Wheat breeding and testing update

Collaborators Program 10/11/2012

Jorge Dubcovsky

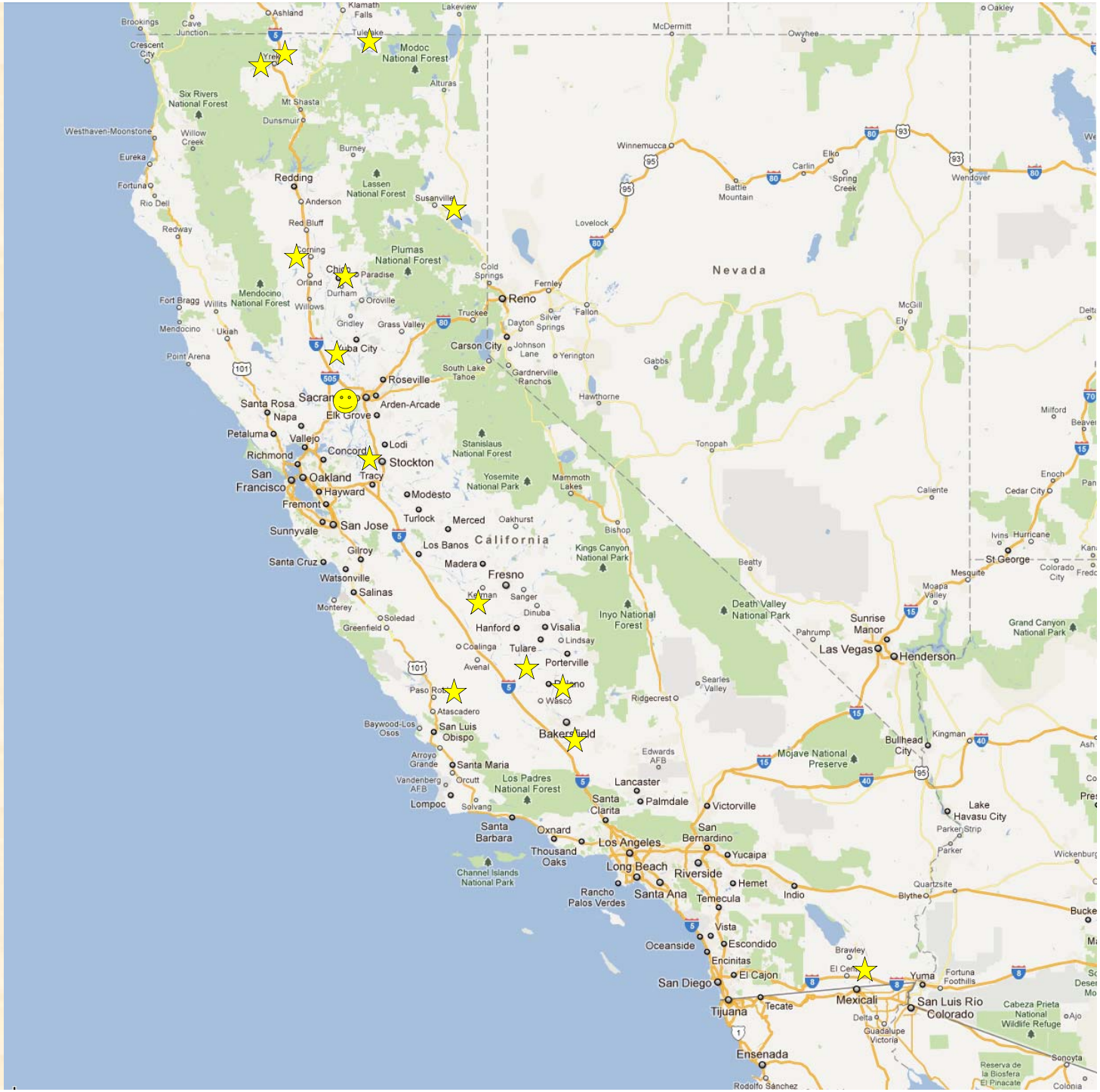
- **Bread wheat breeder (HRS and HWS) Oswaldo Chicaiza**
- **Durum wheat / barley breeding. Alicia del Blanco**
- **Regional Testing wheat & barley. Phil Mayo/ Diane Prato-Mayo/ Sam Fraser.**

Funded by: California Wheat Commission/UC Discovery & CCIA

USDA-CSREES TCAP (Triticeae Coordinated Agricultural Projects)

UCDAVIS PLANT SCIENCES

Small Grains Regional Trials 15 locations 2012. Phil Mayo



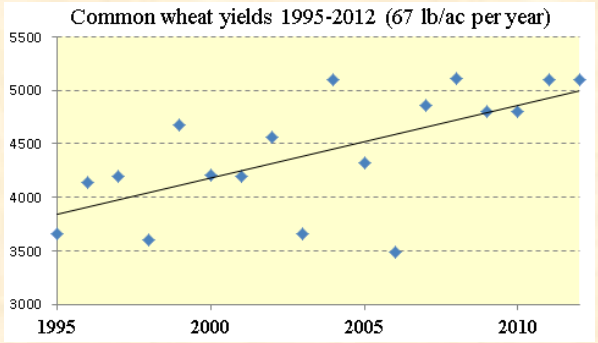
Small Grains Website

http://smallgrains.ucdavis.edu/

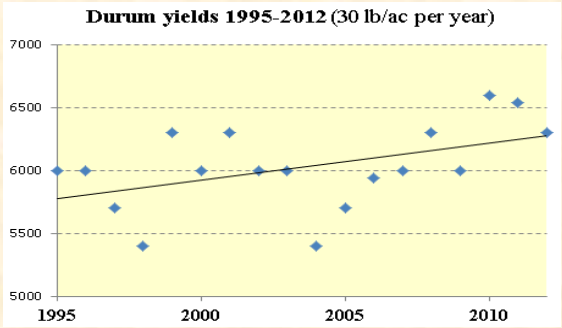
- Cultivar performance
- Disease resistance notes
- Quality evaluations
- 2012 results available
  - 51 Tables uploaded
  - 3 Tables to complete

Wheat Breeding

- Common wheat
  - Identify and deploy new sources of stripe rust resistance
  - Improve drought tolerance



