Grant Code: New

Title: Water Response and Water Use Efficiency of Spring Wheat Cultivars

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Justification/Rationale:
In southern and eastern Idaho, water availability is the most limiting factor for wheat growth (Yang et al. 2018). In these regions, where rainfall is minimal during the growing season, agricultural production depends on supplemental irrigation from surface water and groundwater sources while the water rights adjustments potentially reduce the amount of available irrigation water. On the other hand, during the recent years, rapid soil moisture depletion has prompted many growers to plant spring wheat earlier, and water companies have been struggling to deliver water in a timely manner (Blaine Jacobson, Idaho Wheat Commission Executive Director).
As a result, producers like to plant older varieties which they are very familiar with, even though they may be substantially lower yielding, may not have the best grain quality and may not perform as well under various biotic and abiotic stresses, including water limitations. This is in part because they know from experience how much water those varieties need and can feel they can better plan water distribution within the growing season. Increased knowledge about the water use efficiency (WUE) of newly released varieties, improving the adoption of these varieties by growers and achieve the best grain yield and quality per unit of water applied is one of key priorities.
In this project, we will consider WUE as the amount of water used to produce a unit of wheat grain and will establish a wide range of deficit irrigation levels to detect varietal differences and make the best irrigation recommendation refined down to varieties. This work will help us to provide Idaho wheat growers with more detailed information on appropriate water management. We will also evaluate the profitability and rate of return on adoption of water use efficient varieties, and, in doing so, will account for the yield and quality specific attributes of each variety. This will enable us to develop a standard evaluation process, where potential new varieties could be tested and rated on relative WUE under different production methods, approaches to cultivation, irrigation and water management practices. This can help producers to make a more informed decisions when choosing new varieties.
Comprehensive economic analysis will also include estimates of profitability and rate of return of using advanced precision ag technologies (UAVs) and the incentives and barriers for adoption for these technologies. The estimation of spatial adoption (based on field-level profitability estimates and associated prerequisites) will allow for aggregation at the county and state levels, and, ultimately, for estimates of changes to production and water volumes at such administrative units.

Hypothesis & Objectives:

1) To assess response of newest University of Idaho varieties, other best-performing wheat varieties, and traditional "check" varieties to deficit irrigation levels, to quantify their WUE and its' pattern throughout the growing season,
2) Extension outreach for growers and crop consultants via extension publications (e.g Water Use Efficiency guide for wheat production) and field demonstrations focused on irrigation water use in wheat production, and precision agriculture methodologies including the use of UAVs for crop monitoring and data collection
3) Training and mentoring of graduate students in wheat production and water management
4) To explore the potential of using ground- and aerial-based (UAVs) data to estimate WUE, yield and quality of these varieties

Procedures/Plan of work:

Field experiments will be established at two locations - Parma R&E Center and Aberdeen R&E Center. The experimental design will be a randomized complete block design (RCBD) with three blocks (replicates) and the treatment design will be a factorial set of three water regimes (100% ET, 75% ET and 50% ET), and six spring wheat varieties: hard white spring (HWS) – UI Platinum, Dayn, and Snow Crest and soft white spring (SWS) – UI Stone, Seahawk, and UI Pettit. Irrigation will be applied using sprinkle irrigation system; accurate records of applied irrigation water amounts for each treatment will be kept throughout the growing season. Individual plot size will be 1.5 x 20 m. A 100% ET will be included to represent non-water-stressed conditions. Daily reference grass-based ET (ET_o) will be calculated using data from the Parma AgriMet weather station. Daily ET_c will be estimated by multiplying ET_o by the wheat crop coefficient (K_c) (Allen et al., 1998). Daily soil moisture depletion will be estimated by subtraction of daily ET_c and addition of any daily rainfall or irrigation, starting from 100% field capacity at planting. Soil moisture sensors (CS616, Campbell Scientific Inc., Logan, UT) will be installed at 30-, 60-, and 90-cm depths to provide in-situ soil moisture depletion estimation as a check with the ET-calculated soil water balance method of depletion (Irmak et al., 2014).

