



Wheat Breeding for Specific End-Use Customers

Scott D. Haley

Professor and Wheat Breeder
Colorado State University
Fort Collins, Colorado 80523
wheat.colostate.edu



SOIL AND CROP SCIENCES
COLORADO STATE UNIVERSITY

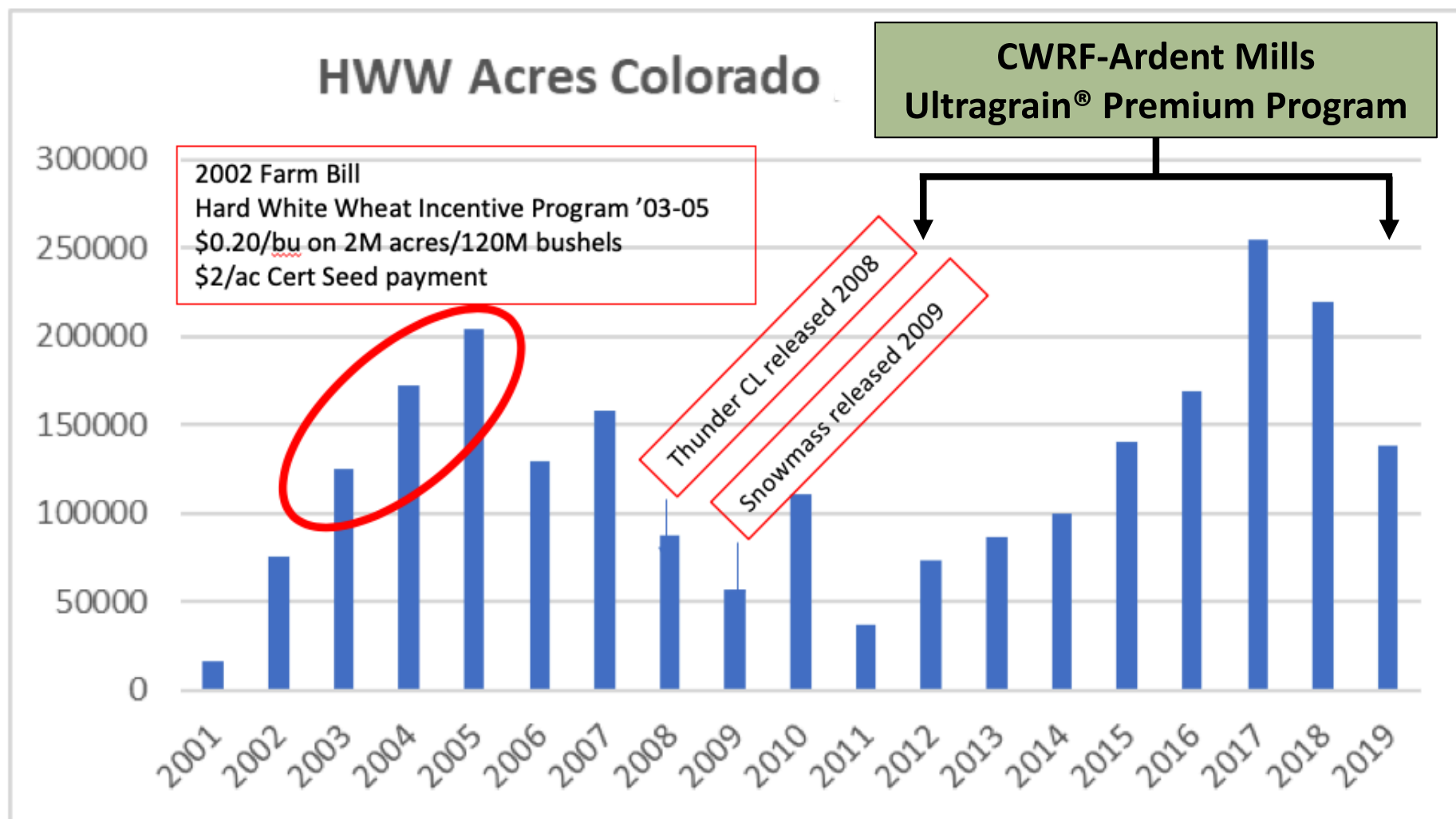


John Stromberger

Hayley Butler

Hard White Wheat in the Great Plains

- History and timeline
 - Expanding markets in Asia in 80s-90s, breeding programs initiated
 - Approval as a new FGIS market class in 1994
 - Congress approves HWW Incentive Program in 2002
 - *Betty & Heyne (1998), Trego (1999), Lakin (2000), Platte (1995)*
- Problems – a case of too many “perfect storms”
 - 2001: stripe rust emergence (and continued race evolution)
 - 2003: abnormally wet harvest leads to pre-harvest sprouting
 - 2005: end of HWW Incentive Program
 - 2007: January blizzards, very high yields, very low protein
 - **Producer expectations for price premiums**
 - **Limitations of grain handling/standards, costs of segregation**



Source – Brad Erker, Executive Director, CO Wheat



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ULTRAGRAIN®

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The Ultragrain® family of flour delivers whole grain nutrition in mainstream foods with the taste, texture and color consumers prefer. It starts with exclusive varieties of white wheat for a sweeter, milder flavor that is uniquely milled to the granulation of white flour. In terms of taste, texture and appearance, other whole wheat flours just don't measure up to Ultragrain whole wheat flour.

Ultragrain Hard



Ultragrain Soft



Ultragrain All Purpose Flour Blend T-2



Ultragrain High Performance



Ultragrain® Flour Products

Source – <https://ardentmills.com/products/ultragrain/>

Home > Products > Ultragrain® > ULTRAGRAIN HIGH PERFORMANCE

ULTRAGRAIN HIGH PERFORMANCE

The next thing in whole grains is here: Ultragrain® High Performance (HP) is the cutting-edge addition to our Ultragrain family of flours. But Ultragrain HP isn't just a new flour. It's the first in a generation of flours with baking advantages like stronger gluten, higher absorption and improved manufacturing performance, resulting in lower formulation costs.

Breads made with Ultragrain HP can reduce your added vital wheat gluten requirement by 50% or more compared to traditional whole wheat flour for the same loaf volume and performance.



Baking Advantages

- Stronger gluten
- Higher water absorption
- Improved manufacturing performance
- Lower formulation costs
- Reduction of gluten by 50% + in whole grain applications

Source – <https://ardentmills.com/products/ultragrain/hp/>

Snowmass Hard White Wheat - 2009

- Pedigree - KS96HW94//Trego/CO960293
 - Trego/CO960293: cross made summer 1999 by Joe Martin (Hays KS)
 - Trego: KSU release 1999
 - CO960293: source of *Wsm2* (WSMV resistance)
 - KS96HW94: Arlin/KS89H20 pedigree
Pro Brand 830 in pedigree of KS89H20 – Bx7^{OE} source (*Glu-B1* HMWG)
 - KS96HW94 – discarded at KSU "because the bake lab said its mix time was too long and it wouldn't fit into their bake schedule" (Joe Martin)
 - KS96HW94 – used in crossing because it was white and it looked good

Serendipity

Cross based on intuition, not prediction

Good yield, WSMV and stripe rust resistant

Nobody told me to toss it due to mix time

Murphy's Law

It is very heat-sensitive (2012, 2013)

Susceptible to new stripe rust race in 2012

IP program based on an inferior variety!



Sunshine - 2014



Breck - 2017



Monarch - 2018



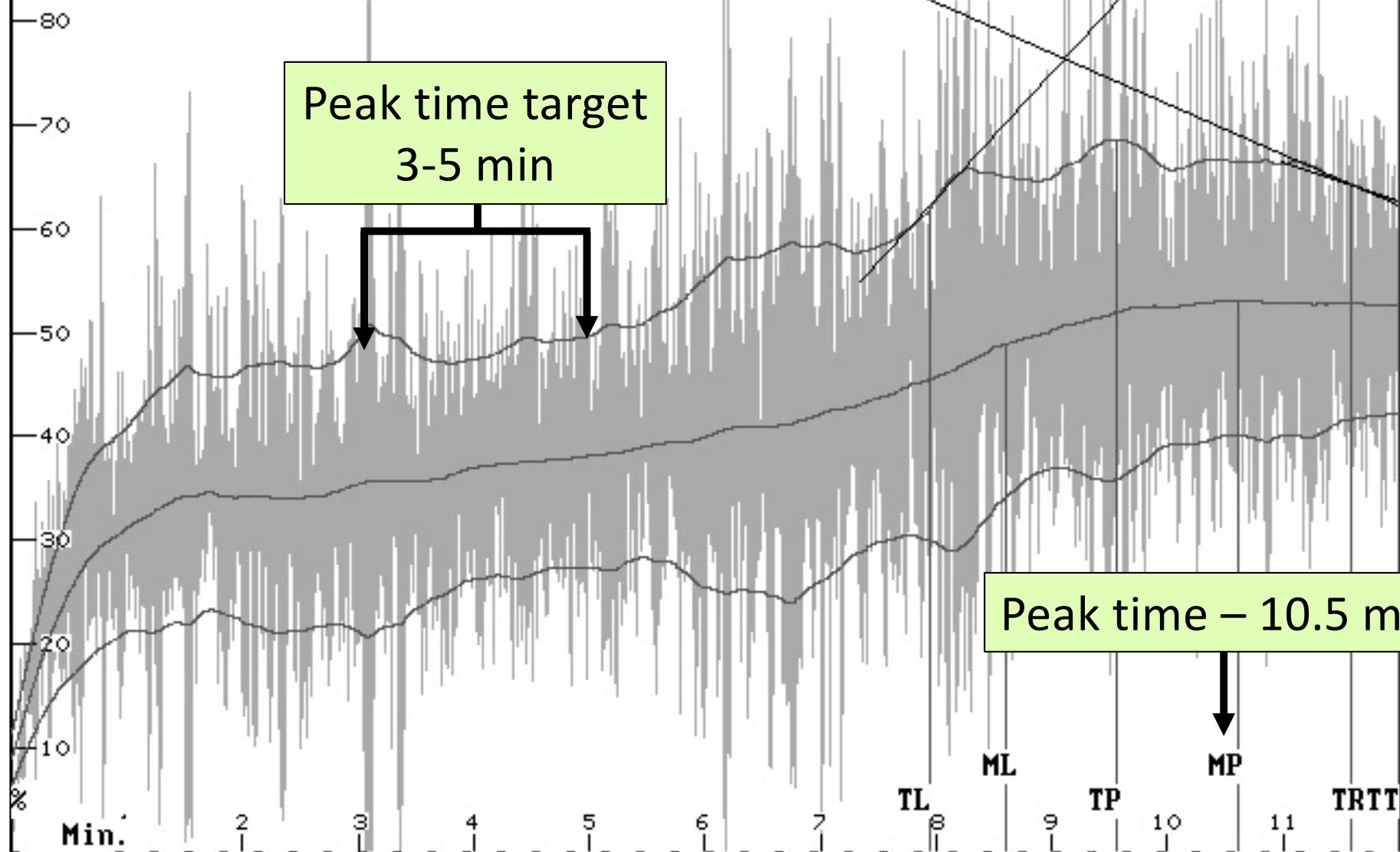
Snowmass 2.0 - 2018

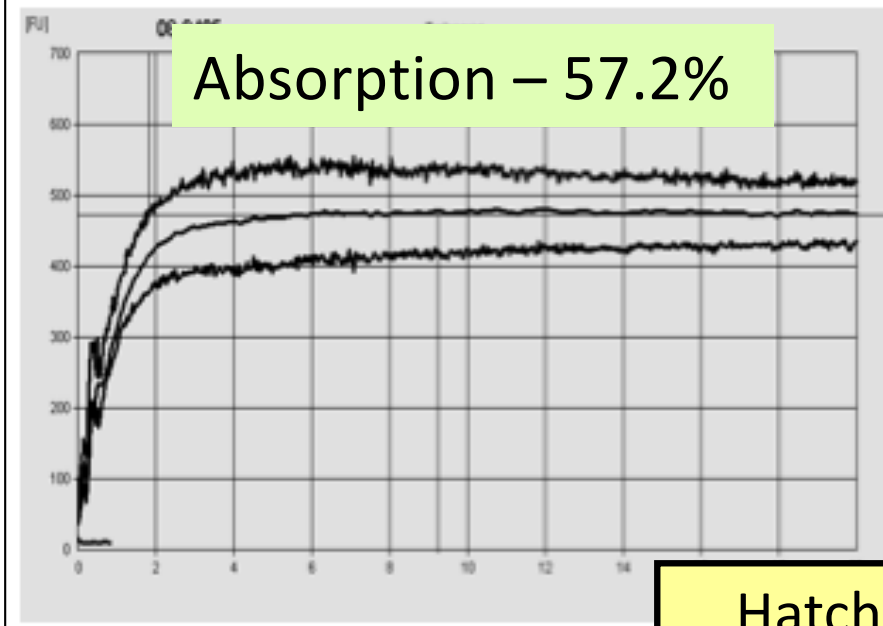
Computerized Mixograph

Source: 'Snowmass'

