FHB Resistance in Durum
-Progress and Challenge

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Outline

- Sources of resistance for durum
- FHB introgression and variety/germplasm development in durum
- What we have learned
- Future research

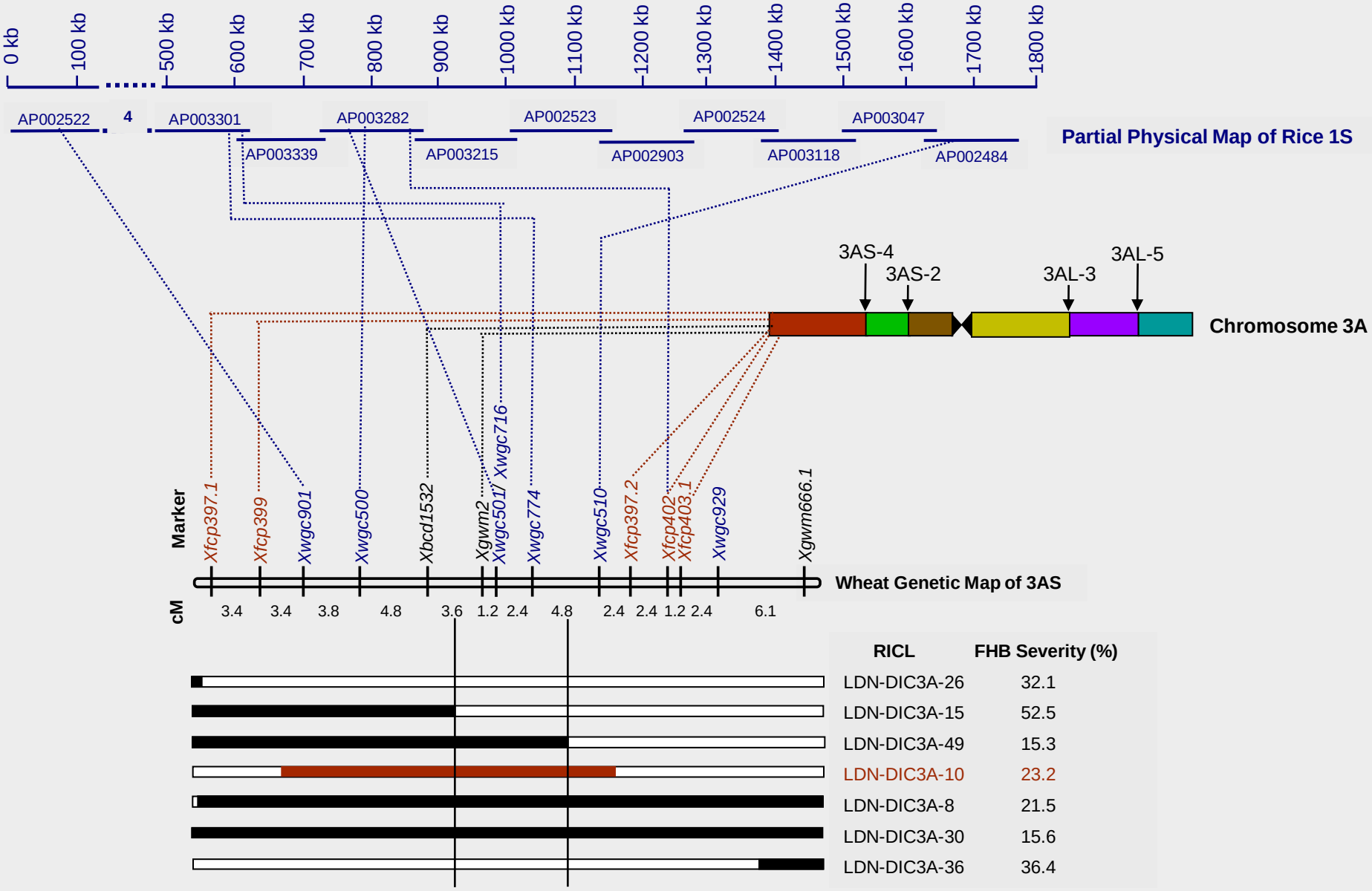
Sources of Resistance for Durum

- Wild emmer wheat – *Qfhs.ndsu-3AS*
- Tunisian durum lines– *Qfhs.ndsu-5BL*
- Cultivated emmer, Persian, and Timopheev's wheat – *Qfhb.rwg-5A.1* and *Qfhb.rwg-5A.2*
- Hexaploid wheat
- Wild relatives of wheat

Mean FHB Severity of LDN-Wild Emmer Substitution Lines in the Greenhouse (1996-1998)

