FOR ADMINISTRATIVE USE
Program Area Code Proposal Code

Minnesota Wheat Research and Promotion Council

RESEARCH PROPOSAL GRANT APPLICATION

1. NAME AND ADDRESS OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

Name: SMSU Agronomy (Contract signer is Deb Kerkaert though if that is important/needed)
Address: 1501 State Street, Marshall MN, 56258

2. TITLE OF PROPOSAL
Utilization of wheat fertility trials to enhance educational opportunities for future ag professionals.

3. PRINCIPAL INVESTIGATOR(S)
Adam Alford Ph.D.,
Elliot Vaughan Ph.D.,
Emeka Nwafor Ph.D

4. PI #1 BUSINESS ADDRESS
Southwest Minnesota State University
1501 State Street
Agriculture, Culinology, and Hospitality Management Department
Marshall, MN, 56258

5. PROPOSED PROJECT DATES (Jan 1 – Dec 31)
Jan 1 – November 15

Note: Annual Research Reports are Due November 15th

6. TOTAL PROJECT COST
$12,000

7. PI #1 PHONE NO.
479-879-2736

8. RESEARCH OBJECTIVES: (List objectives to be accomplished by research grant)

Objective 1: Demonstrate how varying rates of N fertilizer (soil and foliar) impact wheat growth rates, canopy development (quantified via drone photography), final yield, and the overall protein content of the grain for educational purposes.

Objective 2: Familiarize SMSU agriculture students (along with the intern hired to conduct this work) with wheat production practices and provide hands-on learning opportunities and data for the SMSU agriculture curriculum using the wheat plots this project funds.

Attach a 2-page detailed discussion of importance of the proposal to wheat profitability; how study complements previous research in area; procedures to be used; and competency of the research group in achieving research objectives. (Please keep the proposal concise, only 2 pages will be provided reviewers).

Signature Adam Alford

Date
12/27/22

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RESEARCH PROJECT PROPOSAL
(2-pages maximum)

Abstract

This project aims to provide educational opportunities to undergraduate agriculture majors (and other majors!) via utilization of a research plot field experiment. **>90% of the agriculture students at SMSU have no familiarity with wheat as a crop and this project aims to provide a hands-on learning opportunity to rectify this**. This project will look at how varying rates of N fertilizer, as well as additional foliar applications of N, impact wheat growth rates + canopy development (quantified via drone photography), and the overall protein content of the grain. **After input from the MNWR&PC we will also compare a high yielding/low protein variety to a high protein/low yielding wheat variety as a single additional treatment**. Data from field plots, as well as the field plots themselves, will then be used in at least 5 agronomy classes in order to provide hands-on and visual learning opportunities to the established lesson plans and promote student familiarity with the wheat crop.

Describe the background for your proposed project and the importance of this project to the profitability of wheat production in MN

The SMSU agriculture department has several major areas of study including ag business, agronomy, and ag education. SMSU also has ~50 acres of crop land donated by a local alumni and farmer which we routinely use for hands-on student learning and is managed/maintained by SMSU Agronomy. While the research farm is primarily used throughout the school year by agriculture majors as a part of their coursework, additional majors (Biology, Environmental science, Business, and Culinology/Food Science) have been increasingly utilizing the research plots for coursework. This multi-major use of the research plots is great as it allows SMSU agronomy to introduce all types of students to agricultural practices and what goes into research.

My primary responsibility at SMSU is that of an educator, and depending on the student make-up of the agronomy courses I teach, I estimate ~33% of my students each semester actively farm, with another ~33% having some sort of close familial connection to farming (such as occasionally helping out during planting or harvest). The last ~33% are interested in agriculture for its career opportunities and job prospects. With my farming and farming-adjacent students, I have found that many cannot communicate the **why** of whatever practice they are conducting in their field. Said another way, they often know how to operate the machinery, but can't communicate the reason as to why they perform one management practice over another. The proposed research methods are heavy on visual and hands-on learning opportunities, and while somewhat obtuse, one of the main objectives of this project is to help students put their own words to management practices either performed or observed.

