UAV - Based Scouting for Precision Nitrogen Management in Wheat

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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.

DISCUSSION

- ✓ Grain yields were increased with N fertilizer application, but the differences were not statistically significant (Figure 2).
- ✓ Nitrogen fertilizer application significantly increased grain protein content at all 5 sites.
- ✓ Over 250 flights were completed by Take Flight UAS in 2016.
- ✓ At all locations, except for Aberdeen, a complete data set was obtained at Feekes 5 and Feekes 10 growth stages. At Aberdeen, data was collected at Feekes 10 only.
- ✓ Strong correlation between mid-season NDVI (both ground-based and UAV-derived) and spring wheat grain yield was observed for all 5 locations.
- ✓ 65% of variation in grain protein yield (product of grain yield and grain protein content) was explained by biomass index (NDVI*biomass N content) (Figure 3).
- ✓ Biomass weight (Feekes 5) explained 64% of variation in grain yield (Figure 4). Higher aboveground biomass production was associated with lower grain yields.
- ✓ Strong linear relationship between ground-based GreenSeeker NDVI and aerial UAV-derived NDVI was determined (see example for Parma location, Figure 5). This indicated potential for successful utilization of UAVs for utilizing aerial imagery for crop monitoring.
- ✓ Project will continue in 2017 growing season.

MATERIALS AND METHODS

- ✓Study was conducted at 5 experimental locations in Southern ID: Parma, Aberdeen, Ashton, Rupert, and Soda Springs (Figure 1).
- ✓At seeding, spring wheat was fertilized with five N (granular urea (46-0-0) rates: 0, 84, 168, 252, and 336 kg ha^{-1}.
- ✓The plots were scanned utilizing 3DRobotics8X+(quad-copter) small UAV airframe.
- ✓The tandem CanonSX260 (one with near infrared image collection capabilities and another with natural light) were 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 NavigationLtd., 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, SASv9.4 (SASInstitute,Inc.,Cary,N.C.)) will be used to develop wheat yield potential prediction model and the N rate calculator.

PRELIMINARY RESULTS

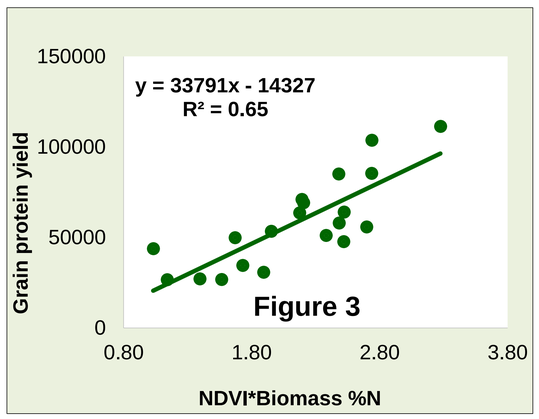


Figure 3. Relationship between spring wheat protein yield and Feekes 5 biomass index, 5 locations in Idaho, 2016.

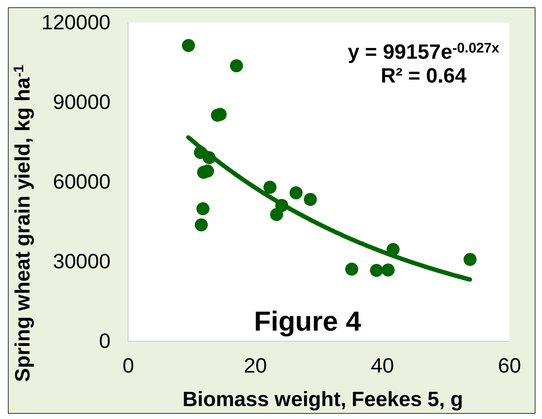


Figure 4. Relationship between spring wheat grain yield and Feekes 5 biomass weight, 5 locations in Idaho, 2016.

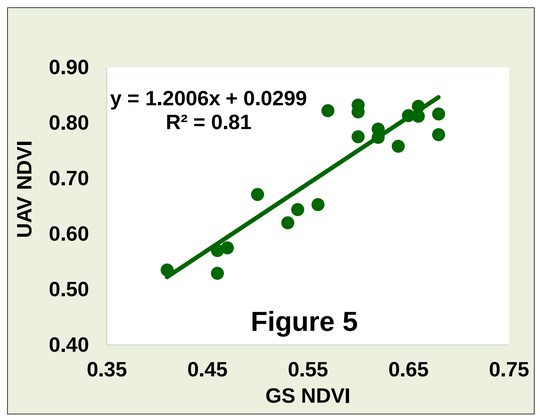


Figure 5. Relationship between GreenSeeker NDVI and UAV-derived NDVI, Feekes 5, Parma, ID.