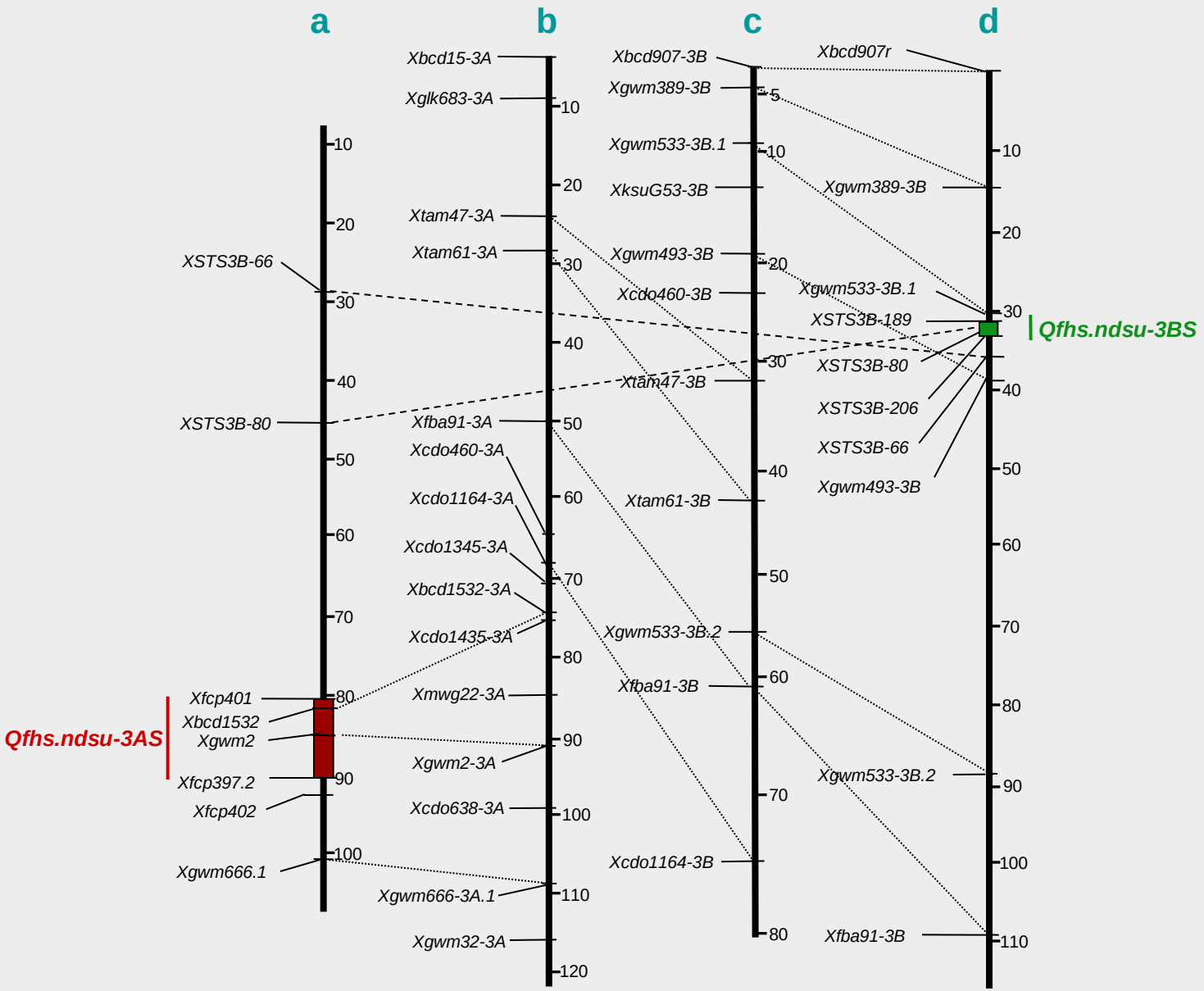
Genotypes	FHB Severity (%)
LDN-16	50.8
LDN(DIC-1A)	36.5
LDN(DIC-2A)	83.9
LDN(DIC-3A)	19.8
LDN(DIC-4A)	48.3
LDN(DIC-5A)	40.6
LDN(DIC-6A)	72.4
LDN(DIC-7A)	65.7
LDN(DIC-1B)	69.2
LDN(DIC-3B)	57.8
LDN(DIC-4B)	36.6
LDN(DIC-5B)	44.8
LDN(DIC-6B)	35.5
LDN(DIC-7B)	57.4
D91103 (resistant check)	29.6
D87450 (susceptible check)	62.6

R. W. Stack and E. Elias Crop Sci. 42:637 (2002)



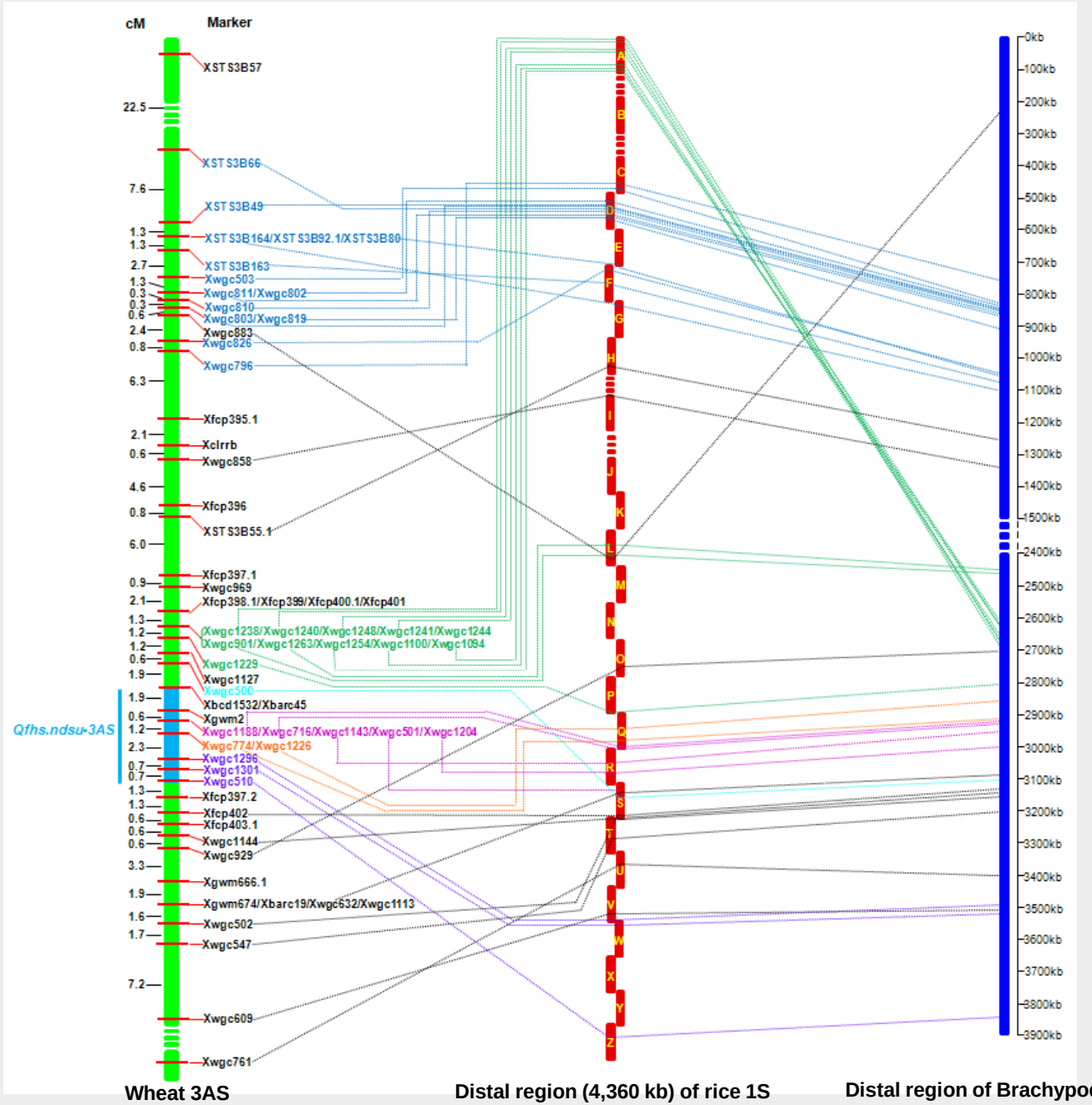
FHB Resistance QTL *Qfhs.ndsu-3AS* Derived from Wild Emmer Wheat

S. Kianian; X. Cai



a Partial genetic map of the chromosomal region harboring *Qfhs.ndsu-3AS;* **b** CMap of 3AS (http:// wheat.pw.usda.gov/GG2/index.shtml); **c** CMap of 3BS (http:// wheat.pw.usda.gov/GG2/index.shtml); **d** Partial fine map of *Qfhs.ndsu-3BS* (Liu and Anderson, 2003; Liu et al. 2006)