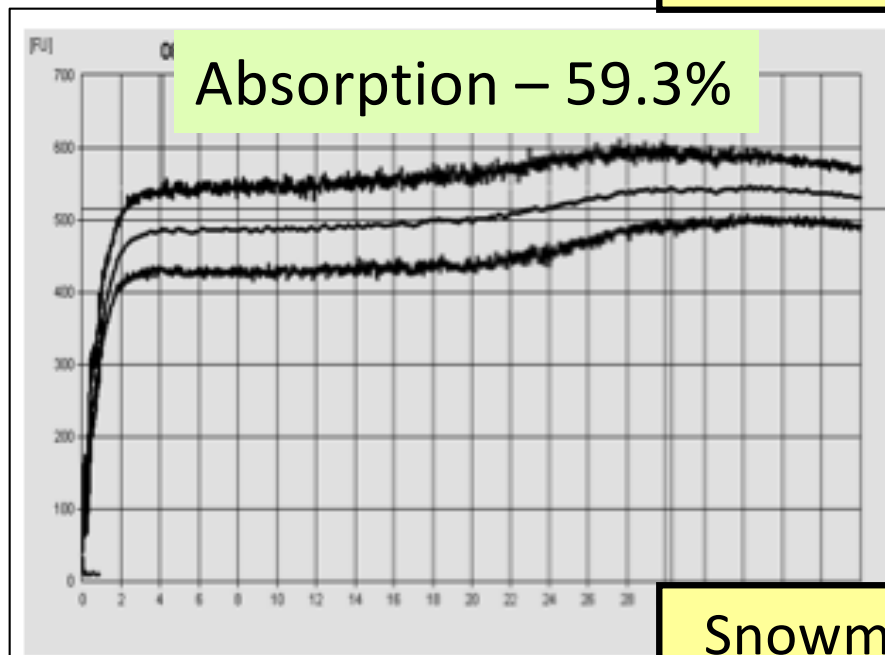
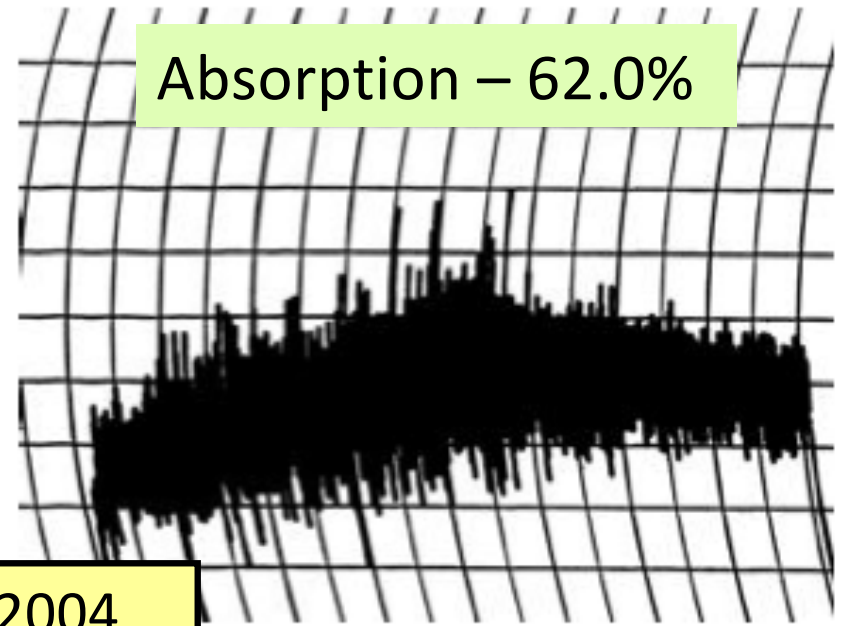
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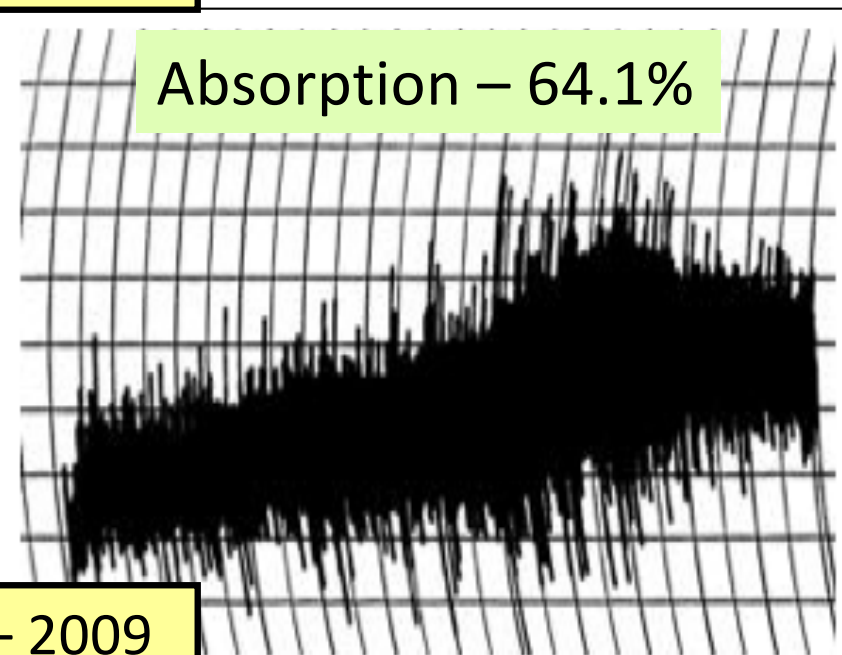




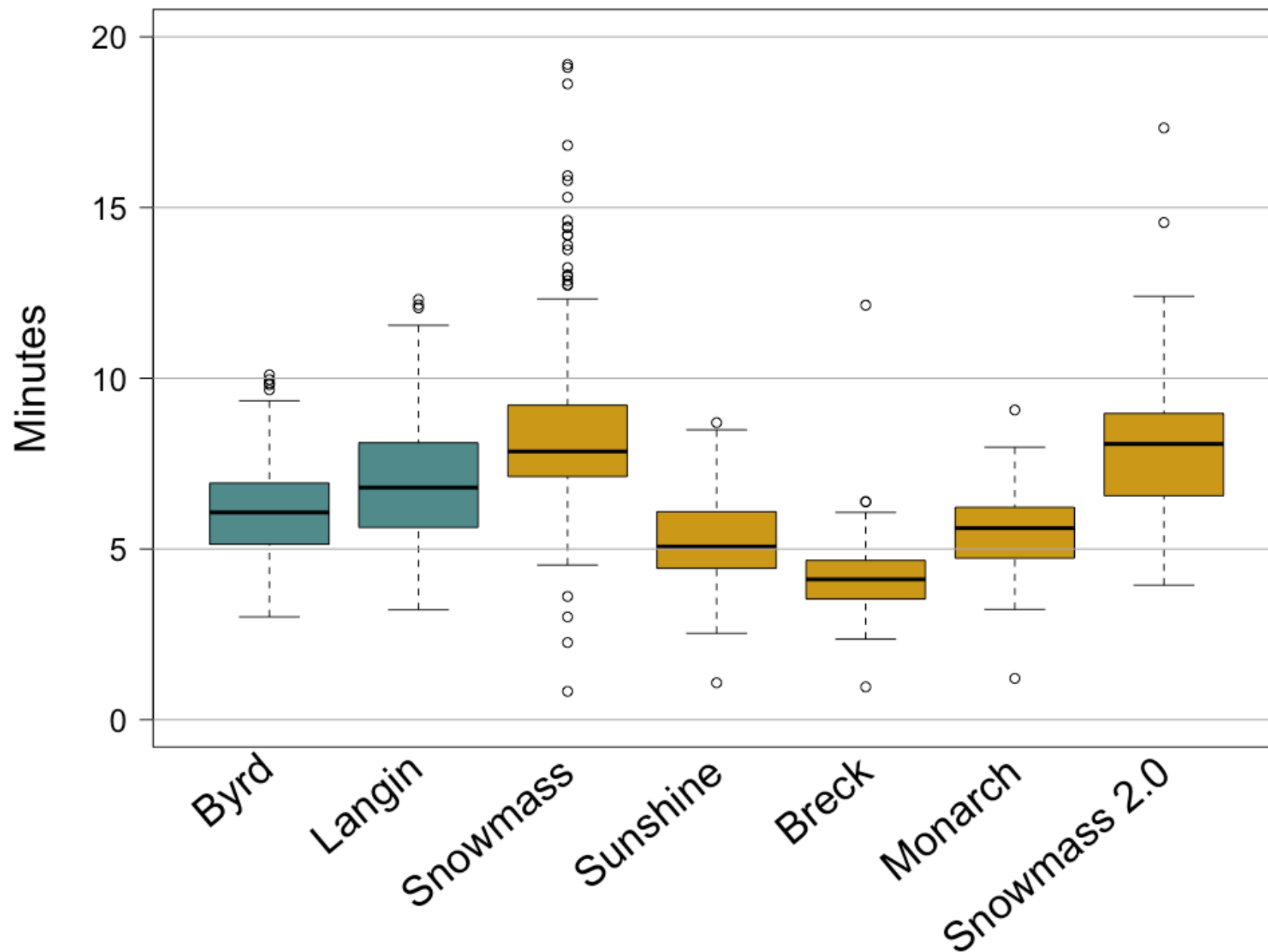
Hatcher – 2004
(12.1% flour pro)

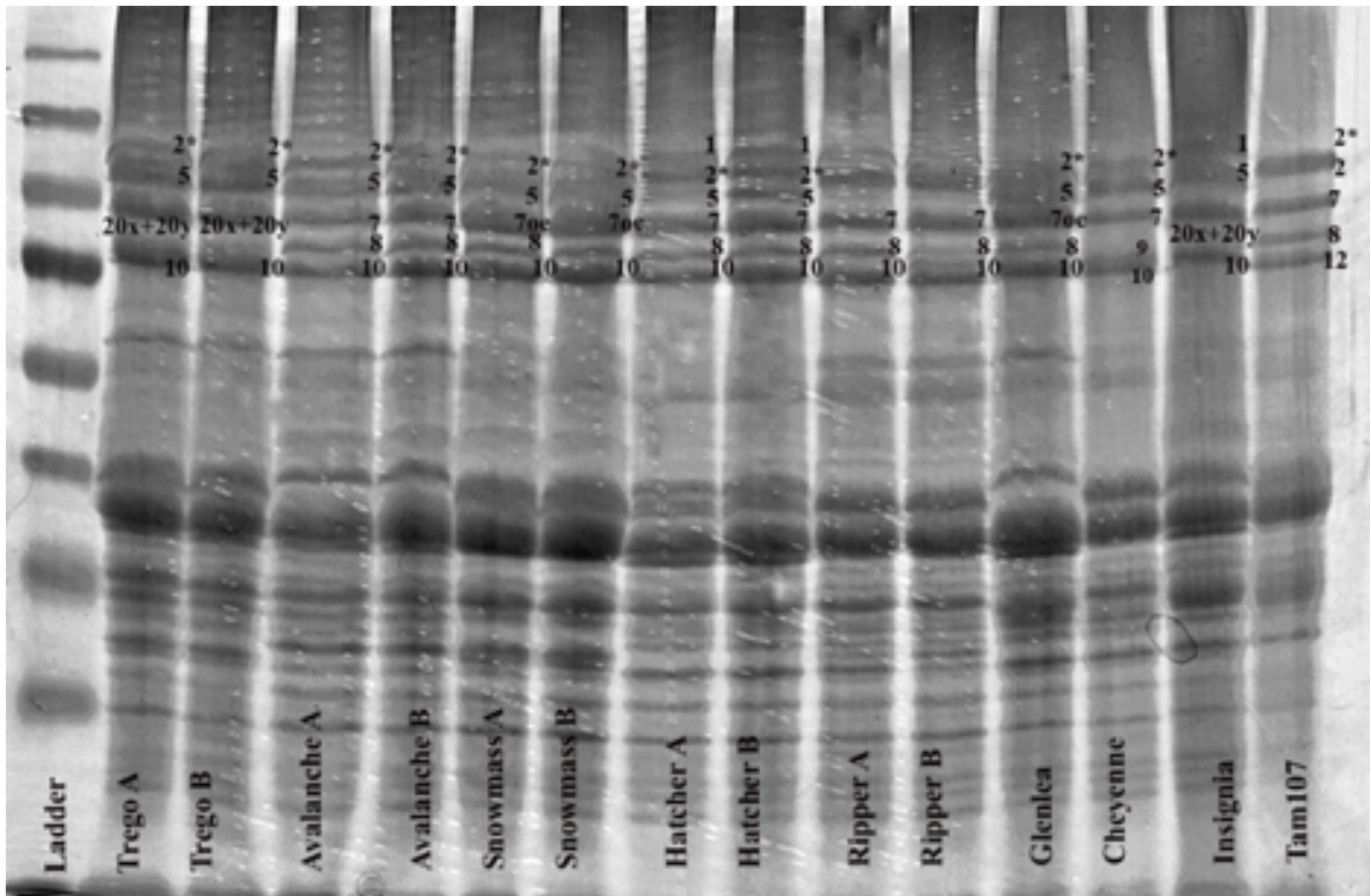


Snowmass – 2009
(12.7% flour pro)

