RESPONSE OF SPRING WHEAT TO VARIED NITROGEN AND WATER APPLICATIONS

Olga S. Walsh, Jessica A. Torrion, Xi Liang, Jordan R. McClintick, Steven M. Blanscet

University of Idaho, Parma, ID
owalsh@uidaho.edu

ABSTRACT

This study's objectives were to 1) determine the minimum N and water requirements for optimum wheat grain yield and quality; 2) develop a sensor-based system for identifying – and distinguishing between – N and water stress; 3) produce grower recommendations based on the developed model; and 4) improve grower adoption of efficient water and N application practices and enhance grower understanding of sensor-based technologies. This was the first year of the study, project will continue in 2017 growing season. Results suggest that wheat grain yield was mostly influenced by water availability, while grain protein content was mainly affected by N application.

INTRODUCTION

Water and N are two vital 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. Furthermore, N fertilizer is the principal (and the most costly) nutrient input (2), 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. This study is meant to serve as an initial step in developing robust practical sensor-based water and N management methodology for a variety of key crops grown in semi-arid regions.

MATERIALS AND METHODS

This study's objectives were to 1) determine the minimum N and water requirements for optimum wheat grain yield and quality; 2) develop a sensor-based system for identifying – and distinguishing between – N and water stress; 3) produce grower recommendations based on the developed model; and 4) improve grower adoption of efficient water and N application practices and enhance grower understanding of sensor-based technologies. The study was conducted at three experimental locations in Southern Idaho and Northcentral Montana. Plot size: 10 x 4 feet. Split-plot design with 4 replicates was used. We chose wheat varieties most widely grown for each location - SWSW Alturas (Parma, ID), HWSW Dayn (Aberdeen, ID), HRSW Egan (Kalispell, MT). Treatments consisted of 4 irrigation treatments (0, 50, 75, and 100 % of measured evapotranspiration (ET)) - main plots, and 4 N rates (0, 150, 200, and 250 kg ha^{-1}) - randomized within each main plot. Irritation was applied utilizing drip irrigation system with flow meters. The subsurface dripper line was installed at 4 inch depth and spaced 28 inches (Parma); surface-placed drip tape was used at Aberdeen and Kalispell. The amount of required irrigation water was based on the estimated crop water use model by AgriMet. Nitrogen fertilizer

was applied at seeding as granular urea (46-0-0). Throughout the season, plant height, crop reflectance - Normalized Difference Vegetative Index (NDVI) was measured with GreenSeeker hand-held optical sensor, chlorophyll content was estimated with SPAD meter. At harvest, spring wheat grain yield, test weight and grain total N content were determined.

RESULTS AND DISCUSSION

Grain yield was mostly influenced by water availability (**Figures 1**, **3**, and **4**). Grain yields ranged from 59.6 to 115.0 bu ac^{-1} at Parma, from 18.8 to 113.1 bu ac^{-1} at Aberdeen, and from 65.4to 95.8 bu ac^{-1} at Kalispell. At Kalispell, the 100% ET treatments, plus the 75% ET treatment with the highest N rate, were the top yielding. At Aberdeen, the 75% ET with the highest N rate and the 100% ET with the second-highest N rate, produced the highest grain yields. At all three locations, the lowest grain yields were obtained with 0% ET treatments, independent of the N rate applied. For all locations, Pearson correlation test showed that, ET has significantly affected grain yield, and there were no significant differences in yield associated with N rate.

Grain protein content was mainly affected by N application. Grain protein content ranged from 8.9 to 12.0% at Parma, and from 14.5 to 15.9% at Kalispell (**Figure 2**), with Aberdeen protein data pending. These protein values are typical for the varieties grown. For both Parma and Kalispell, Pearson correlation test showed that, N has significantly affected grain protein content, and there were no significant differences in grain protein associated with ET.

At Parma, ET has significantly affected number of spikes per plant, and N rate has significantly affected plant height and NDVI (at Feekes 8), SPAD values, NDVI, and biomass total N content (at Feekes 10), and kernel weight. The study will be repeated in 2016-17 growing season.

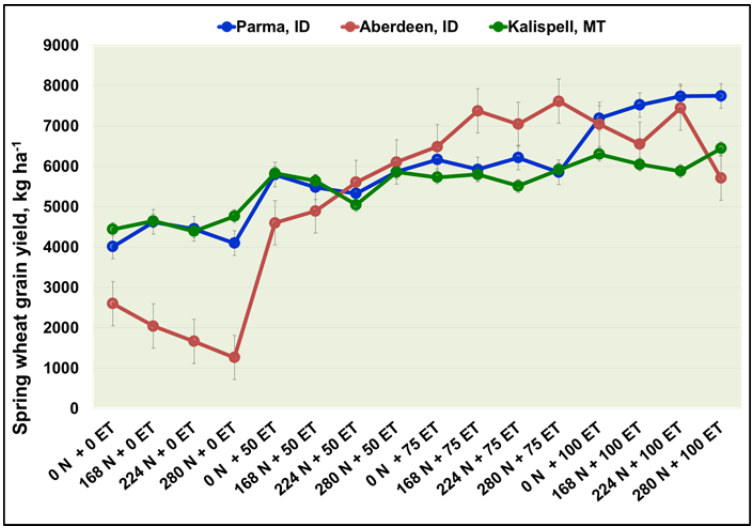

Figure 1. Spring wheat grain yield response to nitrogen and water treatments at three locations, 2016.