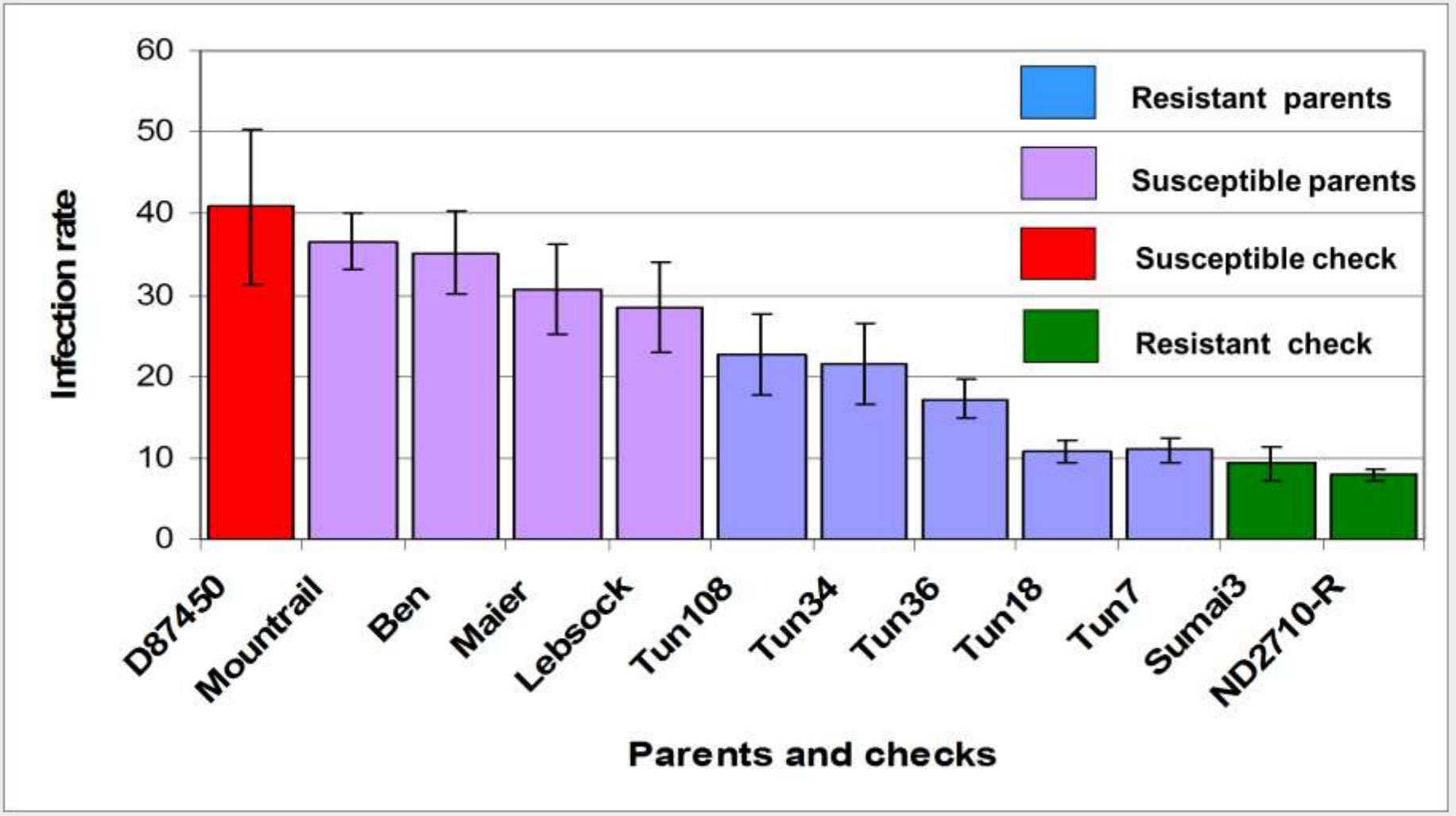
X. Cai Mol. Breed. 2007, 19: 113-124



Saturation Mapping and Comparative Analysis of the Chromosomal Region Harboring *Qfhs.ndsu-3AS*

