

Grant Code: NEW

Title: Planting Dates, Seeding Rates, and Available Moisture for Dryland Winter Wheat Yields

Personnel: Jared Spackman, Assistant Professor, UI Aberdeen; Justin Hatch, Caribou County Extension Educator

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Justification/Rationale:

Water is the most limiting factor for dryland winter wheat production in Southeastern Idaho. Its availability affects producer decisions regarding planting date, planting rate, seeding depth, and fertilizer rates¹. Adequate soil moisture is essential for wheat to germinate, explore the soil profile, access and extract soil nutrients, and assimilate carbon through photosynthesis. In Southern Idaho, annual precipitation ranges from 10 to 20 inches, with approximately half occurring from October through March (<https://www.usbr.gov/pn/agrimet/currentdata.html>). Approximately 48% of the annual precipitation occurs from April through June when most wheat growth occurs. Current predictions estimate that southern Idaho will become warmer with drier summers and wetter winters². Dryland winter wheat producers must make the majority of their agronomic management decisions before they know what the environmental conditions will be for the coming growing season. One strategy to help minimize risks and to manage input costs is to develop yield-water relationships that take into account stored soil water just before planting and the expected growing season precipitation³.

Two other management decisions that can affect available soil moisture are planting date and seeding rate. Dryland winter wheat needs to be planted early enough to allow for tiller and crown development and adequate root growth before winter dormancy. The current Southern Idaho dryland wheat production guide recommends planting in mid-August to early September¹. However, because wheat seedlings require 2.3 inches of available water from germination through tillering³, some producers may plant immediately following a rain event as early as July to take advantage of available moisture. Planting too early can produce large plants that deplete soil moisture and expose the crop to potential disease and insect problems¹. In contrast, planting too late can reduce the number of tillers formed and delay the transition from vegetative to reproductive development. Hot temperatures during reproductive development can reduce spikelet and floret numbers and impair kernel set.

Seeding rates that are too low for a given set of environmental conditions produce reduced yields and may have higher weed pressure due to lack of crop competition. In contrast, seeding rates that are too high produce excessive vegetation that exhausts soil moisture, reduces tiller number per plant, may increase disease potential, and negatively impact yield¹. We are proposing two studies that 1) investigate the impact of planting date and seeding rate on soil moisture and dryland grain yield and quality, and 2) investigate the relationship between available soil moisture at the time of planting plus the expected growing season precipitation and dryland wheat grain yield.

Hypotheses and Objectives:

H_{A1}: Early planting dates and high seeding rates will deplete soil moisture and reduce yield relative to August planting events at low to moderate seeding rates.

H_{A2}: The relationship between yield potential and available soil moisture at the time of planting can be estimated and be used for crop planning purposes.

Objective 1: Evaluate the effect of dryland hard red winter wheat planting date and seeding rate on soil moisture availability, nitrogen use efficiency, and grain quality and yield.

Objective 2: Assess the relationship of available water and spring rainfall with dryland winter wheat grain yield.

Procedures/Plan of Work:

Experiment 1: A pseudo dryland field experiment will be conducted at the Aberdeen R&E Center for three growing seasons. The study will be a split-plot design. The main plots will consist of four planting dates occurring the third week of July, August, September, and October and the split plots will be four seeding rates of 300K, 500K, 700K, and 900K seeds per acre replicated four times (64 total plots). Aberdeen annually receives 7.6 inches of precipitation compared to Grace, Ririe, Ashton, Preston, and Tremonton that receive an annual average of 14.4 inches. Three to five inches of irrigation will be supplied before study initiation in May and June to artificially increase soil available moisture to be similar to other southern Idaho dryland sites. Until planting, the field will be chemically fallowed. A composite soil sample will be taken from each replicate at 1-foot increments down to three feet and analyzed for nutrient status. Immediately before each planting event, soil samples will be collected from each main plot at the 0-6, 6-12, 12-24, 24-36, and 36-48" depths and analyzed for gravimetric water content. These soils will be dried, ground, and analyzed for inorganic nitrogen content. In March after the ground thaws and in August after harvest, soil samples will be taken from each plot at the 0-6, 6-12, 12-24, 24-36, and 36-48" depths and analyzed for gravimetric water content and inorganic nitrogen content. The soil bulk density will be used to convert gravimetric water content to volumetric water content. Additional plot measurements include stand count, tiller number, lodging, insect and disease ratings, grain yield, and other yield metrics (test weight, grain protein, etc.). Whole plant tissue nitrogen will be measured from each plot at harvest. The response of the dependent variables to planting date and seeding rate will be assessed using analysis of variance.

Experiment 2: Each year, we plan to collaborate with 7 dryland winter wheat grain producers across southern Idaho. Targeted locations may include Ashton, Ririe, Soda Springs, Grace, Preston, Pocatello Valley, Rockland, and/or Oakley. Soil samples will be collected at three sampling events (fall planting, the following March, and at physiological maturity) from the 0-6, 6-12, 12-24, 24-36, and 36-48" depths from three or four georeferenced locations in each field (28 georeferenced data points annually). Each soil sample will be analyzed for gravimetric water content and bulk density. The post-harvest soil will be composited across the 5 soil sampling depths and analyzed for nitrate plus ammonium N. To estimate yield components, a 5-foot by 5-foot section of grain will be hand-harvested from each georeferenced point by cutting the straw at the soil surface, separating the grain from the straw, and analyzing the grain and straw for total nitrogen content. Post-harvest tissue and soil samples will allow us to evaluate the nitrogen use efficiency of each data point. We will also collect field management information for each georeferenced point (e.g., seeding rate, variety, planting date, seeding depth, field aspect, slope, planting direction, residue cover, fertility rate, soil taxonomy, etc.). Daily precipitation will be

recorded from the NOAA or AGRIMET weather station in the closest proximity to the field. Each collaborating producer will also be provided with a rain gauge to correct for deviations in daily precipitation if needed. The relationship between grain yield and available soil moisture plus precipitation will be calculated using linear regression. The three soil moisture measurement timings will allow us to evaluate available soil moisture at the time of planting, the amount of moisture accumulated in the soil profile over the winter, and how much moisture remains in the soil at harvest.

