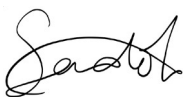


Minnesota Wheat Research and Promotion Council

RESEARCH PROPOSAL GRANT

APPLICATION

1. NAME AND ADDRESS OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE		
Name: Regents of the University of Minnesota Address: Sponsored Projects Administration 454 McNamara Alumni Center, 200 Oak Street SE Minneapolis, MN 55455-2070		
2. TITLE OF PROPOSAL		
Breeding to boost seed-filling and increase Minnesota wheat yields		
3. PRINCIPAL INVESTIGATOR(S)	4. PI #1 BUSINESS ADDRESS	
Walid Sadok	Dept. of Agronomy & Plant Genetics	
PI# 2 Name: James A. Anderson	411 Borlaug Hall	
PI# 3 Name:	1991 Upper Buford Circle	
	St. Paul, MN 55108	
5. PROPOSED PROJECT DATES (calendar years)	6. TOTAL PROJECT COST	7. PI #1 PHONE NO.
1/1/25-12/31/25 Note: Research Reports are Due November 15th of Each Year	\$53,531	612-625-8291
8. RESEARCH OBJECTIVES: (List objectives to be accomplished by research grant)		
<p>The specific objective of this program is to boost the rate of seed-fill to increase MN wheat yields, by increasing flag leaf photosynthesis. This is based on theoretical evidence from our team showing that rising flag leaf photosynthesis during seed-fill could increase current wheat yields by 15% or more. In the first year of this project, we have assembled a population of cultivars that expressed high diversity in this trait. Importantly, we found that the doubling of wheat yields achieved by the U of MN wheat breeding program from 1915 to 2022 has been in part driven by increases in flag leaf photosynthesis.</p> <p>This year's objectives are to 1) confirm this promising finding in two independent locations and 2) develop a high-volume screening method for detecting this trait in large breeding populations. If successful, this project will likely fast-track MN wheat yield increases and therefore boost farmer's economic returns.</p>		
Signature Of Principal Investigator	Date	Phone Number
	November 19, 2024	612-625-8291
Signature Of Authorized Representative	Title	Date
Kelsey Grachek <small>Digitally signed by Kelsey Grachek Date: 2024.11.21 08:12:49 -08'00'</small>	Senior Grants Officer	11/21/2024
Address Of Authorized Representative		Phone Number
Kelsey Grachek, Senior Grants Officer, Office of Sponsored Projects Administration 450 McNamara Alumni Center, 200 Oak Street SE, Minneapolis, MN 55455-2070		612-624-5599

Minnesota Wheat Research and Promotion Council
FULL RESEARCH PROPOSAL TEMPLATE
For Crop Year 2025

(Maximum Two Pages, Plus Itemized Budget)

Please Note: To speed up and streamline the granting process, we now require full proposals be submitted by 1:00 PM CST on November 22, 2024. You will need to include an itemized budget with your proposal that has been approved by your organization's accounting and/or sponsored programs department.

Project Title: **Breeding to boost seed-filling and increase Minnesota wheat yields**

Principle Investigator (PI): Walid Sadok, Associate Professor

Organization: University of Minnesota

Email address and Primary phone number: msadok@umn.edu | 612-625-8291

Additional Investigator(s): James A Anderson

Organization: University of Minnesota

Email address and Primary phone number: ander319@umn.edu | 612-625-9763

Project Period: January 1, 2025 – December 31, 2025.

Estimated cost: \$53,531.

Abstract

The seed-fill period is the most critical window for the productivity of grain crops. This is because during this period, the plant starts to 'digest' itself and inject nitrogen, starch and other compounds into the developing grain. We hypothesized that boosting the flag leaf ability for capturing energy from the sun (a process called photosynthesis) and using it to fuel the movement of carbon and nitrogen into the developing seed could increase spring wheat yields. Our theoretical estimation indicated that boosting flag leaf photosynthesis, could increase wheat yields by 15% or more. In the first year of this project, we confirmed that yield increases achieved by the U of MN wheat breeding program from 1915 to 2022 have been in part driven by increases in flag leaf photosynthesis. Our goal is to confirm this promising finding in 2 locations and develop a high-volume screening method for detecting this trait in large populations. If successful, this project will likely enable higher rates of MN wheat yield increases and directly benefit farmer's economic returns.

Describe the background for your proposed project and the importance of this project to the profitability of wheat production in MN: Seed-fill is the 'money-making' window for wheat growers. During this critical phase of the crop's growth, the wheat plant needs energy to fill the developing grain with nitrogen, starch and other nutritional factors. In a study that we have recently submitted to a peer-reviewed international journal, we found that increases in flag leaf photosynthesis, that is the ability of the plant to use the sun's energy during seed-fill was likely a major contributor to global wheat yield gains. However, this hypothesis was never tested in MN or even US-based wheat. In the first year of this project, we screened 30 varieties released from 1915 to 2022 by the U of MN wheat breeding program for their levels of seed-fill photosynthesis and grain yield in field trial located in Saint Paul. We found that the U of MN wheat breeding program has succeeded in increasing the yield potential of MN-adapted spring wheat varieties consistently from 1915 to 2022, at an average rate of 0.26 bu/ac/yr. More importantly, we found that this rate of yield increase was positively correlated with increases in flag leaf photosynthesis during seed-fill. This increase in photosynthesis was also associated with higher rates of nitrogen remobilization to the seed, confirming our hypothesis. This promising result indicates that pursuing directly this trait as a breeding target is likely to fast-track yield increases. Based on this promising result, our goal for the second year is to replicate this trial in two locations to confirm these findings and develop a high-throughput screening method for high seed-fill photosynthesis to support the breeding program.