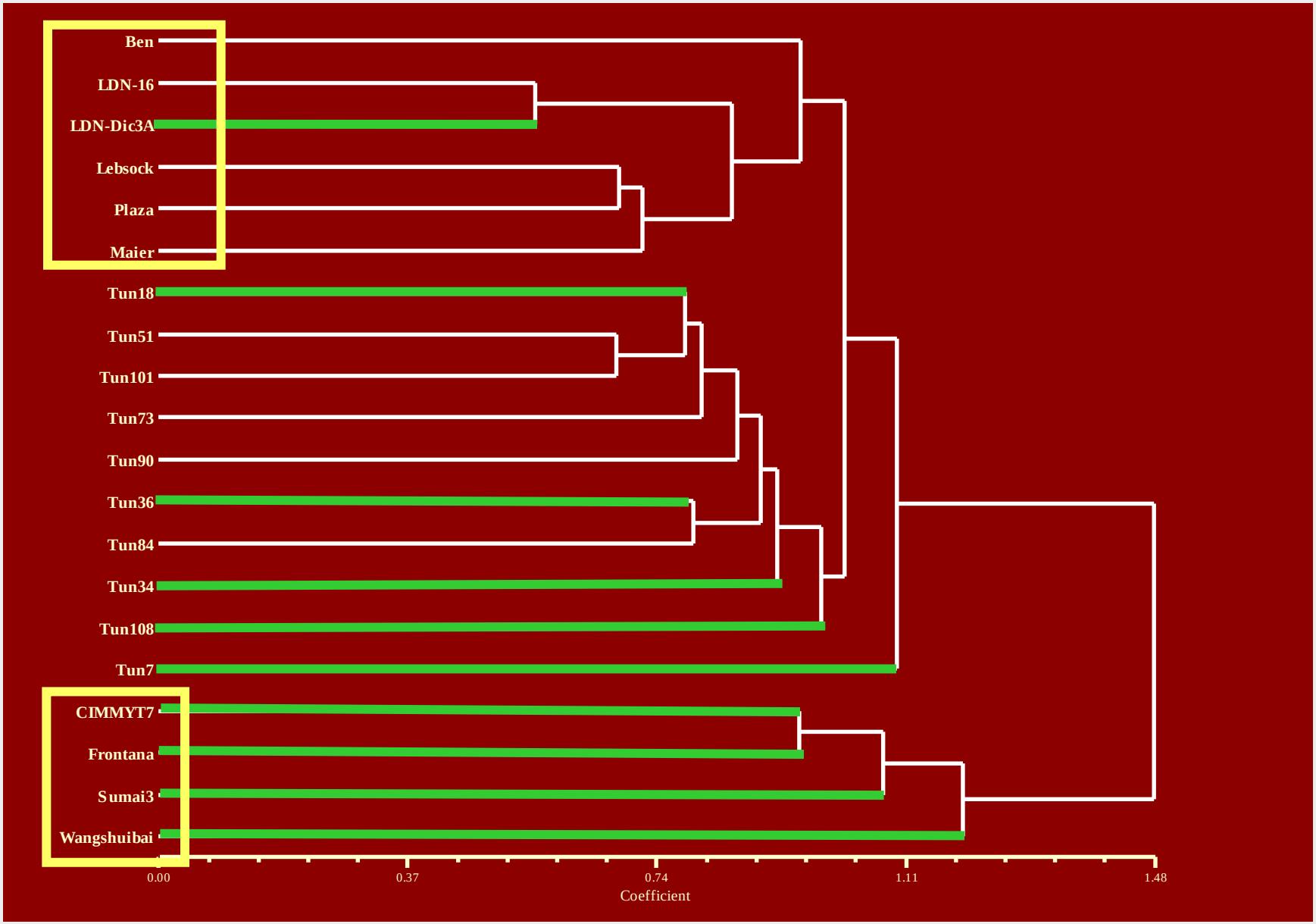
X. Cai

Mean FHB Severity of Tunisian Durum Lines in the Greenhouse (2006-2007)



E. Elias and S. Kianian

Genetic Distance-Based Dendrogram of the Resistance Sources



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Identification of FHB Resistance QTL from Tunisian Lines by Association Mapping

- A FHB resistance QTL on 5BL – *Qfhs.ndsu-5BL*
- A chromosomal region on 3BS potentially associated with FHB resistance
- Susceptibility or suppressor of resistance gene(s) on chromosome 2A

FHB Resistance of Persian and Cultivated Emmer Wheat in the Greenhouse

Genotypes	Winter 2004		Spring 2005	
	3w sp*	3w pt§	3w sp	3w pt
Sumai 3	1.2	7.7	1.2	6.3
Russ	12.7	79.0	6.7	43.9
PI61102 (Persian wheat)	1.7	8.8	3.6	17.4
PI78812 (Persian wheat)	2.0	10.7	1.9	10.7
PI94750 (Persian wheat)	2.6	15.3	2.1	11.6
PI94752 (Persian wheat)	2.4	12.4	1.4	6.7
PI115816 (Persian wheat)	3.8	19.4	3.3	18.3
PI283889 (Persian wheat)	2.2	12.6	1.3	6.6
PI352281 (Persian wheat)	1.4	7.2	3.3	26.5
CI3686 (cultivated emmer)	2.3	13.6	1.8	11.9
CI14086 (cultivated emmer)	2.9	15.6	2.8	14.2
CI14135 (cultivated emmer)	1.1	4.9	2.0	8.5
LSD (0.05)	**2.9**	**17.2**	**2.7**	**16.2**

* Average number of infected spikelets per spike (sp) and § average percent infection (pt) at three weeks post-inoculation

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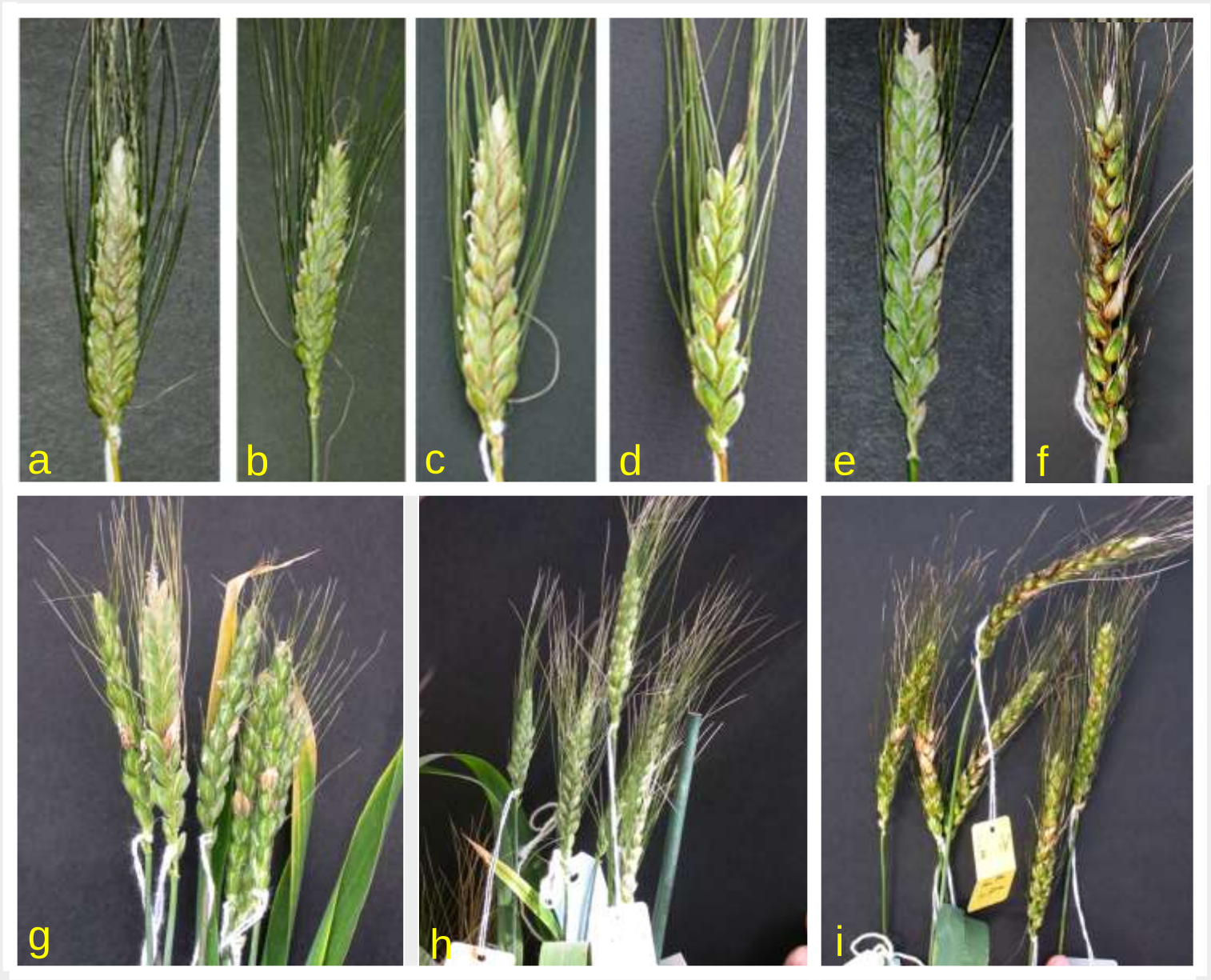