Duration: Three years (Year 1 of 3)

Cooperation/Collaboration: Dr. Spackman's team is primarily responsible for establishing the Aberdeen R&E research plots and collecting data at participating grower fields. Justin Hatch will assist in collecting soil and plant tissue samples.

Anticipated Benefits, Expected Outcomes and Impacts, and Transfer of Information: The seeding rate by planting date data generated from this study will be used to update the dryland wheat production guide. Additionally, this research will allow us to develop the relationship between dryland wheat grain yield with available soil moisture plus precipitation. This could be a valuable tool to help dryland wheat growers better estimate their potential yield for the coming growing season potentially saving money through improved input management. The results will be shared at professional meetings Extension events (Cereal School, field days), and Extension publications. The raw dataset will be published in a publicly available data repository to ensure the longevity of the dataset and its availability for future research applications.

Literature Review:

The relationship between available water in the soil profile plus spring rainfall and grain yield has been investigated for multiple environments including the Columbia Basin³, southeastern Idaho¹, and Colorado⁴. In the Columbia basin, a 1953-1957 dataset found the relationship was described as $Yield = 5.6X - 22.3$ while a 1993 – 2005 study found the relationship was $Yield = 5.8X - 13.5$, where X is total available water (stored soil water plus growing season precipitation) measured in inches. A southeastern Idaho study (1991 – 1996) found the relationship was $Yield = 5.81X - 13.13$ for hard red winter wheat and $Yield = 9.38X - 41.0$ for soft white winter wheat. These equations indicate that a producer with 5 inches of available soil moisture at planting and 11 inches of precipitation over the growing season could expect grain yield of 67.3, 79.3, 79.8, or 109 bu/ac, respectively. These equations also indicate that 4, 2.3, and 2.3 inches of available water are required just for vegetative growth of hard red winter wheat or 4.4 inches of available water are required for soft white winter wheat, respectively. Each additional inch of available water then increased grain yield by 5.6, 5.8, 5.8, and 9.38 bu/ac, respectively. These equations could be further developed into a decision support tool that accounts for wheat price, production costs, and disease and weed pressure.

1. Robertson, L.D., S.O. Guy, and B.D. Brown. 2004. Southern Idaho Dryland Winteer Wheat Production Guide. : 1–95.
2. Projections, R.C. 2013. Intergov. Panel Clim. Chang.: 1311–1394.
3. Schillinger, W.F., S.E. Schofstoll, and J.R. Alldredge. 2012. WSU Extension EM049E
4. Nielsen, D.C. et al. 2002. Agron. J. 94(5): 962–967. doi: 10.2134/agronj2002.0962.
5. Leggett, G.E. 1959. Washington Agriculture Experiment Station Bulletin 609.

FY2023
COMMODITY COMMISSION BUDGET
Principal Investigator: Jared Spackman

Allocated by _____	during FY2021	\$ -
(Commission/Organization)		
Allocated by _____	during FY2022	\$ -
(Commission/Organization)		

REQUESTED SUPPORT:	Awarded for FY2022	Requested for FY2023
Budget Categories		
(10) Salary (staff, post-docs, et NOTE: Faculty salary/fringe not allowed)	\$ -	\$ 8,723
(12) Temporary Help	\$ -	\$ 1,800
(11) Fringe Benefits	\$ -	\$ 3,714
(20) Travel	\$ -	\$ 3,113
(30) Other Expenses	\$ -	\$ 9,737
(40) Capital Outlay >\$5k	\$ -	\$ -
(45) Capital Outlay <\$5k	\$ -	\$ -
(70) Graduate Student Tuition/Fees	\$ -	\$ -
TOTALS	\$ -	\$ 27,087

TOTAL BUDGET REQUESTED FOR FY2023:	\$ 27,087
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BREAKDOWN FOR MULTIPLE INDEXES:					
Budget Categories	Jared Spackman	Justin Hatch	(Insert Co-PI Name)	(Insert Co-PI Name)	
(10) Salary (staff, post-docs, et	\$ 8,723	\$ -	\$ -	\$ -	\$ -
(12) Temporary Help	\$ 1,800	\$ -	\$ -	\$ -	\$ -
(11) Fringe Benefits	\$ 3,714	\$ -	\$ -	\$ -	\$ -
(20) Travel	\$ 2,613	\$ 500	\$ -	\$ -	\$ -
(30) Other Expenses	\$ 9,737	\$ -	\$ -	\$ -	\$ -
(40) Capital Outlay >\$5k	\$ -	\$ -	\$ -	\$ -	\$ -
(45) Capital Outlay <\$5k	\$ -	\$ -	\$ -	\$ -	\$ -
(70) Graduate Student Tuition/Fees	\$ -	\$ -	\$ -	\$ -	\$ -
TOTALS	\$ 26,587	\$ 500	\$ -	\$ -	\$ -
Total Sub-budgets					\$ 27,087