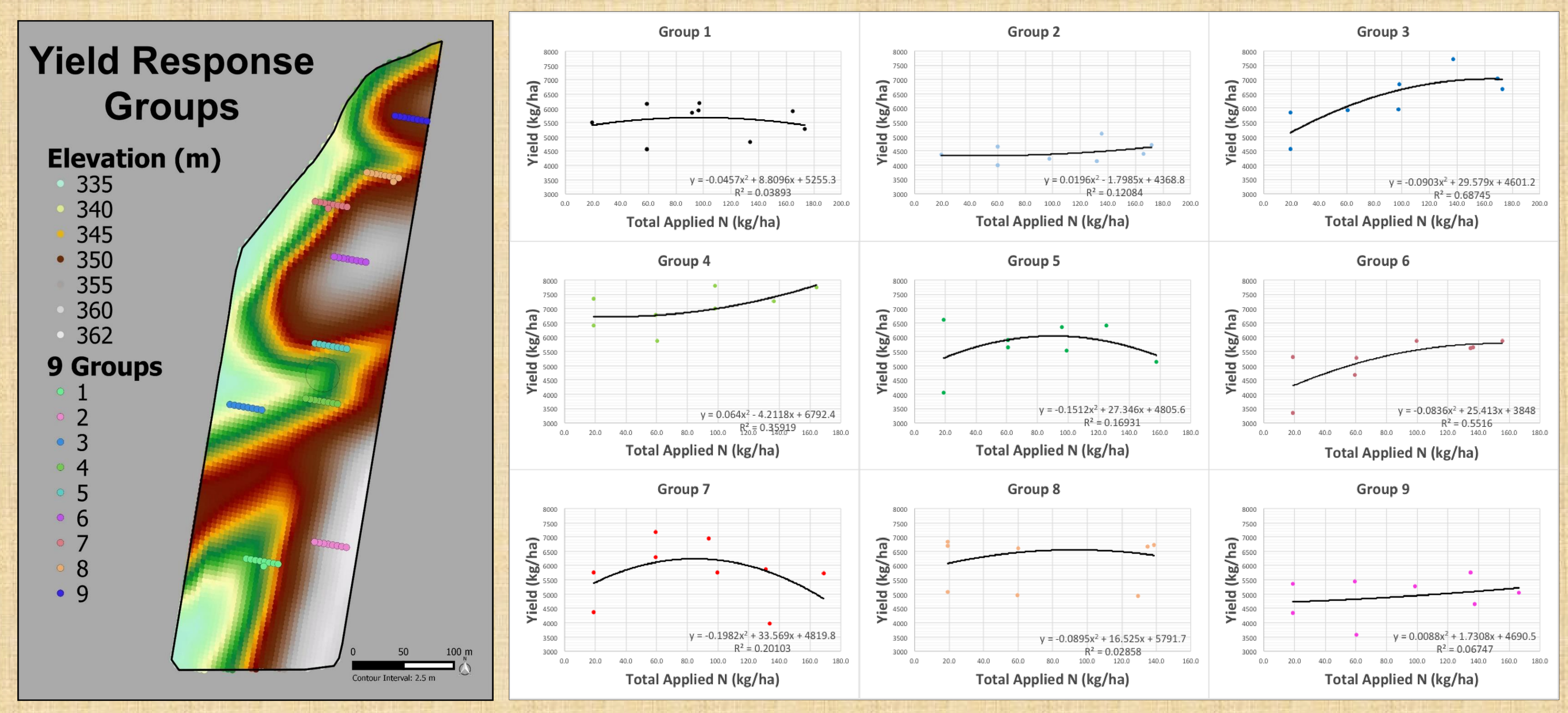
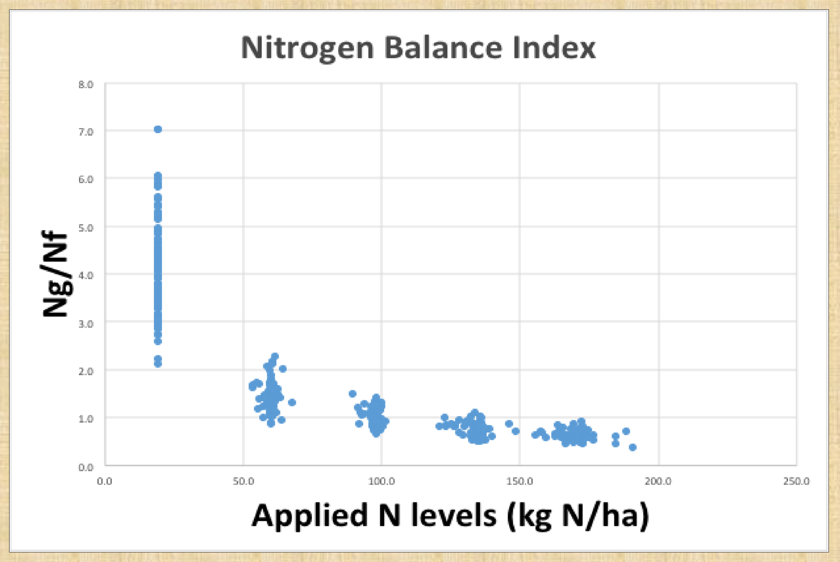
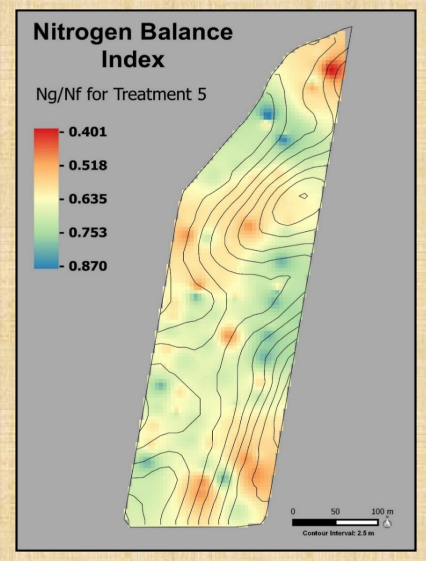