Reactions to *Fusarium graminearum* of cultivated emmer (a-h) and Persian wheat (i) at 21 days post inoculation in the greenhouse

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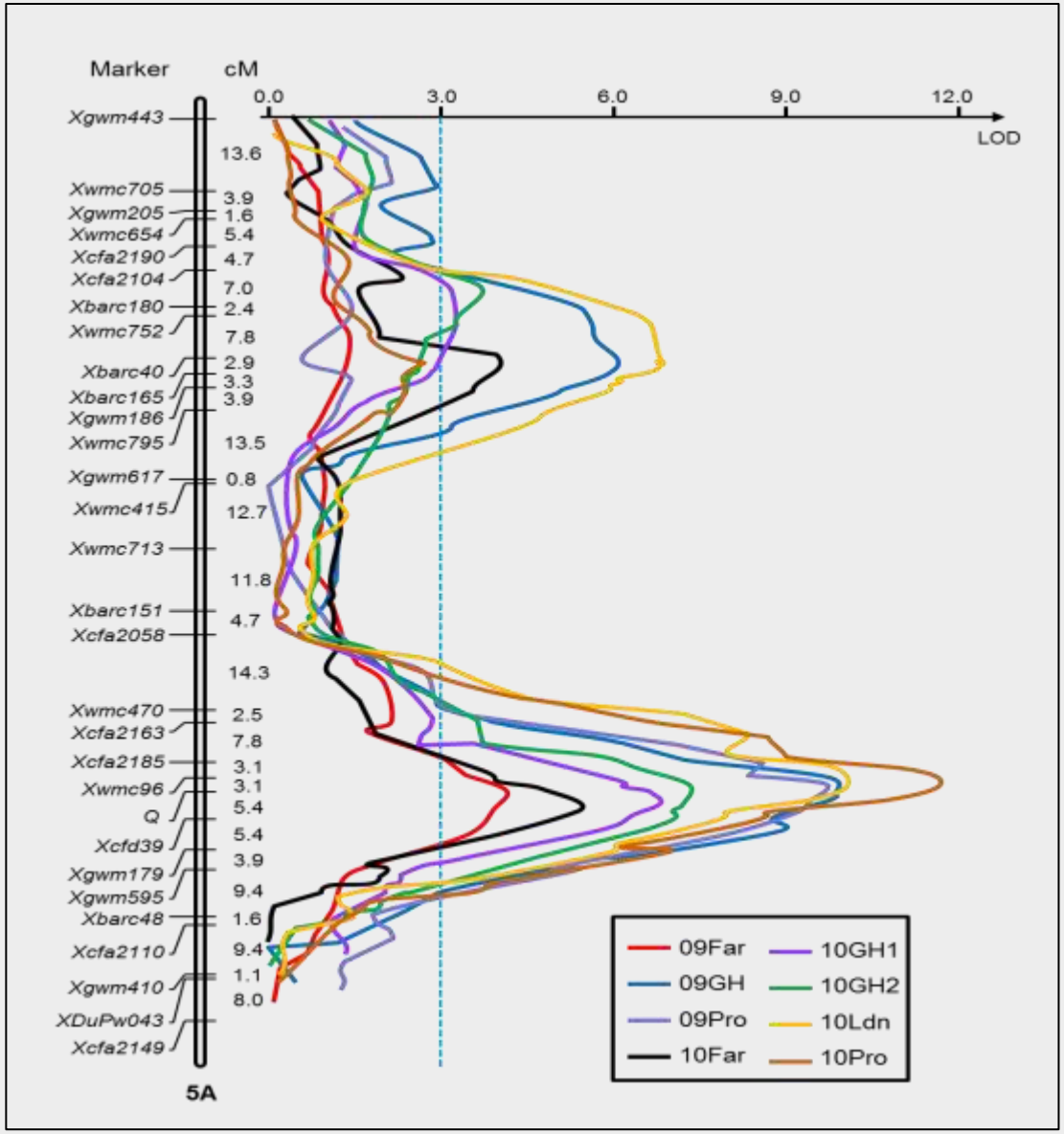
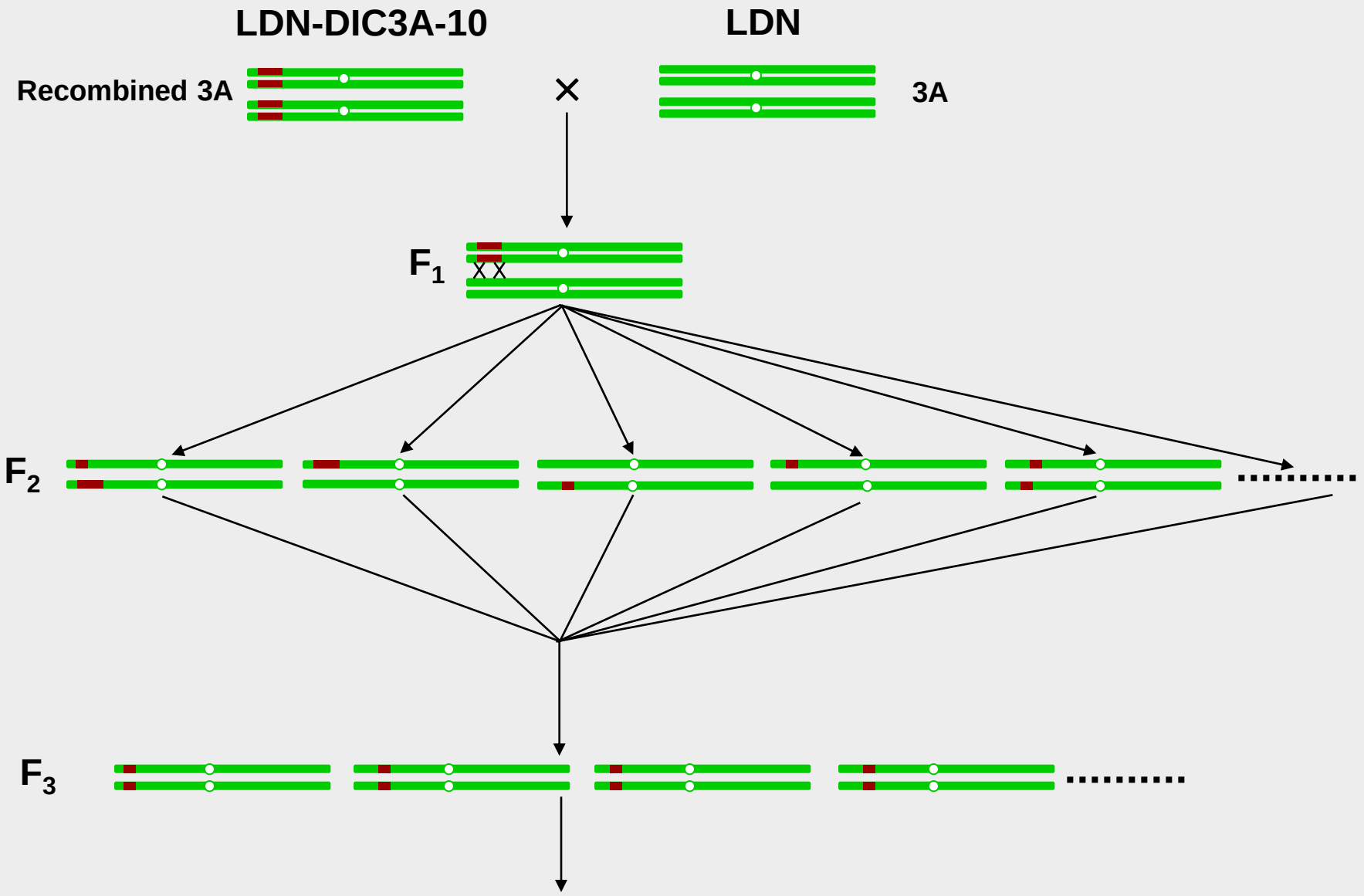
Two FHB Resistance QTL on 5AS and 5AL with Possible Origin of *T. timopheevii* (PI277012)



