

**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**

**Cooperators:** K. Garland Campbell, D.Z. Skinner, A.H. Carter

**Executive summary:**

We used the artificial screening system in the greenhouse to evaluate:  
Winter wheat breeding lines from the WSU and ARS breeding programs.  
The Western Regional Winter wheat hard and soft nurseries  
The Northern and Southern Regional Performance Nurseries  
The Association Mapping Training Panel representing the WSU and ARS breeding programs  
The WSU Spring Variety Trials  
The WSU Winter Wheat Variety Trials are currently being evaluated.  
The Winter Wheat Core Nursery

We now have a dataset of survival scores from 3135 winter wheat breeding lines, cultivars and germplasm.

We evaluated the large association mapping panels and regional nurseries for allelic and copy number variation at genes that are known to be associated with cold tolerance in wheat. Many of these alleles are segregating in our populations.

We conducted an association mapping project for cold tolerance using data available in our breeding programs. In addition to the known loci, we discovered new loci on the group 1 and group 6 chromosomes.

**Impact**

- The data from these cold tolerance trials can be used by growers to select winter wheat that is less sensitive to winter kill (data available on [smallgrain.org](http://smallgrain.org))
- 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.

**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	<a href="http://smallgrains.wsu.edu/">http://smallgrains.wsu.edu/</a>
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	The Western Regional soft and hard winter wheat trials and the Northern and Southern Performance trials were evaluated.	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	Hard Spring Variety Trials evaluated.	Data available by Feb. of the year following the field trials, Feb. 2017-2019	<a href="http://smallgrains.wsu.edu/">http://smallgrains.wsu.edu/</a>
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	Survival data was evaluated for the WSU Winter Wheat and the USDA Winter Wheat breeding programs.	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 <sub>3</sub> -F <sub>5</sub> (early generation) wheat populations that are segregating for cold tolerance and select resistant progeny.	Populations that have been selected for tolerance to deep freezing.	Lack of freezer space delayed progress. New freezers are being installed.	Populations selected each year, 2016-2019.	

**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**

**Cooperators:** K. Garland Campbell, D.Z. Skinner, A.H. Carter

**Executive summary:**

We used the artificial screening system in the greenhouse to evaluate:  
Winter wheat breeding lines from the WSU and ARS breeding programs.  
The Western Regional Winter wheat hard and soft nurseries  
The Northern and Southern Regional Performance Nurseries  
The Association Mapping Training Panel representing the WSU and ARS breeding programs  
The WSU Spring Variety Trials  
The WSU Winter Wheat Variety Trials are currently being evaluated.  
The Winter Wheat Core Nursery

We now have a dataset of survival scores from 3135 winter wheat breeding lines, cultivars and germplasm.

We evaluated the large association mapping panels and regional nurseries for allelic and copy number variation at genes that are known to be associated with cold tolerance in wheat. Many of these alleles are segregating in our populations.

We conducted an association mapping project for cold tolerance using data available in our breeding programs. In addition to the known loci, we discovered new loci on the group 1 and group 6 chromosomes.

**Impact**

- The data from these cold tolerance trials can be used by growers to select winter wheat that is less sensitive to winter kill (data available on [smallgrain.org](http://smallgrain.org))
- 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.

<p>6. Identify genes controlling cold hardiness in winter wheat.</p>	<p>New information about the Fr1, Fr2, and other loci controlling cold tolerance and spring growth in wheat</p>	<p>The Winter Wheat association mapping panel and the Winter Wheat Core Nursery were evaluated.</p>	<p>Sept 2016-June 2019.</p>	<p>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:</p>
<p>7. Determine how cold tolerance interacts with resistance to soil borne disease, specifically snow mold, eyespot, and Fusarium crown rot resistance.</p>	<p>Survival data for wheat populations segregating for resistance to soil borne disease. Selected populations with resistance to cold and to individual diseases.</p>	<p>Lack of freezer space delayed progress. New freezers are being installed.</p>	<p>Trials with specific diseases conducted, one disease per year, 2016-2019.</p>	<p>Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review. Refereed publications.</p>