The purpose of this grant is to provide experiential hands-on and visual learning opportunities for the agriculture, biology, and environmental science students at SMSU. We will achieve this by planting, and maintaining, wheat at differing N rates at the SMSU research plots during the summer for fall and spring classes and will **target student labor** to achieve these objectives. The summer plot work will focus on demonstrating how nitrogen rates can be managed to reduce lodging risk, increase yields, and improve wheat protein quality. Additionally, these plots will also be used to demonstrate various other aspects of wheat production, such as wheat's ability to suppress weeds (which will be assessed with drone imagery and ImageJ photo analysis), and how a wheat rotation can improve soil health, in particular effects on soil organic matter, soil respiration, and soil moisture.

Research methods

In order to investigate and provide data on the role of N-rates on canopy space and development in hard red spring wheat, varying rates of N (90, 120, and 150 lbs/ac) will be applied in relation to soil test values resultant from a composite soil test taken prior to planting. Two additional treatments will also be planted at 90 and 120 lbs N/ac rate, but will receive an additional 30 lbs N/ac via foliar application once anthesis has been reached. These foliar treatments will be used to demonstrate how foliar applications can be used to improve protein content and will be quantified in collaboration with the Agricultural Utilization Research Institute (AURI) at the Marshall location. Finally, after input from the MN wheat research and promotion council we will also include a single higher yielding/lower protein variety to be fertilized at the 120 lbs/ac level. All other varieties will be higher protein/lower yielding. Variety selection will depend on seed availability and suggestions from our local seed dealer. All 6 experimental treatments will receive 23 lbs/ac of P and 30 lbs/ac of K. Fertilizers will be shallowly incorporated with a culti-tiller prior to planting to reduce any fertilizer injury

to wheat seeds.

Each of these six experimental treatments will be planted, and analyzed with a plot size of at least 40 rows (6" row spacing), 60 feet long each, with a targeted planting population of ~1.3 million plants per acre. Plots will be replicated a minimum of four times in a randomized complete block design. Wheat will be combine harvested and weighed with a weigh wagon in late summer. Separate ANOVA models will be constructed for various dependent variables including but not limited to yield, leaf chlorophyll content (measured via chlorophyll meter), and canopy development (measured via drone photography + ImageJ software). Relevant predictors for each statistical model will include fertility treatment and block. Significant ANOVA results will be further analyzed with a Tukey posthoc to determine significant differences between treatments. SMSU owns all farm equipment needed to conduct this research.

Several soil health parameters will be collected before, during and after the growing season. Particular focus will be to parameters related to soil organic matter, including loss on ignition, soil carbon, soil nitrogen, and soil respiration (a measure of plant root and microbial activity). Soil respiration and soil moisture will be measured using sensors constructed and already tested at these field plots. These measurements will be compared across the five wheat treatments as well as to other existing crop rotations on the property (primarily corn and soy).

Timeline for completion

Site/soil prep/fertilization and planting will take place between April 1st- May 10th weather permitting. Foliar treatments will be applied at flowering. Harvest will occur in late July/early Aug, and the final research report including statistical analyses will be turned in by the November due date.

Outreach plan

The grant is centered on student education, and the preliminary results will be shared with the local farming community during the annual SMSU agronomy field day. This event will be a great opportunity to demonstrate how up and coming drone tech can be used in a field setting. As this event is held in July, the project will be ongoing in the 2023 summer, but any preliminary results will be shared, and a tour of the research plot will be given. Final results from this project will be presented as a poster at the summer 2024 field day. The SMSU field day has averaged an attendance of ~75-80 people over the past three years, and has been reported on in the local newspaper all three years.

Additionally, in the 2022-23 academic year, the SMSU research plots, received 50-75 unique undergraduate students, which is ~1/20th of the fulltime undergraduate SMSU student body. This demonstrates that the plots can be used to help augment/enhance student learning for ag focused students, and at the least, help introduce non-ag students to agriculture. This brief introduction for the non-ag students may be superficial at first, but it can help lead to a greater understanding of what types of jobs are involved in modern farming.

