

An aerial photograph of a large farm complex. In the foreground, there are several large, white, rectangular barns and silos. A dirt road winds through the farm. The background consists of vast green fields, some of which are divided into smaller plots, possibly for research or different crop varieties. The sky is clear and blue.

Molecular Markers for disease and sprouting resistance.

Jennifer Zantinge

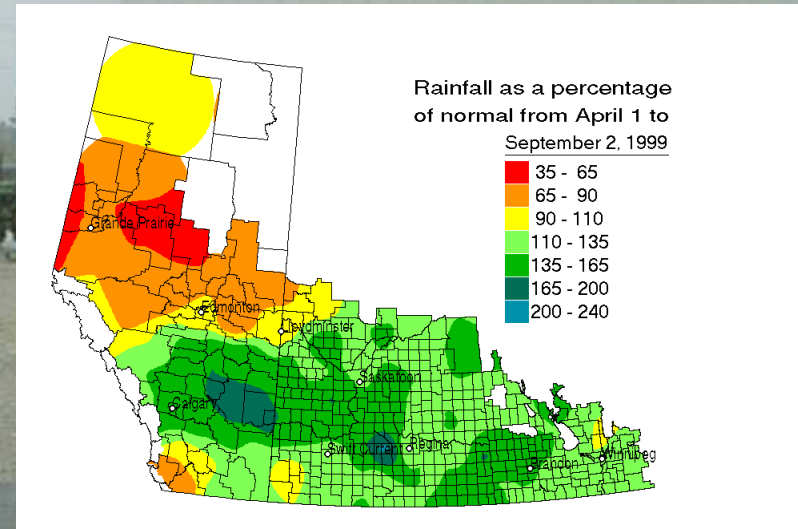
**Shiming Xue, Kristen Steenbergen, Shan Lohr,
Zhanna Hartman and Monica Ban Matei**

FCDC, Lacombe Alberta

Breeding malt barley

- difficult to pyramid genes for disease resistance, agronomic traits and stress tolerance while maintaining malt quality





Traits can be difficult to measure and select

- affected by the environment –temperature, rainfall, diseases
- can be complicated and/or expensive to measure.
- complex genetic control, multiple genes and interactions, epistatic, recessive etc

MAS-marker assisted selection

- Marker-Assisted Breeding (MAB) combines classical plant breeding with the tools and discoveries of molecular biology and genetics, most specifically the use of molecular markers (MAS).