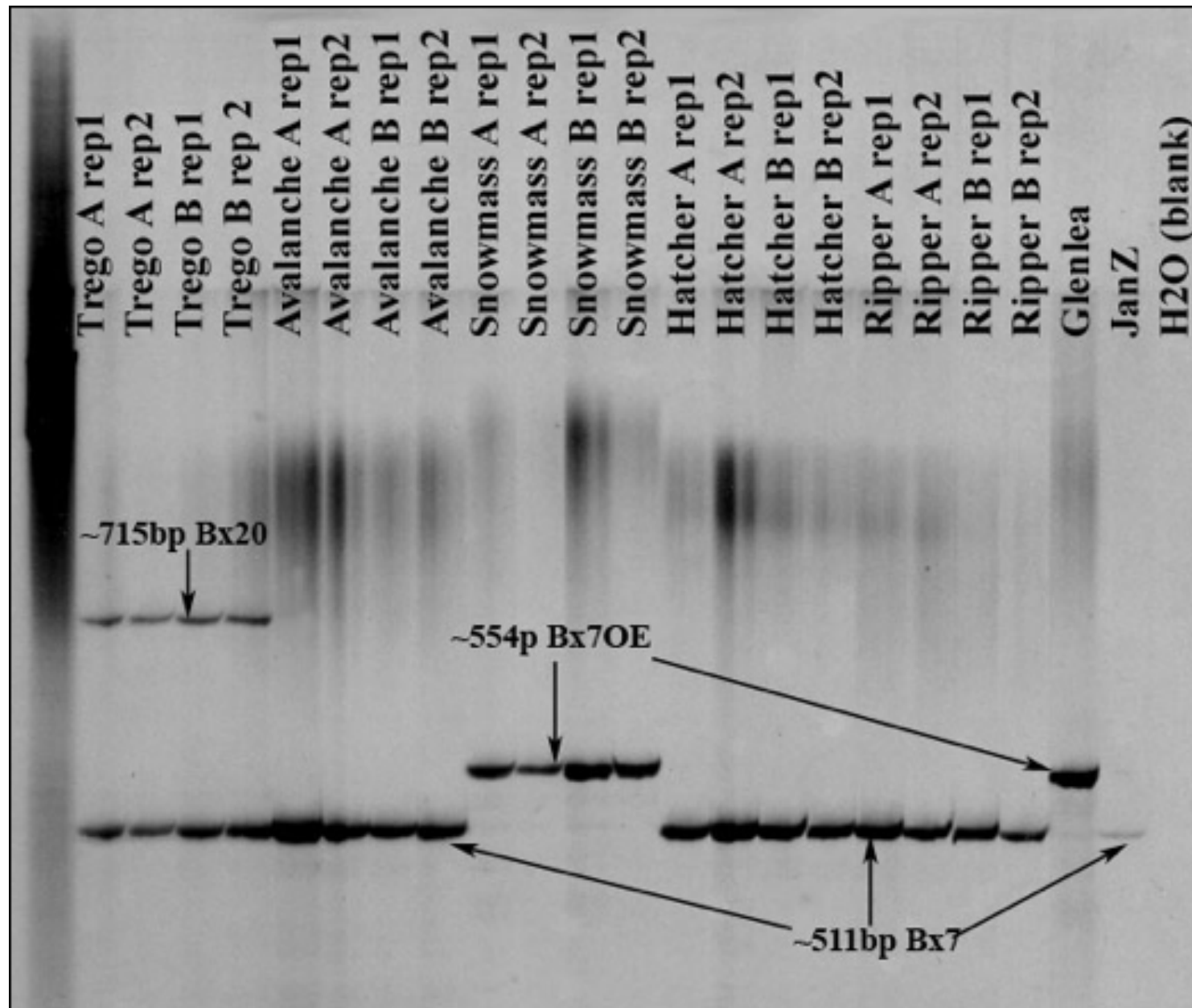


Mixograph Mix Time (Midline Peak Time)



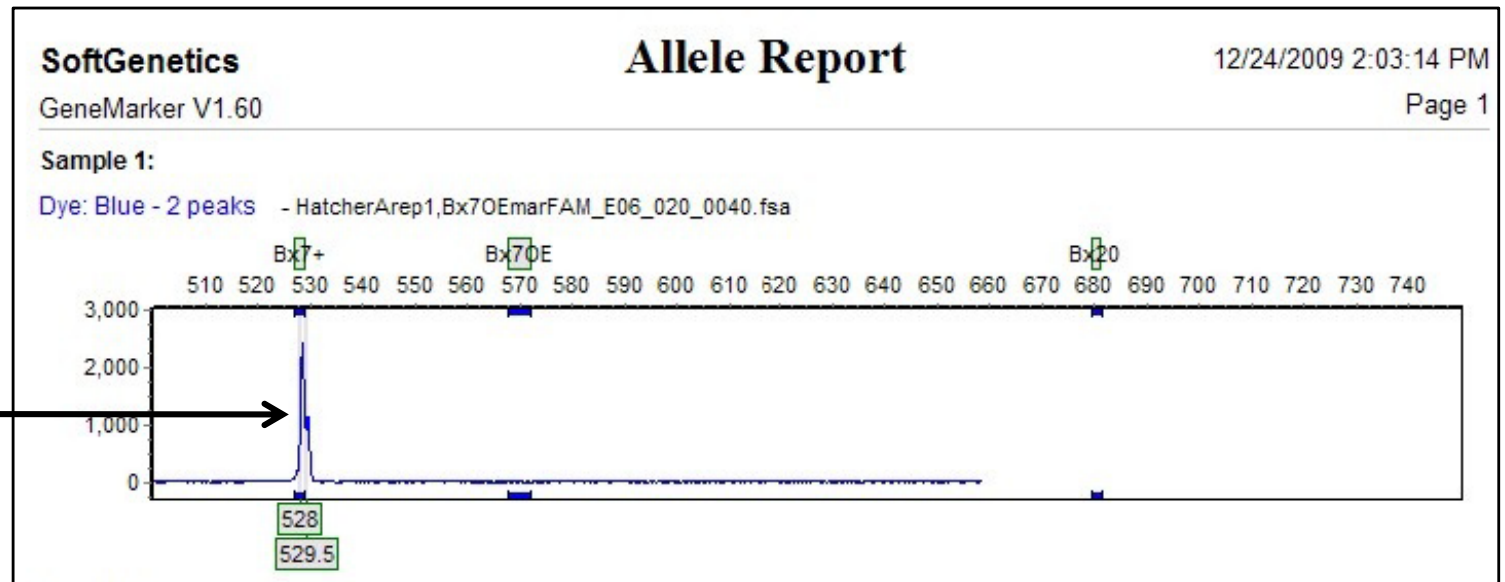


One dimensional SDS-PAGE of high (HMWG) and low molecular weight glutenin (LMWG) subunits

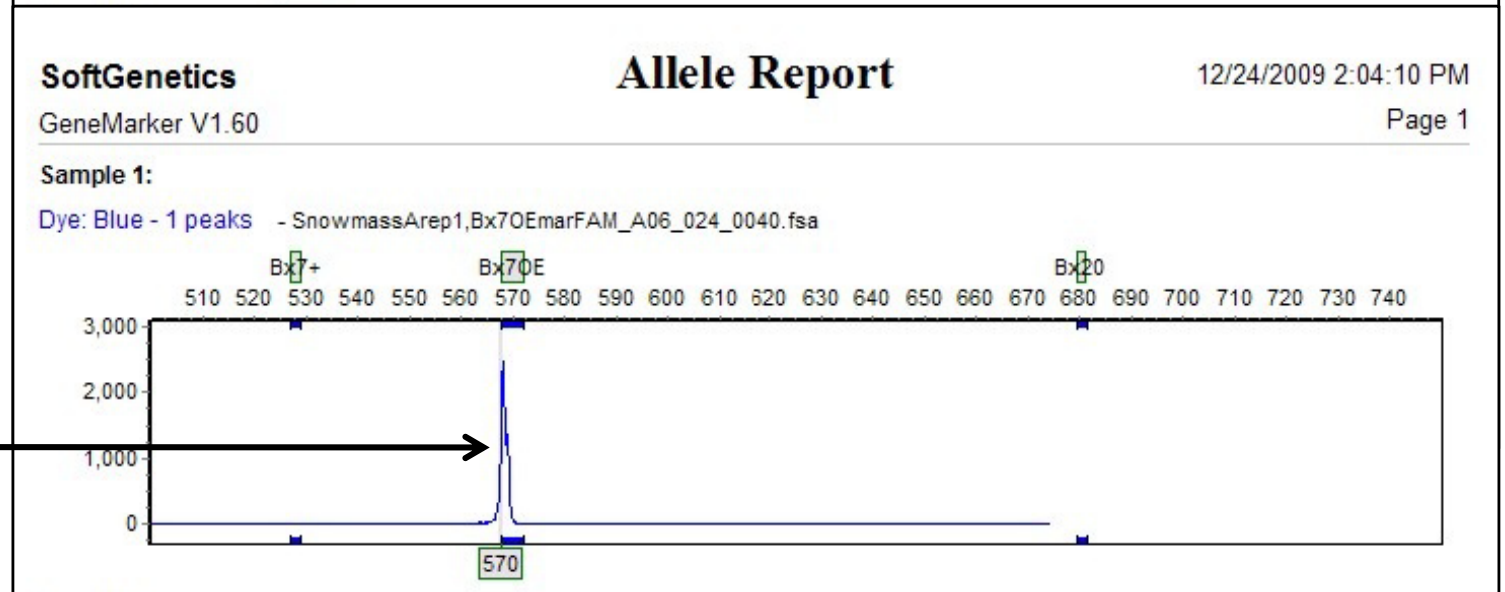


Polyacrylamide gel of PCR products generated using the Bx7MAR primer pair (Butow et al. 2004)

Hatcher
(529 bp)

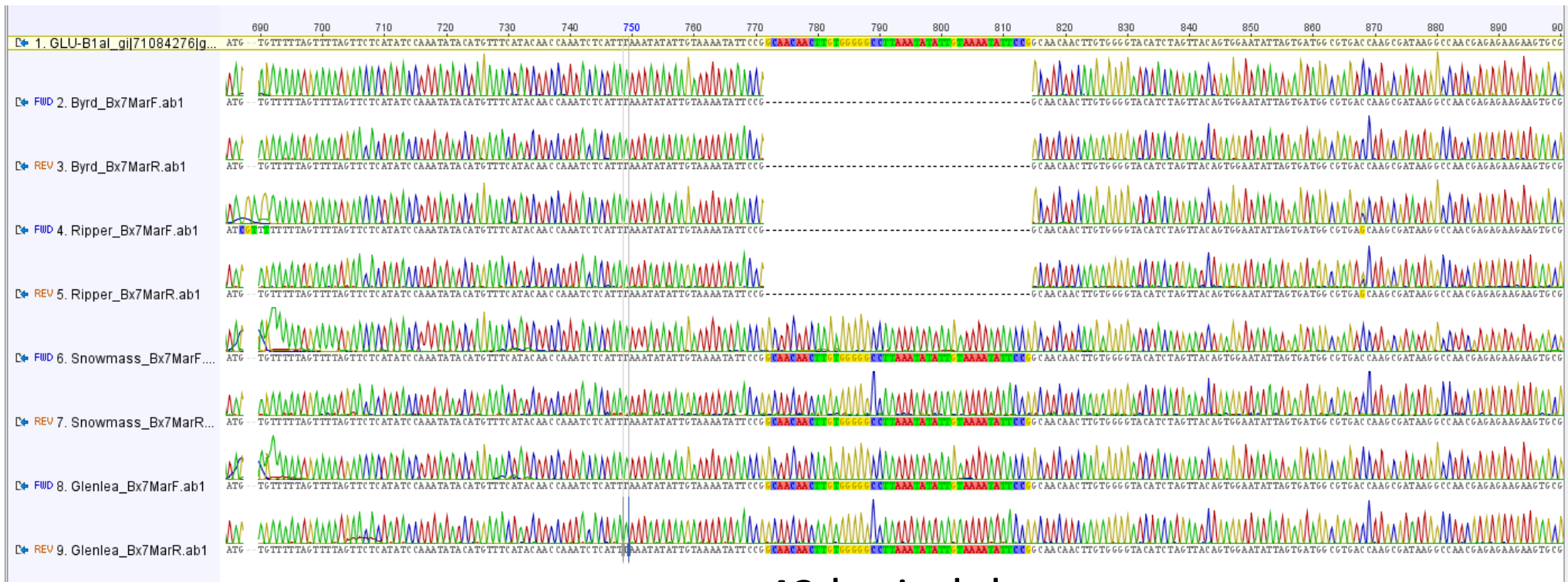


Snowmass
(570 bp)



ABI-based detection of PCR products generated using
the Bx7MAR primer pair (Butow et al. 2004)