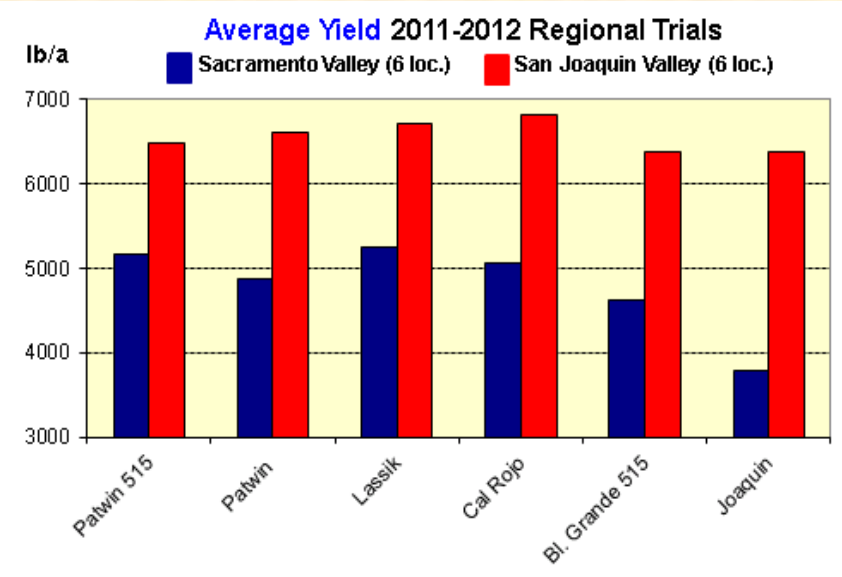
- Durum wheat
  - Reduce cadmium content in the grain
  - Increase gluten strength (W)
  - Increase percent of resistant starch
  - Improve durum wheat salt tolerance



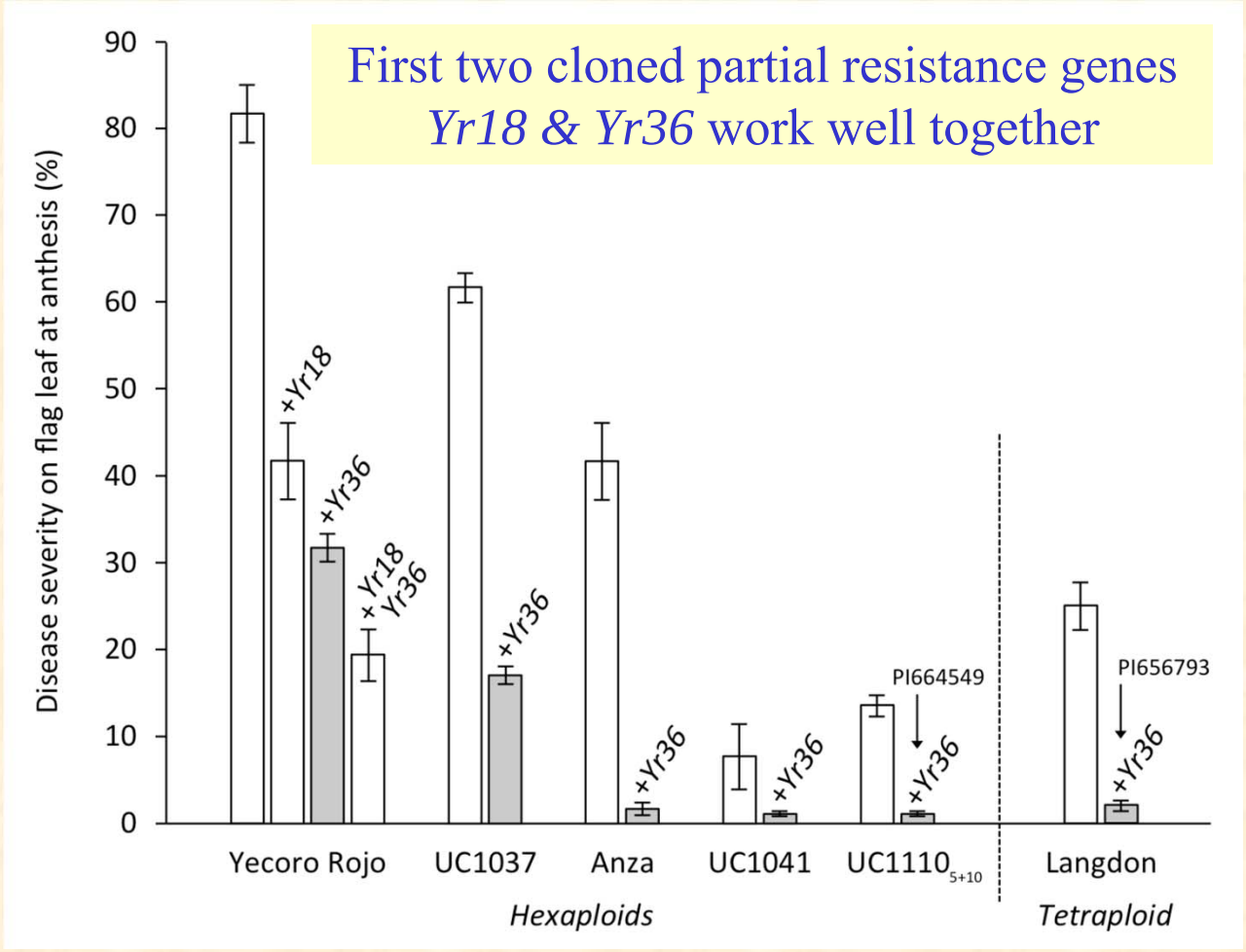
Patwin 515: stewardship of stripe rust resistance genes

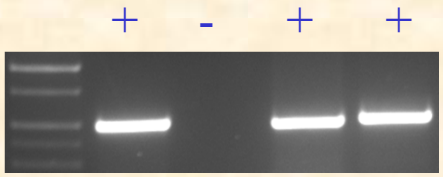
Patwin 515 (*Yr5+Yr15+Yr17*)

- Stripe rust and septoria resistance
- High protein and excellent bread-making quality.
- No problem with Late Maturity Alpha Amylase (falling number).
- Nematode resistance for rotations with tomatoes and carrots