S. Xu Chu et al. 2011 TAG

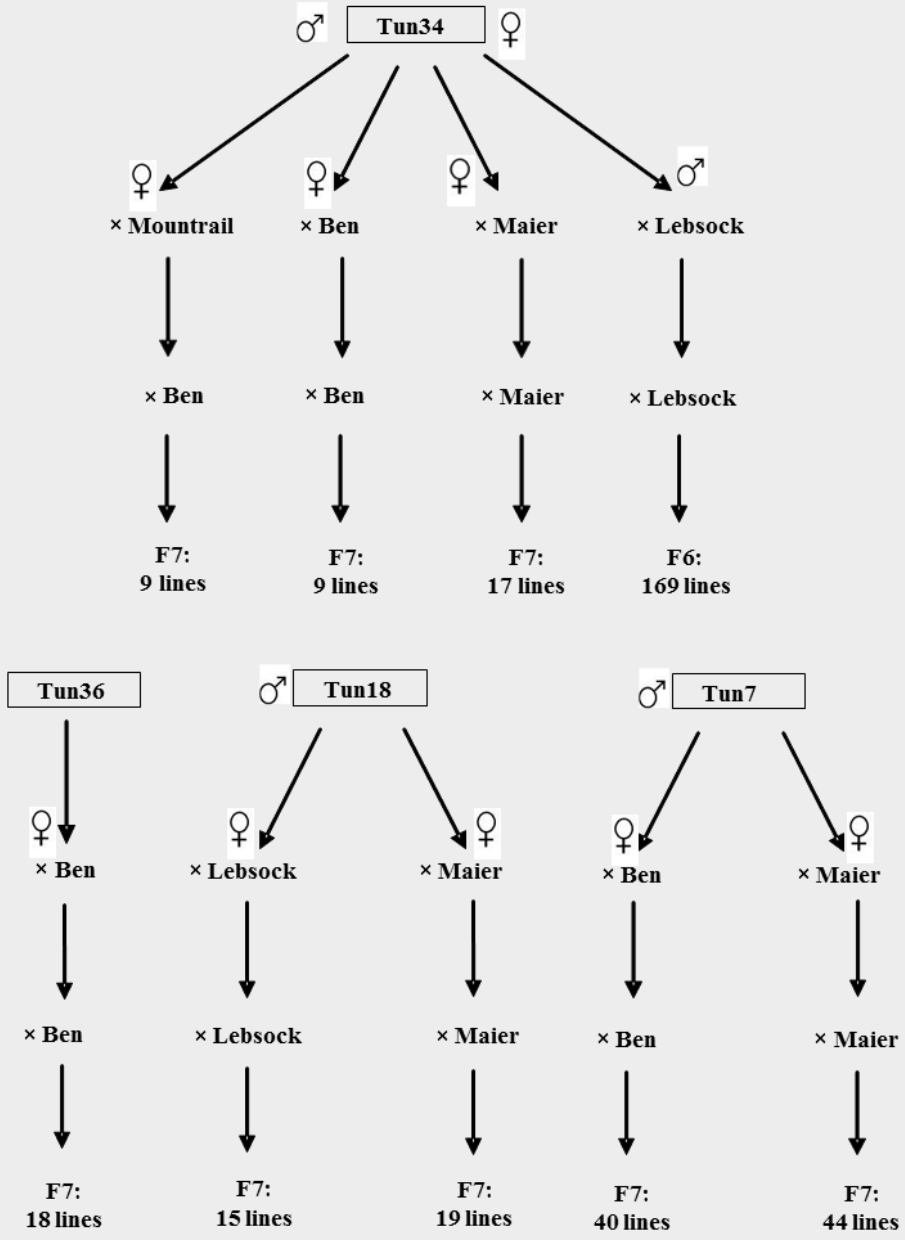
Introgression and Variety/Germplasm Development

- Wild emmer (*Qfhs.ndsu-3AS*)–derived durum lines
- Tunisian lines–derived durum lines
- Cultivated emmer, Persian, and Timopheev's wheat–derived durum lines
- Sumai 3 (*Fhb1*)–derived durum lines
- Wild relative–derived durum lines
- Durum varieties


LDN-DIC3A-10
LDN
Recombined 3A
×
3A
F1
XX
F2
F3
Evaluating homozygous recombinants for FHB resistance

X. Cai

Introgression of FHB Resistance from the Tunisian Lines into Durum



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2009 Durum Uniform FHB Nursery, Langdon, ND

Divide

Emmer-derived durum line

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FHB Severity and DON of Durum Wheat Cultivars (2007 - 2010)

Genotypes	Field (%)	Greenhouse (%)	DON (ppm)
Alkabo	38.0	32.2	1.9
Divide	38.7	30.3	1.6
Grenora	38.8	20.0	3.2
Lebsock	39.4	28.9	2.4
Mountrail	46.5	56.7	3.1
Tioga	44.3	16.5	2.0
Number of environments	12	4	6

