Grant Code: New

Title: Improving Nitrogen Management in Southeast Idaho Dryland Winter Wheat

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Justification/Rational: Nitrogen (N) fertilizer is one of the key crop inputs in successful wheat production. N is used by wheat in higher quantities than any other applied nutrient and represents a major expense in the crop budget. The amount of N required by the plant varies as growth stage changes throughout the season and having sufficient N is necessary to achieve optimal yield and to ensure protein levels in harvested grain meet market benchmarks. N management in semi-arid dryland winter wheat production systems in Southeast (SE) Idaho is particularly complicated due to year-to-year variability in precipitation. High precipitation in the spring and preceding fall increase wheat production but insufficient N, coupled with partial loss of N from abundant precipitation, can cause low protein levels in wheat, resulting in considerable loss in value at market. In low precipitation years, excess N fertilization represents an unnecessary expense in a year when yields are down.

The current dryland winter wheat N fertilizer recommendations for Idaho and Utah were published in 2004 and 1993, respectively, but were likely based on data from research trials from the 1970s and 80s (Stark et al. 2004; James and Topper 1993). Considering the progress made in wheat genetics and management, coupled with changing soil and climatic conditions, updated research on N fertilizer rates and timings is needed. Furthermore, advanced fertilizer technologies such as controlled- or slow-release N may provide prolonged and sustained soil N through the flowering stage. Data collected across multiple sites and years will allow us to improve the current N recommendations for Idaho dryland wheat growers.

Objectives: The objective of the proposed field study is to evaluate the effects of different combinations of N sources, rates, application timings, and advanced fertilizer technologies on the overall stand, yield, and grain quality of wheat. By conducting the study at multiple locations and years, we hope to be able to determine N recommendations that maximize returns for SE Idaho dryland wheat growers.

Methods/Plan of Work: The study is being conducted on dryland production acres at the Utah State University (USU) Blue Creek Research Farm (located approximately 5 miles south of the Idaho state line) and on five SE Idaho production farms (located near Pocatello Valley, Rockland, Treasureton, Soda Springs, and Ririe). These six locations are representative of the soils, climate, and management practices of dryland wheat growers in SE Idaho. Our original proposal was for three on-farm sites, but additional locations were added in the third year of the project to increase the reliability of the results and the N management recommendations that come from this work. The project, currently in year 2, is proposed to continue for three years in adjacent fields at each location.

At each location, the experimental design is a randomized complete block (RCB) with four replications. Treatment factors are a combination of N source, rate, and application timings and are detailed in Table 1. Nitrogen sources include ammonium nitrate (AN), a polymer coated urea product

(PCU), urea, and urea with urease and nitrification inhibitors (INHIB). The PCU product being used is Environmental Smart Nitrogen or ESN, while the INHIB product is marketed under the trade name Super U. Nitrogen application timings are fall, spring, and 2- and 3-way splits. There are four N rates (0, 50, 75, and 100% of recommended N based on University of Idaho recommendations) for AN, PCU, and INHIB treatments. A high, non-limiting treatment (150% N) and a Grower Standard Practice (GSP) rate are included for comparison. Fall 2021 fertilizer applications were made on Oct 21 (Treasureton), Oct 22 (Pocatello Valley and Rockland), and Nov 17 (Blue Creek). Early spring fertilizer treatments will be applied when weather and soil conditions permit field entry, and the late spring fertilizer treatments will be applied when wheat plants in plots begin to head.

Other than fertility treatments applied, the plot areas are managed uniformly by cooperating farmers according to best management practices for dryland wheat in the region. Chlorophyll measurements will be collected with the Apogee MC-100 chlorophyll meter at heading and again at mid-grainfill. At maturity, data will be collected on tiller density, spike length, plant height, and harvest index. Plots will then be harvested with a small plot combine to measure wheat yield. Subsamples will be collected from each plot to measure grain protein content, test weight, moisture, and kernel weight. Soil fertility can influence end-use quality beyond a simple measure of protein and includes the functional quality of that protein in stability of dough and the quality and quantity of starch. To assess end-use quality, a grain sample (400 g) from a subset of treatments at each location will be submitted to the University of Idaho Aberdeen Wheat Quality Laboratory to test SRC's and/or SDS sedimentation, milling, mixograph and full bake. The subset treatments for additional milling and baking analysis will be selected based on which treatments performed the best and would be of greatest interest to growers. All data will be analyzed with ANOVA using PROC MIXED and means separated using the pdiff option in SAS.

