

Grant Code: AP5490

Title: Developing Soft White Winter Wheat for Idaho

Personnel: Yueguang Wang, and Randy Lawrence, Department of Plant Sciences, UI.

Address: Yueguang Wang, Department of Plant Sciences, University of Idaho, 875 Perimeter Drive, Moscow, ID 83844-2333; 208-885-9110; ywang@uidaho.edu

Justification/Rationale:

Wheat is the primary grain used in U.S. grain products — approximately three-quarters of all U.S. grain products are made from wheat flour. It is grown in 42 states in the United States (<https://www.wheatworld.org/wheat-101/wheat-facts/>). Idaho is one of the few places where buyers can find several different classes of wheat in one place. These classes include soft white (winter and spring), hard red (winter and spring), hard white (winter and spring), and durum. Wheat production plays an important role in Idaho's economy. Idaho wheat production typically averages approximately 100 million bushels/year with a value of almost \$500 million (<http://www.idahowheat.org/>). Wheat production also provides job opportunities, not only in the production process, but also in transportation, storage, milling and input supply industries. The Pacific Northwest (PNW) states of Idaho, Washington and Oregon are the principal soft white winter wheat producing area in the United States. Currently, about 80% of soft white wheat grown in the PNW is sold to international buyers (<http://www.idahowheat.org/market/pnw-sww-marketing-plan.aspx>). Soft white winter wheat is one of the major agricultural commodities in Idaho. To maintain producer profitability, it is critical to develop new cultivars with high yield potential, good quality and good disease resistance. To achieve these objectives, the University of Idaho (UI) and Limagrain Cereal Seeds (LCS) established a collaborative wheat breeding program with the help of the Idaho Wheat Commission (IWC) in 2012.

Hypothesis & Objectives:

The primary hypothesis of this research is that the recombination of desired genotypes (genes) followed by multi-year, multi-site evaluation in the field and the laboratory will lead to the development of new cultivars of soft white winter wheat with increased yield, improved agronomic characteristics and superior end-use quality, that can be produced with reduced grower input costs. The breeding processes can be accelerated using new technologies. The objective of this project is to develop new soft white winter wheat varieties for PNW and ID.

Procedures/Plan of Work

1. Developing New Soft White Winter Wheat Cultivars:

1.1 Planting locations and materials: Different environmental sites were used to identify the performance. In 2021 fall planting season, 8 new lines were selected to attend SVT including WSU, OSU, UI and WRSWN. A total of 33 elite lines were selected for 2022 Idaho Yield Trials (IYT) which were grown in 6 UI locations and 4 LCS locations. A total of 74 advanced breeding lines (F₆ generation) were selected for 2022 UI F₆ yield trials which were planted at 4 UI locations and 2 LCS locations. A total of 535 F₅ breeding lines and 195 DH head row selections were planted in Genesee and Walla Walla for first year yield trials. Five grams of each IYT lines, F₆ lines, F₅ lines and DH selections were sent to LCS for molecular marker analysis in the LCS Lab. A total of 520 DH head rows were planted in Moscow. All IYT lines except 3 controls were increased in Genesee and Walla Walla. All F₆ lines were increased in Moscow. A total of 10,368 F₄ head rows were planted in Moscow for head row selection next year. A total of 236 F₃ bulk populations were planted in Moscow for head selection next year. A total of 782 F₂ bulk populations were planted

in Moscow. Five grams of each F₃ and F₂ populations were sent to LCS and planted in Walla Walla for observation. A total of 486 F₁ crosses were planted in field and greenhouse. Summarizing 2021 fall planting, we planted 4,424 yield plots and 14,728 head rows in UI locations and LCS locations. UI total planting area is 13 acres.

1.2 Breeding methods: The main objective is to develop new varieties. Traditional wheat breeding method is used as primary method. Double haploid and molecular marker assisted selection will also be used to shorten the breeding process. Speed breeding is used in the Moscow greenhouse to accelerate the breeding program.

2. Development of CLEARFIELD Soft White Winter Wheat: Three released Clearfield varieties (UI Magic CL+, UI Castle CL+ and UI Palouse CL+) are used as the donors for imazamox resistant genes. UI Magic CL+ had a successful run, it is currently the leading 2-gene Clearfield SWWW variety in the PNW, but it is increasingly vulnerable to stripe rust. In 2020, we released VI Voodoo CL+ and VI Presto CL+ which are from UI Magic CL+ and UI Palouse CL+ separately. VI Voodoo CL+ and VI Presto CL+ are expected to take over UI Magic CL+ acreage and extend into new microclimates. A new Clearfield will be “proposed” for release in the fall of 2022.

