Precision Sensing for Improved Wheat Production

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OBJECTIVES

To improve wheat production in Idaho by:
- developing sensor-based nitrogen (N) rate calculator, and
- enhancing the variety testing program by utilizing precision agriculture methodologies.

INTRODUCTION

- ✓ Wheat is one of the Idaho's most important crops and one of the main cereals grown in 42 of 44 Idaho counties.
- ✓ Idaho is 5th in the nation in wheat production, with 780,000 acres of winter and 480,000 acres of spring wheat planted in 2014.
- ✓ Nitrogen use efficiency (NUE) is only about 35-40% in most wheat production systems due to temporal and spatial variability.
- ✓ Remote sensors and precision cameras allow for accurate assessment of plant health. Development of sensor-based calculator for making N rate recommendations would help Idaho wheat growers to improve NUE by recommending N based on yield potential.
- ✓ The calculator could be used in-season for 1) "blanket" fertilization - one rate applied to the whole field (works best for smaller fields), or 2) variable-rate fertilization using on-the-go sense and spray units (for larger operations).
- ✓ The sensor-based approach to N fertilization has been shown to deliver over $10 per acre in savings.
- ✓ Precision agriculture – is one of the most substantial markets for the Unmanned Aerial Vehicles (UAVs), aircrafts that can fly without a human operator on-board.
- ✓ Mounted on the UAVs, sensors and cameras enable rapid screening of large numbers of experimental plots to identify crop growth habits that contribute to final yield and quality in a variety of environments.
- ✓ The major challenge in the adoption of UAVs for agriculture is the lack of proof of concept and sound methodologies for incorporating the UAV-based data into crop management decisions.

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PRELIMINARY RESULTS

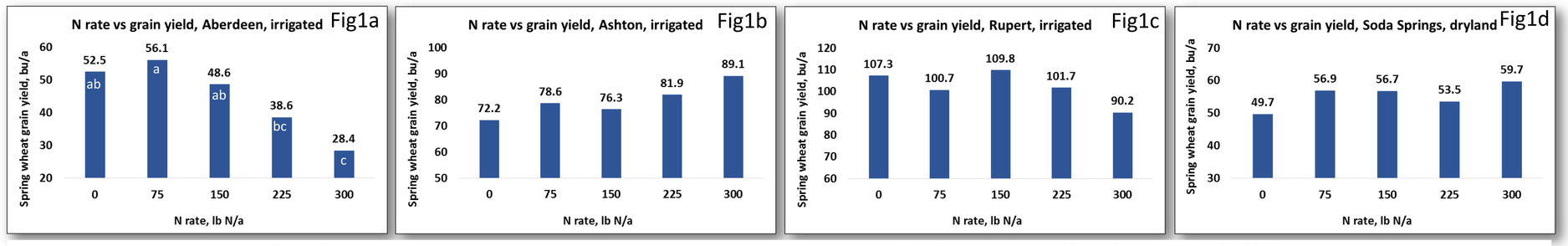


Fig1. Effect of N fertilizer rate on winter wheat grain yield, Aberdeen (1a), Ashton (1b), Rupert (1c), and Soda Springs (1d), ID, 2015.

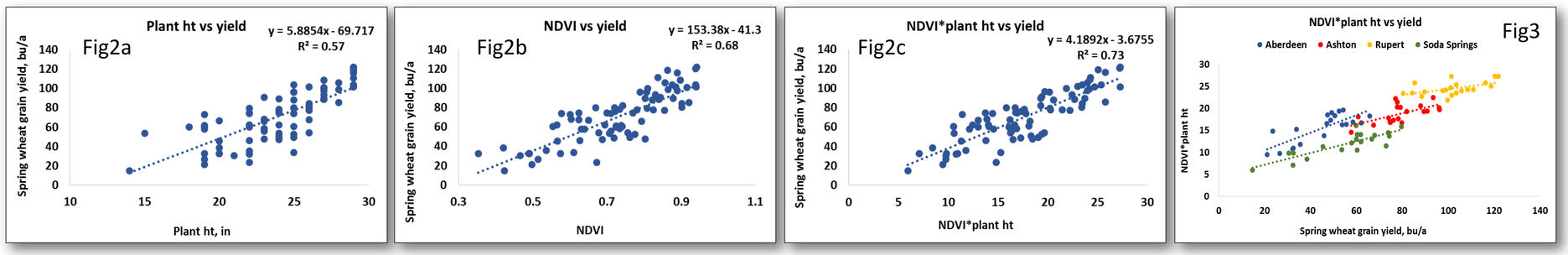
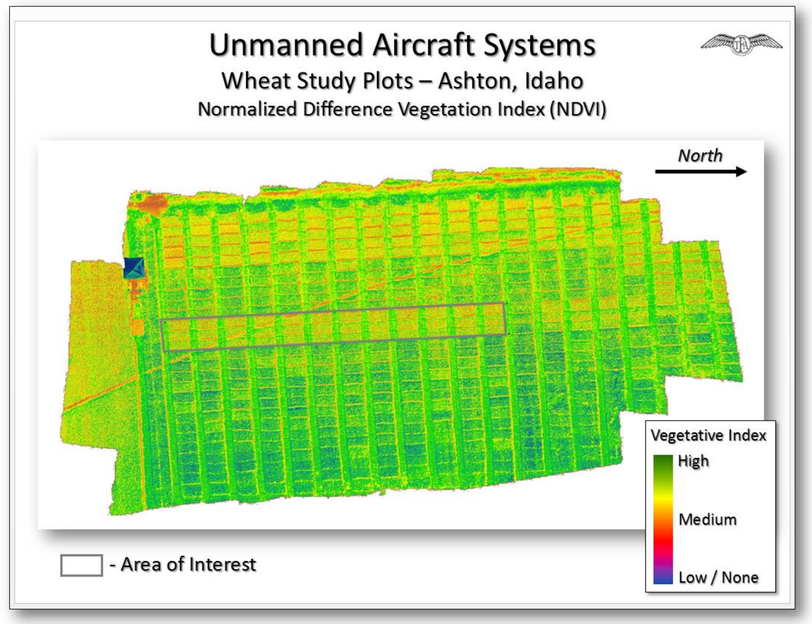