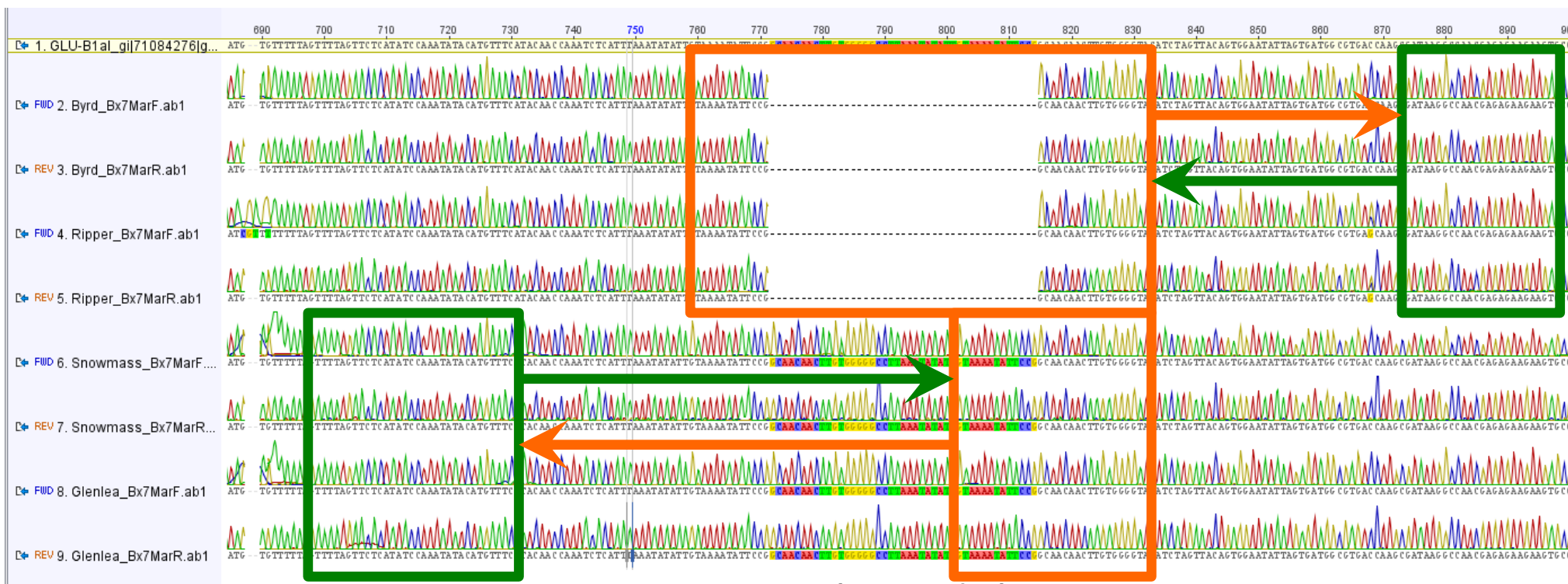
KASP Marker Development for Bx7^{OE}



43 bp indel

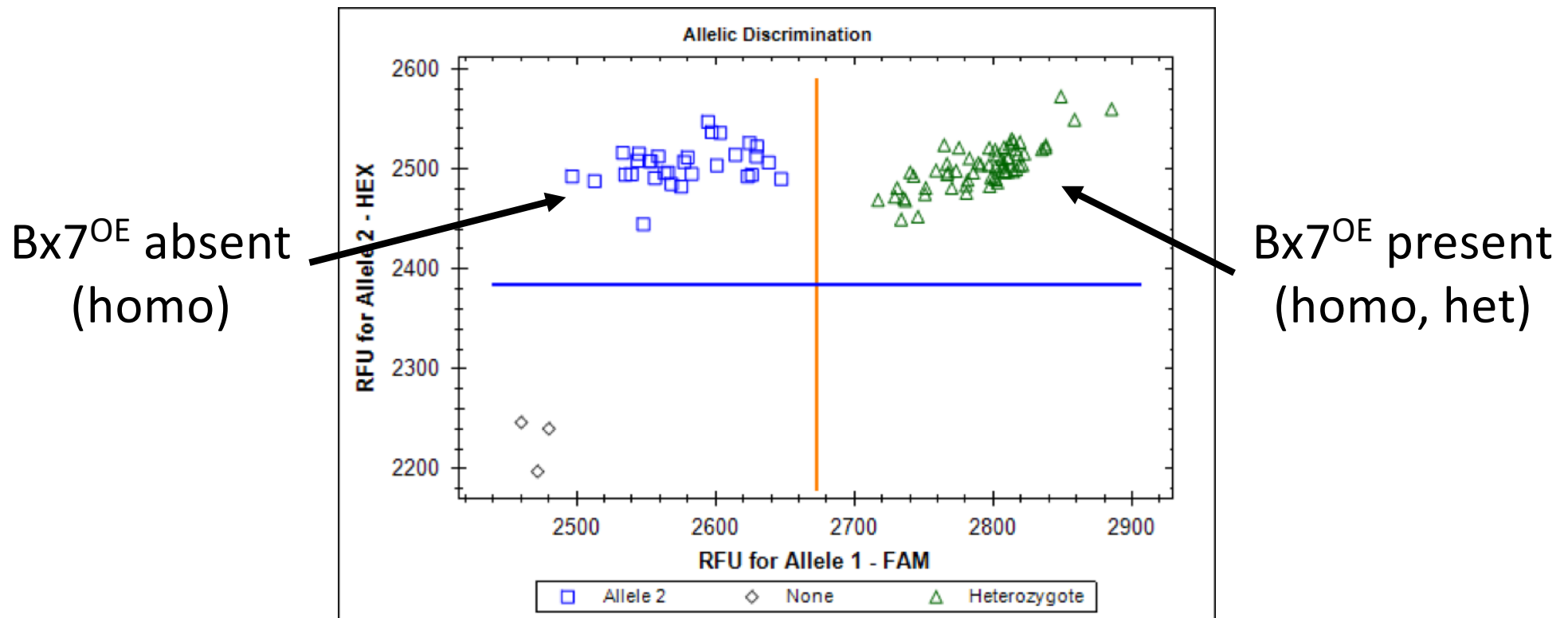
KASP marker design – complicated by ~200bp highly repetitive sequences flanking the insertion/deletion

KASP Marker Development for Bx7^{OE}



Primer	Target	Sequence
A1	Insertion-Bx7OE	CGGCAACAACCTTGTGGGGGC
F1	Insertion-Bx7OE	GTTGTTGCCGGAATATTTTACAATATATTTAAG
A2	Deletion-Bx7	TATTCCGGCAACAACCTTGTGGGGTA
F2	Deletion-Bx7	CACTTCTTCTCTCGTTGGCCTTATC

KASP Marker Development for Bx7^{OE}



KASP cluster analysis of Bx7/Bx7^{OE} KASP primers

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ULTRAGRAIN HIGH PERFORMANCE

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Baking Advantages

- Stronger gluten – "Yeah, I get that."
- Higher water absorption
- Improved manufacturing performance
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Source – <https://ardentmills.com/products/ultragrain/hp/>

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Baking Advantages

- Stronger gluten – "Yeah, I get that."
- Higher water absorption – "Really? I didn't know that."
- Improved manufacturing performance
- Lower formulation costs
- Reduction of gluten by 50% + in whole grain applications

Source – <https://ardentmills.com/products/ultragrain/hp/>



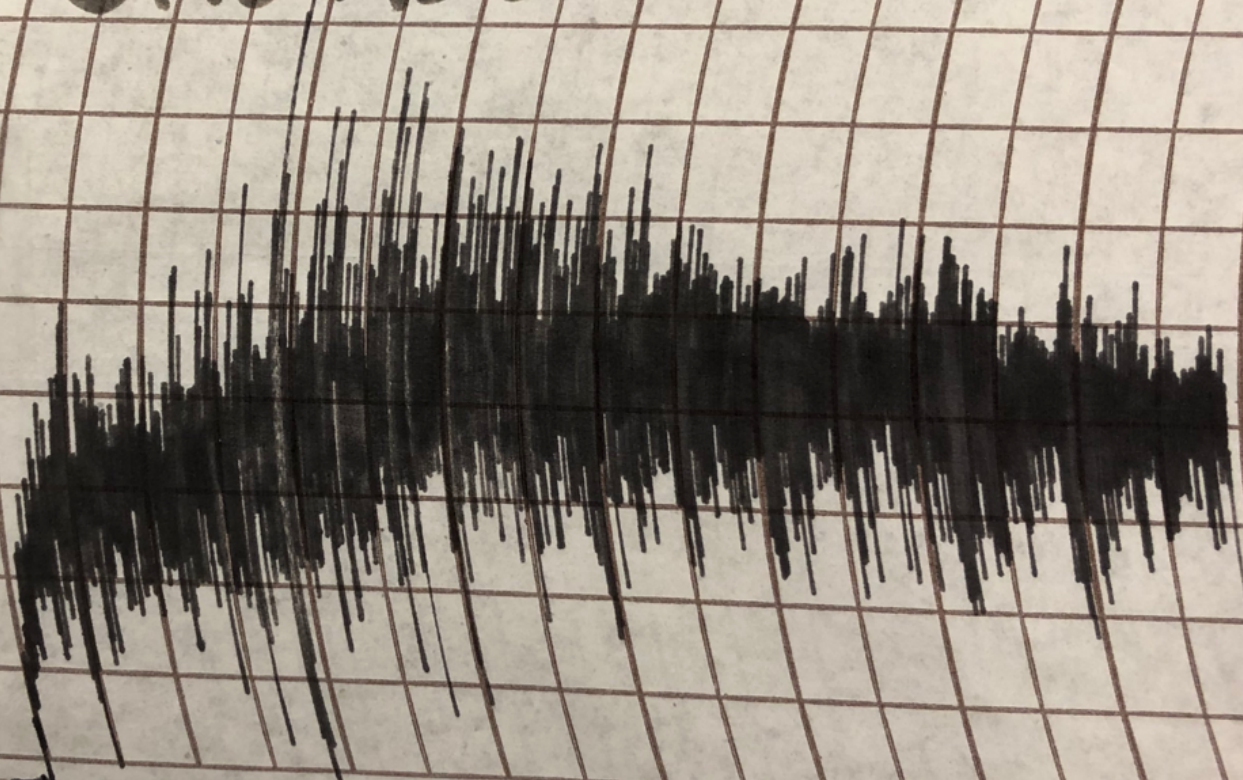
Me

Craig
Morris

Hayley
Butler

Chart No. NMC 2310

61% Abs



T MCO, Inc. 544 "J" Street Lincoln, Nebraska 68508

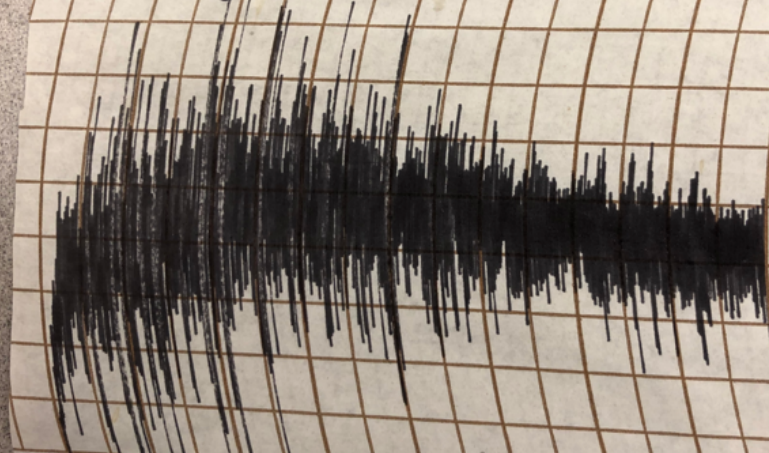
NAT

Cnn

Pred. Abs

Chart No. NMC 2310

55% Abs



TMCO, Inc. 544 "J" Street Lincoln, Nebraska 68508

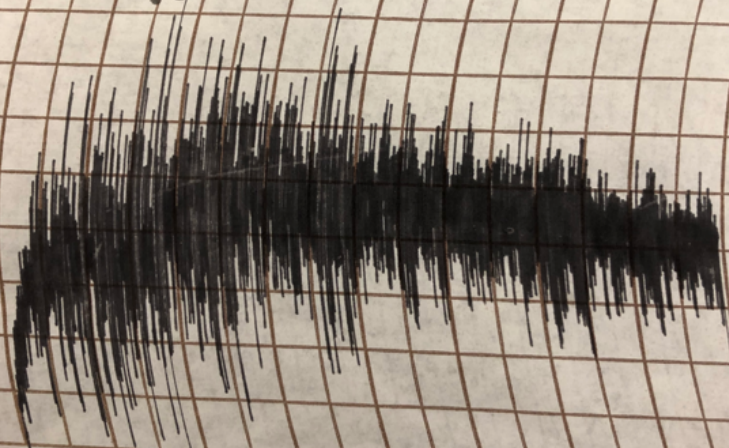
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Printed in U.S.A.