Data collection:

The following data will be collected from the research area (a dedicated 0.2 m^2 section within each plot) at Feekes 5 and Feekes 10 growth stage:

- Plant height (by measuring height of 10 randomly selected plants per plot)
- Biomass production estimate- as Normalized Difference Vegetative Index (NDVI, using Decagon SRS-NDVI Sensor)
- Wet and dried biomass weight (by hand-harvesting all above ground biomass within the 0.2 m^2 area)
- Biomass N content (laboratory analysis)
- Plant height, biomass WUE, N content and final grain yield will be estimated using multispectral camera RedEdge™ M (MicaSense, Seattle, WA) mounted on an Unmanned Aerial Vehicle (UAV) Matrice 100 (DJI, Los Angeles, CA), and PhotoScan cutting-edge image processing software (AgriSoft, St. Petersburg, Russia)

At maturity, the following data will be obtained:

- crop yield (by harvesting the rest of the crop within the strips and extrapolating the yield to kg per ha basis)

- yield components will be determined (test weight, number of spikes per plant, number of seeds per spike, weight of the seeds per plant)
- grain nutrient content (grain will be analyzed for N content)
- wheat grain quality will be assessed: 1) baking quality analysis (mixing time, water absorption, loaf volume, crumb grain score), 2) solvent retention capacity (SRC) will be carried out at the University of Idaho Wheat Quality Lab
- samples could be also provided to other researchers upon request for further analysis
- Profitability and rate of return on adoption of water use efficient varieties will be evaluated

Data analysis:
The response of yield and quality of spring wheat of different varieties to applied treatments will be assessed. Water use efficiency will be calculated by dividing total biomass by total applied water for each treatment. Nitrogen uptake at various water levels will be calculated by multiplying wheat grain yield by wheat grain total N content. Nitrogen use efficiency will be calculated using the difference method (Varvel & Peterson, 1990). Biomass N content data collected mid-season will be used to validate yield potential prediction equation developed from recent studies in Idaho.

Duration: 2 years, plus continuation

Cooperation/Collaboration:
The project will be instrumental in providing valuable data for several programs including plant cropping systems, physiology, food science, and wheat breeding.

Anticipated Benefits, Expected Outcomes and Impacts, and Transfer of Information:
We expect to produce at least 2 professional research publications (one focused on the response of wheat varieties to deficit irrigation, and one – on the use of UAVs for water management in wheat). Other publications are probable depending on projects findings. The results will be shared at the professional meetings of national, regional, and local level. Based on our preliminary research results in Idaho spring wheat varieties, we expect to confirm that substantial irrigation water savings (at least 25%) can be realized by appropriate water use without yield or quality penalties. Preparing the next generation of skilled agricultural researchers to strengthen Idaho agricultural industry is an important task. We will train a M.S. student in agricultural research methodologies, and UAV utilization for in-field assessment of wheat crop status. We will include this project in our regular updates during field days, cropping schools, the newly proposed Canyon County cereal school, and other events. We plan to produce at least 1 extension publication and will post updates in the quarterly Idaho Crops & Soils Newsletter; will include the project in the on-line education including Twitter and Idaho Crops & Soils News Blog. Establishment of our own UAV data collection system will enable us to collect excellent quality data more efficiently.

FY2020

IDAHO WHEAT COMMISSION - BUDGET FORM

Principal Investigator: Sanaz Shafian

Allocated by	Idaho Wheat Commission	during FY 2018	$	-
Allocated by	Idaho Wheat Commission	during FY 2019	$	-

REQUESTED FY2020 SUPPORT:

Budget Categories	(10) Salaries (*staff, post-docs, etc.*)	(12) Temp Help	(11) Fringe	(20) Travel	(30) OE	(70) Graduate Tuition/ Fees	TOTALS
Idaho Wheat Commission	$ 9,000	$ 5,500	$ 4,800	$ 8,100	$ 15,000	$ -	$ 42,400

TOTAL BUDGET REQUEST FOR FY 2020: $ 42,400

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

Budget Categories	*Sanaz Shafian*	*Olga Walsh*	*Xi Liang*	*Patrick Hatzenbuehler*
(10) Salaries	$ -	$ 5,000	$ 4,000	$ -
(12) Temp Help	$ -	$ 2,500	$ 3,000	$ -
(11) Fringe Benefits	$ -	$ 2,483	$ 2,317	$ -
(20) Travel	$ 2,000	$ 3,000	$ 600	$ 2,500
(30) Other Expenses	$ 5,000	$ 5,000	$ 5,000	$ -
(70) Graduate Student Tuition/F	$ -	$ -	$ -	$ -
TOTALS	$ 7,000	$ 17,983	$ 14,917	$ 2,500

Total Sub-budgets $ 42,400

Explanatory Comments:

Fall 2018 Version