Cloned genes for partial resistance to stripe rust



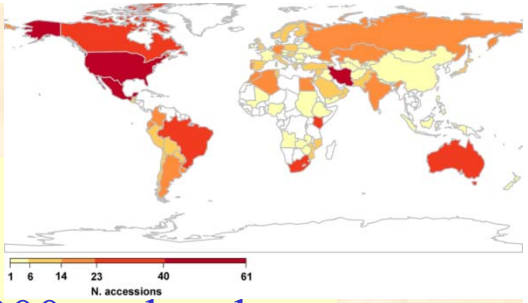


Perfect marker for *Yr36*

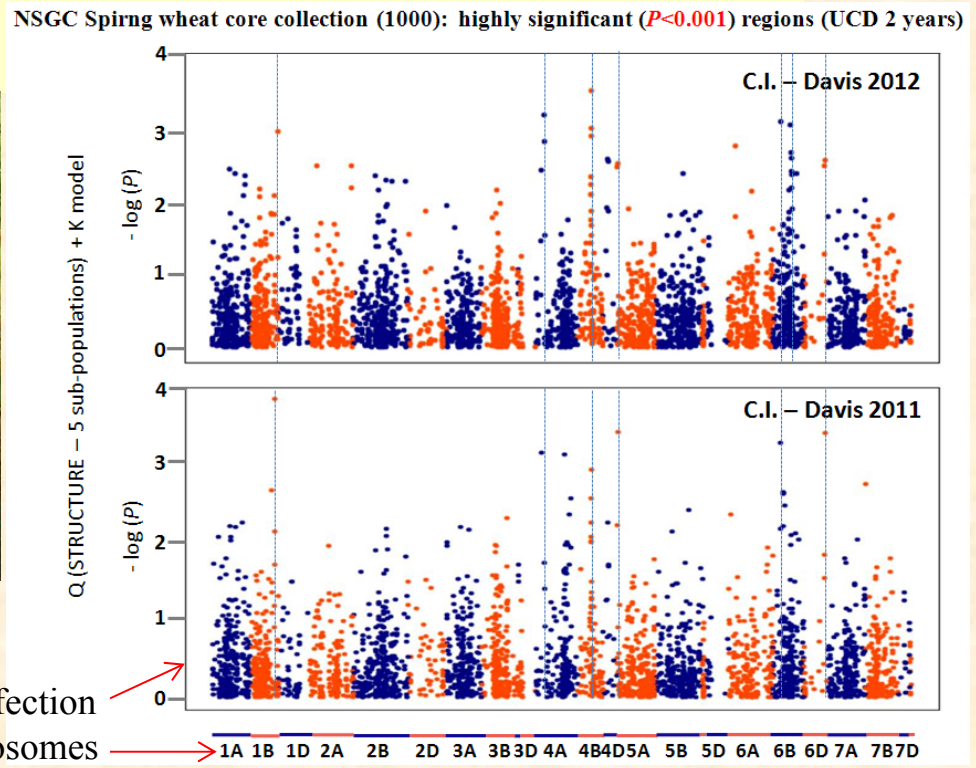
Yr36 is closely linked to the high grain protein content gene.

Yr48 is another partial resistance gene with perfectly linked molecular markers that is ready to deploy

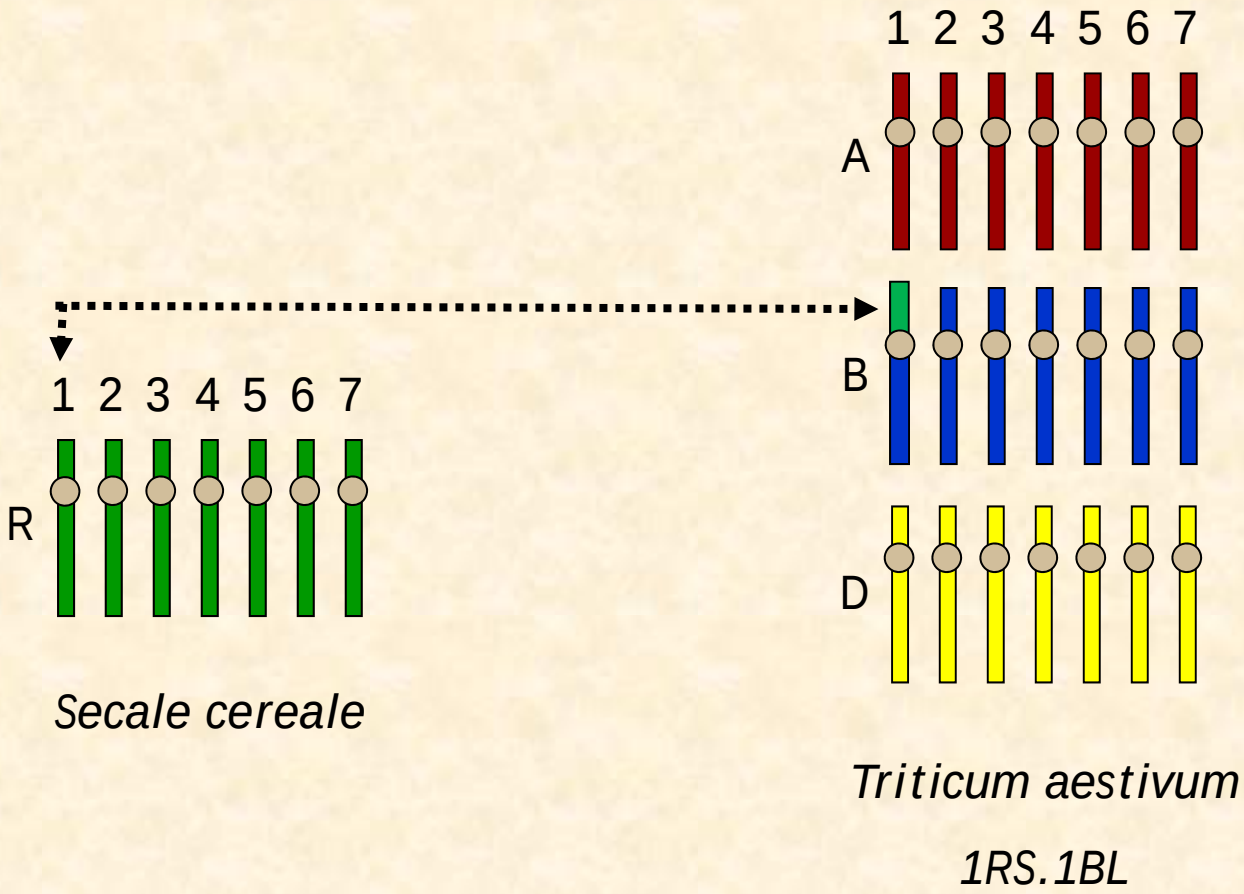
New sources of stripe rust resistance



- We screened 1,000 accessions for the NSGC wheat core collection for stripe rust resistance 2011/2012.
- We genotyped these 1,000 lines with a chip including 9,000 molecular markers: 9,000,000 datapoints!
- We used association mapping to determine which regions of the wheat genome are associated with resistance.
- 7 regions identified with highly significant $P<0.001$ resistance both years. Crosses started.