3. Enlarge Germplasm Resources: Backcrossing and top-crossing methods are used to enlarge germplasm resources. Each year, we made more crosses in UI Moscow greenhouse. Besides single crosses, we also made backcrosses, 3-way and 4-way crosses. In 2021, a total of 486 F₁ crosses, including 79 single crosses, 194 3-way crosses, 139 4-way crosses and 74 double crosses were made. In 2021 winter, we are making more crosses in greenhouse.

Duration: 5 years (2022-2026)

Cooperation/Collaboration:

Most of breeding materials were planted in Parker Farm and Kambitsch Farm. IYT and F₆ were also planted in Tammany, Cavendish, Fenn, Ferdinand, Lewiston and Bonners Ferry with the help of cooperators. Quality of IYT and F₆ samples were sent to Aberdeen Wheat Quality Lab. Eight new lines were selected to attend SVT including WSU, OSU, UI and WRSWN. UI includes Northern (Kurt Schroeder), Southwestern (Olga Walsh), Southern (Juliet Marshall) and Eastern (Juliet Marshall). IYT and F₆ samples were sent to Dr. Xianming Chen in USDA-ARS Pullman for stripe rust resistance test.

Anticipated Benefits, Expected Outcomes and Impacts, and Transfer of Information:

The new cultivars and germplasm released by this project will maintain or increase productivity for the wheat producers in Idaho. Yield and end-use quality will be improved, increasing the marketability of Idaho and the PNW wheat, both domestically and internationally. Information on new cultivars will be made available through research publications, extension publications, commodity schools, grower meetings, extension field days and websites.

Literature Review:

The primary purpose of the SWWW breeding program has been the development of wheat cultivars for the wheat producers of Idaho, that improve both yield potential and end-use quality. Examples of such cultivars are Brundage (Zemetra *et al.*, 1998), Brundage 96 (Zemetra *et al.*, 2003), UI-WSU Huffman (Brown, 2014), UI Magic CL+, UI Castle CL+ and UI Palouse CL+. From 2012, UI and LCS work together and co-released 5 varieties, including VI Bulldog, VI Frost, VI Shock, VI Voodoo CL+ and VI Presto CL+. VI Bulldog has extremely strong straw with large

heads and excellent top-end yield potential. It has good stripe rust resistance and superior end-use quality. It is ideal for the high production growers. VI Frost has excellent winter hardiness and promising snow mold tolerance with good stripe rust resistance. VI Frost is ranked “Most Desirable” on the Preferred Wheat Varieties list for having excellent quality characteristics. It is best suited for low rainfall production where winter hardiness is crucial. VI Shock was released specifically for southern Idaho irrigated acres where it ranked at the top for yield over 4 years. It has very good straw strength, consistently good test weight, excellent stripe rust resistance and excellent end-use quality. VI Voodoo CL+ and VI Presto CL+ are two-gene Clearfield Plus SWWW varieties which will replace UI Magic CL+. VI Voodoo CL+ has the same plant type as UI Magic CL+, with improved yield potential and stripe rust tolerance. VI Presto CL+ has improved winter-hardiness, taller plant height, and even better stripe rust and C-stripe tolerance.

Citations:

- Brown, J. 2014. New wheat honors UI graduate. Lewiston Tribune article. 7, 2014.
- Zemetra, R.S., M.L. Lauver, K. O'Brien, T. Koehler, E.J. Souza, S.O. Guy, L. Robertson, and B. Brown. 2003. Registration of 'Brundage 96' wheat. *Crop Sci.* 43: 1884.
- Zemetra, R.S., E.J. Souza, M. Lauver, J. Windes, S.O. Guy, B. Brown, L. Robertson, and M. Kruk. 1998. Registration of 'Brundage' wheat. *Crop Sci.* 38:1404.

