Genotypic diversity and GWAS of canopy wilting among maturity group IV accessions

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Soybean Breeders Workshop
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DIVISION OF AGRICULTURE
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Soybean Agronomists and Physiologists?

Soybean Breeding and Genetics, Univ or Arkansas

- Tenure track
- 90% Research, 10% teaching
- Well funded, state supported
- Excellent & experienced staff
- Located on main campus, Fayetteville
- Screening begins 3/1/17

Delayed wilting under stress

Wilting rating of ~30

- Background on delayed
- Mapping canopy wilting in biparental populations
- Mapping delayed canopy wilting with a GWAS

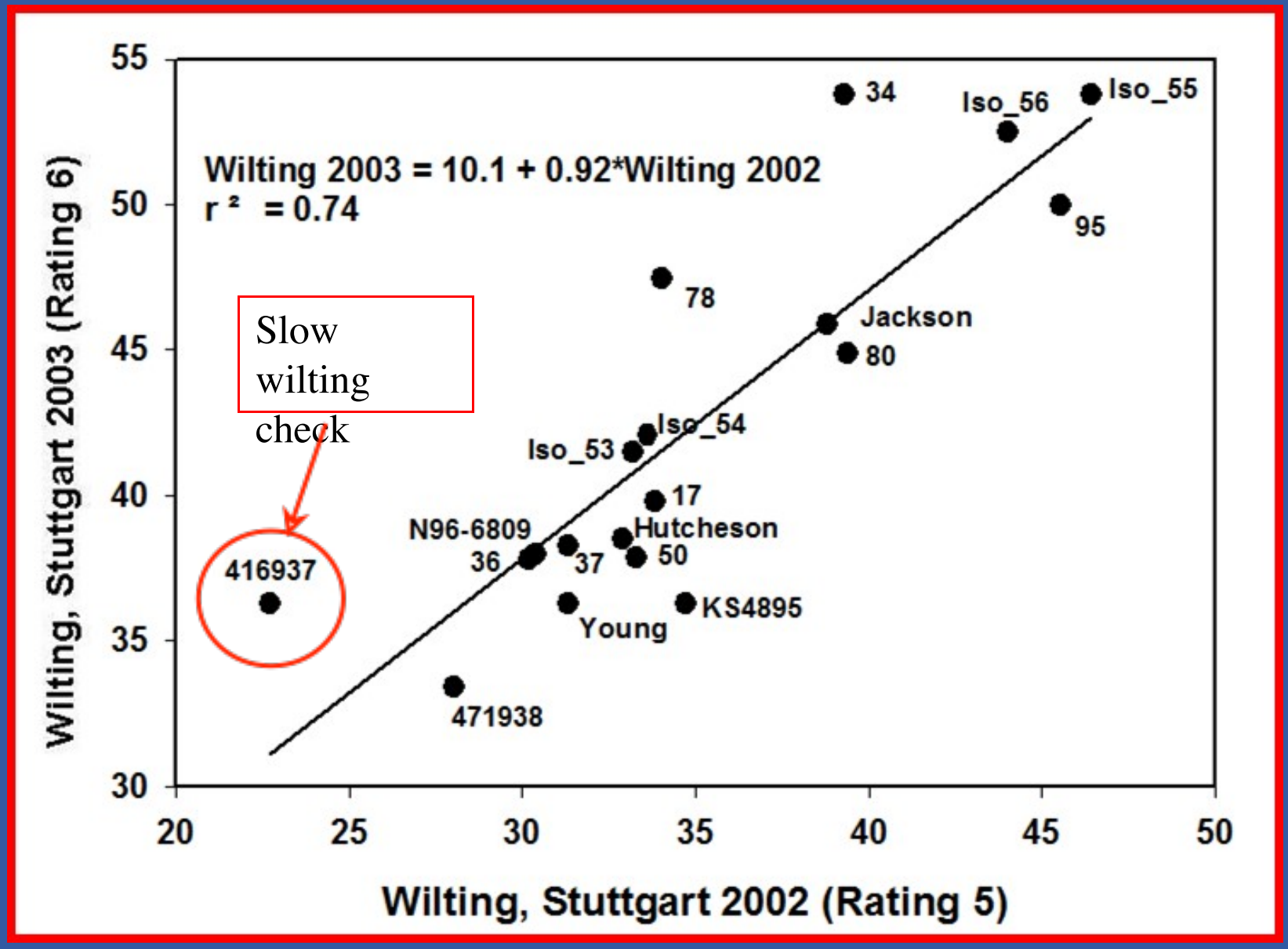
Wilting rating of ~70


University of Arkansas
University of Georgia
University of Missouri
ARS-USDA, Maricopa AZ
NC State
University of Nebraska
University of Minnesota
Kansas State
ARS-USDA, Stoneville, MS

Characteristics of Effective Screening Tools

- Rapid – allow large numbers to be evaluated
- Repeatable – heritable
- Relevance in the field and for yield