This project will synergize the growing popularity of drones with hands-on student learning needs, and provide the images and data for future assignments in the agronomy courses within the agronomy department. Data generated from the field plots will be used to provide hands on learning experiences and data sets to at least 5 different agriculture courses. A single example of how the data and field plot could be utilized has been provided for each class below:

AGRO 132 Crop Production + Lab (Where the effect of fertility on yield will be used for a lab)
AGRO 212 Grain and Forage Crop Management (Where the weed suppressive ability and soil quality aspects of wheat will be demonstrated)
AGRO 332 Crop Quality and Traits (Where wheat protein content will be demonstrated with samples and chem analysis)
AGRO 341 Principles of Pest Management + Lab (Where various wheat pests will be shown, IDed, and collected)
AGRO 454 Experimental Design in Agriculture + Lab (Where statistical data collected from this project will be analyzed)

List other current, pending, or planned funding sources and submissions for this project: None for this project.

Research group (other collaborators not listed as PIs): Ben Swanson at AURI and/or depending on availability. Kirsten Brichler M.S. adjunct professor at SMSU.

Relationship to past projects and research conducted by you or others in the region:
Similar projects which utilized drone imagery to capture canopy development as a function of fertility treatment have been conducted at SMSU in corn and soy. As such we have an established working operating procedure for the drone portion of this project.

Minnesota Wheat Research and Promotion Council

RESEARCH PROJECT PROPOSAL BUDGET

Project Title: Utilization of wheat fertility trials to enhance educational opportunities for future ag professionals.

Principal Investigator(s) / Project Director(s) Adam Alford Ph.D., Elliot Vaughan Ph.D., Emeka Nwafor Ph.D	Funds Requested For Year 1 (2022)	Year 2 (2023)	Year 3 (2024)
A. Salaries and Wages	$6,750	$	$
1. Co-principal Investigator(s)	$1,250		
2. Senior Associates	$500		
3. Research Associates – Post Doctorate			
4. Other Professionals			
5. Graduate Students			
6. Prebaccalaureate Students	$5,000		
7. Secretarial - Clerical			
8. Technical, Shop and Other			
B. Fringe Benefits	$500		
C. Consulting and Professional Services	$1750		
D. Supplies and Services	$2750		
E. Travel			
F. Sub-Contracts			
G. Repairs & Maintenance			
H. Rentals & Lease			
I. Other Expenses	$250		
TOTAL AMOUNT OF THIS REQUEST (per year)	**$ 12,000**	**$**	**$**

Budget Justification:
$1,250 (A1) for PI salary to maintain the plot, oversee the student worker, and conduct statistical analyses. While the student will be doing most of the field work, they usually do it in concert with the PI.

$500 (A2) for occasional adjunct labor. I have found that at some point in the summer both the PI and student intern will be unavailable for work simultaneously, or we need an extra hand during high labor field operations (fertilizing, planting, beating the rain, etc.). This budgetary item will ensure funds are there for a SMSU adjunct to cover that work.

$5,000 (A6) for student intern for 300 hours of work @ $17/hour and
$500 (B) for student intern overhead/insurance @ 10% of pay rate

$2,750 (D) for herbicide, fertilizers, pesticides, high quality wheat seed, incidentals (fuel, in-field equipment repair, plot stakes, sensor repair, etc.)

$1250 (C) for soil testing to target fertility rates pre plant and throughout the season. An initial composite preplant soil test will be conducted to ensure we achieve our fertility goals, and a second per treatment composite sample will be conducted later in the season to see how fertility levels change between treatments throughout the season. Money will also be used to fund tests that provide info on soil parameters related to soil organic matter, including loss on ignition, soil carbon, soil nitrogen, and soil respiration (a measure of plant root and microbial activity).

$500 (C) for wheat quality (protein) testing conducted with AURI. Money will cover lab hours as well as any shipping costs samples incur if they need to be sent to other locations depending on machine/instrument availability.

$250 (I) for signage and handouts for both field days which will also include large plot markers/signs.