Duration: This is the funding request for year 3 of a 3-year project. Fall treatments will be applied in late 2023, with additional treatments in Spring 2024, followed by data collection and harvest later that summer.

Cooperation/Complementation: This is a cooperative project with the Idaho Wheat Commission, Uof I, and Utah State University, in close collaboration with Sarah Windes at the Uof I Aberdeen Wheat Quality Lab and several southeast Idaho dryland wheat growers. Additional cooperators include Justin Hatch, Sawyer Fonnesbeck, and Bracken Henderson, the local county based Uof I Extension Educators in Caribou, Oneida, and Franklin counties, respectively.

Anticipated Benefits/Expected Outcomes: Predicting wheat N requirements accurately requires an extensive data set. Decades have passed since the last intensive effort to assess N fertilizer needs of dryland wheat in Southeast Idaho. Considering the progress made in genetic traits and management, changing soil and climatic conditions, and improvements in fertilizer technology, the need for re-assessing the N recommendation is warranted. Therefore, the proposed wheat fertility trial will identify the N source, rate, and application timings to optimize grain yield and protein.

Transfer of Information/Technology: Experimental sites will be showcased at field tours, and the Blue Creek site will be highlighted at the major field day hosted there. Dates of events will be advertised through the IWC weekly newsletter and Field Day calendar. Results and updated recommendations will be published in the scientific and Extension literature. Our collaborative efforts will develop relationships between the Idaho Wheat Commission, SE Idaho wheat growers, Uof I, and

Utah State University, that will lead to the potential for additional collaboration in the future.

Literature Review: N fertilization is often considered to be an important factor in yield determination and protein content (Cassman et al. 1992). N needs of winter wheat are dynamic and change throughout the growing season; little is needed during early growth stages, uptake is rapid during tillering, jointing, and heading, then declines between anthesis and maturity (Brown et al. 2005). Due to uneven N uptake, split applications of N fertilizer have the potential to increase grain yield and protein content (Cassman et al. 1992; Graham and Stockton 2019). In semi-arid environments where moisture is limited, the benefits of split applications are more variable because sufficient soil moisture may not be present for late-applied N uptake (Hartman and Nyborg 1998).

References:

1. Brown, B. M. Westcott, N. Christensen, B. Pan, and J. Stark. 2005. Nitrogen management for hard wheat protein enhancement. PNW Extension Publication PNW578. Oregon State University, Corvallis.
2. Cassman, K.G., D.C. Bryant, A.E. Fulton, and L.F. Jackson. 1992. Nitrogen supply effects on partitioning dry matter and nitrogen yields to grain of irrigated wheat. Crop Sci. 32:1251-1258.
3. Graham, C.J., and M. Stocton. 2019. Winter wheat response to fertilizer type and timing in western South Dakota. Agron. J. 111:1433-1440.
4. Hartman, M.D., and M. Nyborg. 1989. Effect of early growing season moisture stress on barley utilization of broadcast-incorporated and deep-banded urea. Can. J. Soil Sci. 69:381-389.
5. James, D.W., and K.F. Topper. 1993. Utah Fertilizer Guide. Utah State University Extension. Available at: https://extension.usu.edu/agwastemanagement/ou-files/nmp_template/Utah_Fertilizer_Guide.pdf
6. Stark, J.C., R.L. Mahler, and T.A. Tindall. 2004. Nutrient management for dryland winter wheat production for Southern Idaho. *In* Southern Idaho Dryland Winter Wheat Production Guide. University of Idaho Extension Bulletin 827. Available at: https://www.extension.uidaho.edu/publishing/pdf/bul/bul0827.pdf

Table 1. N fertilizer treatments for dryland hard red wheat at 5 SE Idaho locations and the USU Blue Creek Research Farm. Nitrogen sources include ammonium nitrate (AN), polymer coated urea (PCU), urea, and urea with urease and nitrification inhibitors (INHIB). Nitrogen rates will be calculated based on University of Idaho recommendations for the yield goal of each individual location.