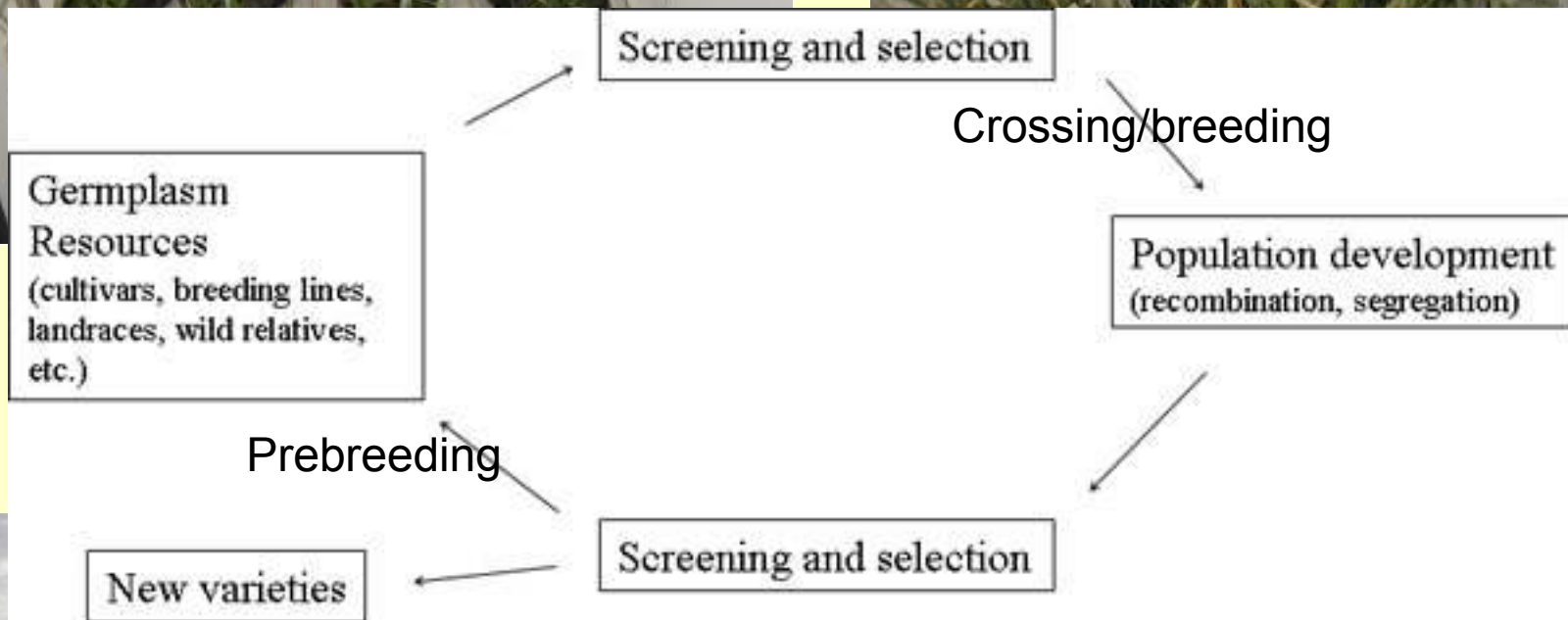


What are molecular markers?

- Identifier of a particular phenotype and/or genotype; easily be followed from generation to generation.
- Molecular marker: variants in the DNA sequence (eg microsatellites)

Scored

Utilization of MAS in breeding cycle



Traits

- Scald resistance



Goal: durable or multi-gene resistance to scald into lines with good malting quality.

- Preharvest sprouting (PHS) tolerance

Goal: develop some tolerance to PHS, without affecting malting quality.