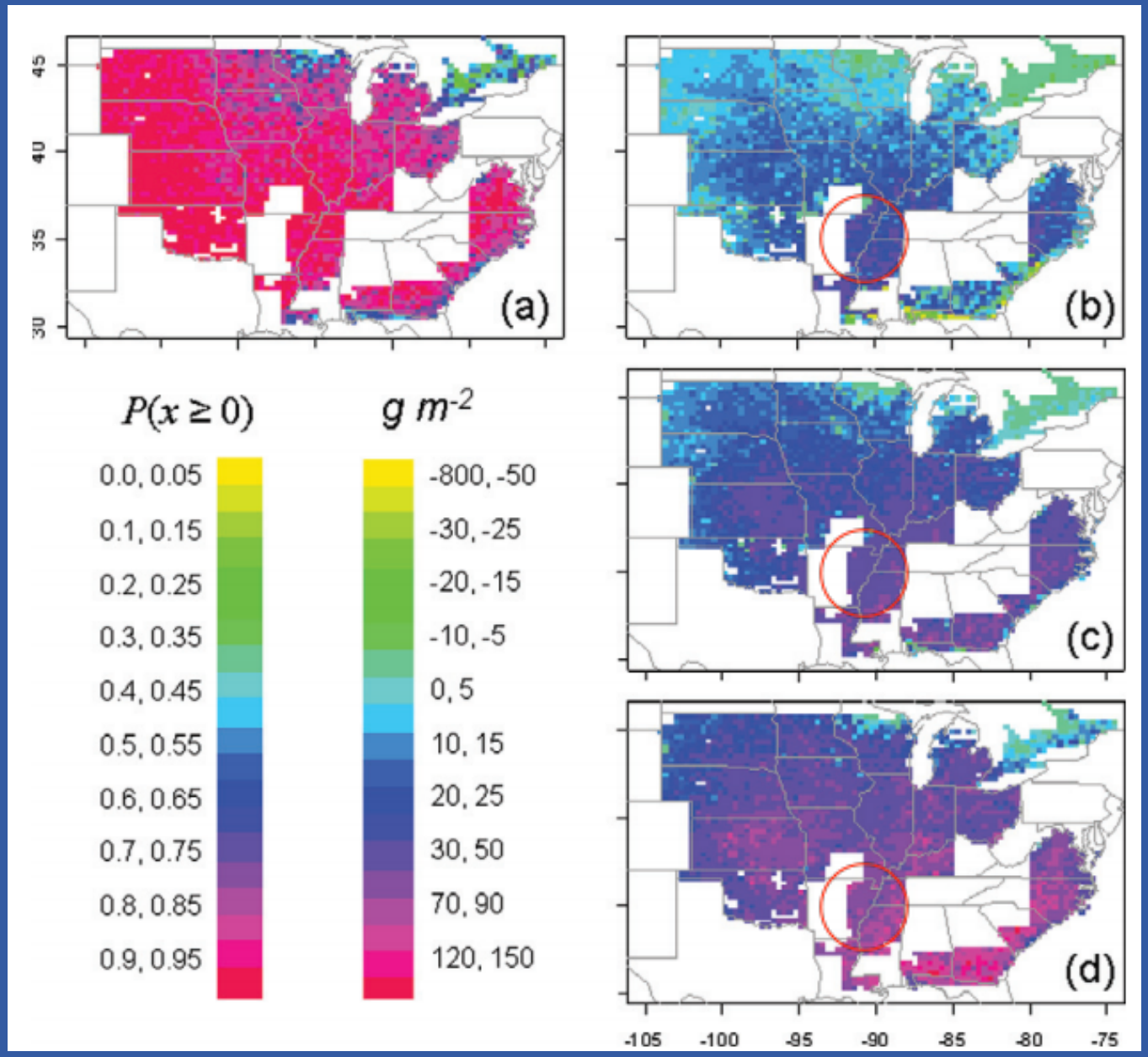
Repeatability of Wilting Ratings



King, Purcell, and Brye. 2009. Crop Sci. 49: 290-298.

