

PROJECT NO: New

TITLE: Adopting Deficit Irrigation Practices in Spring Wheat Production in Southern Idaho

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JUSTIFICATION:

Seasonal drought conditions occur frequently in southern Idaho, especially during the summer months (U.S. Drought Monitor. 2015). The high frequency of drought events in this area results from the precipitation distribution, which does not coincide with optimal spring cereal growth and development. Growth early in the season mainly depends on water from snowmelt and rainfall. The critical period of booting and flowering in spring wheat starts from late May or early June. The rainfall during the summer is relatively low, and by that time a large portion of the soil water from snowmelt is depleted by plants in the field. For instance, seasonal water use in spring wheat (April to August) at Aberdeen is approximately 22 inch (Li et al., 2012), but the rainfall during that period averages only 3-4 inch (AgriMet. 2015). In Idaho, 58% of the harvested spring wheat acreage was irrigated in 2012 (USDA NASS, 2013). Furthermore, ground water consumption needs to be reduced by 240,000 acre-feet annually (or 13% reduction) to stop the aquifer's decline in Snake Plain (Magicvalley.com, 2016). Under these circumstances, irrigation should be utilized more efficiently by coordinating more effectively with critical crop growth stages. For instance, full irrigation can be applied during critical reproductive stages (i.e., booting, flowering, and grain-fill), but deficit irrigation is applied at early vegetative growth and maturity (also defined as regulated deficit irrigation) (Du et al., 2010; Kang et al., 2000; Li et al., 2005). The deficit irrigation practices evaluated in this study will indicate appropriate deficit irrigation strategies for spring wheat production associated with local environments (i.e., seasonal precipitation distribution and soil type) for southern Idaho.

OBJECTIVES:

To adopt deficit irrigation practices in spring wheat production:

- 1) To evaluate cultivars for grain yield and WUE under well-watered and deficit-irrigated conditions;
- 2) To evaluate deficit irrigation strategies in spring wheat production, and identify best deficit irrigation practices in different cultivars in southern Idaho.
- 3) To evaluate deficit irrigation effects on wheat end-use quality, including impacts on falling numbers.

PROCEDURES:

Experiments will be conducted at the research station of University of Idaho Aberdeen Research & Extension Center at Aberdeen, ID. The soil is Declo loam, which is a very common agricultural soil in this area. Three spring wheat cultivars (Dayn (hard white), SY Coho (hard red), and Alturas (soft white)) will be planted in plots of 10 by 20 feet. Plots will be maintained under well-watered (100% ET) and four deficit irrigation treatments using sprinkler irrigation systems. Deficit irrigation throughout the season will be applied at 50 and 75% of ET, and regulated deficit irrigation will be applied at 50-100 and 100-50% of ET switched at the booting stage. The experiment will be laid out in a split-plot design with four replicates. Irrigation treatments will be

the main plot, and cultivars will be the split plot. All nutrients will be supplied as needed, following the current University of Idaho guidelines for crop fertilization.

In order to accurately estimate seasonal water use, soil water content will be measured before planting and after harvest. Rainfall and irrigation will be recorded as water inputs, and irrigation will be applied on a weekly basis based on the spring cereal ET from the AgriMet system.

During the growing season, crop physiological measurements will be taken in each plot at specific growth stages (booting, heading, anthesis, and grain-fill) to explain the impact of water deficiencies on crop growth and development. Measurements include biomass, normalized difference vegetation index (NDVI) (GreenSeeker, Trimble Inc. Sunnyvale, CA), leaf area index (LAI) (AccuPAR LP-80 unit, Decagon Devices Inc. Pullman, WA), canopy temperature (Apogee infrared radiometer, Apogee Instruments, Inc. Logan, UT), and photosynthetic rate (LI-COR 6400 portable photosynthesis system, LI-COR Inc. Lincoln, NE).

At harvest, plants will be sub-sampled from each plot by separating leaves, stems, and grain heads, and oven dried at 70°C to determine dry biomass and yield components (i.e., grain number per spike, spike numbers in a 3-ft row, and thousand kernel weight, etc.). Water use efficiency (WUE) will be calculated as grain yield divided by seasonal water use (including soil moisture depletion, irrigation, and rainfall) in each cultivar under different irrigation treatments. Grain quality will be evaluated by measuring grain protein, falling number, and in baking tests. Data will be statistically analyzed using ANOVA, and significance differences between means will be identified from multiple comparisons to identify cultivars and irrigation treatments with high yield, quality, and WUE.