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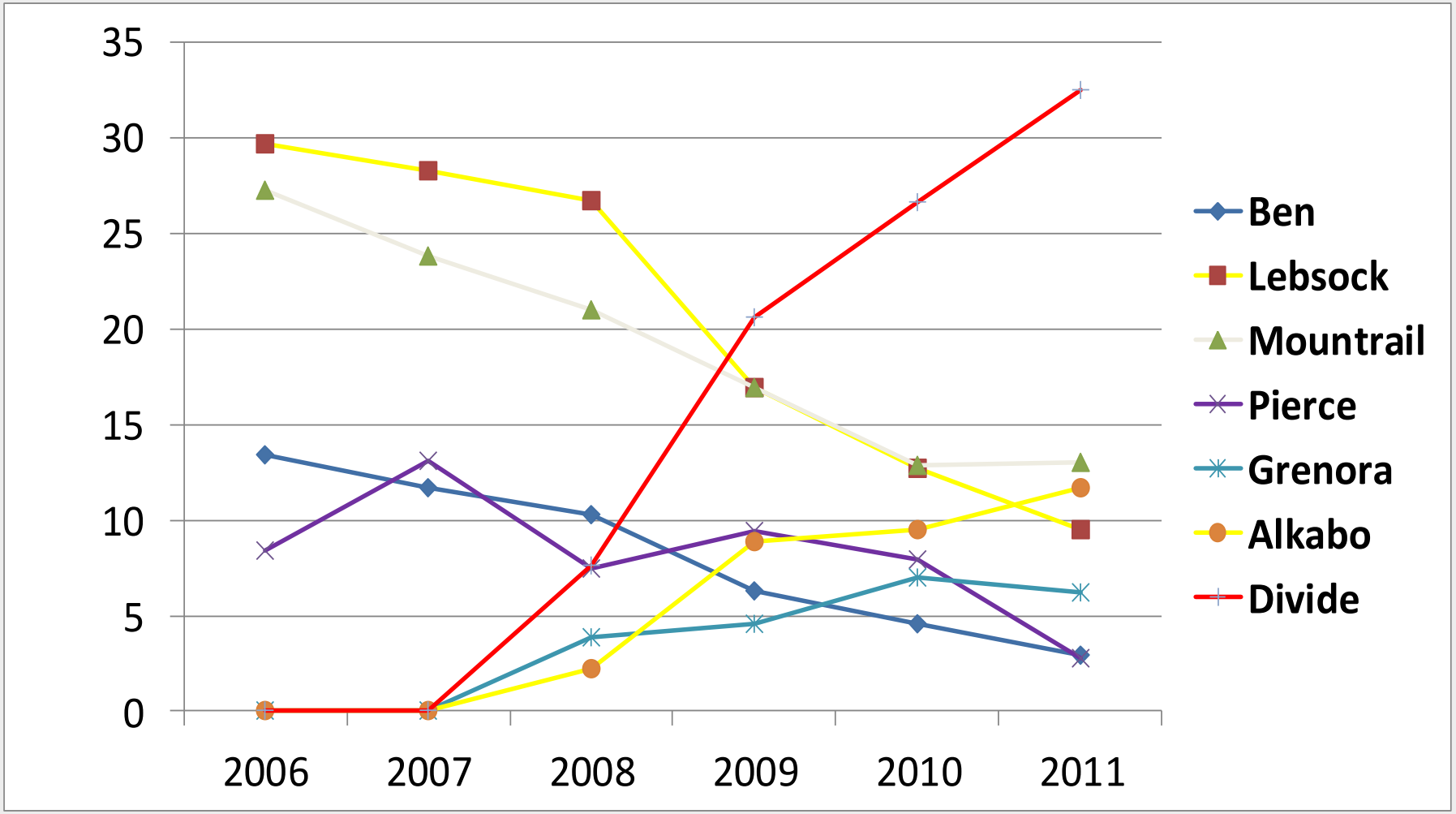
Durum Wheat Cultivars Grown in ND



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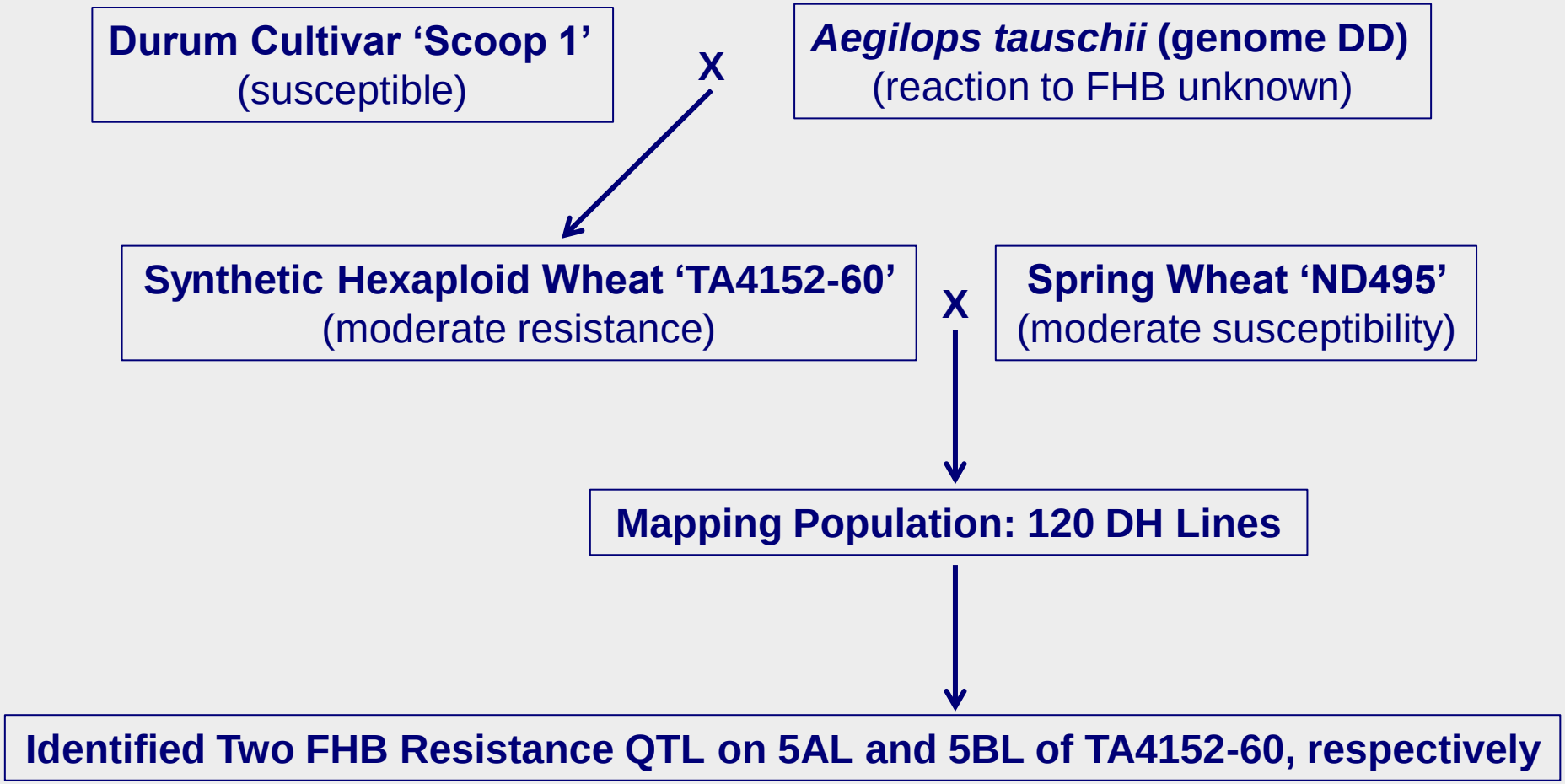
What We Have Learned