Chart No. NMC

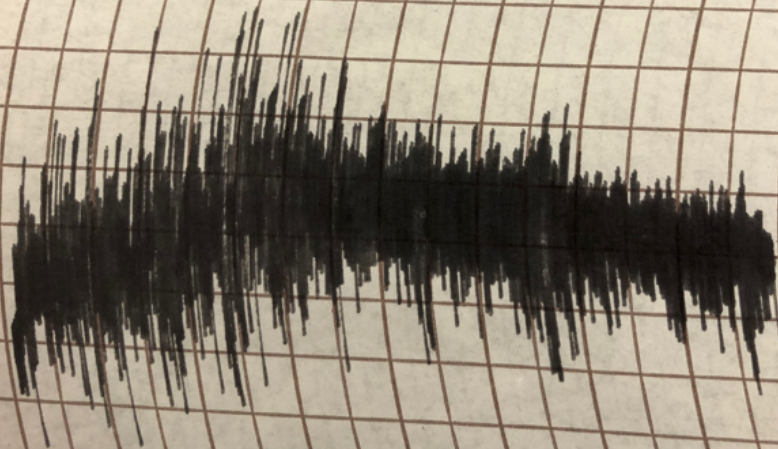
57% Abs



NATIONAL MANUFACTURING A Division of TMCO, Inc. 544 "J" Street Lincoln, Neb

Chart No. NMC 2310

59% Abs

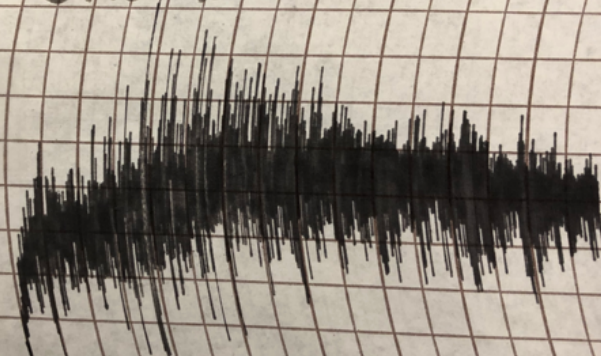


TMCO, Inc. 544 "J" Street Lincoln, Nebraska 68508

-8

Chart No. NMC 2310

61% Abs



TMCO, Inc. 544 "J" Street Lincoln, Nebraska 68508

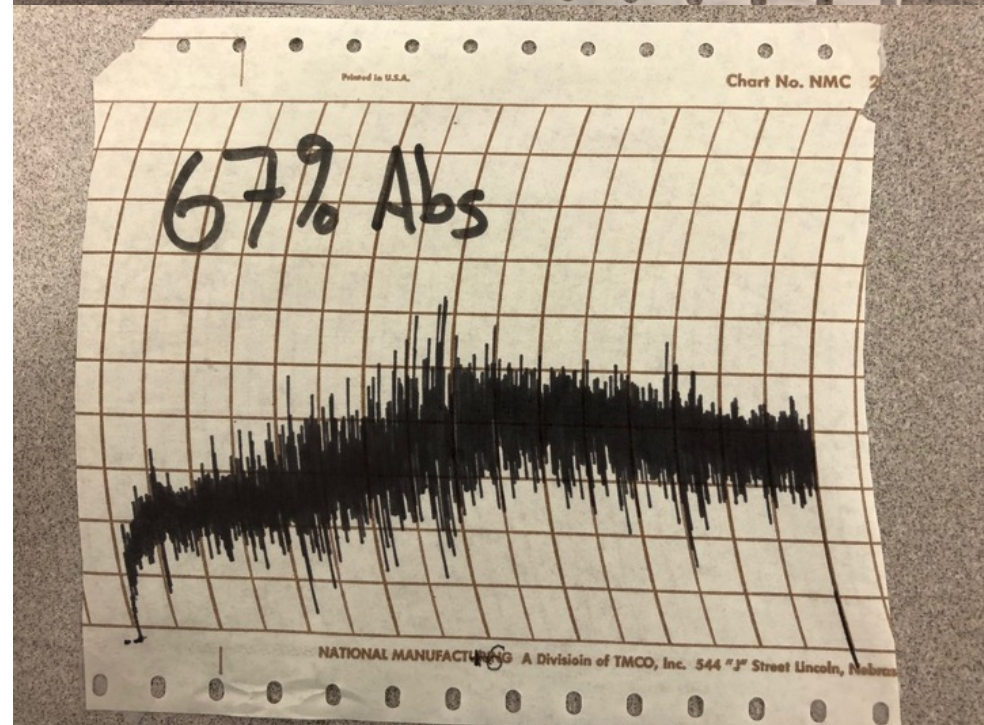
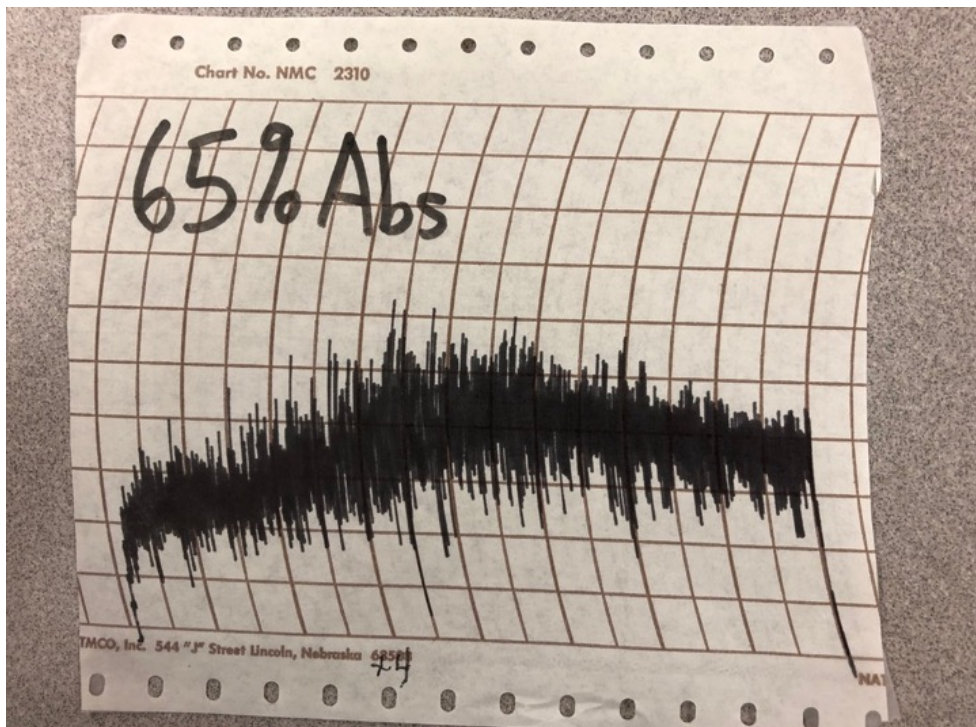
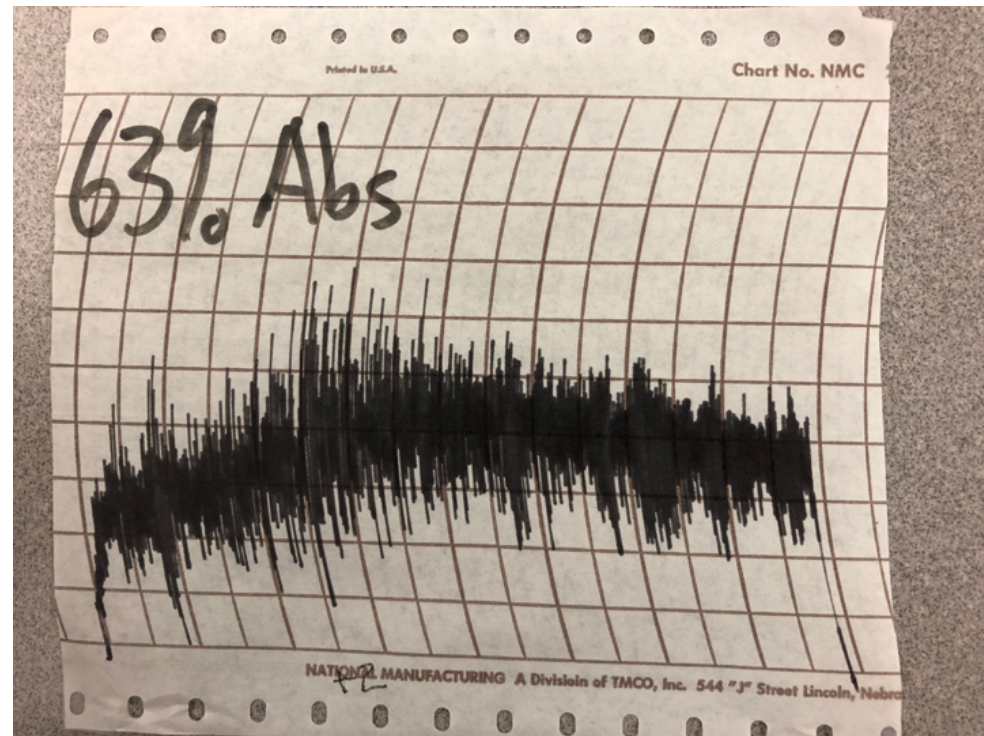
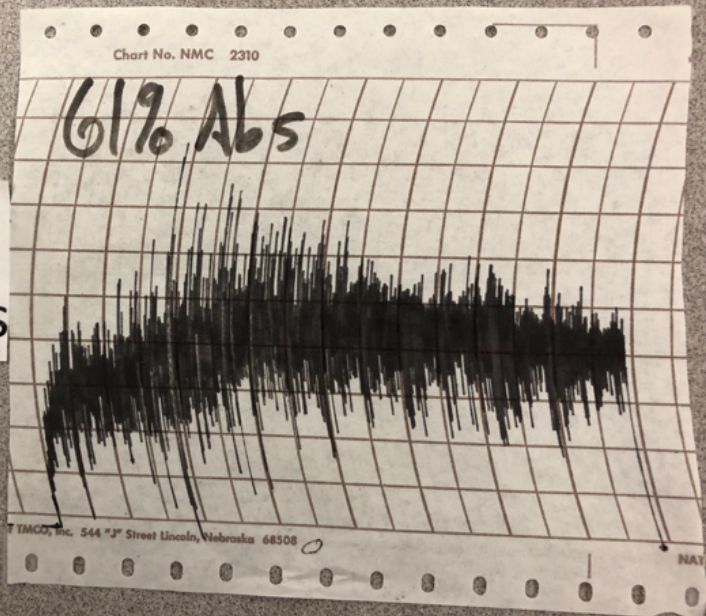
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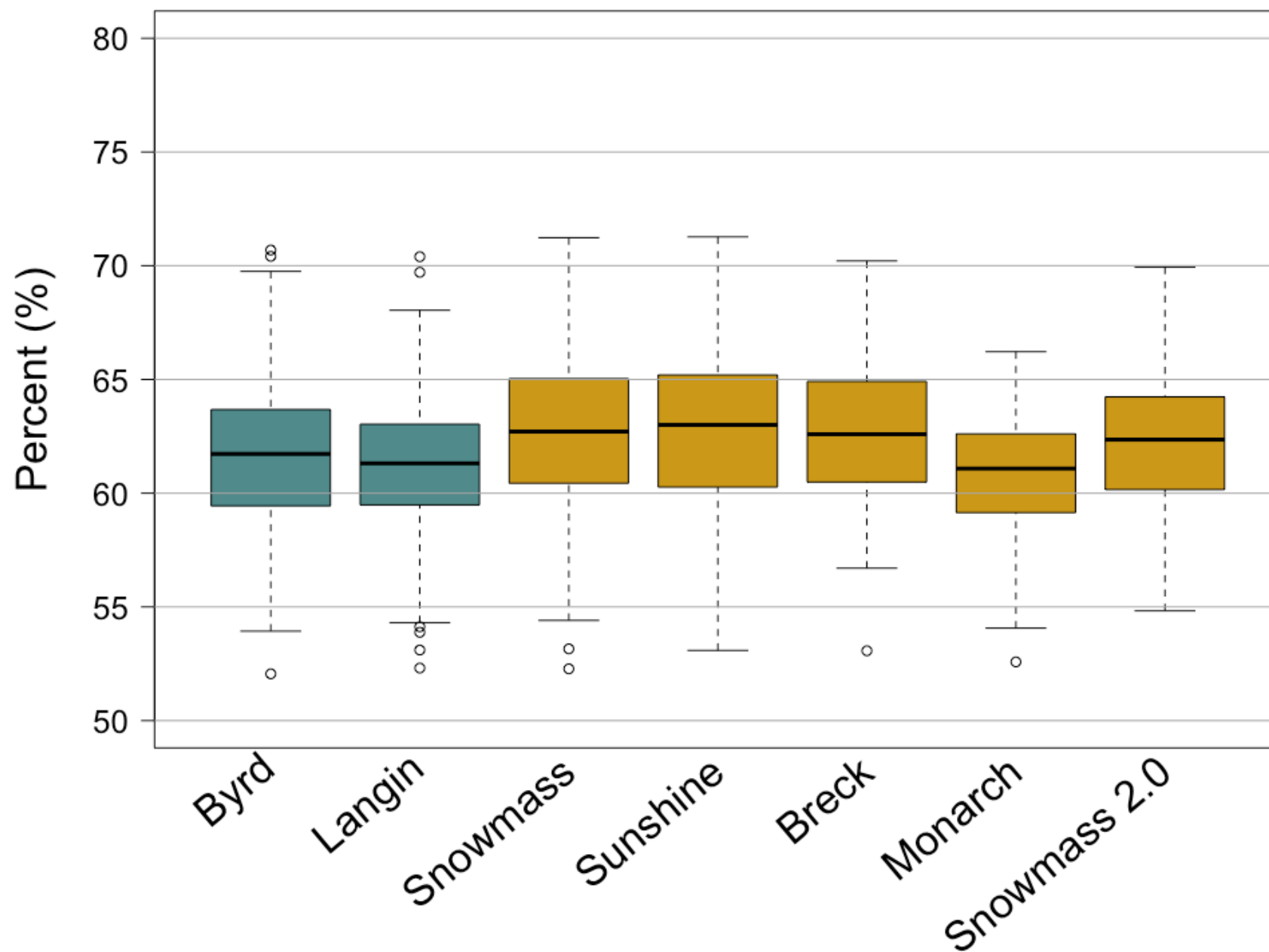
Cnn

