Grant Code: New

Title: Improving nitrogen application in hard spring wheat with considerations of subsoil residual N and varietal differences

Personnel: Xi Liang, Cropping Systems Agronomist, Aberdeen Research & Extension Center, University of Idaho; Olga S. Walsh, Cropping Systems Agronomist, Parma Research & Extension Center, University of Idaho.

Address: Xi Liang, University of Idaho, Aberdeen Research & Extension Center, Aberdeen, ID 83210; xliang@uidaho.edu

Justification/Rationale: In our experiments conducted in 2016 and 2017, soil residual nitrogen (N) at 0-2 feet prior to planting ranged from 80 to 130 lb N/acre, which allowed for more N application to increase grain yield, according to the University of Idaho guideline for hard spring wheat fertilization under irrigated conditions. However, one hard white and one hard red varieties of spring wheat failed to show increases in grain yield in response to various N rates from residual N (zero N application) to a high N rate of 250 lb/ac (soil residual N plus N application) (Yang et al., 2018). Consistently, aboveground biomass and its N concentration at harvest were not different among the N rates.

These results may suggest that N applications overtime have built up soil N fertility, and residual N from previous crops might be plenty for the following wheat crop. For N fertilization, soil residual N is usually quantified at 0 to 1 or 0 to 2 feet, whereas the root system of wheat can reach as deep as 6 feet. Thus, soil residual N located at 3 to 4 feet can be used by wheat, which is seldom counted towards N input. On the other hand, to improve grain yield, N uptake has been genetically increased through breeding efforts over the last a few decades, so the N requirement for optimal yield in recently developed varieties may not be as high as old varieties. Thus, it is imperative to investigate N requirement for optimal grain yield with considerations of soil residual N from a deep soil profile and differences in N uptake among recently developed varieties.

Hypothesis & Objectives: The lack of response of grain yield to N application could be due to underestimates of soil residual N and/or improved capability of N uptake in recently developed varieties. Thus, the objectives of the current proposal are 1) to develop N fertilizations based on residual soil N in a deeper soil profile (e.g., up to 4 feet instead of 2 feet), and 2) to evaluate varietal differences in N uptake, grain yield and quality in response to different N rates.

Procedures/Plan of Work: Four hard red spring wheat varieties WB9668, WB9411, SY Basalt, and LCS Iron are selected due to their excellent performance in the southcentral and southeast Idaho. In variety trails from 2015 to 2017, WB9668 and WB9411 produced high grain protein (>14%), and SY Basalt and LCS Iron exhibited high yield potential among all the tested varieties of hard red spring wheat (Marshall et al., 2016, 2017, and 2018). The selected varieties will be planted at Aberdeen and Parma Research & Extension Centers in April 2019 in response to four N rates, including zero, low, medium, and high N rates. The experiment will be laid out in a randomized complete block design with four replicates.

The zero N rate represents soil residual N. The low, medium, and high N rates will target 150, 250, and 350 lb/ac, from soil residual N and N fertilizers. The high N rate is based on the University of Idaho guideline and small grain reports for hard spring wheat fertilization under irrigated conditions. In order to accurately estimate soil residual N, soil samples will be collected

every 6 inches from the soil surface up to 4 feet deep before planting and used for measuring total and mineral N (e.g., nitrate and ammonium). At each rate with N application, 70% of N will be applied at tillering and 30% at booting (McDonald and Hooper, 2013). Other nutrients, pesticides, and irrigation will be applied following the current University of Idaho production guidelines.

During the growing season, crop physiological measurements will be taken in each plot at stages of tillering, stem elongation, booting, heading, flowering, grain filling, and maturity to explain the impact of N availability on crop growth and development. Measurements include normalized difference vegetation index (NDVI) (GreenSeeker, Trimble Inc. Sunnyvale, CA) and leaf area index (LAI) (AccuPAR LP-80 unit, Decagon Devices Inc. Pullman, WA). Plant samples will be collected at the same stages from each plot, and the samples will be used for measuring biomass accumulation and N uptake.

At harvest, besides grain yield and test weight, yield components (i.e., grain number per spike, spike numbers in a 3-ft row, and thousand kernel weight, etc.) will also be determined. Grain quality will be evaluated by measuring grain protein, falling number, and in baking tests. Grain yield, yield components, quality, will be statistically analyzed using ANOVA, and significance of means will be established from multiple comparisons to identify varieties and N rates with optimal yield and quality.

Duration: Three years

Cooperation/Collaboration: Katherine O'Brien (end-use quality analysis), Wheat Quality Lab, University of Idaho, Aberdeen Research & Education Center, Aberdeen, ID.

Anticipated Benefits, Expected Outcomes and Impacts and Transfer of Information: Soil residual N in 3-4 feet is seldom quantified and thus rarely considered as N input in wheat production. Including soil residual N from a deep soil profile could reduce N fertilization, and thus reduce production cost. Varieties may differ in grain yield and quality under different N rates. Results from this study will provide references on N fertilization in hard spring wheat production in southern Idaho. Results of this project will be delivered to growers at cereal schools and field days, as well as summarized as extension bulletins and progress reports.

Literature Review: In a study conducted on 474 sites over 2000-2012, the mean soil mineral N (e.g., nitrate and ammonium) prior to planting was 62 lb/ac at 2-4 feet and 38 lb/ac at 3-4 feet, which accounted for 52 and 32% of mineral N in a 4-foot soil profile, respectively (Oliver et al., 2013). Even without the quantification of mineralized N from organic matter during the growing season, such soil residual N at depth is considerable and can be used by wheat crops. For instance, under well-watered conditions, reducing N application from 214 lb/ac to 160 lb/ac (i.e., 25% of reduction) did not cause grain yield loss with soil residual N at 0-3 feet of 60-90 lb /ac (Djumaniyazova et al., 2010). Thus, subsoil N should be considered into N application decisions on soils with no constraints to root growth.

N requirement to achieve optimal grain yield and protein varies among wheat varieties. Over the last five decades, N uptake has increased in parallel with the increase in grain yield through breeding efforts (Sadras and Lawson, 2013). Thus, there is a need to adjust N application to newly developed varieties with higher yield potential.

FY2020

IDAHO WHEAT COMMISSION - BUDGET FORM

Principal Investigator: Xi Liang

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	$ 8,000	$ 6,000	$ 4,634	$ 1,000	$ 8,000	$ -	$ 27,634

TOTAL BUDGET REQUEST FOR FY 2020: $ 27,634

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

Budget Categories	*Xi Liang*	*Olga Walsh*	*(Insert CO-PI Name)*	*(Insert CO-PI Name)*
(10) Salaries	$ 4,000	$ 4,000	$ -	$ -
(12) Temp Help	$ 3,000	$ 3,000	$ -	$ -
(11) Fringe Benefits	$ 2,317	$ 2,317	$ -	$ -
(20) Travel	$ 500	$ 500	$ -	$ -
(30) Other Expenses	$ 4,000	$ 4,000	$ -	$ -
(70) Graduate Student Tuition/F	$ -	$ -	$ -	$ -
TOTALS	$ 13,817	$ 13,817	$ -	$ -

Total Sub-budgets $ 27,634

Explanatory Comments:

Fall 2018 Version