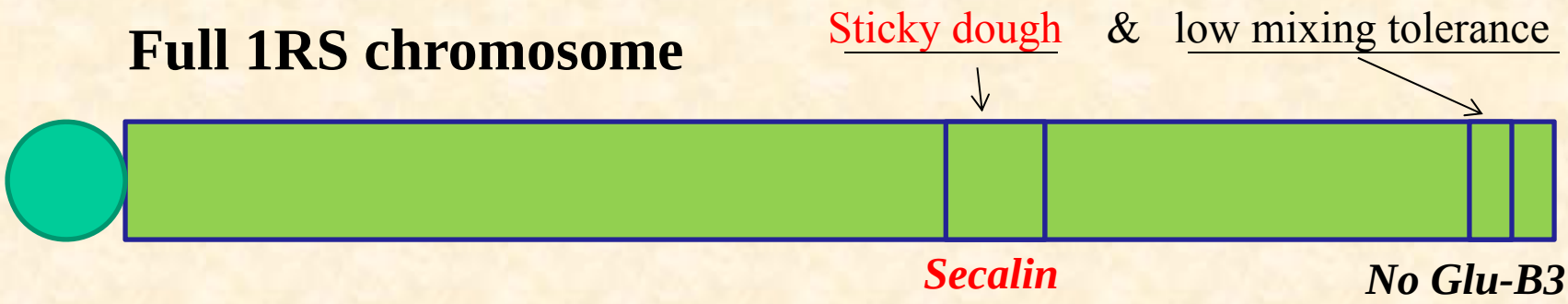
Drought resistance gene from rye



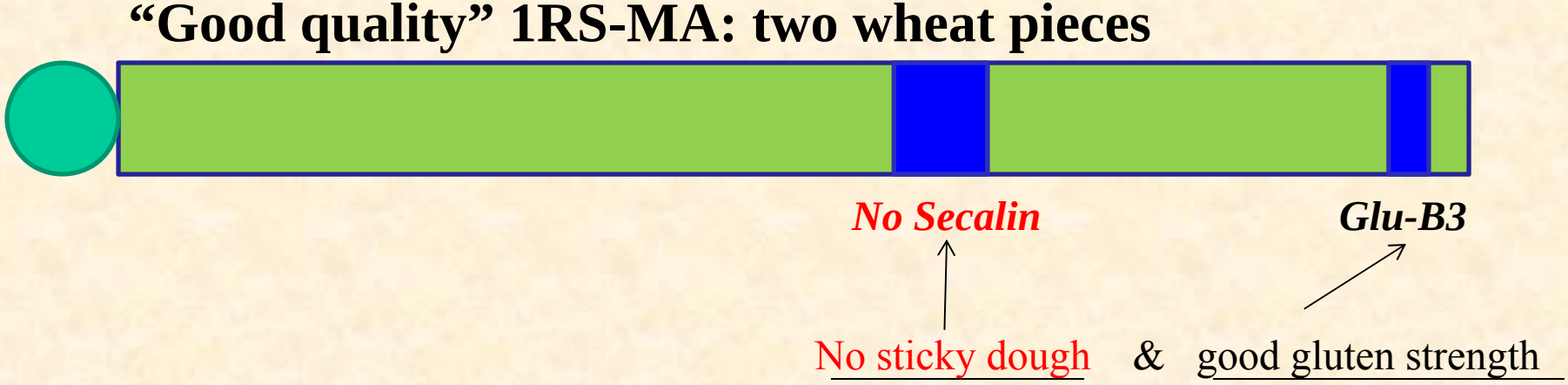
Engineering “good quality” 1RS

Adam Lukaszewski

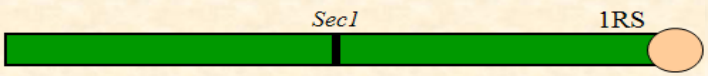
Full 1RS chromosome

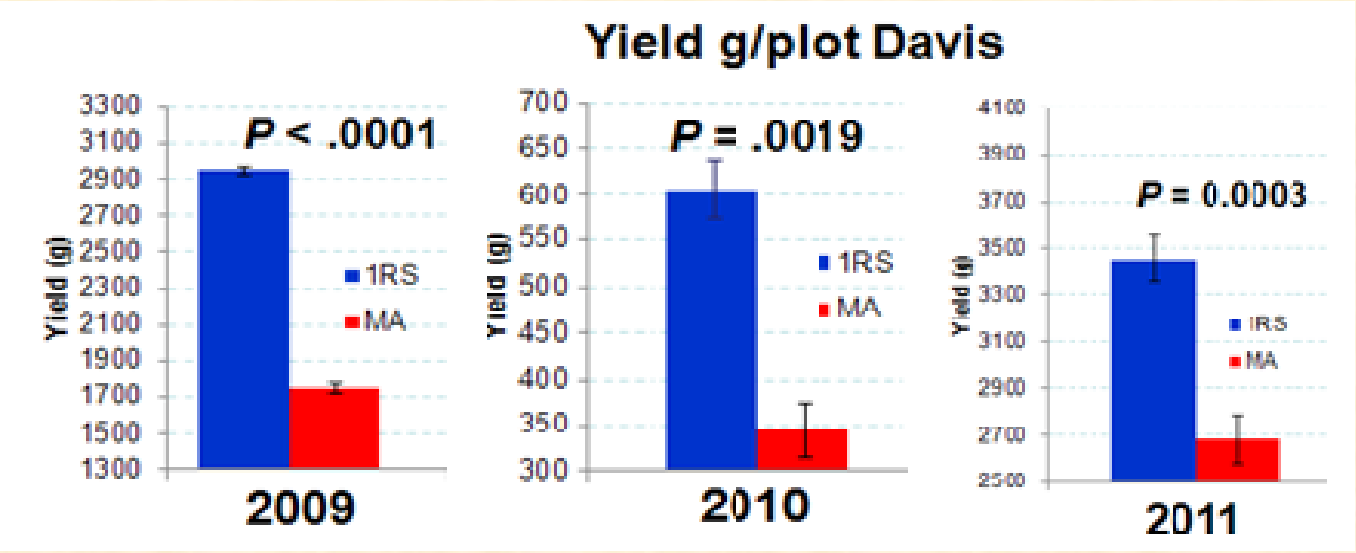


“Good quality” 1RS-MA: two wheat pieces



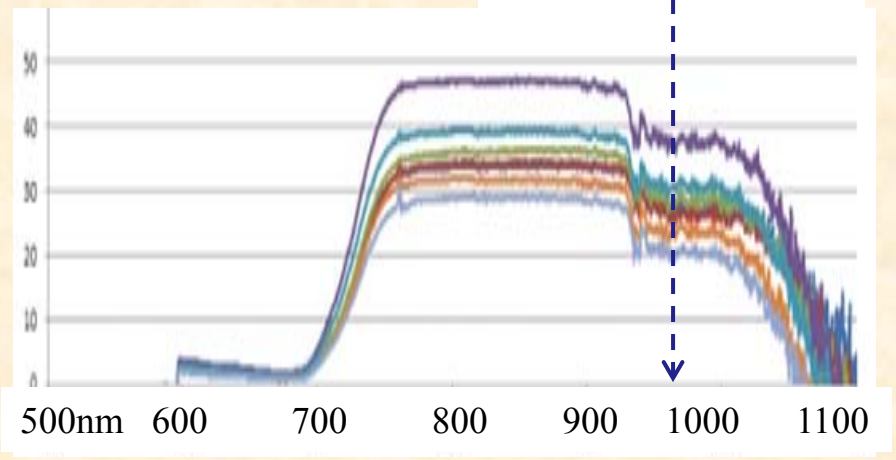
“Good quality-1RS” effect on drought tolerance