Pred. Abs

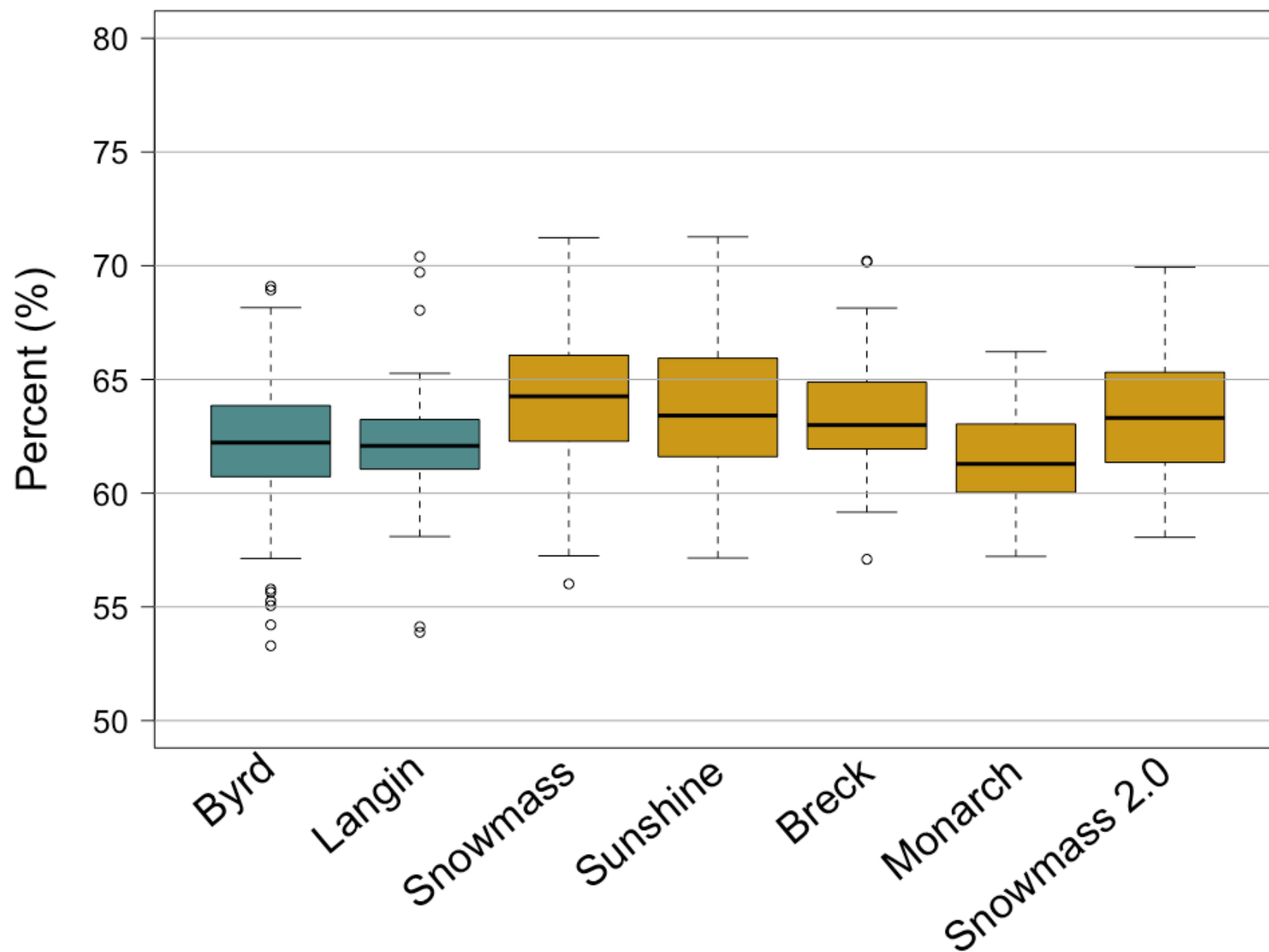
Cnn
Pred. Abs



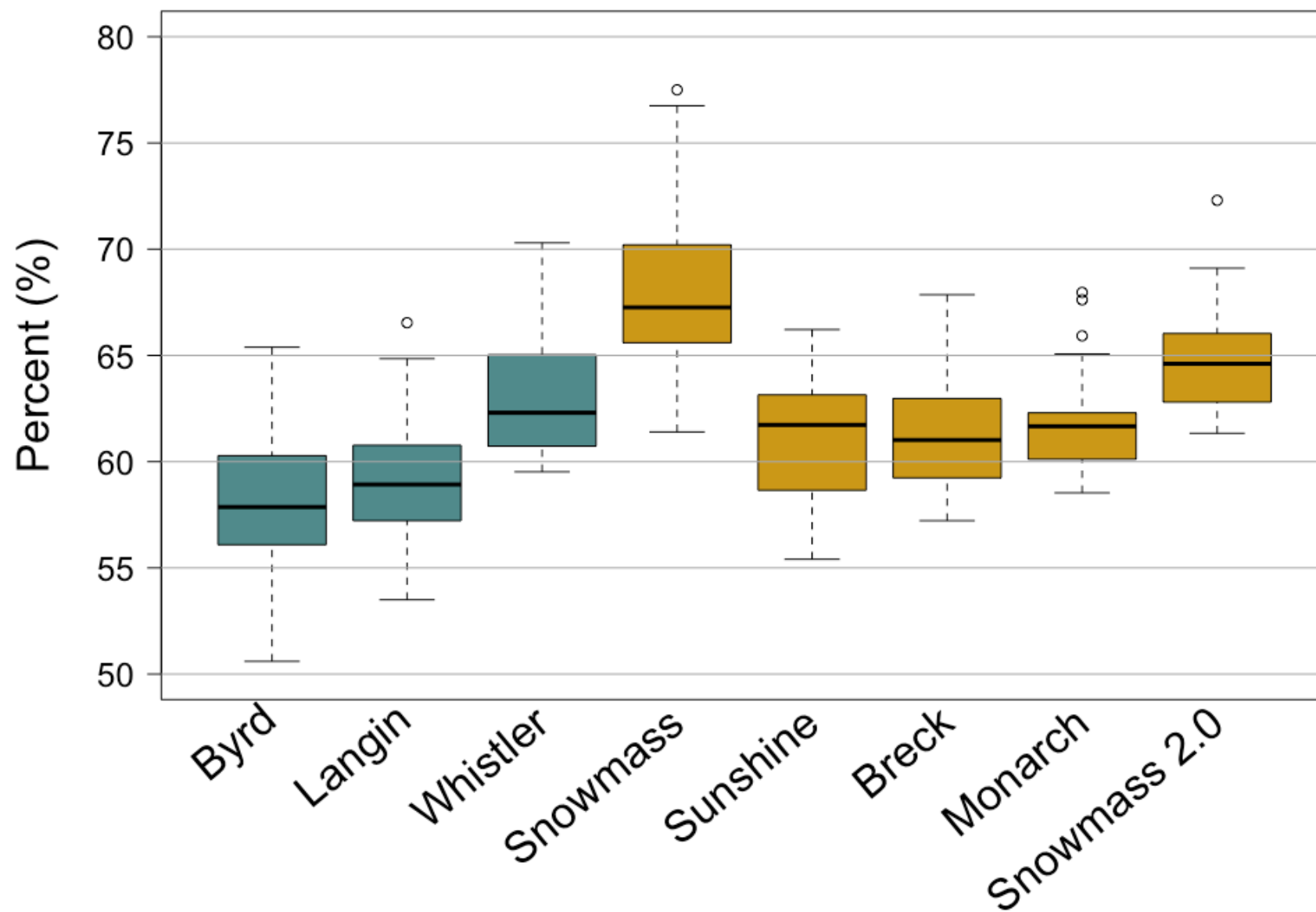
Mixograph Water Absorption



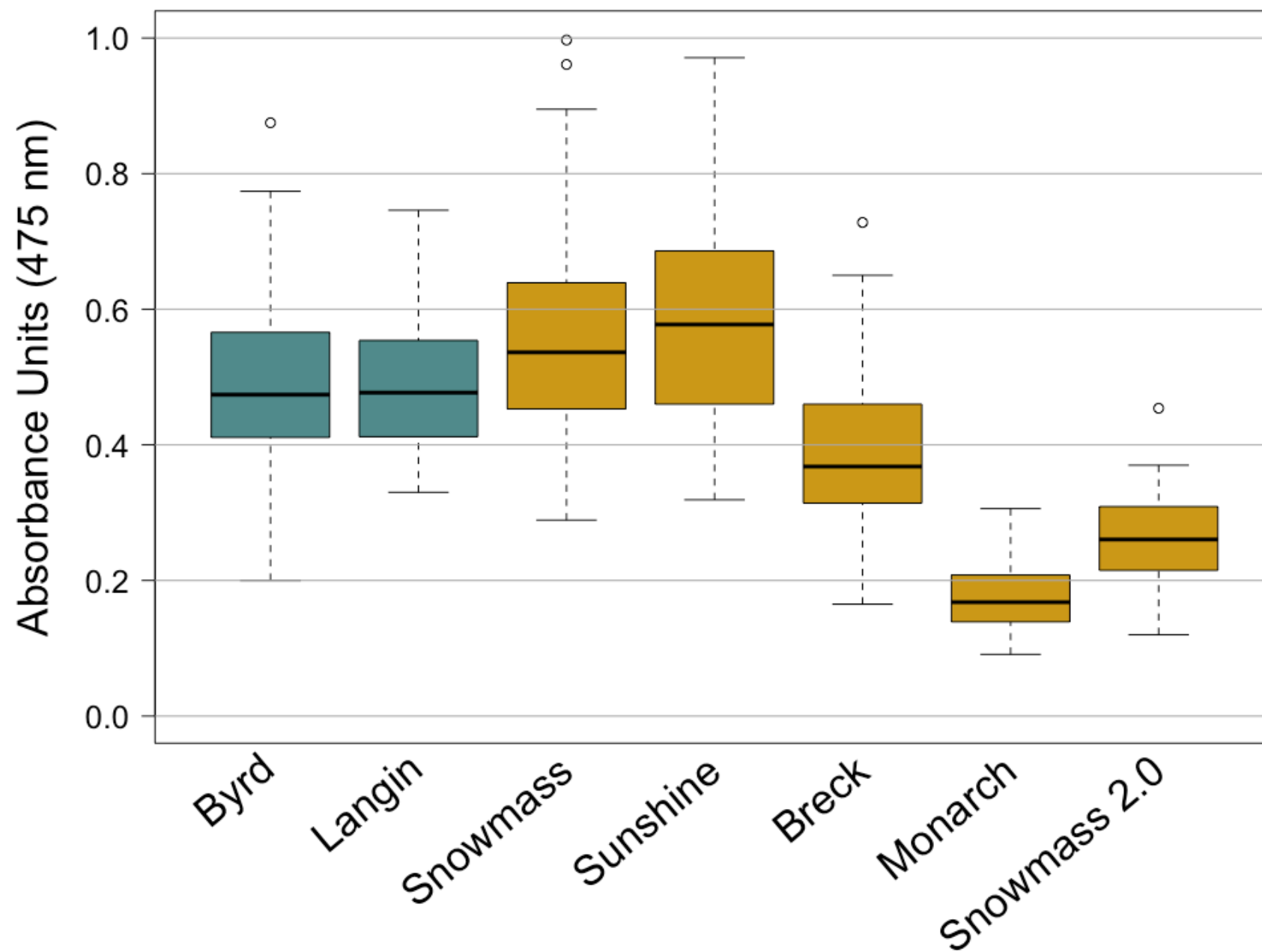
Bake Water Absorption



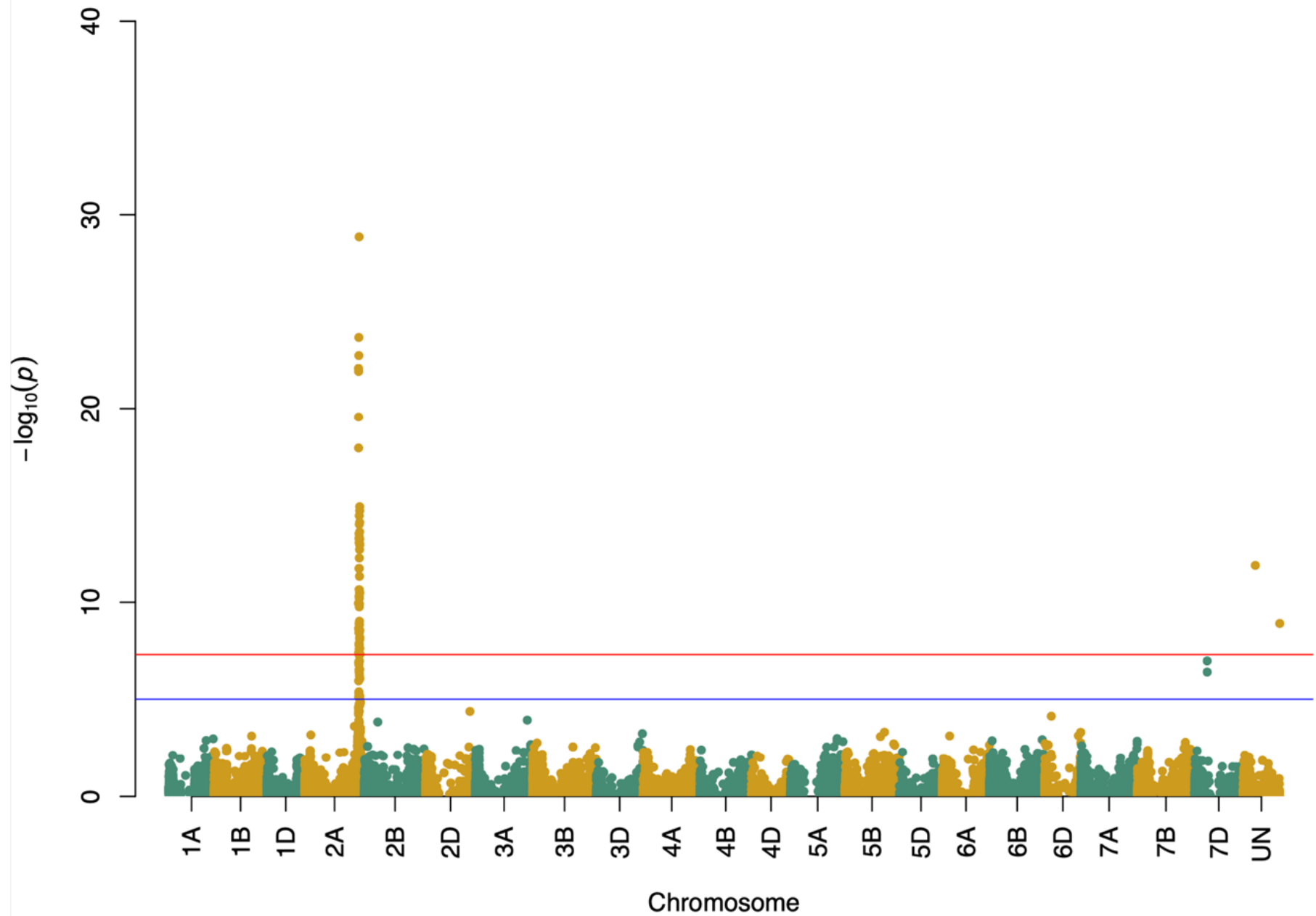
SRC Water Absorption



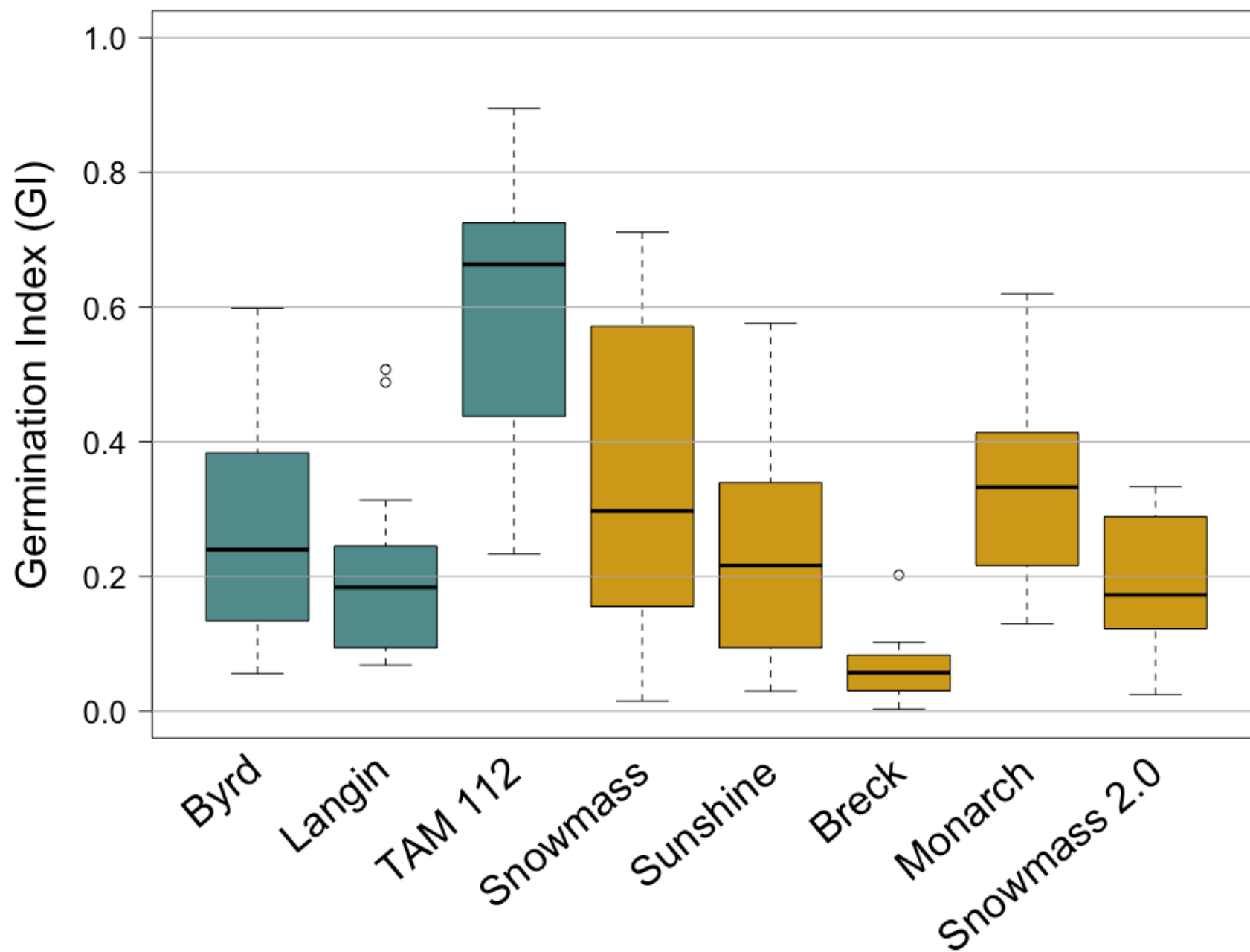
Polyphenol Oxidase (L-DOPA assay)



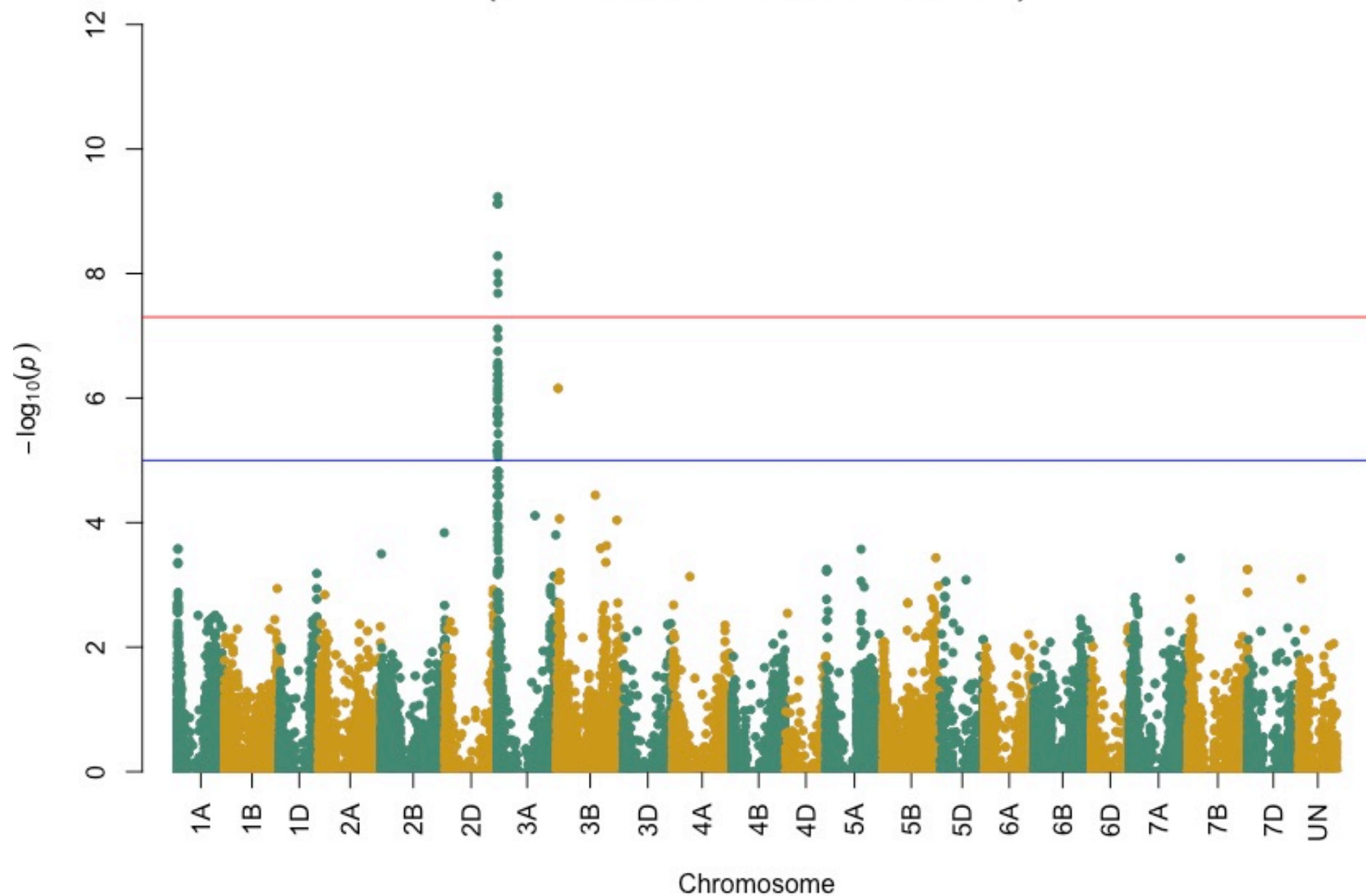
Genome Wide Association – PPO (2019 GBS)
(1631 individuals x 31923 markers)



Pre-Harvest Sprouting Tolerance



