Identifying and Distinguishing Between Nitrogen and Water Stress

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OBJECTIVES

- ✓ To evaluate the effects of nitrogen rates and irrigation treatments on wheat plant growth and yield
- ✓ To develop methods to predict yield and grain protein content in varying nitrogen and water environments, and to determine the minimum nitrogen and water required to maintain wheat grain yield and quality; and
- ✓ To develop models predicting yield loss due to nitrogen stress and yield loss due to water stress.

INTRODUCTION

- ✓ Water and nitrogen (N) are two key production inputs for most cropping systems.
- ✓ Sustainability of crop production in semi-arid and arid regions of the Western U.S. is threatened by limited water availability, which results in increasing competition from urban development, environmental restrictions, and energy production sectors.
- ✓ Nitrogen fertilizer is the principal (and the most costly) nutrient input, yet its use efficiency is only about 40 -50% in most U.S. agricultural operations.
- ✓ Wheat is an integral crop for Western U.S., where it is grown as a main cash crop or as a vital rotational crop in combination with other high-value crops such as vegetables, pulses and seed oil.
- ✓ There is an urgent need to develop more efficient nutrient management strategies in order to maximize wheat grain yields and enhance grain quality.

MATERIALS AND METHODS

The study was conducted in spring wheat at two experimental locations in SW Idaho: Parma and Notus.

- ✓ Split-plot design with 4 replicates
- ✓ 3 irrigation treatments (50, 75, and 100 % of measured evapotranspiration (ET)) - main plots
- ✓ 4 N rates - randomized within each main plot
- ✓ Plot size: 10 x 40 ft
- ✓ Irrigation:
  - applied every 7 days utilizing the subsurface drip irrigation system with flow meters
  - dripper line at 8 inch depth and spaced 28 inches
  - based on the estimated crop water use model by AgriMet

N fertilizer was applied at seeding as granular urea (46-0-0)

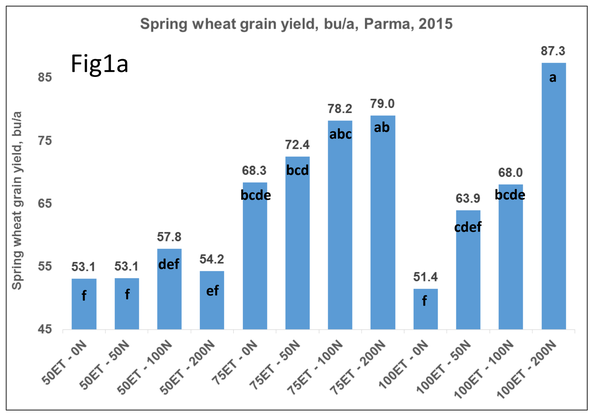
- ✓ Data collection: Plant height, crop reflectance - Normalized Difference Vegetative Index (NDVI) was measured with GreenSeeker, chlorophyll content was estimated with SPAD, leaf area index (LAI) was measured with AccuPAR LP-80

At harvest, spring wheat grain yield, test weight and grain total N content were determined.

DISCUSSION

- Spring wheat grain yield responded differently to N and water application at two experimental sites. Significant differences in yield associated with N treatments were much more pronounces at Parma (loam), compared to Notus (loamy sand) (Figs 1 and 2). Lower soil organic matter (1.2%) coupled with sandy soil texture resulted in lower nutrient holding capacity, compared to Parma site (3.3% organic matter, loamy texture).
- For both locations, the optimum water treatment was 75% ET (Figs 1 and 3). Strong linear relationship was observed between the ET rate and soil VWC (Fig4).
- Averaged across the ET treatments, no significant differences associated with N rate were noted at any of the two sites. While comparable yields were obtained for all N rates at Notus, the incremental increase in yield was noted for Parma (Fig 2).
- Relationship between NDVI and yield was more pronounced at Parma (Fig 5a). NDVI was significantly affected by the ET treatments with 75% ET being optimum for maximizing biomass production (Fig 7).
- Very week relationship between SPAD (Fig5b) and LAI (Fig5c) and yield was observed for both sites, especially at less responsive Notus site.
- N rate has significantly affected biomass N content (Fig 6) at both sites; biomass N content increased with increased N application rate.
- The study will be repeated at two locations in Idaho, and expanded to Montana.
- Producer field days will be organized to showcase the research plots at each experimental site, each summer. Grower collaborators will conduct farmer-to-farmer extension by sharing their knowledge and experience.
- Outreach events for school/college students – will be focused on introducing the concepts of water and fertilizer use in agriculture and educating students on the importance of efficient resource management for sustainable crop production and continued food security.
- International Nitrogen Use Efficiency Conference will be hosted at the University of Idaho in August 2016.The conference will bring together researchers and extension specialists working in the area of precision agriculture and nutrient and water use efficiency.