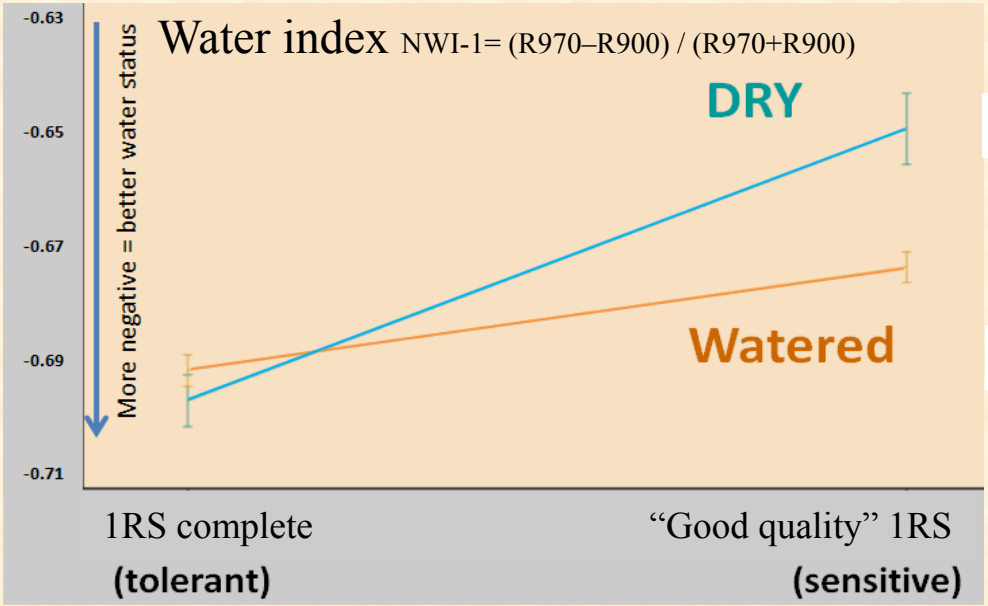




Seeing the plants in the infrared: Canopy Spectral Reflectance

970nm associated with plant water status





Bad water status

Good water status

A super 1B chromosome

2012 CSR data suggest that the distal 1RS segment is important for drought tolerance

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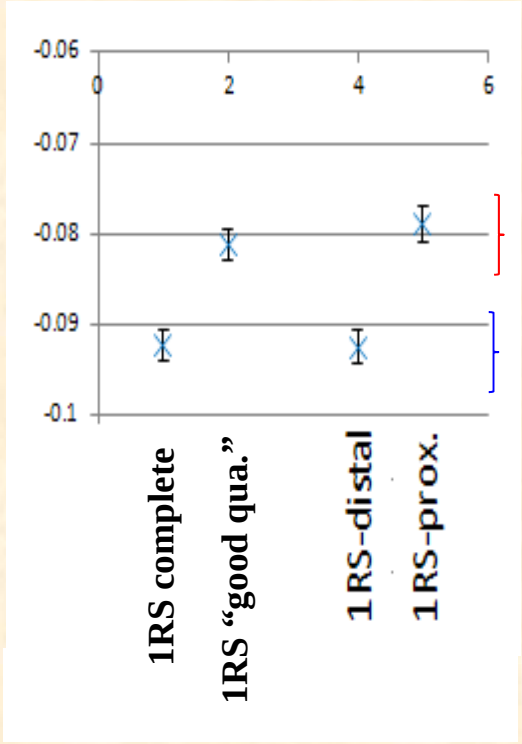
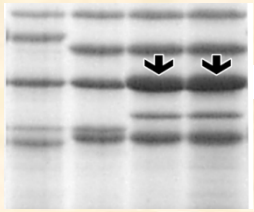
To keep the 1RS drought tolerance we need to sacrifice the *Glu-B3* strong gluten gene from wheat



Susceptible to drought

Drought tolerant

Duplication of the 7Bx subunit

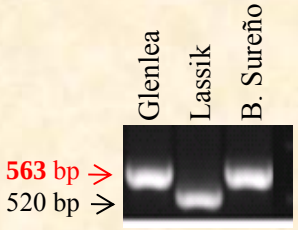


HMW subunits

7Bx^{OE} →

To compensate the loss of *Glu-B3*

We introduced the 7Bx^{OE} high gluten strength



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We have a perfect DNA marker.

None of the CA varieties has 7Bx^{OE}

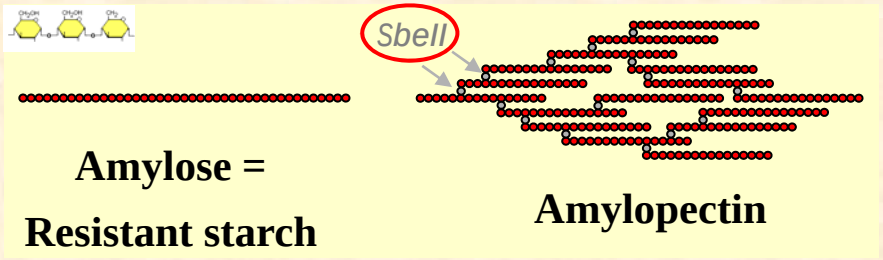
7Bx^{OE}
Strong gluten

Yr15
Stripe rust resistance

No secalin
no sticky dough

1RS distal segment
Drought tolerance
No Glu-B3

Increasing resistant starch in bread and pasta wheat



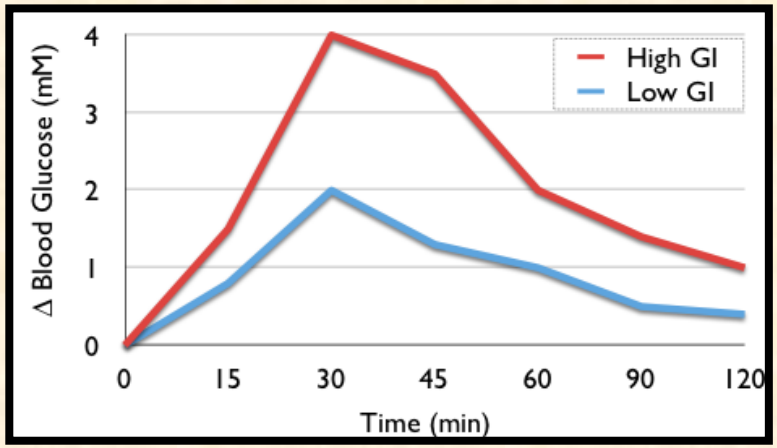
- **Amylose** is not absorbed in the small intestine and behaves as fiber: **resistant starch**

- Wheat is one of the main sources of resistant starch (**~50%**).