Yield Benefit of Slow Wilting Trait

>75%



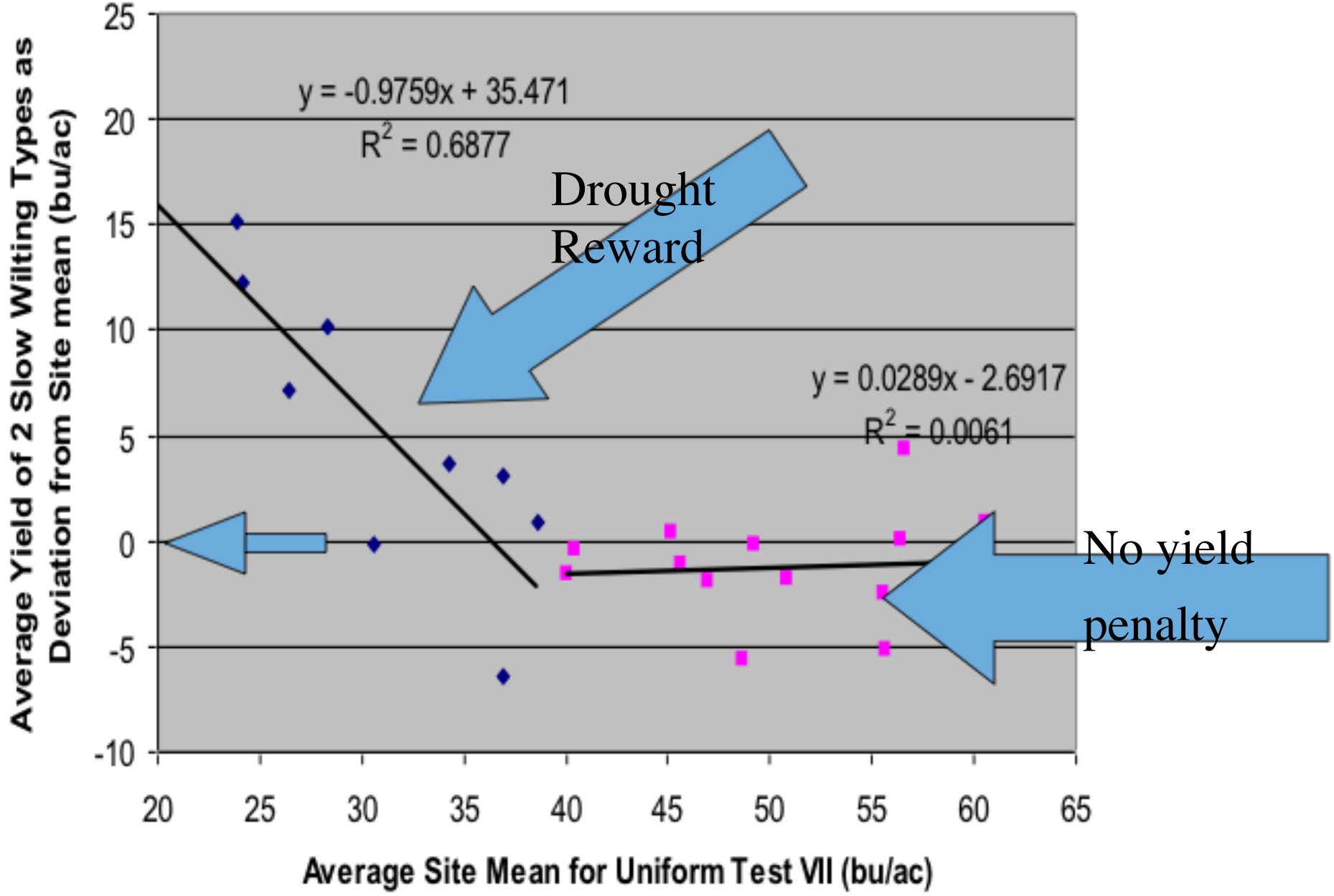
Wet, 250-400 kg/ha

Median, 250-500 kg/ha

Dry, ~600 kg/ha

Sinclair et al. (2010) Agron. J. 102:475

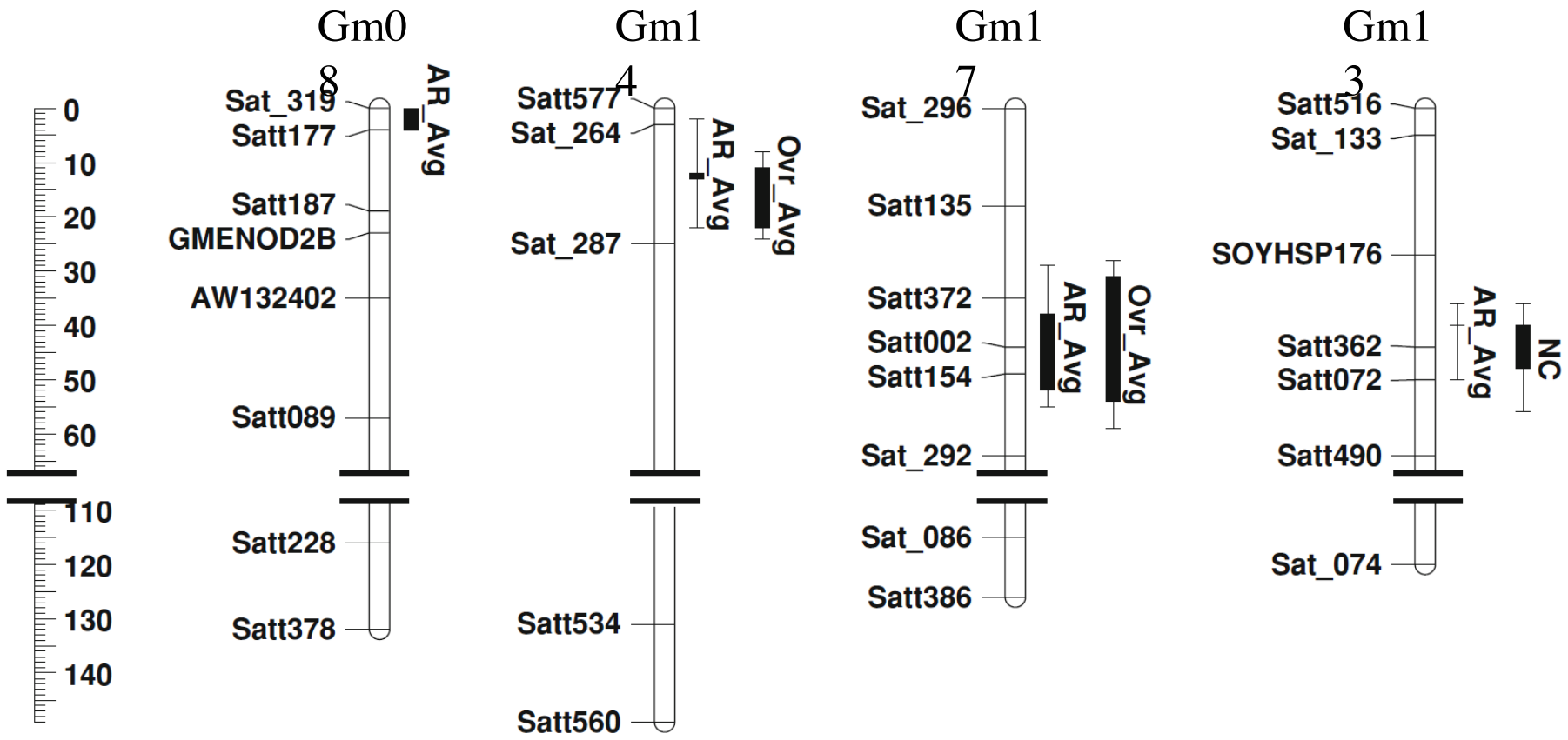
5 STATES - TEST DATA 2004-06



Delayed wilting under stress

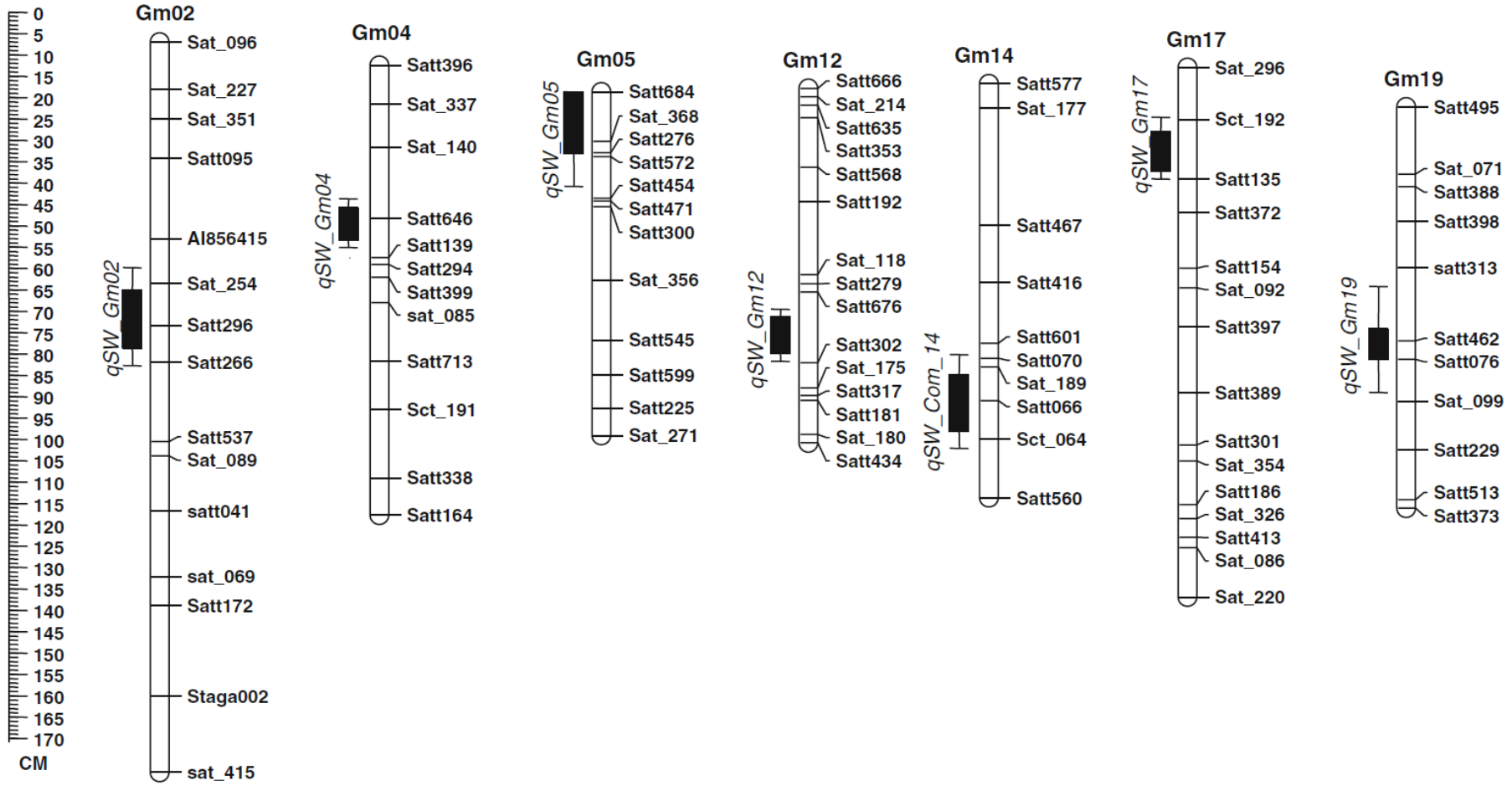
- Background on delayed canopy wilting
- **Mapping delayed canopy wilting in biparental populations**
- Mapping delayed canopy wilting with a GWAS panel

KS4895 x Jackson



Charlson et al. 2009. Theor. Appl. Genet. 119:587

Benning x PI 416937



Abdel-Haleem et al. 2012. Theor. Appl. Genet. 125:837

Meta analysis of wilting

- Five populations
  - KS4895 x Jackson -1 (97 RILs)
  - KS4895 x Jackson -2 (168 RILs)
  - KS4895 x PI424140 (103 RILs)
  - A5959 x PI416937 (103 RILs)
  - Benning x PI416937 (150 RILs)
- A total of 15 site years
- Wilting QTLs projected onto the consensus map for meta-analysis