PRELIMINARY RESULTS



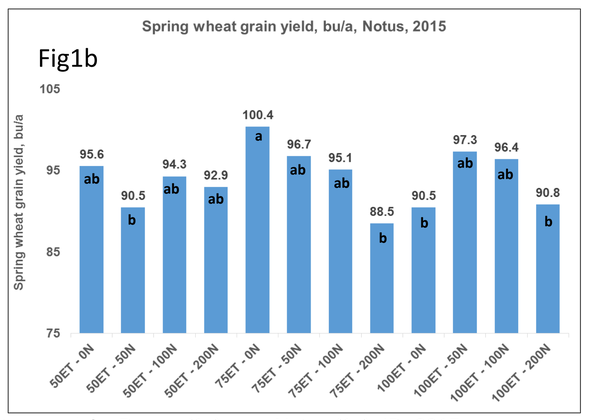
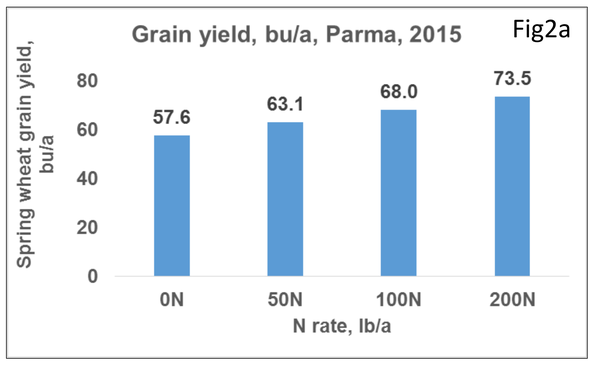


Fig1. Effect of N and water treatments on spring wheat grain yield, Parma (1a), and Notus (1b), ID, 2015.



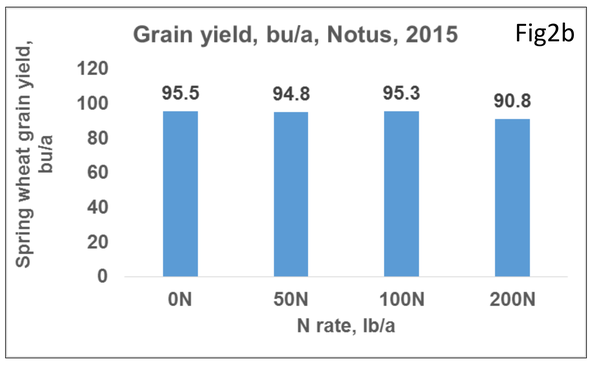
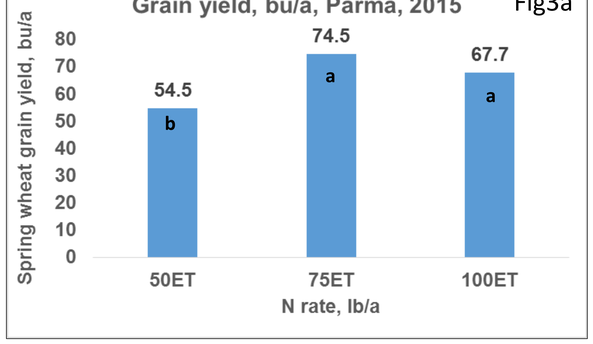


Fig2. Effect of N rate (averaged across water treatments) on spring wheat grain yield, Parma (2a), and Notus (2b), ID, 2015.