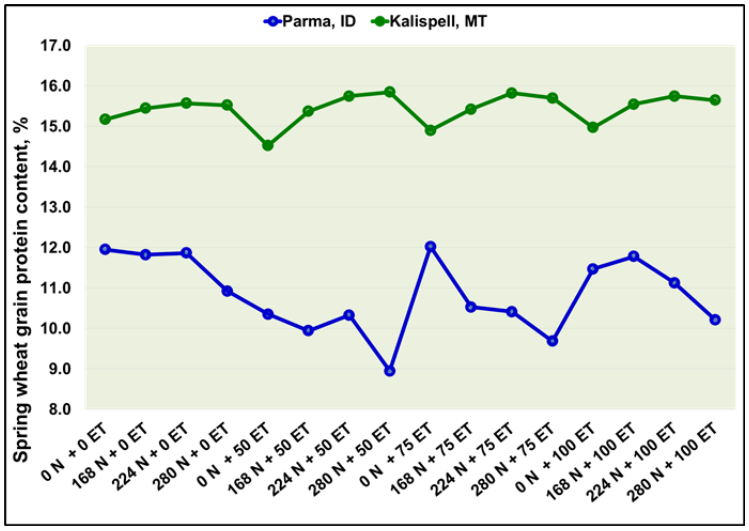

Figure 2. Spring wheat grain yield response to water treatments, Parma, ID and Kalispell, MT, 2016.

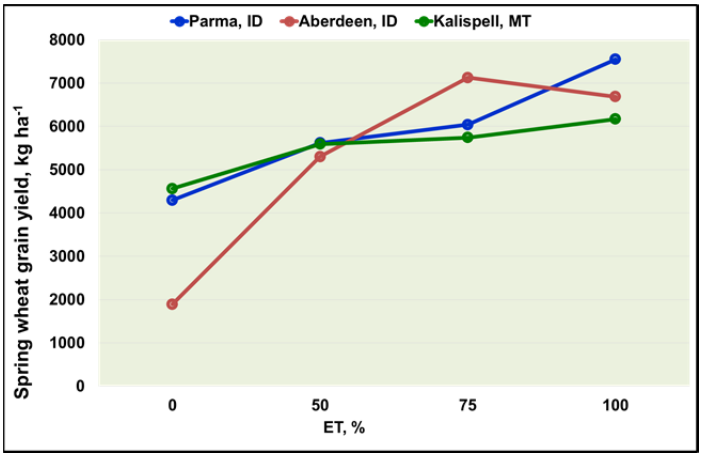

Figure 3. Spring wheat grain yield response to nitrogen and water treatments averaged over the nitrogen treatments at three locations, 2016.

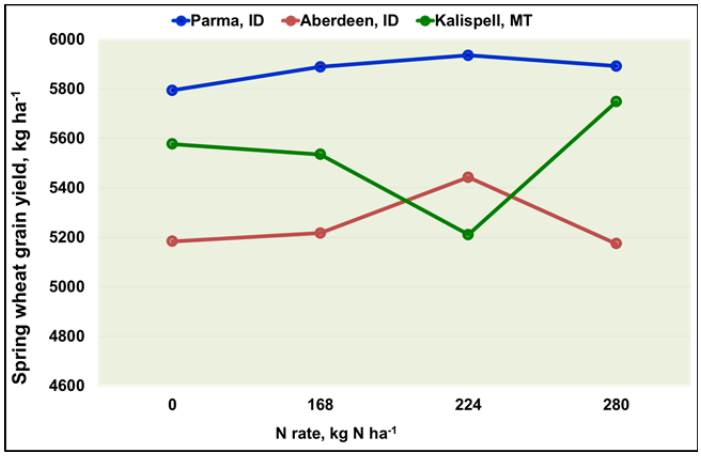

Figure 4. Spring wheat grain yield response to nitrogen treatments averaged over the water treatments at three locations, 2016.

SUMMARY

This was the first year of the study, project will continue in 2017 growing season. Grain yield was mostly influenced by water availability, while grain protein content was mainly affected by N application. Further analysis of grain yield and quality, as well as yield components, and root characteristics will be conducted. Field days will be organized at all three locations to showcase the project and deliver research results to stakeholders.

REFERENCES

Neibling H., and Z. Qureshi, 1997. Scheduling the Last Irrigation on Wheat and Barley. University of Idaho Extension. http://www.uidaho.edu/~/media/Files/Extension/Drought/scheduleIrrigationGrain2.ashx

Cossey D.A., W.E. Thomason, R.W. Mullen, K.J. Wynn, C.W. Woolfolk, G.V. Johnson, and W.R. Raun, 2002. Relationship between ammonium and nitrate in wheat plant tissue and estimated nitrogen loss. Journal of Plant Nutrition, 25(7): 1429–1442. http://www.nue.okstate.edu/Index_Publications/Cossey_PDF.pdf.

Gupta, M.L., and Khosla, R., 2012. Precision nitrogen management and global nitrogen use efficiency. In K. Harald & G. Martha Patricia Butron (Eds.), Proceedings of the 11th International Conference on Precision Agriculture, Indianapolis, USA. https://www.ispag.org/proceeding_module/authors/default/details/abstract_id/1013

Acknowledgement: This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2015-38640-23779 through the Western Sustainable Agriculture Research and Education program under subaward number SW16-031. USDA is an equal opportunity employer and service provider.