Fig. 4. Yield response curves at different field locations

Applied N (kg N/ha)	Avg Yield (kg/ha)	Range: Min/Max	Standard Deviation	Avg Protein (%)	Range: Min/Max	Standard Deviation
19	5703	3360/8440	939.03	8.373	6.6/12.9	1.140
60	5980	3570/8610	911.65	8.884	7.2/12.0	1.090
100	6319	4240/8360	912.87	9.837	7.4/14.2	1.325
130	6076	3970/9390	925.00	10.46	8.2/13.4	1.232
170	6064	3980/9070	1130.83	11.25	8.4/16.2	1.485

Table 1. Avg grain yield and protein data for each treatment





Left: **Fig. 5.** N balance index for each applied N level
Right: **Fig. 6.** Treatment 5 N Balance Index, IDW interpolation

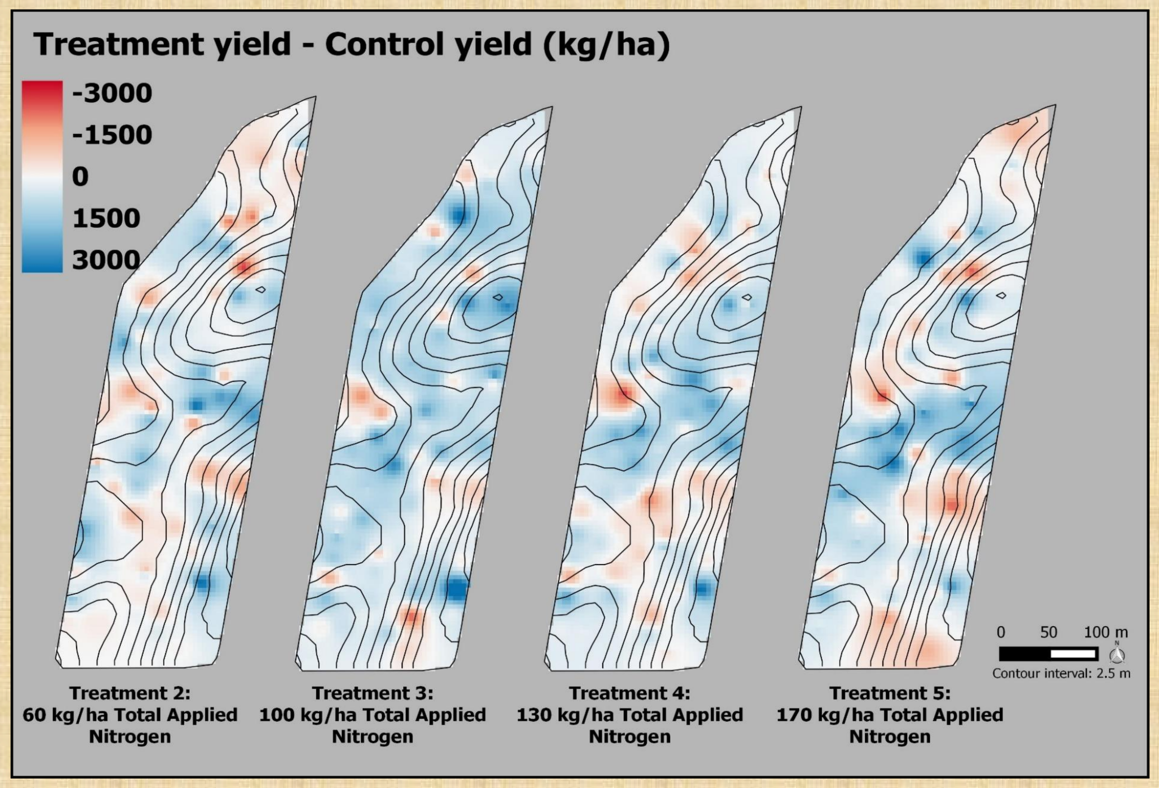


Fig. 7. Yield difference by treatment, IDW interpolation

Discussion/Future Work

- Preliminary analyses show considerable variation in wheat yield response to N across the field. Response varied from large negative responses (yield penalties) to large positive responses at site-specific field locations.
- N balance index varied considerably across the field, though overall it decreased with increased N fertilizer.
- Future analyses will add soil N and plant residue data to perform more complete analyses of NUE as well as N response using the Mitscherlich equation.
- Final data analyses will allow for development of management zones based on winter wheat performance criteria such as NUE, maximum yield, efficiency factors.
- N rates that led to the greatest wheat performance (yield, NUE, efficiency factor) for each management zone will be evaluated.

Reference

- Huggins, D.R. 2010. Site-Specific N Management for Direct-Seed Cropping Systems. http://csanr.wsu.edu/program-areas/climate-friendly-farming/climate-friendly-farming-final-report/. CSANR, Pullman, WA

Acknowledgements

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