Scald

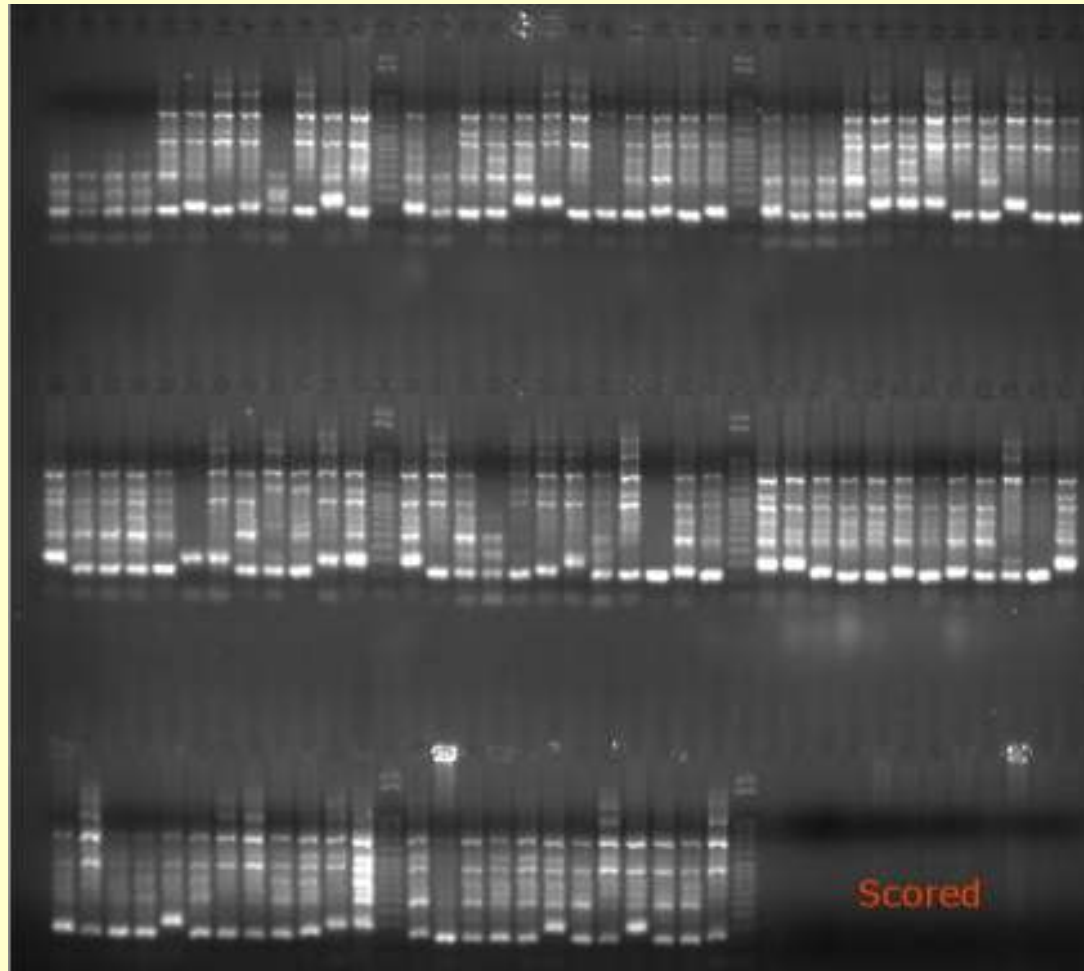


Scald (*Rhynchosporium secalis*) of barley is prevalent in central Alberta and causes considerable yield and quality losses. Scald can rapidly change in pathotype composition and frequency, thereby making it difficult to develop durable scald resistance in barley.

Marker development

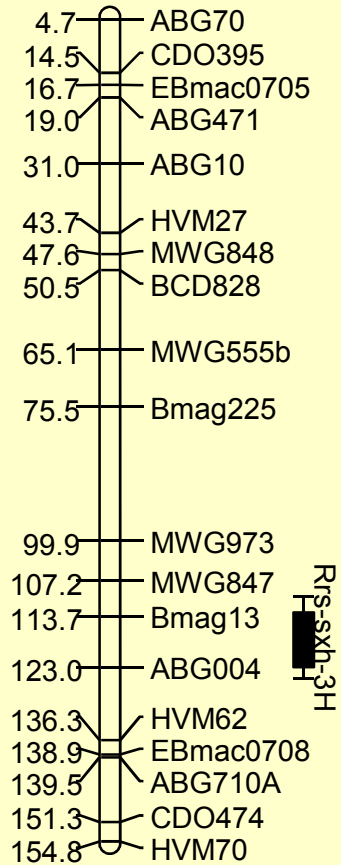
- Linkage mapping
- Viable marker tightly linked and polymorphic across populations
- Segregation and molecular marker analysis on 146 F8 recombinant inbred lines (RIL) derived from the cross of Harrington (susceptible) and Seebe (resistant).
- Seebe, carries durable genetic resistance but has high beta-glucan levels in the malt.

SSR HVM36
dormancy
population

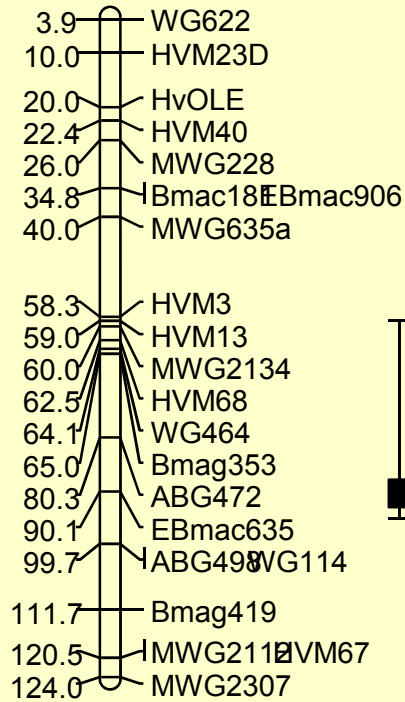


Analyzed the genetic population with ~300 SSR markers, to detect polymorphism that were linked to Scald resistance