FY2023
COMMODITY COMMISSION BUDGET
Principal Investigator: *(Yueguang Wang)*

Allocated by	<u>Idaho Wheat Commission</u>	during FY2021	\$	106,077
	<i>(Commission/Organization)</i>			
Allocated by	<u>Idaho Wheat Commission</u>	during FY2022	\$	102,755
	<i>(Commission/Organization)</i>			

REQUESTED SUPPORT:	<u>Awarded for FY2022</u>	<u>Requested for FY2023</u>
Budget Categories		
(10) Salary <i>(staff, post-docs, et NOTE: Faculty salary/fringe not allowed)</i>	\$ -	\$ 23,712
(12) Temporary Help	\$ 58,160	\$ 59,748
(11) Fringe Benefits	\$ 4,595	\$ 14,812
(20) Travel	\$ 10,000	\$ 10,000
(30) Other Expenses	\$ 30,000	\$ 30,000
(40) Capital Outlay >\$5k	\$ -	\$ -
(45) Capital Outlay <\$5k	\$ -	\$ -
(70) Graduate Student		
Tuition/Fees	\$ -	\$ -
TOTALS	\$ 102,755	\$ 138,272

TOTAL BUDGET REQUESTED FOR FY2023:	\$ 138,272
---	-------------------

BREAKDOWN FOR MULTIPLE INDEXES:				
Budget Categories	<i>(Insert Lead PI name)</i>	<i>(Insert Co-PI Name)</i>	<i>(Insert Co-PI Name)</i>	<i>(Insert Co-PI Name)</i>
(10) Salary <i>(staff, post-docs, et</i>	\$ -	\$ -	\$ -	\$ -
(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				\$ -

Annual Report

Grant Code: AP5490

Title: Developing Soft White Winter Wheat for Idaho

Personnel: Yueguang Wang, and Randy Lawrence, Department of Plant Sciences, UI.

Collaborator: Jay Kalous, Limagrain Cereal Seeds (LCS)

Address: Yueguang Wang, Department of Plant Sciences, University of Idaho, 875 Perimeter Drive, Moscow, ID 83844-2333; 208-885-9110; ywang@uidaho.edu

Accomplishments: The Soft White Winter Wheat (SWWW) project was conducted by UI North Idaho Wheat Breeding Team in cooperation with Limagrain Cereal Seeds (LCS). Significant achievements of the SWWW project over the past year include:

1. In 2020-2021, we produced breeder seed for 7 lines – UIL17-7706 CL+, UIL15-028024, UIL13-046145A, UIL13-587007, UIL13-553051A, UIL15-115005 and UIL13-056023A. Summarizing all data after 2021 summer harvest, 3 lines are kept, those are UIL17-7706 CL+, UIL15-028024 and UIL13-046145A. Both of UIL17-7706 CL+ and UIL15-028024 are promising to be released next year. UIL13-046145A is suggested to continue to attend SVT because it showed excellent performance in irrigated areas in Southern Idaho. We got 888 # and 355 # of breeder seed for UIL17-7706 CL+ and UIL15-028024 respectively this summer. These seeds are arranged to produce Foundation seeds by David Hoadley in fall 2021.
2. In order to prepare for releasing varieties, we sent 120 pounds of UIL17-7706 CL+ and UIL15-028024 with UI Magic CL+ (as check) to PNW Wheat Quality Council to check end-use quality this fall. Preliminary results from Aberdeen's Quality Lab showed that the quality of UIL17-7706 CL+ and UIL15-028024 look similar with UI Magic CL+.
3. Sent 300 grams samples of 2021 UI IYT grown in 5 locations from UI to Aberdeen Wheat Quality Lab for quality testing. The 5 locations include Bonners Ferry, Fenn, Lewiston, Genesee and Moscow.
4. Sent 300 grams samples of 2021 UI F₆ generation grown in 3 locations from UI to Aberdeen Wheat Quality Lab for quality testing. The 3 locations include Moscow, Genesee and Tammany.
5. 2021 fall planting was finished at the end of October. The materials were planted at 8 UI locations and 4 LCS locations. UI locations include Moscow, Genesee, Lewiston, Tammany, Cavendish, Ferdinand, Fenn and Bonners Ferry. LCS locations include Walla Walla, Reardan, Eureka and Ritzville.
6. A total of 13 elite lines, including 5 releases (UI Magic CL+, VI Frost, VI Shock, VI Voodoo CL+, VI Presto CL+) and 8 new lines (UIL15-028024, UIL17-7706 CL+, UIL13-046145A, UIL14-085001A, UIL16-072025, UIL16-478001, UIL15-451104B and UIL15-423062A) are selected to attend State Variety Testing (SVT) including WSU, OSU, UI and WRSWN. UI includes Northern (Kurt Schroeder), Southwestern (Olga Walsh), Southern (Juliet Marshall) and Eastern (Juliet Marshall).