Research methods:

In this second year, we will replicate the trial in St Paul while adding Crookston as a second location. This is needed to ensure that our results are robust and not depending on artefactual findings that emerge in one

location and in one single year. Genotypes will consist of the same 30 cultivars released between 1915 and 2022 including 4 checks (Shelly, Linkert, MN-Torgy, MN-Rothsay) which will be planted in yield plots (approx. 4 ft. X 9 ft.), using a randomized complete block design with three replications. Plots will be managed per the typical management practices in the two locations with fungicide application around the flag leaf stage. Flag leaf photosynthesis measurements will be conducted at solar noon on sunny days using a portable photosynthesis system (LiCOR 6800). This sophisticated system will make it possible to measure the flag leaf's photosynthesis in the field while controlling for environmental fluctuations such as light, windspeed, temperature and humidity. Due to the time-consuming nature of these measurements, we will dedicate three LiCOR 6800 machines to conduct these measurements (3 users simultaneously). These will take place several times during the season, starting at the flowering, milk, soft dough and hard dough stages.

In parallel to these photosynthesis measurements, we will track leaf nitrogen (N) status at these phenological stages to quantify the rate of N remobilization to the seed. Additionally, we will measure leaf greenness both proximally and remotely. The proximal measurement consists of using a small hand-held chlorophyll meter that clamps on the leaf to measure its greenness. The remote-sensing approach will rely on scanning the entire canopy using an RGB (Red-Green-Blue) camera mounted on an unmanned aerial system (UAS; Inspire 2, DJI). These greenness measurements represent indirect estimates of photosynthesis and N levels, (and therefore are less precise) but are much faster to perform. By using them, our goal is to evaluate their potential for higher-throughput screening of seed-fill photosynthesis. This will be the case if a significant correlation between flag leaf photosynthesis during seed-fill and canopy greenness is identified.

Outline the timeline for completion: January-March 2025: Assembling genotypes for the study, preparing equipment. April-August 2025: planting, plant husbandry and collecting field data. September-December 2025: analyzing the data and reporting.

What methods, if any, will be used to disseminate your research findings out to the greater public, beyond the final report due to Minnesota Wheat Research and Promotion Council: We are planning on disseminating these findings to growers at the winter Prairie Grains Conference. At the end of the project, we will also communicate updates on our research online on the U of MN extension portal and through ad hoc meetings and field days to growers and other agriculture professionals. Our results will be disseminated more broadly to the scientific community through presentations in major conferences such as the Crop Science Society of America meetings. We expect this research will generate publishable results targeting scientific journals with a large and diverse readership such as Crop Science or Agronomy Journal. We have recently submitted the analysis that generated this proposal to a peer-reviewed international journal, where MWR&PC support is acknowledged.

List potential collaborators or co-investigators you may consider inviting to participate: As of this writing the key collaborator identified is the co-PI on this project who is wheat breeder Jim Anderson (Department of Agronomy & Plant Genetics, U of MN).

Estimate the budget requirements: 0.3 FTE Salary and fringe (\$27,520) to support a graduate research assistant | 0.125 FTE Salary and fringe (\$9094) to support a research technician | 1 month summer salary and fringe for PI Sadok who will conduct photosynthesis measurements with technician and RA (14,917). \$2,000 will be needed to perform N quantification of the flag leaf. Total cost is \$53,531.

List sources and amounts of additional funding for this project and indicate if they have committed to provide funding or if you have requested funding: Drs. Anderson and Sadok have received funding for a graduate student from a federal grant proposal (USDA). The student will participate and provide in-kind support for conducting drone-based measurements. Additional in-kind will be provided by the Sadok lab through funding from MAES for supplies and maintenance costs of the three photosynthesis systems and the unmanned aerial system and by the Anderson lab through funding from USWBSI to support for growing/harvesting the trial .

Submit full proposal (max. 2 pages) and itemized budget to bsorenson@mnwheat.com by 1:00 PM, 11/22/24

Minnesota Wheat Research and Promotion Council

RESEARCH PROJECT PROPOSAL BUDGET

Project Title: Breeding to boost seed-filling and increase Minnesota wheat yields	
Principal Investigator(s) / Project Director(s) Walid Sadok and James Anderson	<u>Funds Requested</u>
A. Salaries and Wages	\$ 35,748
1. Faculty	\$ 10,920
2. Senior Associates	
3. Research Associates – Post Doctorate	
4. Other Professionals	\$ 6,874
5. Graduate Students	\$ 17,945
6. Prebaccalaureate Students	
7. Secretarial - Clerical	
8. Technical, Shop and Other	
B. Fringe Benefits	\$ 15,783
C. Consulting and Professional Services	
D. Equipment	
E. Travel	
F. Sub-Contracts	
G. Repairs & Maintenance	
H. Rentals & Lease	
I. Other Expenses	\$ 2,000
TOTAL AMOUNT OF THIS REQUEST	\$ 53,531