Hwang et al. 2016. Molecular Breeding 36:91-105

Hwang et al. 2016. Molecular Breeding 36:91-105

Meta analysis of wilting

- Nine meta QTLs identified in eight clusters
- R2 values of meta QTLs: 0.09 to 0.22
- Heritability for multi-year environments: 0.52 to 0.78
- Meta analysis decreased CI approximately two-fold

Hwang et al. 2016. Molecular Breeding 36:91-105

Delayed wilting under stress

- Background on delayed canopy wilting
- Mapping delayed canopy wilting in biparental populations
- **Mapping delayed canopy wilting with a GWAS panel**

GWAS of Canopy Wilting

- A panel of 373 diverse MG 4 accessions plus checks
- Salina, KS (2015, 2016), Pine Tree, AR (2016), Rohwer, AR (2016)
- Two reps/site year
- Multiple ratings per year, average values for each site year for GWAS
- BLUP values used for GWAS
- FarmCPU model
- 31,260 polymorphic SNPs with MAF > 5%

Kaler, Purcell, Schapaugh, and Ray. (unpublished results)

Correlation of Average Wilting Between Environments

	SA-15	SA-16	PT-16	RO-16
SA-15	-	0.53	0.40	0.46
SA-16		-	0.49	0.66
PT-16			-	0.55
RO-16				-

N = 373, P < 0.0001

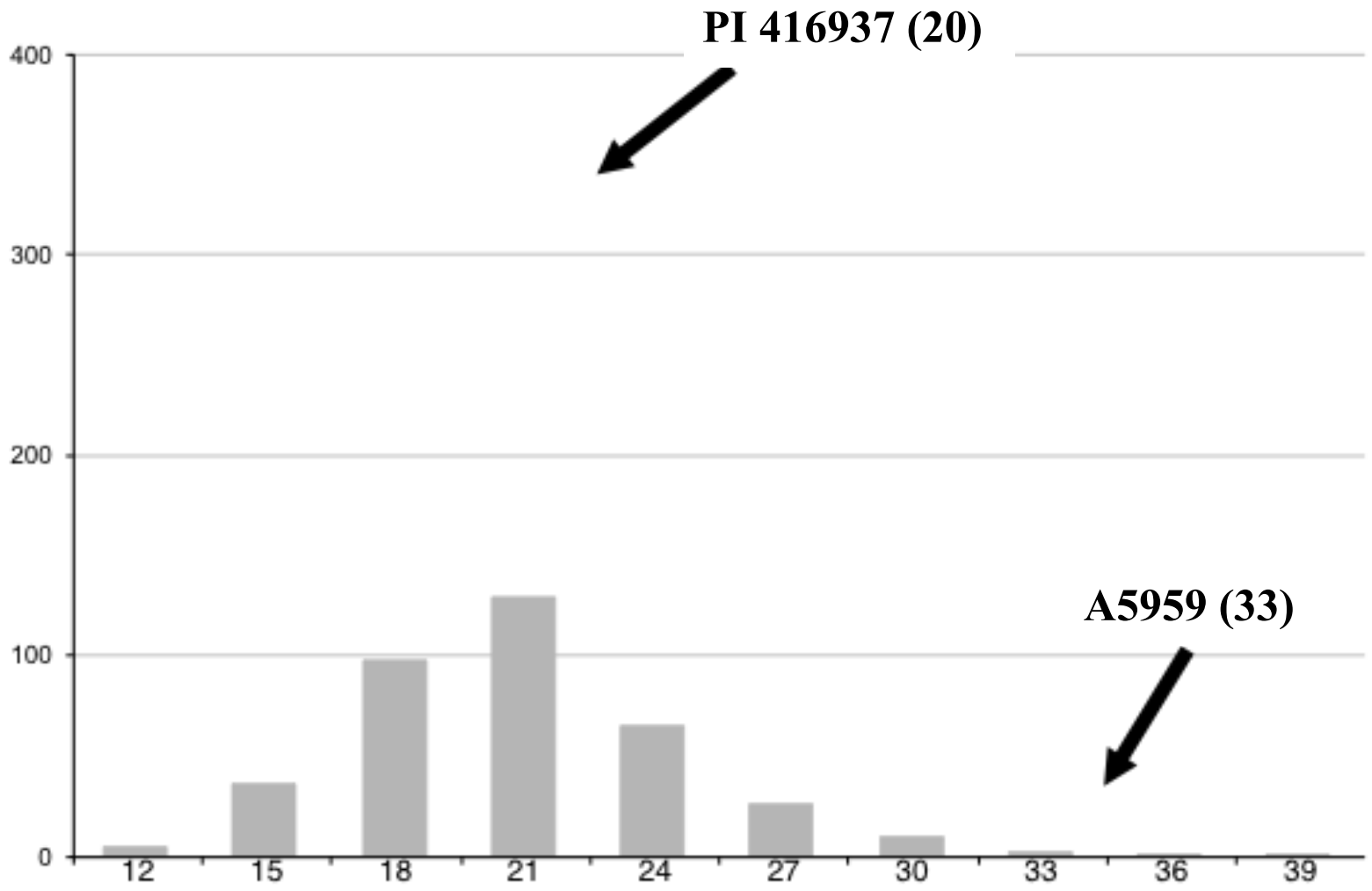
Kaler, Purcell, Schapaugh, and Ray. (unpublished results)

Broad Sense Heritability of Wilting

Environment	Heritability
Salina 2015	69
Salina 2016	84
Pine Tree 2016	59
Rohwer 2016	74
overall	80

2 replications/environment; 373 entries/rep

Kaler, Purcell, Schapaugh, and Ray. (unpublished results)