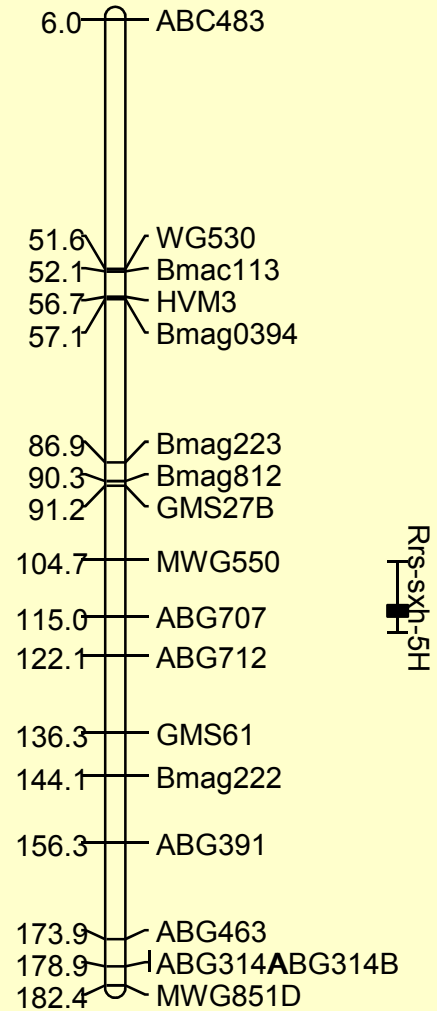
3H



4H



5H



identified a major QTL for scald resistance on the 4H and two minor QTLs on the 3HL and 5HL.

Validation selection of scald resistance from 'Seebe' and malting quality.

- 4 crosses consisting of advanced lines with good malting quality and scald resistant variety, Seebe
- MAS analysis, using markers linked to 3 QTLs
- Simple correlations were run between malting quality traits and the scald ratings and markers using SAS systems PROC CORR

Correlation of markers to scald ratings for J04064 population

Marker	2007 U of Alberta	2007 Lacombe	Seedling	2008 Lacombe
5H-275bp	-0.139 ns	0.078 ns	-0.051 ns	0.004 ns
4H-425bp	0.106 ns	0.324***	0.016 ns	0.421 ***

Linkages with malt quality? None?

Current MAS screening on malt barley breeding lines



- Automated work-process increase through put, 1000/day
- DNA purification
- PCR set up

In 2009, 700 lines were assessed for the Harrington/Seebe scald resistance marker in six populations.

In 2009, 14 lines selected for scald resistance by MAS were evaluated in the B2Y2. Of these lines 11 showed excellent scald resistance in the Lacombe scald nursery. Four lines were advanced to the 2010 B2Y3 nursery based on scald resistance, yield, and agronomic



Results from 2009

population	cross	pedigree	No. of lines in 2010 B2Y1
J04049	TR661/Seebe	CDC Thompson/ Camelot/Seebe	5
J04056	TR662/Seebe	Stein/leo//Seebe	2
J04064	H93014003/ Seebe	Manley/Leo//AC Metcalf///Seebe	3
J04070	H03014014/ Seebe	Manley/Leo//AC Metcalf///Seebe	3
J04075	H93016013/ Seebe	Manley/Leo// TR238///Seebe	3
J04079	H93102002/ Seebe	I92124/TR238// Seebe	6

2010 MAS for scald

population	cross	pedigree
J05018	H93014003/H92066207 (TR03664)	Manley/Leo//AC Metcalfе///Harrington/Seebe
J05029	H94050005/TR03664	H93125F1/Seebe/Harrington/ Seebe
J05033	H92020198/TR03664	Leo/CDCThompson// Harrington/Seebe
J05035	TR03664/Bentley	Harrington/Seebe// I92125/TR229
J05036	TR03664/H93174006	Harrington/Seebe// H92076F1/TR238
J05037	TR03664/H92067002	Harrington/Seebe///TR622/ Seebe
J05038	TR03664/H94039004	Harrington/Seebe//H93098F1/ Seebe

Preharvest sprouting resistance

- Wet conditions at harvest may initiate germination (pre-harvest sprouting, PHS).
- Germination occurs while the grain is still attached to the spike, prior to harvest.
- PHS results in lower yields and poor grain quality.



MAS-Preharvest sprouting resistance

- To identify, map QTLs and develop molecular markers linked to genes affecting seed dormancy and PHS resistance in 'Samson' (feed barley with high dormancy).
- Develop markers that could be used to integrate some dormancy in malt barley without affecting quality.

Seed Dormancy

- The failure of an embryo to germinate when grains are placed under otherwise favorable conditions of moisture and warmth.
- Seed dormancy is an important trait that can affect barley seed quality because it determines resistance to PHS.
- PHS resistance is affected, by the seed hull which is of maternal origin.