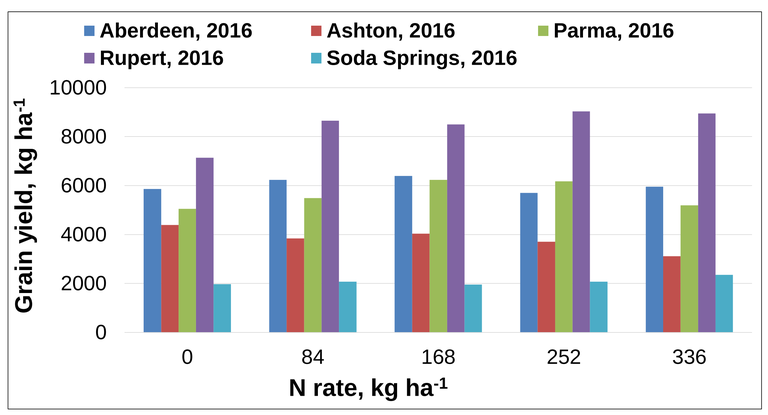
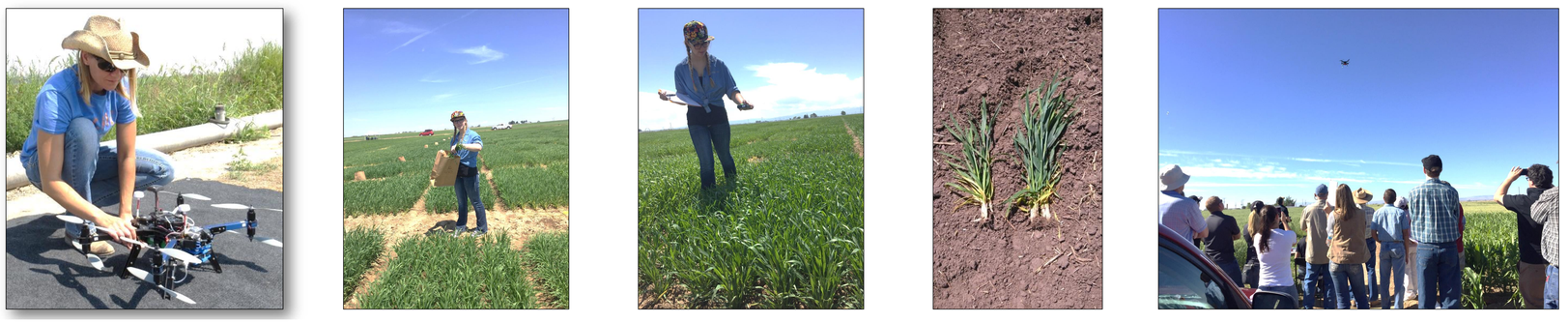
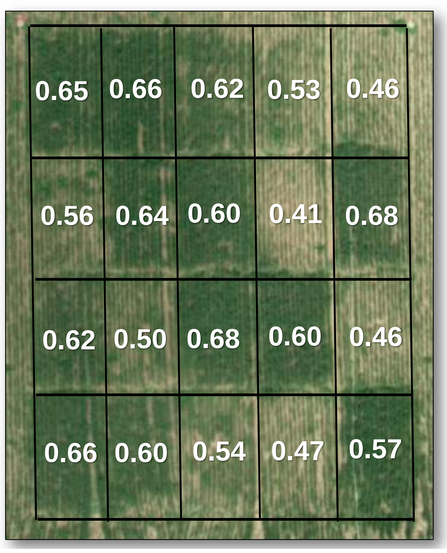


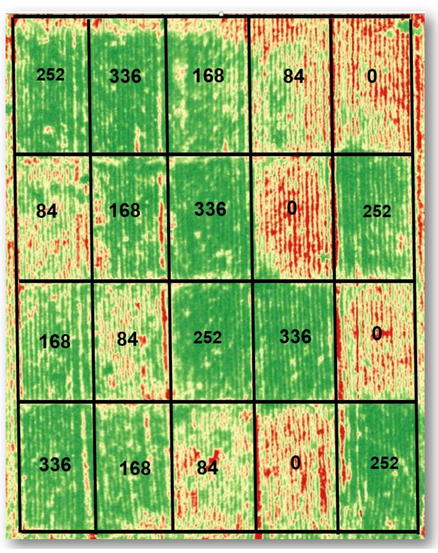
Figure 2. Grain yields as affected by N rate, 5 locations in Idaho, 2016.

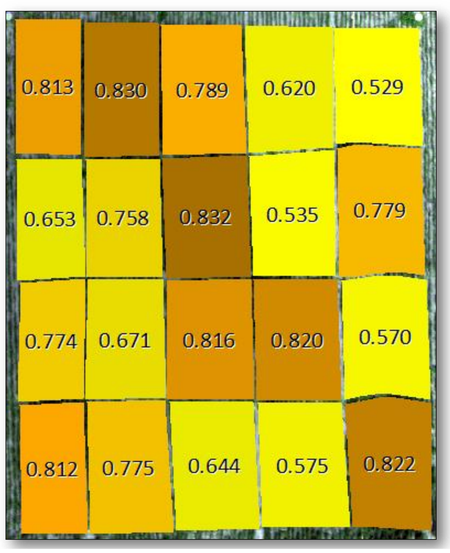


Figures 7. From L to R: Kristin Swoboda (Take Flight UAS, LLC) performs drone calibration prior to flight; Taking wheat biomass samples and measuring NDVI of wheat, Rupert, ID; wheat plant height and biomass production differences between unfertilized check plot and 336 kg ha^{-1} rate, Soda Springs, ID; Drone demonstration at 2016 Cropping Field Day, Parma ID.

Figure 1. Map of experimental locations.







N rate	Yield, kg ha^{-1}	Protein,%
0	5047	8.7
84	5488	9.1
168	6237	11.1
252	6171	11.5
336	5192	12.3

Figure 6 (L to R): For Parma, ID location: UAV-derived RGB image overlaid with ground-based GreenSeeker NDVI (Feekes 5); UAV-derived NDVI map showing N rate treatments; Map showing UAV-derived NDVI (Feekes 5), and Table showing applied N rates, harvested grain yield and grain protein content.

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