Washington Grain Commission
Wheat and Barley Research Annual Progress Reports and Final Reports

PROJECT #: 30109-6600

Progress report year: 1 of 3

Title: Evaluation And Selection For Cold Tolerance In Wheat

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Executive summary:

We were unable to complete all of the proposed objectives due to the funding cut of approximately 45%. We prioritized screening the Extension variety trials and new advanced breeding lines.

We used the artificial screening system in the greenhouse to evaluate the Washington Extension Soft and Hard Winter Wheat Trials, and the Western Regional Soft and Hard winter wheat nurseries.

- In the Washington State Hard Winter Wheat Nursery, the Norstar check was the most cold tolerant followed by Esperia, WA8229, WA8197, WB-Rimrock, WA8207, the Eltan check, WA8246, Keldin, Bauermeister, the Otto check, SY Clearstone CL2, OR2110679, Whetstone, WB40590, WA8247, WB-Arrowhead, and Farnum.
- In the Washington State Soft Winter Wheat Nursery, the most cold tolerant soft winter wheat was Norstar followed by ORCF103, WB-Junction, Curiosity CL+, Eltan, IDN07-28017B, ARS-Crescent, Masami, Bruehl, WA8251, Otto, and ARS06135-9C.
- In the Western Regional Soft Winter Wheat Nursery, Norstar was followed by ARS06135-9C, LWW14-70445, ARS06-132-45C, OR2121086, ORLD21130092, and ARS20060194-0-10L.
- In the Western Regional Hard Winter Wheat Nursery, the Otto check was the most tolerant, line followed by Kharkof, Eltan, Norstar, and ARS09200-0-T3.

We rated 430 breeding lines from regional winter wheat breeding programs for survival. All three breeding programs had lines that were more and less winter tolerant so this data provides useful information for selection.

We scored survival in a doubled haploid population derived from Cara/Xerpha and survival ranged from 10% to 99% in this population. This data will be added to agronomic data collected from multiple field locations from 2014-2016 to identify loci for adaptation and for winter survival that can be used by local breeding programs to developed improved and adapted cultivars.

We scored survival in a large Winter Wheat Core Nursery representing a global collection of winter wheat cultivars. The association mapping that we will conduct in this population will identify new sources of cold tolerance, of growth, and development that will be used to continue to improve survival.

We discovered that freezing tolerance follows a diurnal pattern. In plants grown under 12 hours light/12 hours dark at a constant 3 degrees C (37 degrees F), cold tolerance was significantly greater at the midpoints of the light, and of the dark periods, compared to the end of either light or dark period. This new knowledge will help us to schedule our freezing test runs to achieve the maximum freezing tolerance. It also has implications in the genetic control of freezing tolerance, which seems to involve the day length sensing system in plants.

Impact

- The data from these cold tolerance trials was published in the seed buyers guide so that farmers can select winter wheat that is less sensitive to winter kill.
- Our results from screening the regional nurseries, and screening breeding lines has been used by winter wheat breeders to select for resistance to winter injury.
- Varieties released from the WSU winter wheat breeding program have consistently excellent cold tolerance and this tolerance has been maintained because of testing using the procedures developed by this project.
- Because of the high correlation between our artificial screening trial and winter survival in the field, we are able to incorporate better cold tolerance into our early generation breeding lines.
- Most breeding programs have both winter tolerant and less tolerant breeding lines. The identification of molecular markers associated with freezing tolerance complements our screening system and increases our current screening capacity from about 1000 varieties and breeding lines to several thousand progeny from segregating populations per year. **D. Communication:**

Refereed papers

Kruse, E, Carle, S, Wen, N, Murray, TD, Skinner, DZ, Garland-Campbell, KA, and Carter, A.H, 2017 Genomic Regions Associated with Tolerance to Freezing Stress and Snow Mold in Winter Wheat." In press.

Skinner, D.Z., Bellinger, B.S. 2016. Freezing tolerance of winter wheat as influenced by extended growth at low temperature and exposure to freeze-thaw cycles. Canadian Journal of Plant Science. doi: 10.1139/CJPS-2016-0154.

Skinner, D. Z. 2017. Advances in cold-resistant wheat varieties. Chapter 7 In: Achieving sustainable production of wheat. Vol. 1. P. Langridge, ed. ISBN-13: 9781786760166..

Abstracts

Popular Press

Web

Presentations

WGC project number: **3019-6600**
WGC project title: **Evaluation And Selection For Cold Tolerance In Wheat**
Project PI(s): **Kimberly Garland-Campbell and Arron Carter**
Project initiation date: **7/1/16**
Project year: **2 of 3**

Objective	Deliverable	Progress	Timeline	Communication
1. Evaluate Washington winter wheat variety trials.	Survival data for all lines in winter wheat variety trials.	In 2016 survival data was collected for the soft and hard winter wheat variety trials.	Data available by Feb. of the year following the field trials, Feb. 2017-2019	Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review. Refereed publications.
2. Evaluate cold tolerance of new breeding lines in US regional nurseries in order to identify germplasm to use in crossing for better winter survival.	Survival data for lines in US regional nurseries	In 2016, survival data was collected for the soft and hard western regional nurseries	Data available by April of the year following the field trials, April 2017-2019.	Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review. Refereed publications.
3. Evaluate cold tolerance of spring wheat variety trials.	Survival data for lines in spring wheat variety trials	We did not collect survival data for spring wheat variety trials due to funding cut.	Data avilable by Feb. of the year following the field trials, Feb. 2017-2019	Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review. Refereed publications.
4. Evaluate cold tolerance of advanced breeding lines contributed by A. Carter, K. Gill, M. Pumphrey, R. Zemetra and others in the PNW as well as those in the ARS breeding program.	Survival data for advanced breeding lines submitted by regional breeders	In 2016, survival data was provided on advanced breeding lines in the WSU Winter Wheat program(208 lines); the USDA Club wheat breeding program(102 lines), and to B. Zemetra (120 lines)	Data available by June of the year that entries are submitted, June 2017-2019.	Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review.

5. Evaluate cold tolerance of F_3-F_5 (early generation) wheat populations that are segregating for cold tolerance and select resistant progeny.	Populations that have been selected for tolerance to deep freezing.	This was not accomplished due to funding cuts.	Populations selected each year, 2016-2019.	Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review.
6. Identify genes controlling cold hardiness in winter wheat.	New information about the Fr1, Fr2, and other loci controlling cold tolerance and spring growth in wheat	In 2016, survival data was recorded in a 130 member DH mapping population of Cara/Xerpha. We completed recording survival data for the Winter Wheat Core Nursery.	Sept 2016-June 2019.	Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review. Refereed publications.
7. Determine how cold tolerance interacts with resistance to soil borne disease, specifically snow mold, eyespot, and Fusarium crown rot resistance.	Survival data for wheat populations segregating for resistance to soil borne disease. Selected populations with resistance to cold and to individual diseases.	This was not accomplished due to funding cuts.	Trials with specific diseases conducted, one disease per year, 2016-2019.	Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review. Refereed publications.