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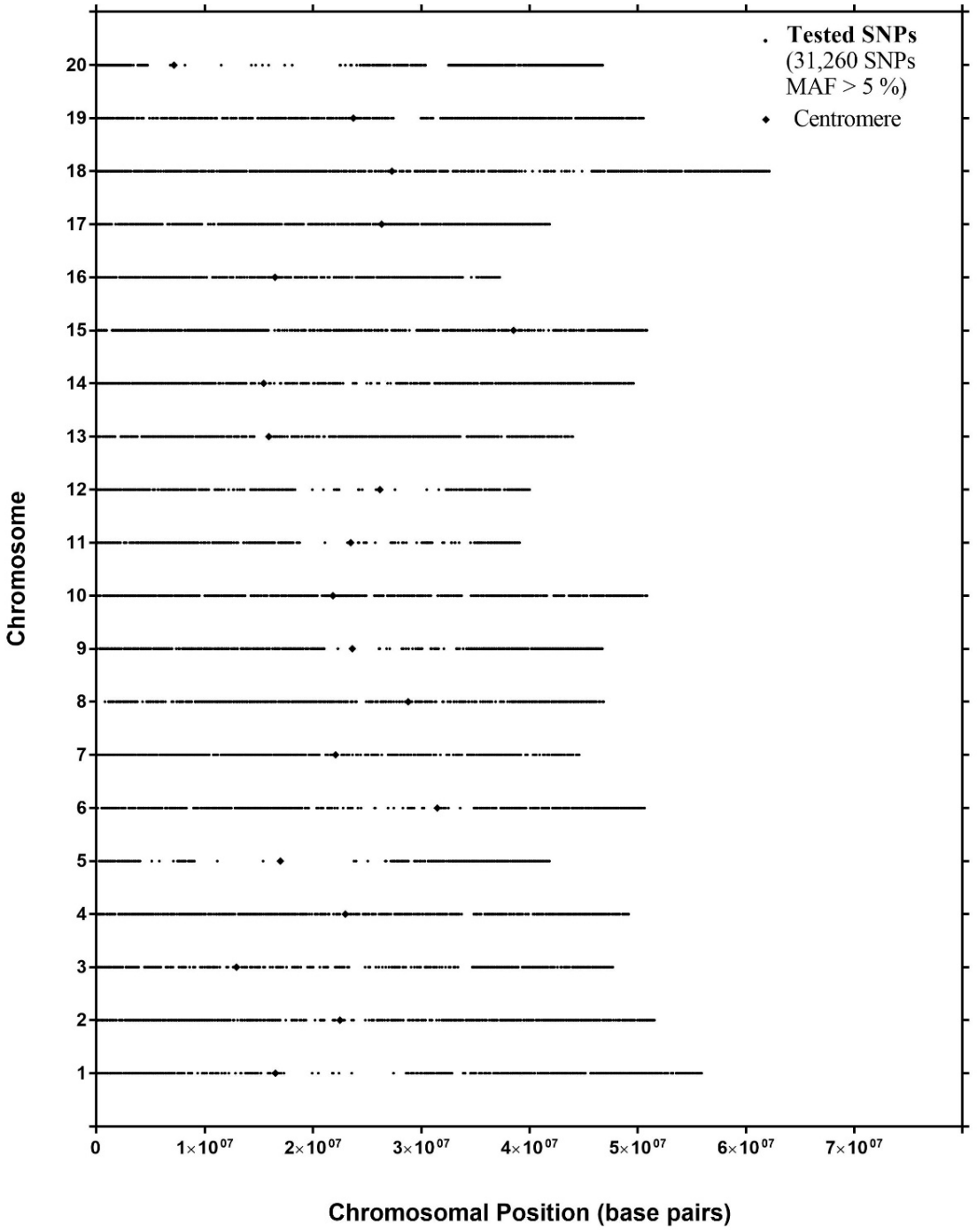
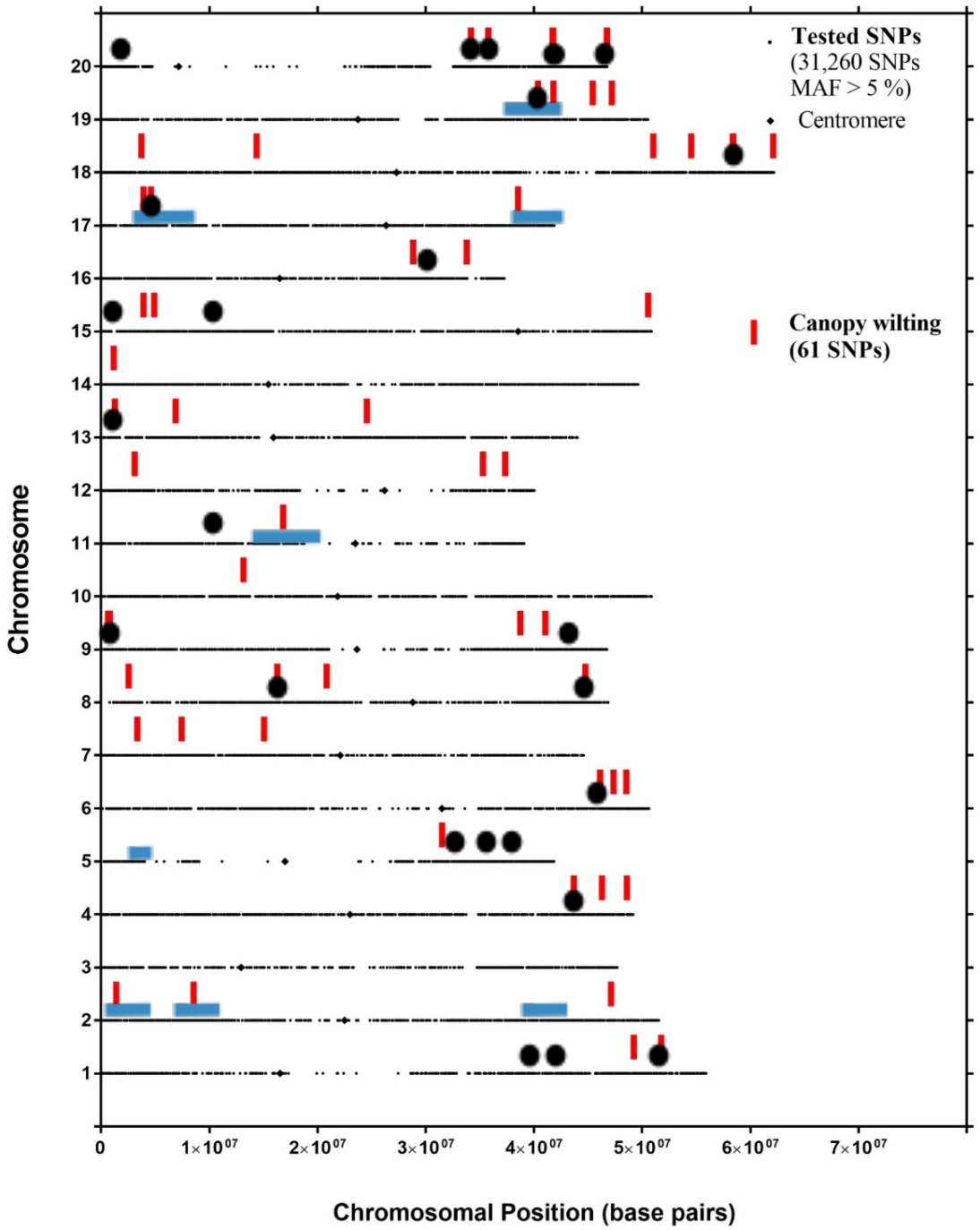
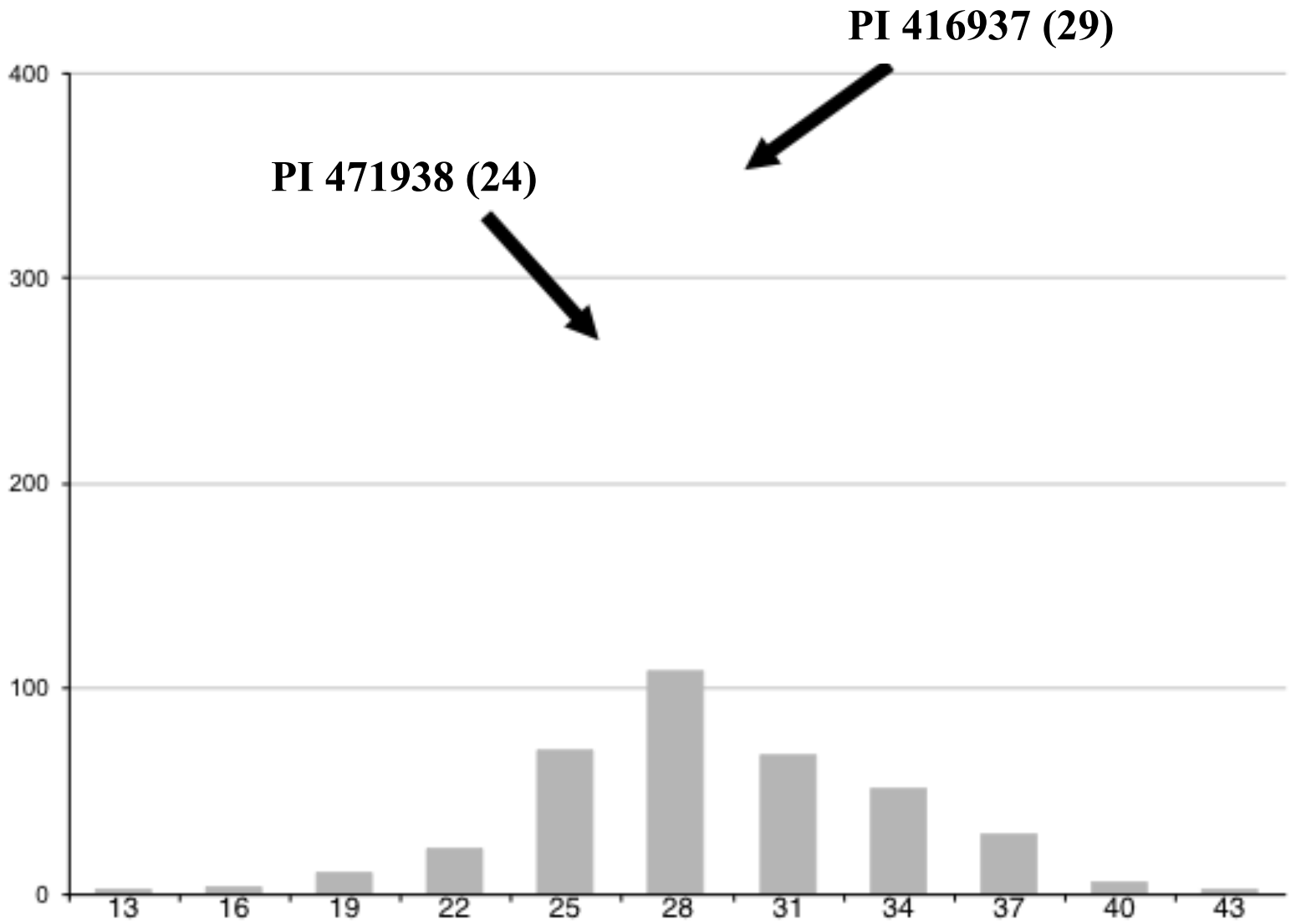