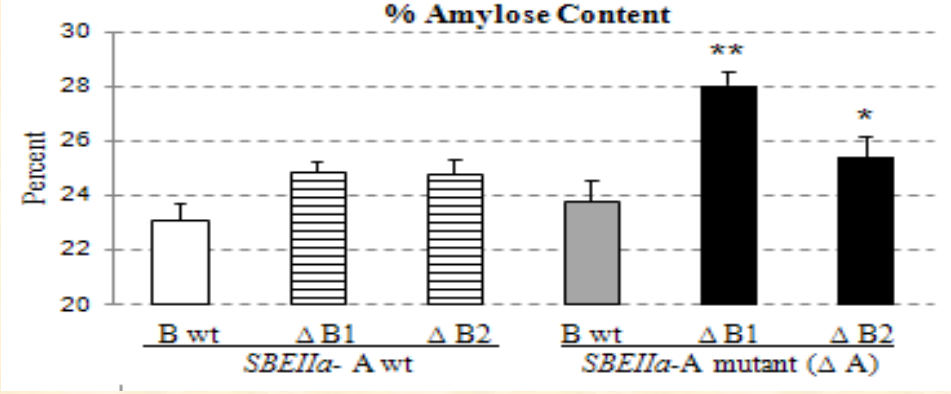
Beneficial health effects of RS:

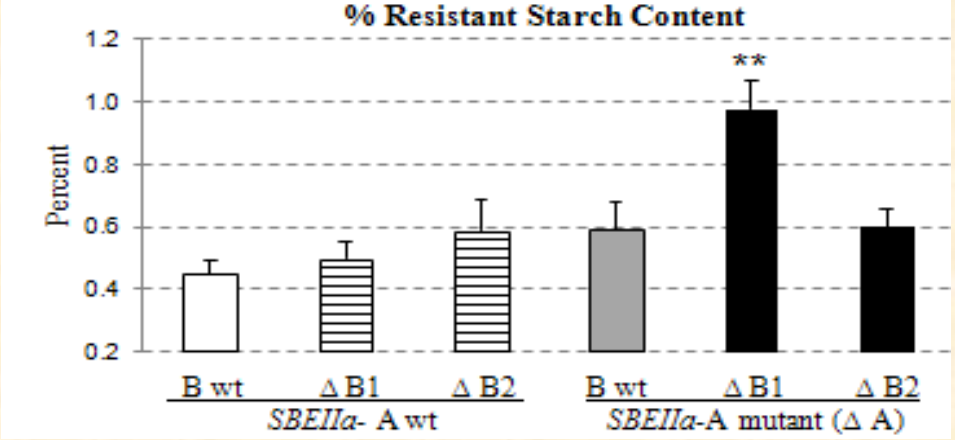
Large intestine: enhanced fermentation and laxation; increased uptake of minerals; beneficial changes in the microflora; and reduced diarrhea.

Systemic benefits: extended satiety (helps reduce weight), reduces glycemic index and demand for insulin, increases short-chain fatty acid production in the large intestine.



Knock out of *SbeIIa* genes increase resistant starch



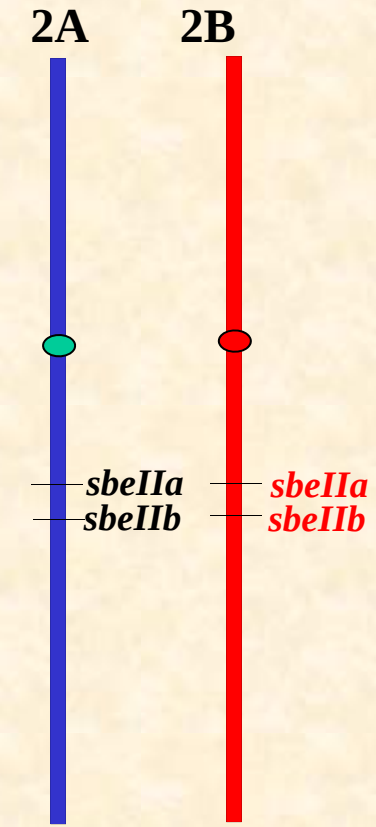


- Wild type **Kronos**
- Mutants only B genome
- Mutants only A genome
- Mutants both A and B genome