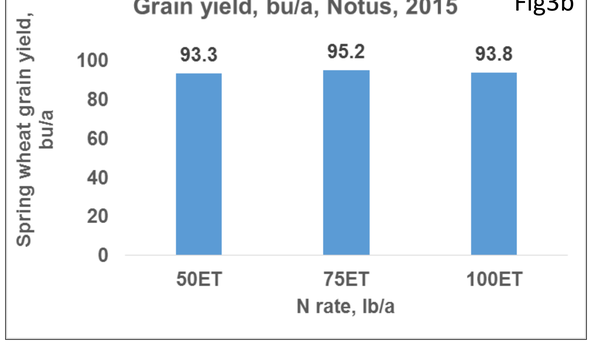


Fig3. Effect of water treatments (averaged across N rates) on spring wheat grain yield, Parma (3a), and Notus (3b), ID, 2015.

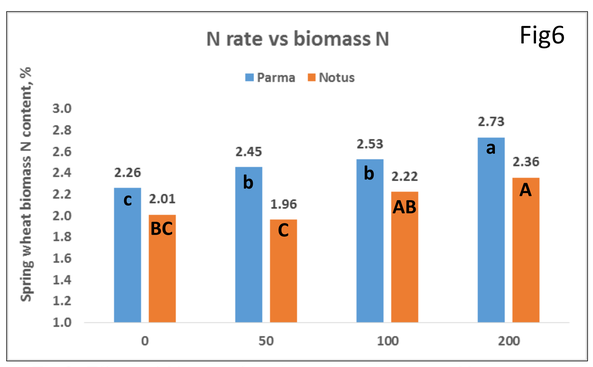


Fig6. Effect of N rate of spring wheat biomass N content, Parma and Notus, ID, 2015.

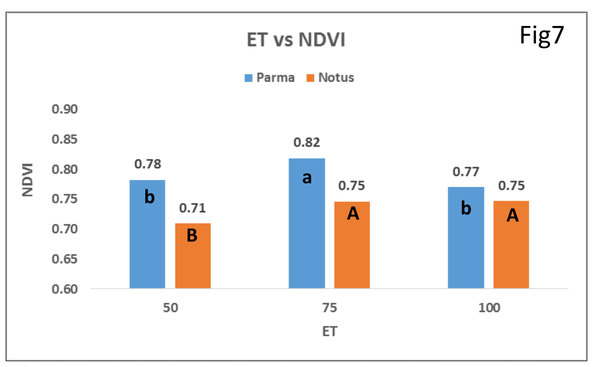


Fig7. Effect of water treatments on spring wheat NDVI, Parma and Notus, ID, 2015.

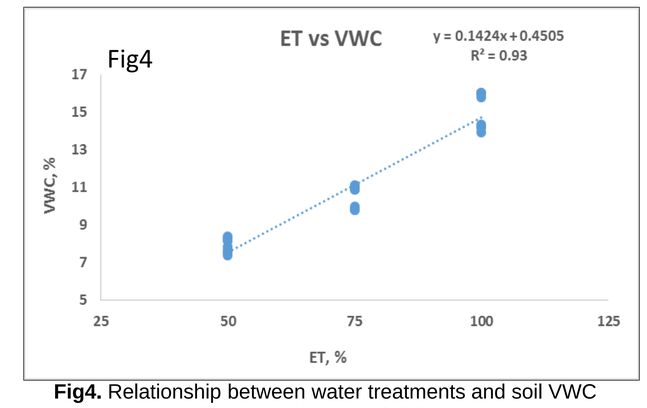


Fig4. Relationship between water treatments and soil VWC Parma and Notus, ID, 2015.

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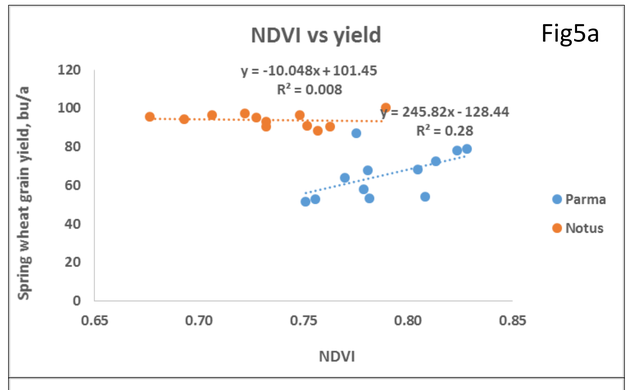

Fig5. Relationship between NDVI and grain yield (5a), SPAD and grain yield (5b), and LAI and grain yield, Parma and Notus, ID, 2015.

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