Tested SNPs
(31,260 SNPs
MAF > 5 %)
Centromere
Chromosome
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
1×10^07
2×10^07
3×10^07
4×10^07
5×10^07
6×10^07
7×10^07
Chromosomal Position (base pairs)



- 61 significant SNPs (P < 0.0003)
- 51 putative loci
- 21 SNPs present in 2 or more environments
- Allelic effect (major – minor) -7.4 to 5.2

- 6 meta QTLs coincident with significant SNPs

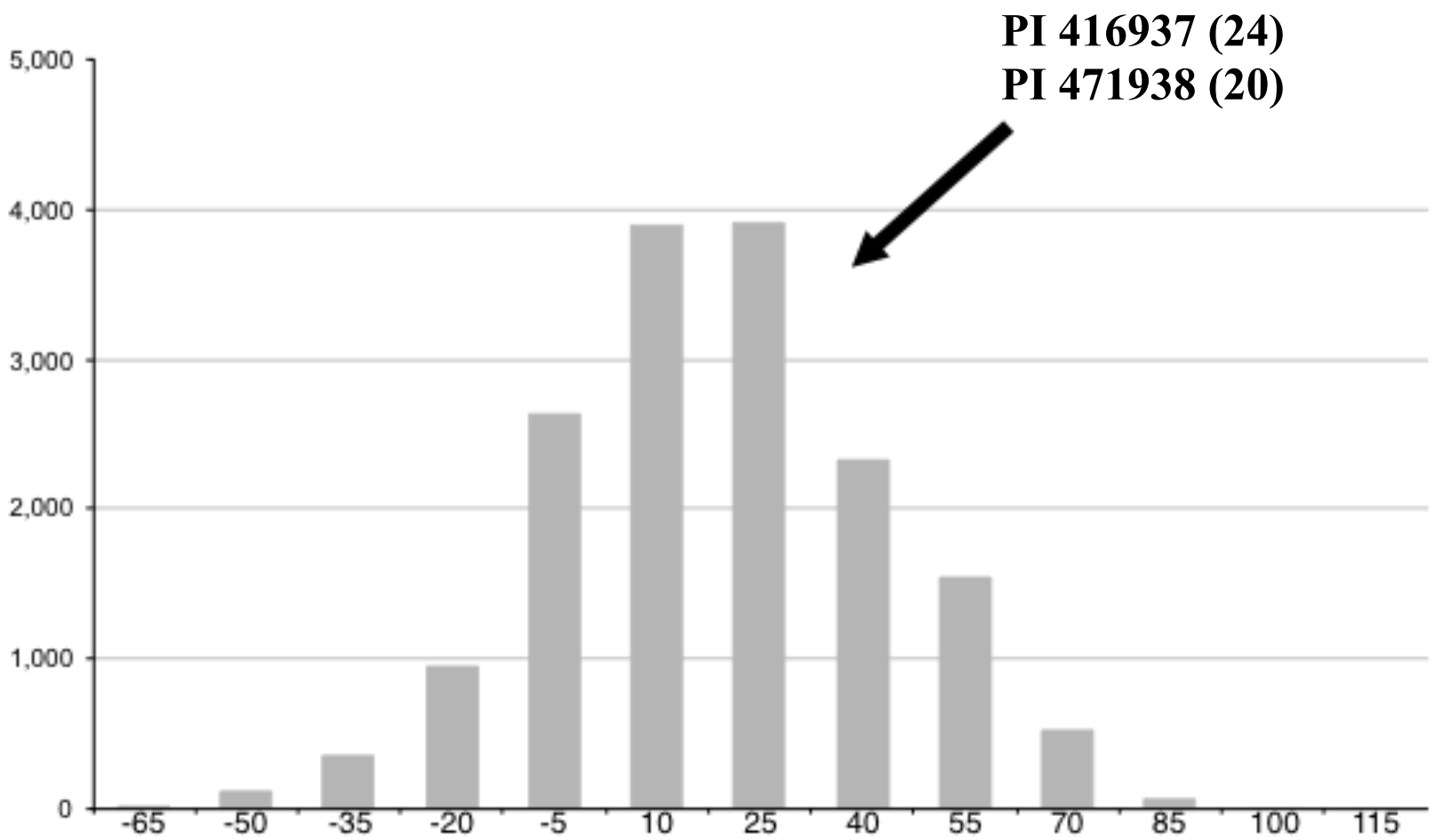
- 34 significant SNPs (P < 0.0003) averaged over environments
- 23 putative loci