Durum wheat double *SbeIIa* mutants

- 22% increases in amylose
- 115% increase in resistant starch

Knock out of *SbeIIa* and *SbeIIb* to increase resistant starch

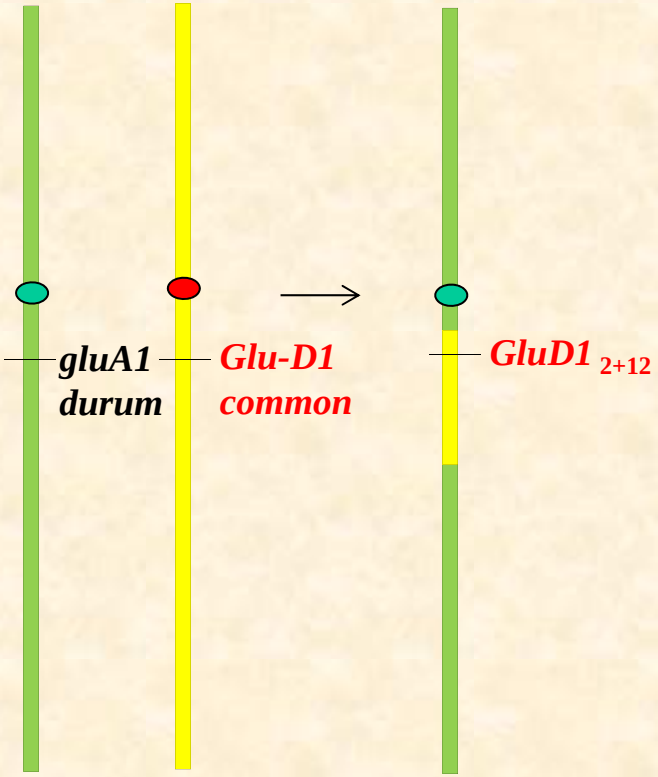


***SbeIIa* and *SbeIIb* are close but we separated them by recombination**

Quadruple *SbeIIa* + *SbeIIb* mutants

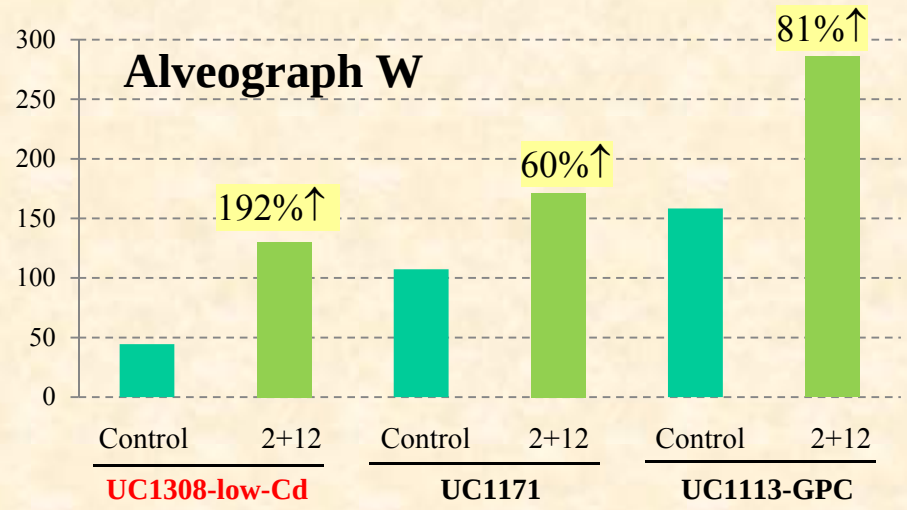
- There are two similar *SbeII* genes named a and b
- We combined the *sbeIIa* and *sbeIIb* on chromosome 2A
- We combined the *sbeIIa* and *sbeIIb* on chromosome 2B
- We crossed the two lines and generated several quadruple mutants. We will increase seeds 2012-2013
- We initiated transfer of these two chromosomes to common wheat, to combine with D genome *sbeII* mutants

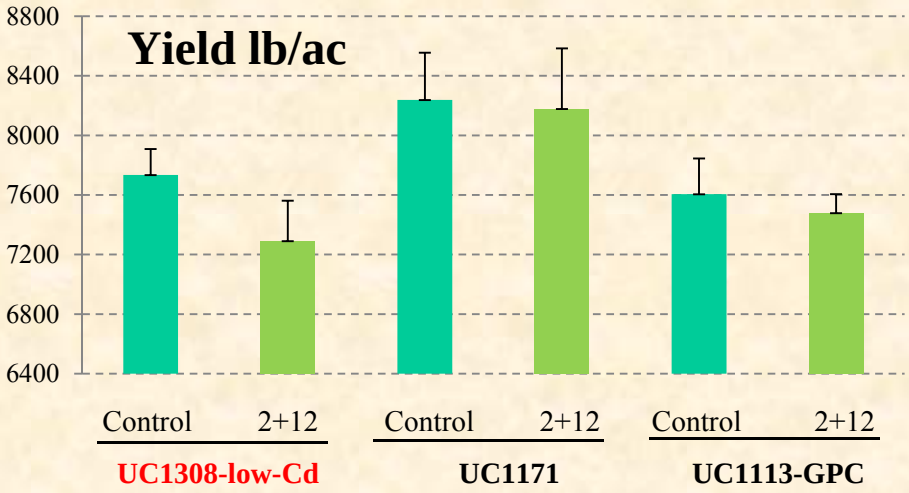
Increased gluten strength in durum wheat



***glu-A1* is not functional in many durums**

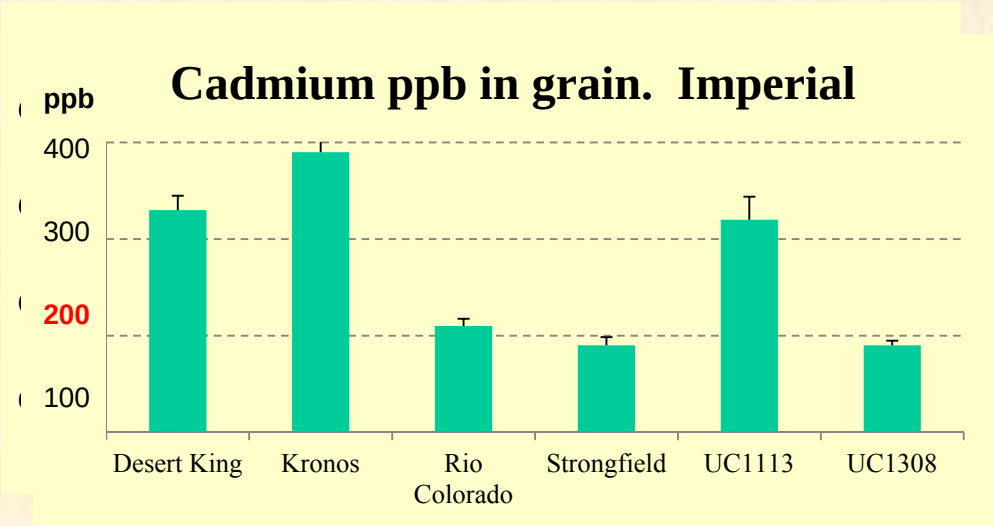
We introgressed the *Glu-D1*$_{2+12}$ allele into three durum varieties