No.	Treatments	Source	Application Timing
1	Control (no N applied)		
2	GSP (grower standard practice)		
3	Non-limiting (150% N)	AN	3-way split (1/3 each in fall and early and late spring)
4	100%N	AN	Fall
5	100%N	AN	Spring
6	100%N	AN	2-way split (1/3 fall, 2/3 early spring)
7	100%N	AN	2-way split (1/3 fall, 2/3 late spring-Heading)
8	100%N	AN	2-way split (1/2 fall, 1/2 late spring-Heading)
9	100%N	AN	3-way split (1/3 each in fall and early and late spring)
10	50%N	PCU	Fall
11	75%N	PCU	Fall
12	100%N	PCU	Fall

13	50%N	PCU	Spring
14	75%N	PCU	Spring
15	100%N	PCU	Spring
16	50%N	Inhibitors	Fall
17	75%N	Inhibitors	Fall
18	100%N	Inhibitors	Fall
19	50%N	Inhibitors	Spring
20	75%N	Inhibitors	Spring
21	100%N	Inhibitors	Spring
22	100%N	Urea	Fall
23	100%N	Urea	Spring
24	100%N	Urea	2-way split (1/3 fall, 2/3 early spring)

FY2024

COMMODITY COMMISSION BUDGET

Principal Investigator: Jared Spackman

Allocated by	_____ *(Commission/Organization)*	during FY2022	$ -
Allocated by	_____ *(Commission/Organization)*	during FY2023	$ -

REQUESTED SUPPORT: Budget Categories	*Awarded for FY2023*	*Requested for FY2024*
(10) Salary *(staff, post-docs, et NOTE: Faculty salary/fringe not allowed*	$ -	$ 3,735
(12) Temporary Help/IH	$ -	$ 1,220
(11) Fringe Benefits	$ -	$ 2,081
(20) Travel	$ -	$ 3,528
(30) Other Expenses	$ -	$ 1,733
(40) Capital Outlay >$5k	$ -	$ -
(45) Capital Outlay <$5k	$ -	$ -
(70) Graduate Student Tuition/Fees	$ -	$ -
TOTALS	$ -	$ 12,297
TOTAL BUDGET REQUESTED FOR FY2024:		$ 12,297

BREAKDOWN FOR MULTIPLE INDEXES:

Budget Categories	*Jared Spackman*	*(Insert Co-PI Name)*	*(Insert Co-PI Name)*	*(Insert Co-PI Name)*
(10) Salary *(staff, post-docs, et*	$ -	$ -	$ -	$ -
(12) Temporary Help	$ -	$ -	$ -	$ -
(11) Fringe Benefits	$ -	$ -	$ -	$ -
(20) Travel	$ -	$ -	$ -	$ -
(30) Other Expenses	$ -	$ -	$ -	$ -
(40) Capital Outlay >$5k	$ -	$ -	$ -	$ -
(45) Capital Outlay <$5k	$ -	$ -	$ -	$ -
(70) Graduate Student Tuition/Fees	$ -	$ -	$ -	$ -
TOTALS	$ -	$ -	$ -	$ -
			Total Sub-budgets	$ -

Budget Justification

$	3,735	10: Technicians, $19.91, at approximately 188 hours, fertilizer applications, soil and plant tissue sample collection and processing, data analysis, canopy sensing
$	1,220	12: Temporary Help with PERSI benefits, $15, at approximately 81 hours, soil and plant tissue sample collection and processing, harvest, and canopy sensing
$	2,081	**Fringe rates: Staff = 42%; IH= 8.7%; Student= 3.6%* 11: 42% for technician, 42% for temporary help with PERSI benefits *Per Diem= $55/day In-State; Mileage= $0.625/mi*
$	3,528	20: Abdcrdeen fleet vehicle mileage rate is being used to calculated mileage. On Farm Travel: 9 day trips from Aberdeen to Soda Springs, 2 travelers, 200 miles ($1440); 9 day trips from Aberdeen to Ririe, 2 travelers, 200 miles ($1440); Lunch per diem (2 persons x 18 days x $18 ($648)
$	1,733	30: Materials: wire flags, plot stakes, rubber bands, bags, labels ($375.42); 2 soil samples analyzed for complete nutrients at $63/sample ($126); Trailer Rental: 2 trips @ daily rate of $40 ($80); Plot combine rental ($1152)