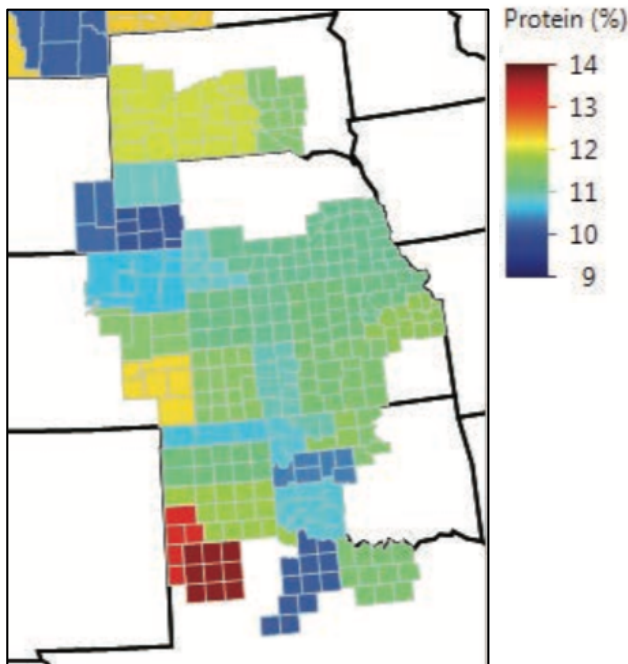
Genome Wide Association - Preharvest Sprouting (2014-2017)
(406 individuals x 49106 markers)



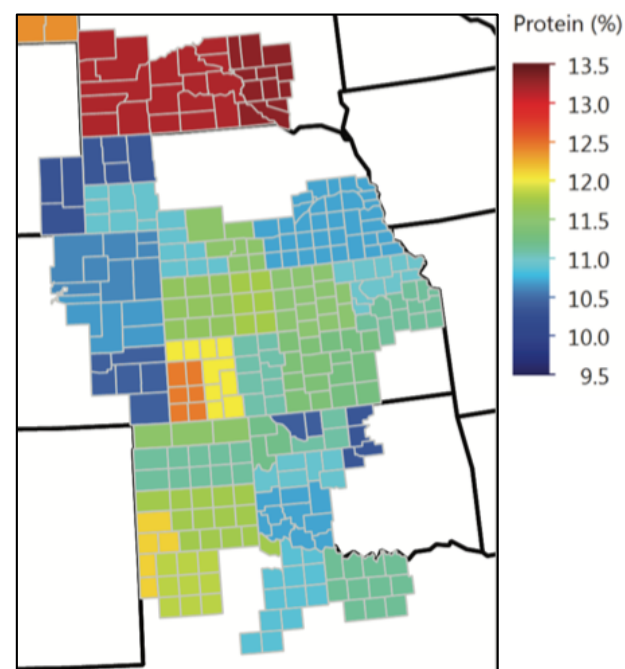
Grain Protein

- Since 2014, winter wheat in eastern Colorado has generally received above average precipitation, resulting in higher than average grain yields.
- Unfortunately, in many areas producers have experienced low grain protein in their crop, resulting in price discounts not just here in Colorado but throughout the region.