Kaler, Purcell, Schapaugh, and Ray. (unpublished results)

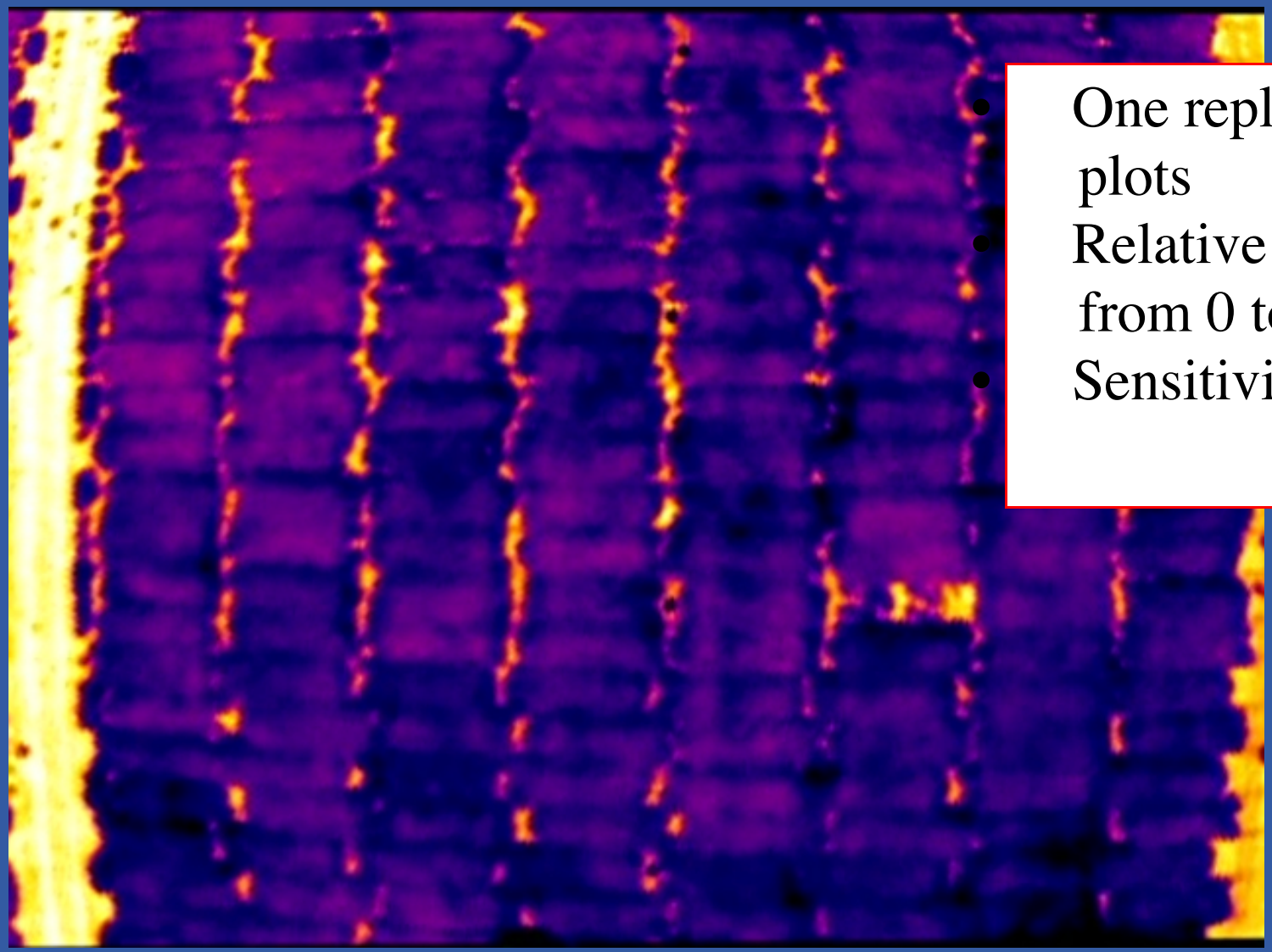
PI 416937 (24)
PI 471938 (20)

Kaler, Purcell, Schapaugh, and Ray. (unpublished results)