7. Head rows of UIL13-046145A (1440 head rows) were planted in Genesee as breeder seeds next year, because it performed well in SVT this year.
8. Head rows of UIL14-085001A, UIL16-072025, UIL16-478001, UIL15-451104B and UIL15-423062A (480 head rows for each line) were planted in Genesee as breeder seeds next year, because they were selected to attend SVT this year. These lines will also be used for PVP data collection.
9. A total of 33 elite lines were selected for 2022 Idaho Yield Trials (IYT) which were grown in 6 UI locations (Bonners Ferry, Fenn, Cavendish, Lewiston, Genesee, Moscow) and 4 LCS locations (Walla Walla, Reardan, Eureka, Ritzville).
10. A total of 74 advanced breeding lines (F₆ generation) were selected for 2022 UI F₆ yield trials at 4 UI locations (Moscow, Genesee, Tammany and Ferdinand) and 2 LCS locations (Walla Walla and Reardan).
11. All IYT lines except controls were increased in Genesee and Walla Walla. All F₆ lines were increased in Moscow.
12. A total of 535 F₅ breeding lines were planted in Genesee and Walla Walla for first year yield trials.
13. A total of 195 DH head row selections which are from 5 crosses were planted in Genesee and Walla Walla for first year yield trials.
14. Five grams of each IYT lines, F₆ lines, F₅ lines and DH head row selections were sent to LCS for molecular marker analysis in the Limagrain Lab.
15. A total of 10,368 F₄ head rows were planted in Moscow for head row selection next year.
16. A total of 520 head rows which are from 3 crosses were planted in Moscow.
17. A total of 236 F₃ bulk populations were planted in Moscow for head selection next year.
18. A total of 782 F₂ bulk populations were planted in Moscow.
19. Five grams of each F₃ and F₂ populations were sent to LCS and planted in Walla Walla for observation.
20. A total of 486 F₁ crosses, including 79 single crosses, 194 3-way crosses, 139 4-way and 74 double crosses were planted in field and greenhouse.
21. A total 22 entries of WRSWN were planted in Moscow
22. A total of 11 entries of WRHWN were planted in Moscow
23. A total of 71 entries of 3YSWW from LCS were planted in Genesee, Cavendish and Tammany.
24. A total of 31 entries of 3YHRW from LCS were planted in Genesee.
25. UIL13-046145A, UI Magic (as check) and VI Shock (or as check) are planted in Genesee for 2022 PNW WQC. Each line was planted with 24 plots.
26. Summarizing 2021 fall planting, we planted 4,424 yield plots and 14,728 head rows in UI locations and LCS locations. UI total planting area is 13 acres.

Projections: Moscow greenhouse is used to make crosses and increase top cross F₁ and F₂ seeds. Crosses including single crosses, 3-way and 4-way crosses were made during summer. Single crosses are planted in field. 3-way and 4-way crosses are planted in greenhouse. Speed breeding method is being used to shorten generation time. Seeds are germinated in petri dishes with moistened filter paper, then put the dishes into growth chamber for vernalization at constant temperature (36°F) and photoperiod (8 hours light / 16 hours dark) for 2 months. The vernalized seedlings are transplanted into 12x6 cell flats and grown in greenhouse at 22/2 hours (light/dark) and temperature 75°F/65°F (light/dark). The plants are fertilized continuously. The heads are cut

at two weeks after anthesis, dried at 86°F (30°C) for one week. Thresh the dried heads and repeat the steps as above. This makes it possible to cycle through 3 generations per year. Another advantage of speed breeding is that we can plant more crosses one time, e.g., 3600 lines in cells VS 256 lines in pots per bench. Currently, 194 3-way crosses, 139 4-way and 74 double crosses are growing in the greenhouse.

Double Haploid (DH) is a fast and effective method to shorten breeding process. In 2021, 520 DH head rows which came from 3 crosses were planted in Moscow for observation and selection. We also will continue to select and send multiple crosses to LCS for DH treatment in the future.

Field management, such as weed and pest control, will be emphasized to help ensure success of field trials. Data will be taken during different growth stages. Early generation selection (F₁, F₂, F₃ and F₄), high generation selection (F₅, F₆, IYT, et al.) and head selection for breeder seeds will be a priority for us next year. When harvested, we will prepare and plant seeds for State Variety Testing Trials, Western Regional and Idaho Yield Trials at different locations in Washington, Oregon and Idaho. Also we will continue to prepare and plant seeds from each generation for ongoing wheat breeding projects.

Publications: No