2016



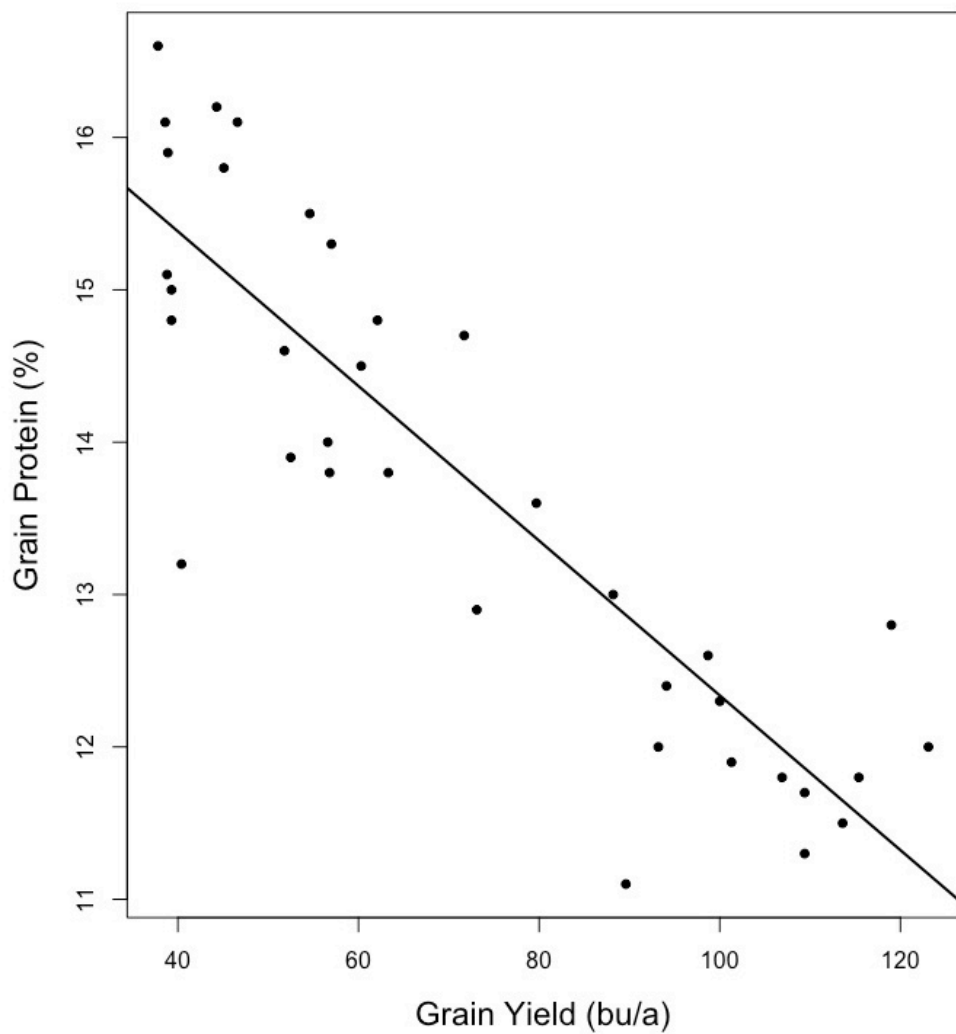
2017



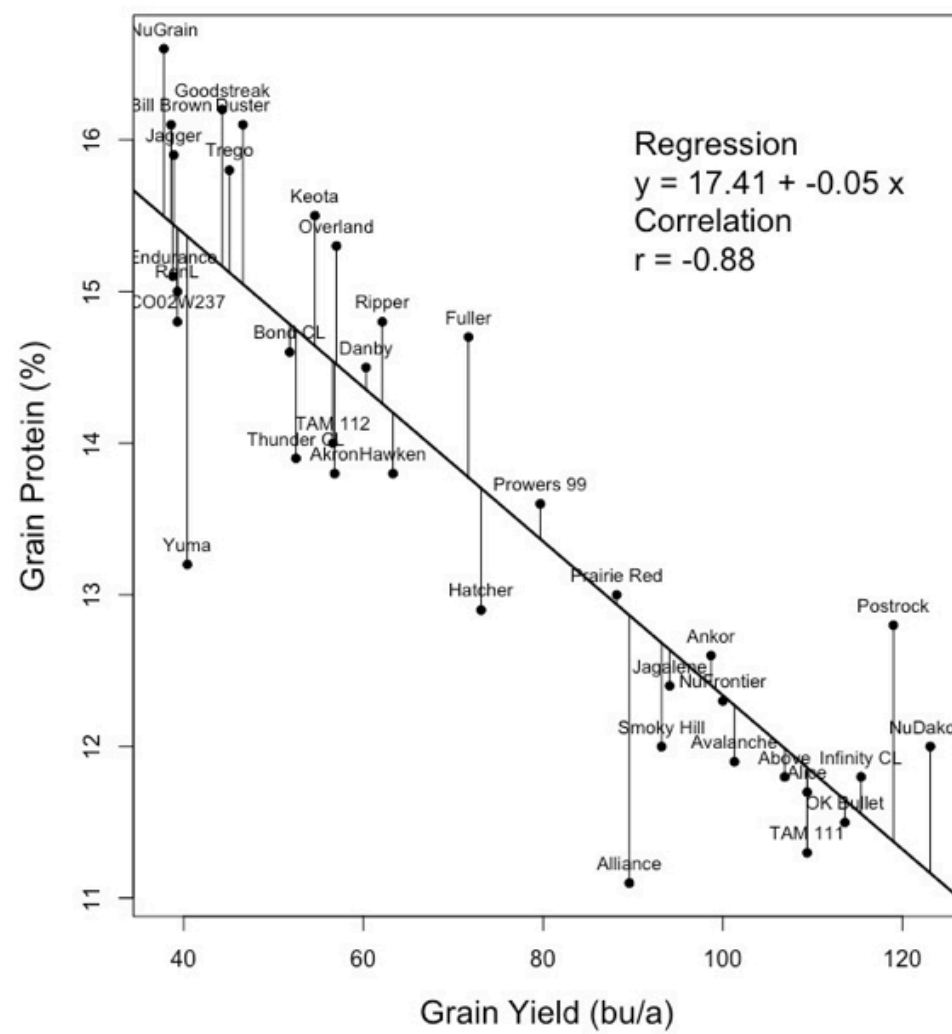
<https://www.plainsgrains.org>

Grain Protein Deviation

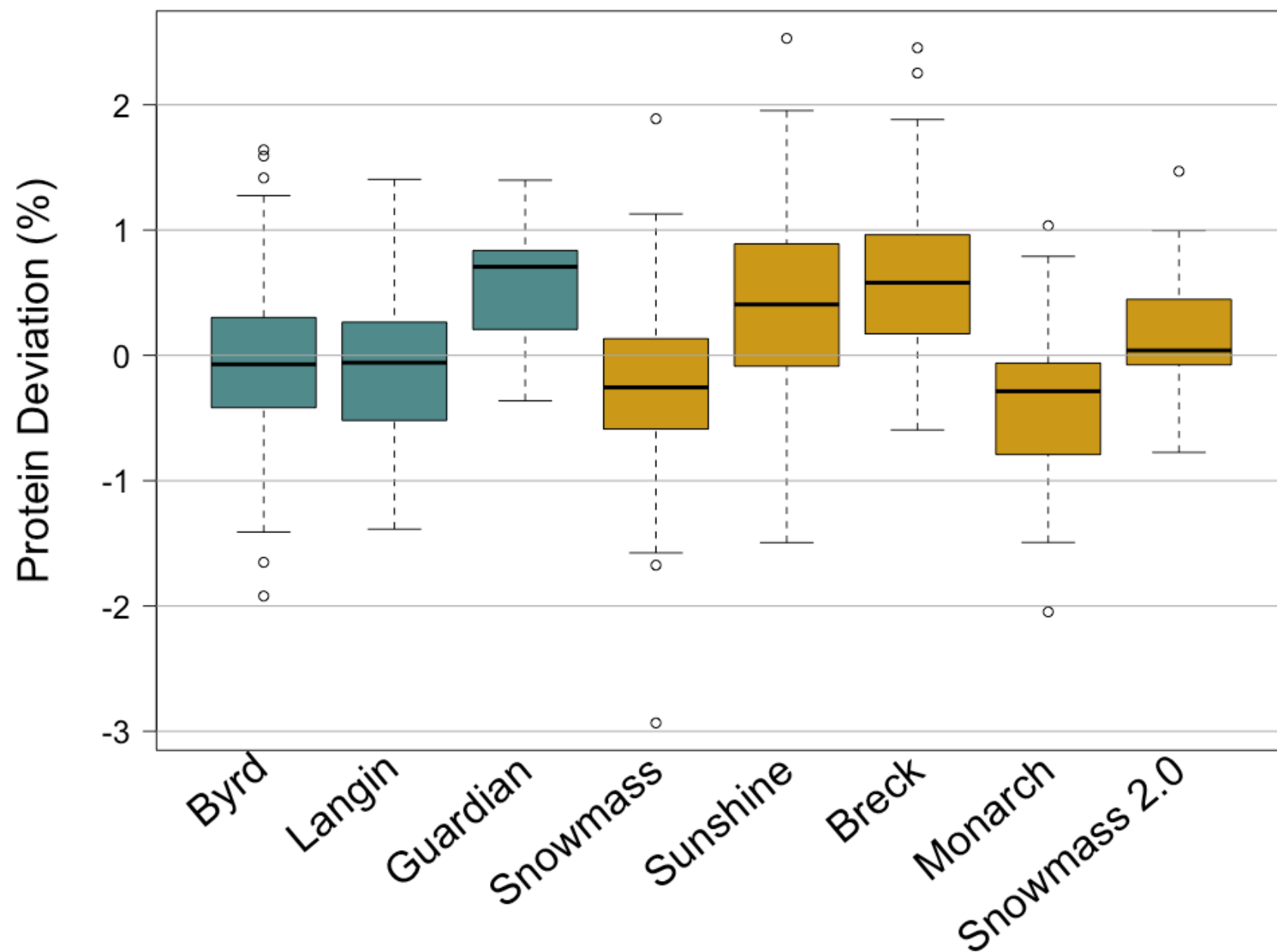
2007 Julesburg UVPT
Grain Yield vs Grain Protein



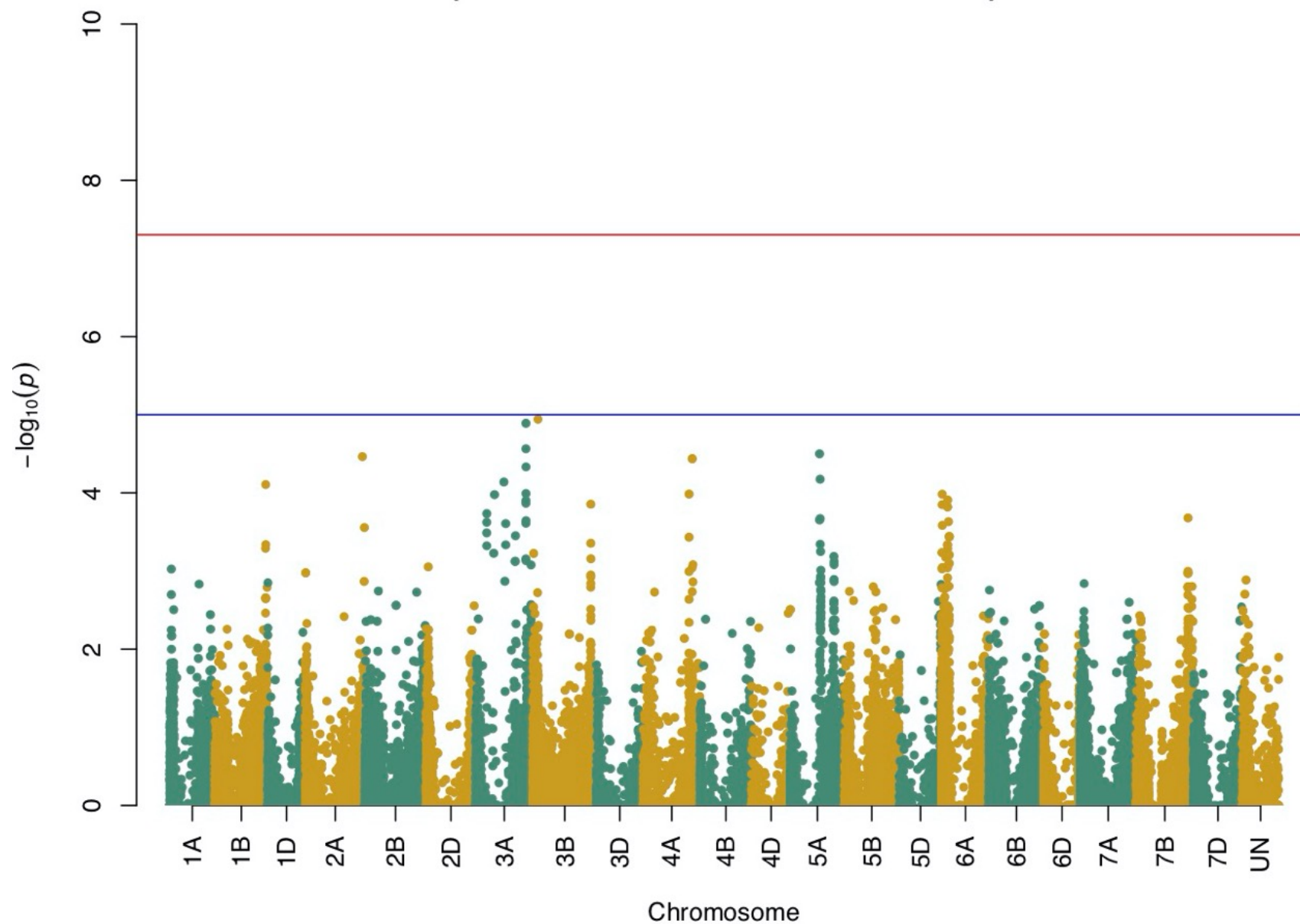
2007 Julesburg UVPT
Grain Yield vs Grain Protein



Grain Protein Deviation (GPD)



Genome Wide Association – Grain Protein Deviation (1685 individuals x 47304 markers)



A Few Closing Thoughts

- Hard white wheat was headed for the "ash heap of history" in Colorado in 2007-2008. The CWRF-Arden Mills Ultragrain® Premium Program saved it, and overall this was a good thing – for hard red winter wheat improvement too.
- The CWRF-Arden Mills Ultragrain® Premium Program was initially based on something that we did not fully understand. Open communication with our partner helped us to understand it better.
- Developing wheat varieties for an identity-preserved program can be fun and rewarding for the breeder, but can sometimes be a little frustrating. Identity-preserved programs can also be frustrating – or expensive – for the other entities involved.
- Identity-preserved programs do not operate in a vacuum, as other genetic advances where wheat producers have choice (e.g., hard red winter wheat, maize, sorghum, etc) directly affect the economic viability and sustainability of the identity-preserved model.

Acknowledgements



Colorado Wheat
Administrative Committee



Colorado
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Questions?