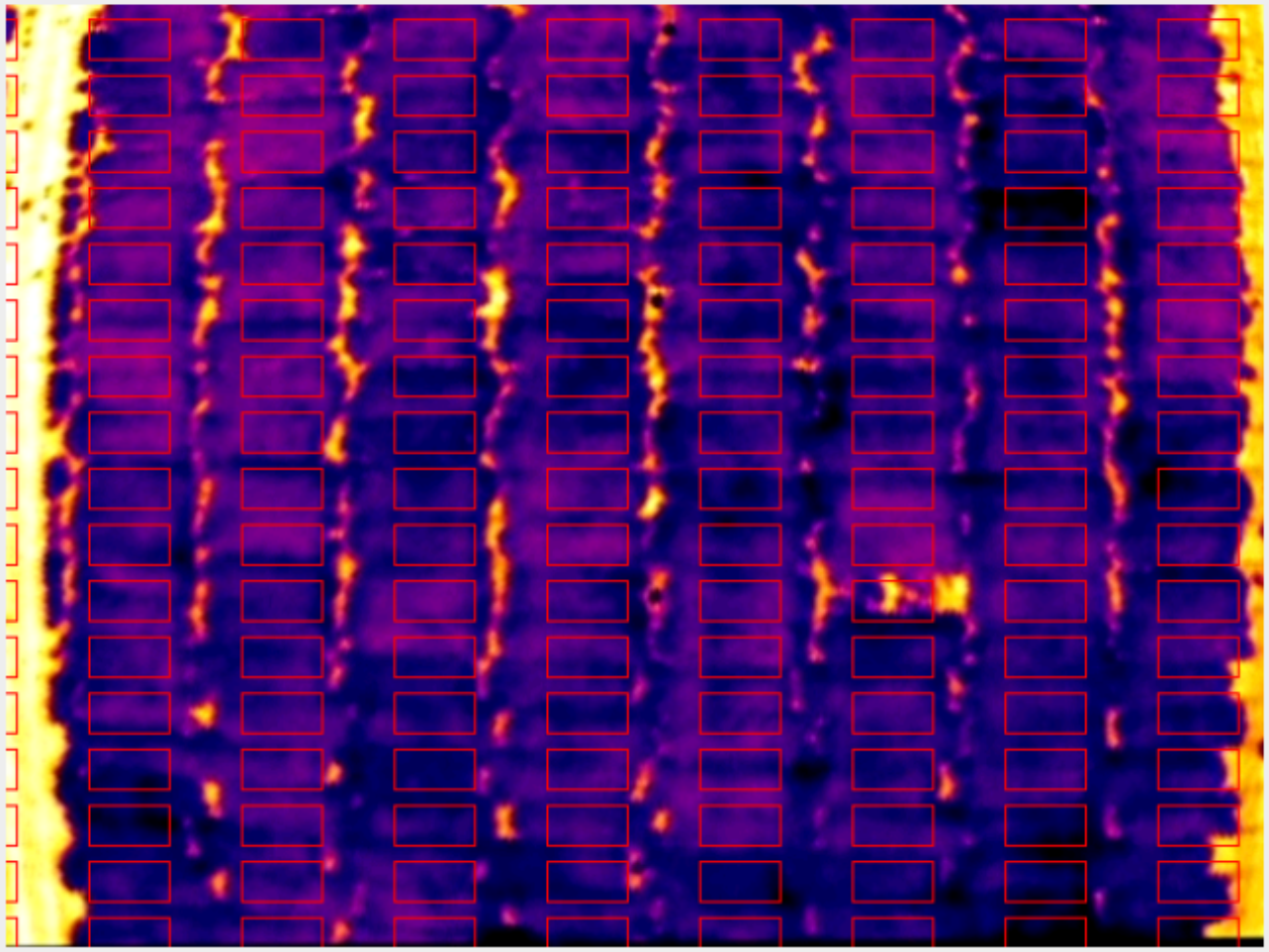


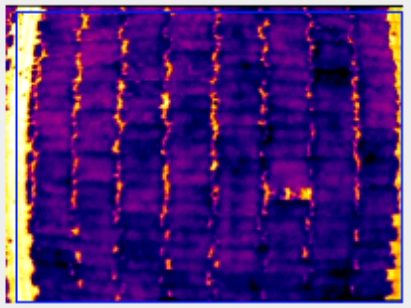
Kaler, Purcell, Schapaugh, and Ray. (unpublished results)

Infra Red Canopy Temperature



- One replication – 375 plots
- Relative temperature from 0 to 255
- Sensitivity: 0.05 C





Use the dx and dy sliders to change the width and height of each area to be sampled (i.e., to select the inner rows of each plot). Once satisfied with the selected sample areas, click next.

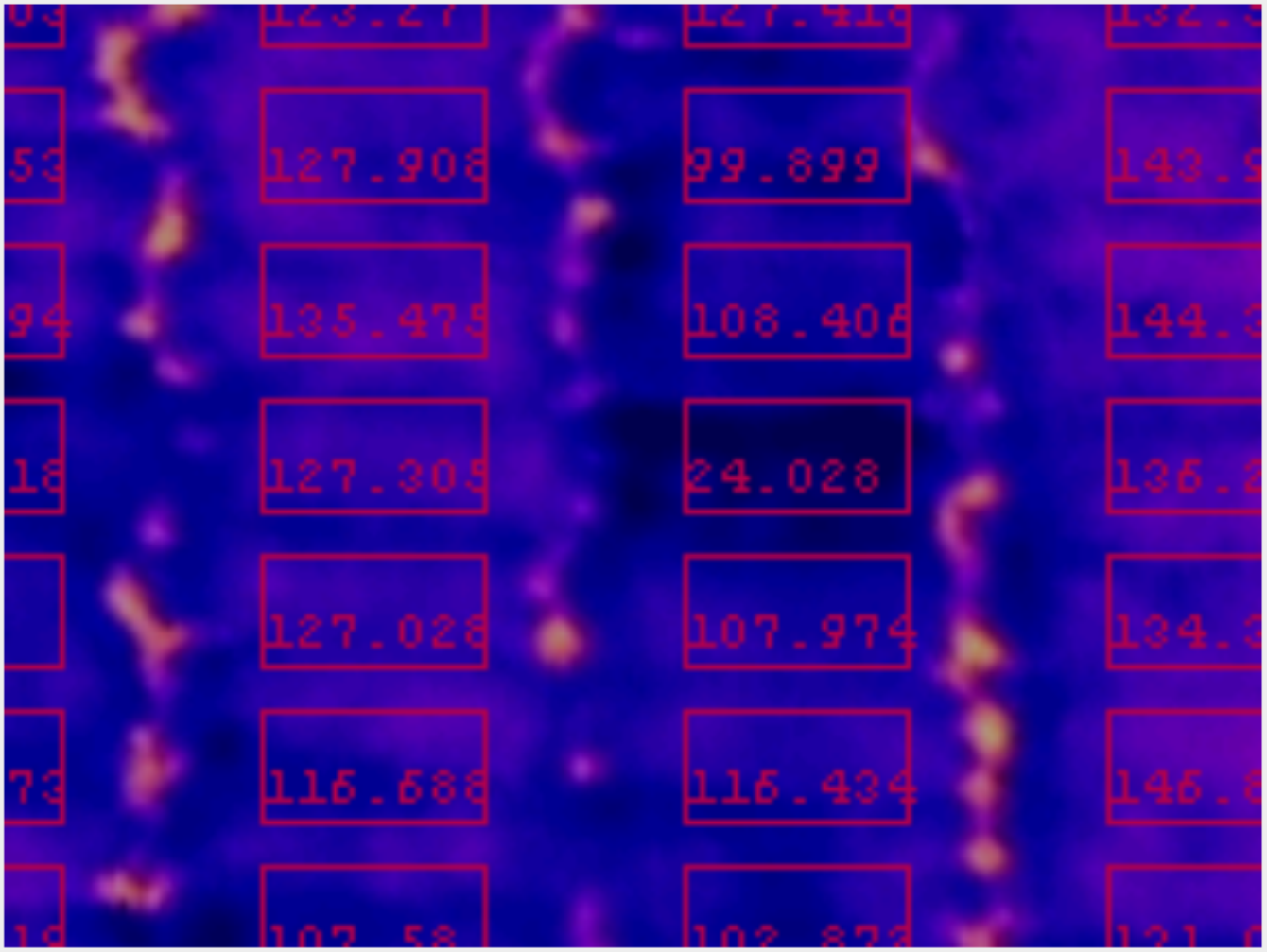
dx is 18 pixels

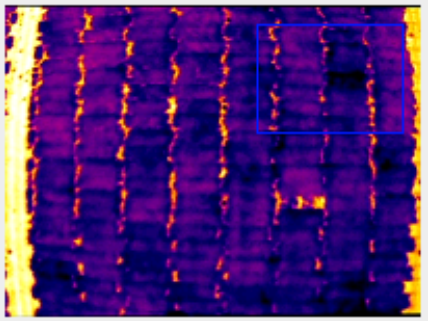
0 3 6 9 12 15 18 21 24 27 30 33 36

dy is 4 pixels

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Purcell and Purcell (unpublished results)





Select the results to save to file. Use the sliders to move the transparent overlay. All results within the overlay will be saved. When ready, click the 'Save Results' button and select a filepath and name of your choice. Note that the filename must end in '.csv'.

The first column is 0

The last column is 8

The first row is 0

The last row is 17

Purcell and Purcell (unpublished results)

Final Thoughts

- Canopy wilting is relatively quick, repeatable, and has agronomic significance
- 9 meta-QTLs associated with wilting
- More extreme phenotypes and genotypes for wilting than reported previously
- Future research with IR temperature under drought and water-replete conditions can help tease out mechanisms.