DURATION: 3 years

COOPERATION:

Katherine O'Brien, University of Idaho Wheat Quality Lab, Aberdeen Research & Extension Center, Aberdeen, ID

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER:

Compared with the 100% ET irrigation treatment, 75% ET throughout the season and 50-100% ET are expected to maintain grain yield and increase WUE. Cultivars may differ in grain quality under different irrigation treatments, and the best deficit irrigation strategy may differ among cultivars. Results from this study will provide direction on adopting deficit irrigation in spring wheat production in southern Idaho, and recommendations can be provided on reduced irrigation input to maximize economic return in spring wheat production. Results of this research will be communicated to growers and researchers through cereal schools, newsletters, websites, progress reports, conferences, and refereed journal publications.

LITERATURE REVIEW:

Implementation of deficit irrigation will deliberately impose moderate drought stress on crops throughout the season, such as irrigating at 75% of recommended crop use rates, maintaining soil water content at 50-60% field capacity, or decreasing irrigation frequency (Rowland et al., 2012; Du et al., 2010). Deficit irrigation to induce moderate drought stress has been shown to maintain crop yield and quality and improve WUE (Du et al., 2010; Masoero et al., 2013; Rowland et al., 2012). For instance, peanuts grown under 75% of recommended irrigation rates throughout the season produced similar kernel yield to those grown under full irrigation (Rowland et al., 2012).

In another study, a 26% reduction in water availability did not affect biomass production, chemical composition, and digestibility of forage maize (Masoero et al., 2013). Winter wheat maintained at soil water content of 70% field capacity during the growing season produced relatively high grain yield and WUE (Kang et al., 2002).

Regulated deficit irrigation is an alternative deficit irrigation strategy that imposes water deficits only at selected phenological stages, such as at early vegetative growth and maturity, but full irrigation during critical reproductive stages (Du et al., 2010; Kang et al., 2000; Li et al., 2005). Regulated deficit irrigation has been successfully used to conserve water in many fruit and nut tree species and row crops without yield loss in a variety of environments, and in some cases has been led to increases in yield and WUE (Du et al., 2010; Fereres and Soriano, 2007; Kang et al., 2000; Kang et al., 2002; Rowland et al., 2012; Zhang et al., 2006). For instance, regulated deficit irrigation strategies could produce similar grain yield in winter wheat with 7-25% less water use compared with full irrigation (Du et al., 2010; Kang et al., 2002). Regulated deficit irrigation could reduce shoot growth during vegetative development, contributing to lower water consumption through canopy transpiration, which is particularly beneficial in arid areas (Kang et al., 2000; Zhang et al., 2006).

Citations:

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IDAHO WHEAT COMMISSION - BUDGET FORM

Allocated by Idaho Wheat Commission during FY 2016

Allocated by Idaho Wheat Commission during FY 2017

REQUESTED FY2018 SUPPORT:

	Salary	Temporary Help	Fringe	Travel	OE	Graduate Tuition/Fees	TOTALS
Idaho Wheat Commission	\$ 450	\$ 6,300	\$ 2,761	\$ 500	\$ 8,000	\$ -	18,011

TOTAL BUDGET REQUEST FOR FY 2018: \$ 18,011

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

	<i>Liang</i>	<i>Neibling</i>	<i>Marshall</i>	
Salary	\$ -	\$ -	\$ 450	-
Temporary Help	\$ 3,800	\$ 2,000	\$ 500	-
Fringe Benefits	\$ 1,554	\$ 818	\$ 389	-
Travel	\$ -	\$ 500	\$ -	-
Operating Expenses	\$ 3,500	\$ 3,500	\$ 1,000	-
Graduate Student Tuition/Fees	\$ -	\$ -	\$ -	-
TOTALS	\$ 8,854	\$ 6,818	\$ 2,339	-
Total Sub-budgets				\$ 18,011

Explanatory Comments: (see FY2018 Guidelines for definition)

The first year budget, and it is a little high in operating expenses due to the irrigation system installation. The budget of subsequent years will be lower

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