- FHB resistance of durum materials in the greenhouse and field conditions
- The role of D genome in FHB resistance
- The role of spike structure in FHB resistance
- Suppression of FHB resistance in tetraploid wheat

Potential Effect of D genome on FHB resistance



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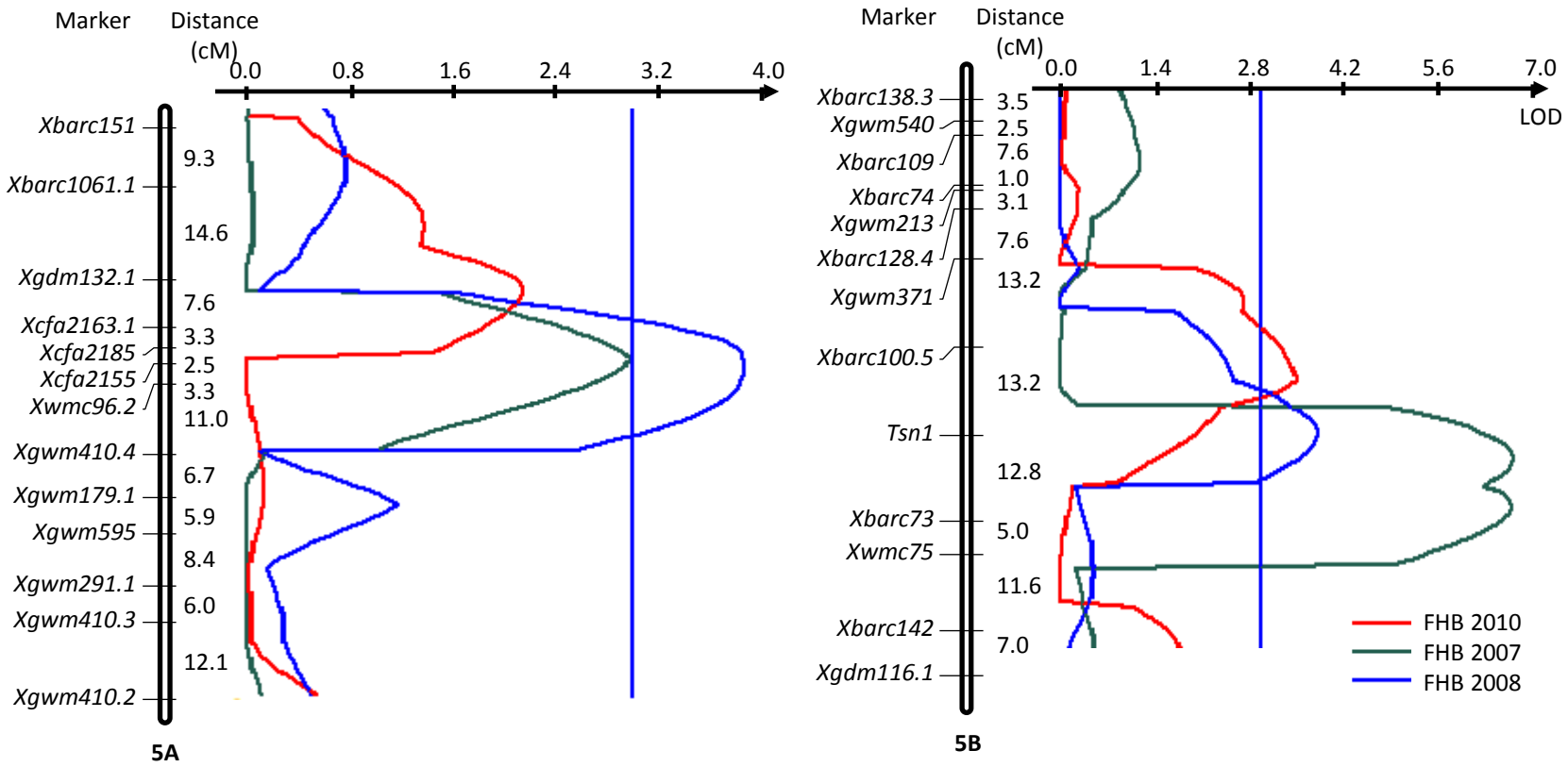

Major QTLs on chromosome 5A and 5B identified in the mapping population from the cross between the synthetic wheat line TA4152-60 and the spring wheat line ND495. The 5A QTL peaked at the interval between *Xgdm132.1* and *Xgwm410.4*, and explained up to 11% of the phenotypic variation. Whereas the 5B QTL explained up to 20% of the trait variation and peaked at the interval between markers *Xbarc100.5* and *Xwmc75.* FHB 2007 and FHB2008 were based on the data from greenhouse inoculation. FHB 2010 was based on the data from the disease nursery located at Fargo, ND.

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Mean FHB Severity of LDN-D genome Substitution Lines in the Greenhouse (2011)

Genotypes	FHB Severity (%)
LDN 1D(1A)	76.89
LDN 2D(2A)	69.38
LDN 3D(3A)	57.25
LDN 4D(4A)	66.77
LDN 5D(5A)	29.60
LDN 6D(6A)	83.80
LDN 7D(7A)	70.18
LDN 1D(1B)	84.53
LDN 2D(2B)	68.66
LDN 3D(3B)	55.87
LDN 4D(4B)	53.24
LDN 5D(5B)	58.04
LDN 6D(6B)	49.40
LDN 7D(7B)	51.46
LDN	70.04
Chinese Spring	73.16

X. Cai

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Future Research

- Search for novel/effective sources of resistance, especially Type I resistance
- Characterize the role of D genome and spike structure in FHB resistance
- Manipulate D-genome chromosomes and suppressor genes to enhance FHB resistance in durum
- Develop elite germplasm and superior varieties from the resistance sources available for durum

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- ND Wheat Commission
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U.S. Wheat & Barley
Scab Initiative