Fig2. Relationship between plant height (2a), NDVI (2b), and NDVI*plant height (2c) on spring wheat grain yield, Aberdeen (1a), Ashton (1b), Rupert (1c), and Soda Springs (1d), ID, 2015.
Fig3. Relationship between NDVI*plant height (2c) on spring wheat grain yield, by experimental location Aberdeen (1a), Ashton (1b), Rupert (1c), and Soda Springs (1d), ID, 2015

MATERIALS AND METHODS

- ✓ Study was conducted at 4 experimental locations in Eastern ID, Aberdeen, Ashton, Rupert, and Soda Springs.
- ✓ At seeding, spring wheat was fertilized with five N (granular urea (46-0-0) rates: 0, 75, 150, 225, and 300 lb N/a.
- ✓ The plots were scanned once per month utilizing 3D Robotics 8X+ (quad-copter) small UAV airframe.
- ✓ The tandem Canon SX260 (one with near infrared image collection capabilities and another with natural light) will be used to collect the wheat reflectance measurements – Normalized Difference Vegetative Index (NDVI).
- ✓ The same day, the experimental plots were scanned with the ground-based handheld GreenSeeker sensor (Trimble Navigation Ltd., Sunnyvale, CA) to calibrate and correlate the UAV-based readings with the ground-based readings.
- ✓ The relationship between NDVI values and harvested grain yield (determined with regression analysis, SAS v9.4 (SAS Institute, Inc., Cary, N.C.)) will be used to develop wheat yield potential prediction model and the N rate calculator.

UAV protocol implemented by Take Flight LLC, Boise/Nampa, Idaho.
- ✓ **Flight Speed:** 5 mph (2.3 m/sec)
- ✓ **Flight Height:** 20, 30, 40, 60, and 100 ft Above Ground Level (AGL)
- ✓ **Battery Time:** Flight times vary with outdoor air temperature, wind velocity, and elevation of plots. Typically10,000mAh batteries can provide 6 minutes of flight.



DISCUSSION

- ✓ Current University of Idaho fertilizer N guidelines for spring wheat: Yield Goal x 2.5 + 40 lb N/a at flowering. The mean yield (averaged across treatments, for 4 sites) achieved in this study was 70 bu/a. According to UI recommendations, the optimum N rate should be 215 lb N/a. Nitrogen fertilizer rate significantly affected winter wheat grain yield at one of four sites (Fig1). Relationship between N rate and grain yield suggested that 75 lb N/a rate is close to optimum for Eastern ID. Study results underline the importance of updating N fertilizer guidelines.
- ✓ Strong linear relationship between plant height and grain yield (Fig2a), GreenSeeker NDVI and grain yield (Fig2b) indicated potential great potential for developing sensor-based N recommendations. GreenSeeker NDVI helped to explain 68% of variation in spring wheat grain yield (Fig2b), combining NDVI and plant height has increased the accuracy of yield prediction was increased to 73% (Fig2c). The relationships between NDVI and grain yield was similar for irrigated and dryland sites (Fig3).
- ✓ Further analysis of spectral reflectance data collected with the camera-equipped UAV is pending. The UAV protocol will be adjusted to ensure best quality imagery.

We are grateful to Idaho Wheat Commission for funding this project. Contact information: Dr. Olga Walsh, University of Idaho, Parma Research & Extension Center; Address: 29603, U of I Lane, Parma, ID 83660; Telephone: (208)722-6701