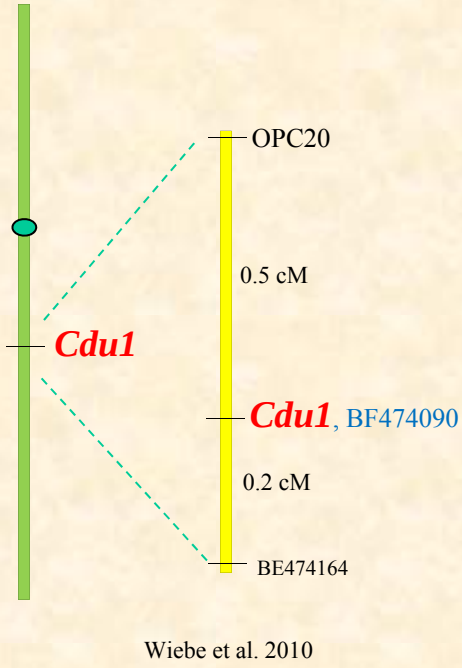




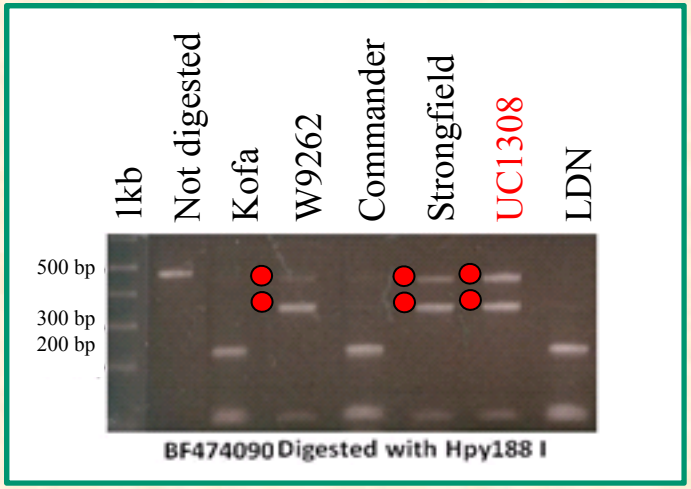
The *Glu-D1*$_{2+12}$ allele increased alveograph W (60-192%) without significant penalty on yield (Imperial Valley)

Low Grain Cadmium uptake: *Cdu1* (chromosome 5BL)





Marker BF474090 linked to low Cd
(now we have a perfect marker for ***Cdu1***)



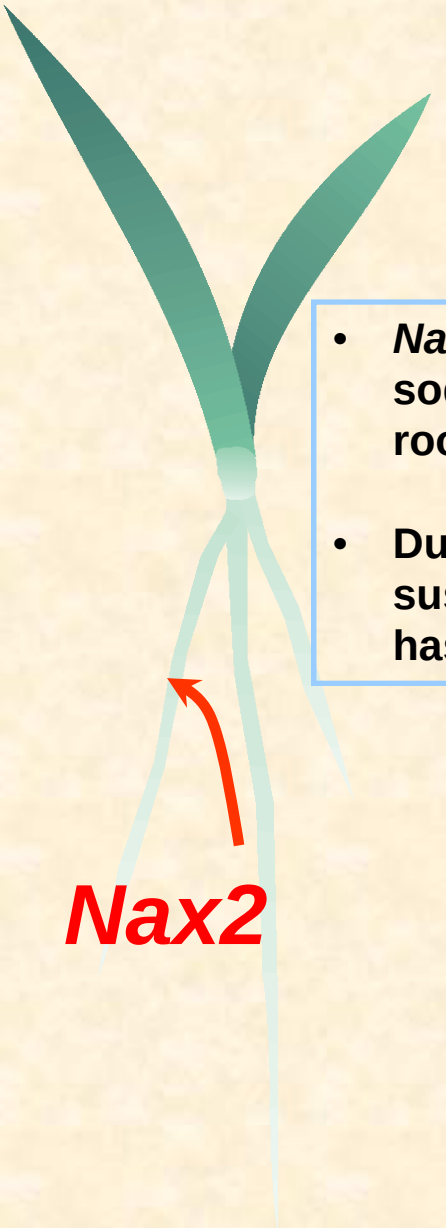
Source of Low Cd: Strongfield

	Low Cd generation
Desert King	BC5F2
UC1113	BC6F2
UC1585	BC4
Kronos	BC6F2
Westmore	BC6
D04-AZ335	BC6

Promising lines for low Cd

- **UC1690**.
  - High yield in San Joaquin (1st 2011-12) and Imperial (14th 2011-12)
  - Highest semolina extraction (63.4%) [1.5% above Kronos]
  - Firmness= Kronos. Color= Desert King= 9
  - Breeder seed harvested 2012
- **Elite 12210/10**
  - Color= 10
  - Moved to Regionals 2012-2013
- Canadian Line **DT557** extra low Cd
  - Extra low Cd in Canada will be tested in 2012-213
  - Crosses initiated

Improving durum wheat salt tolerance



- ***Nax2*: Controls exclusion of sodium from the xylem in the roots**
- **Durum wheat is more susceptible to salt because it has defective Nax2 genes**

California lines with Nax2:

Desert King	***BC5F3***
UC1113	***BC6F2***
UC1503	***BC6F3***
UC1581	***BC6***
Kronos	***BC6F2***

Increased seed in Tulelake

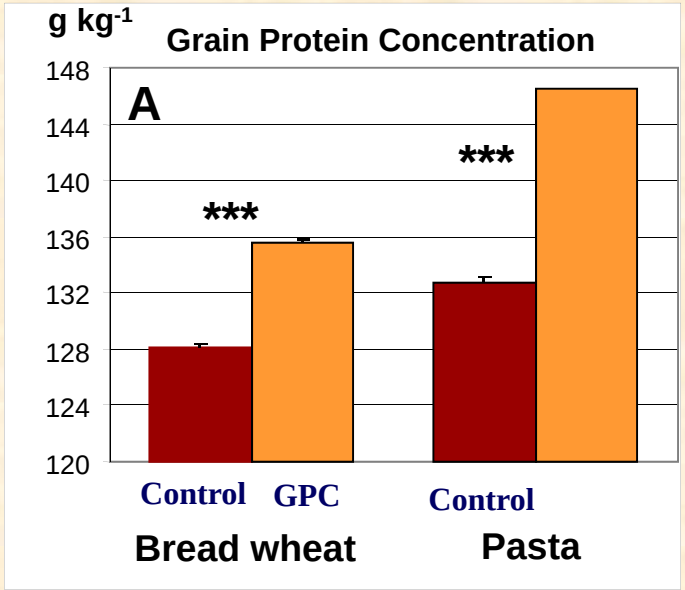
Bob Hutmacher – UC West SIDE REC

Collaboration to test effect of salinity on these lines

Questions?

Desert King - High Protein : a durum for the Sacramento Valley

Comparison isogenic lines for GPC gene (6 bread wheat and 3 durum)



We used molecular markers to introduce the high GPC gene into Desert King

Elite yield trials	**Yield lb/ac**	**Protein %**
Kronos	9,460	13.4
Kofa	7,780	13.3
Desert King	9,790	13.2
Desert King HP	9,550	**14.5**

New discoveries → new opportunities
Expand durum to N San Joaquin & Sac. Valleys.
Blends to correct low GPC