

Genetic Control of Natural Variation in Maize Shoot Apical Meristem Architecture

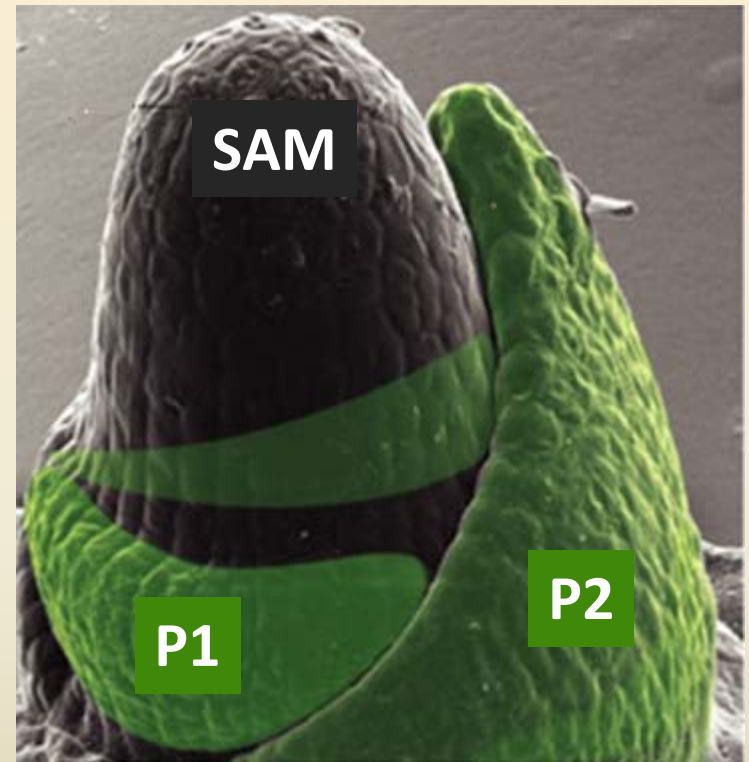
Addie Thompson

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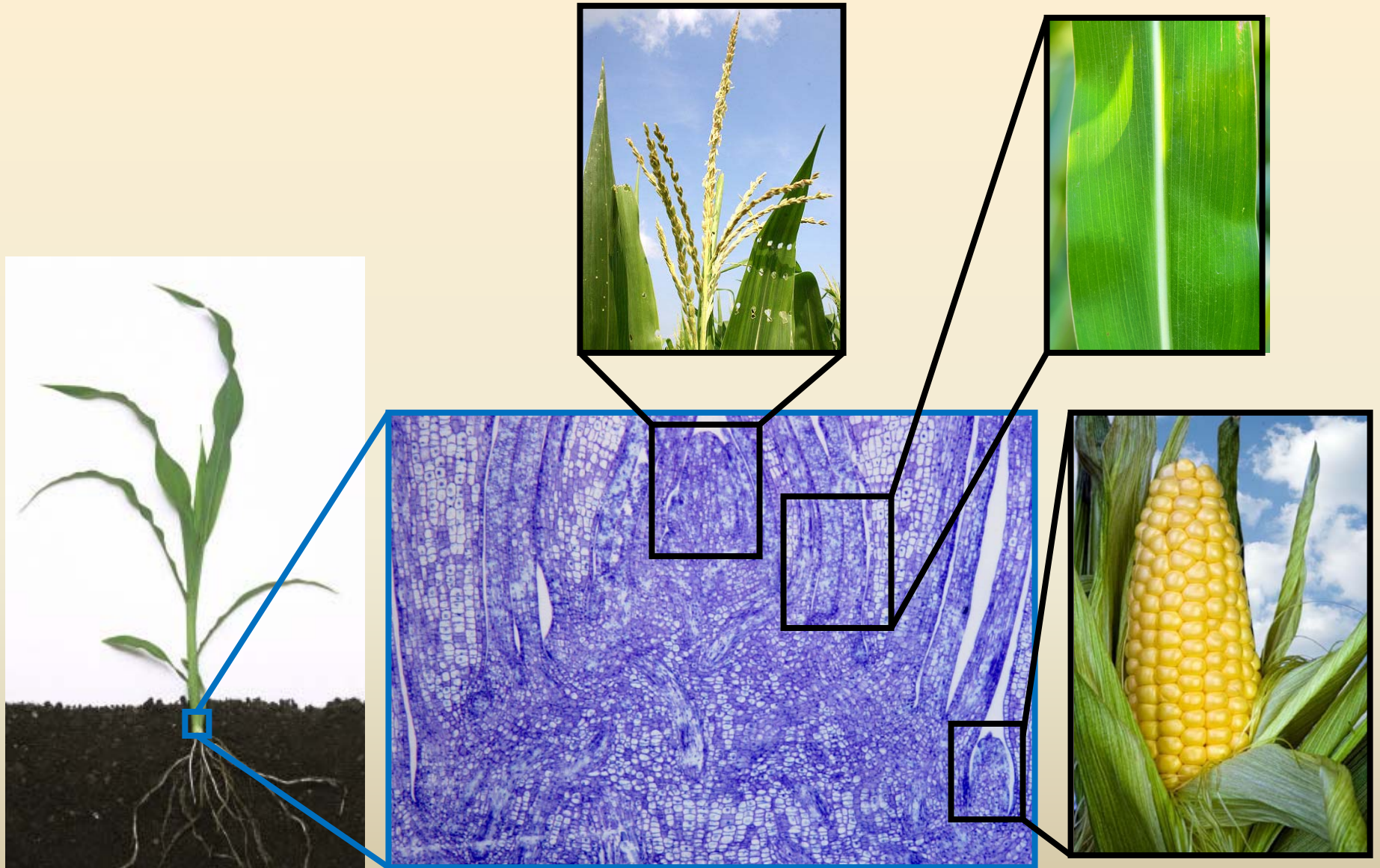
PAG, January 2012

The Shoot Apical Meristem (SAM)

- Contains undifferentiated cells
- Forms above-ground organs
- Leaves initiated in plastochron intervals
- Balance between stem cell maintenance and organogenesis



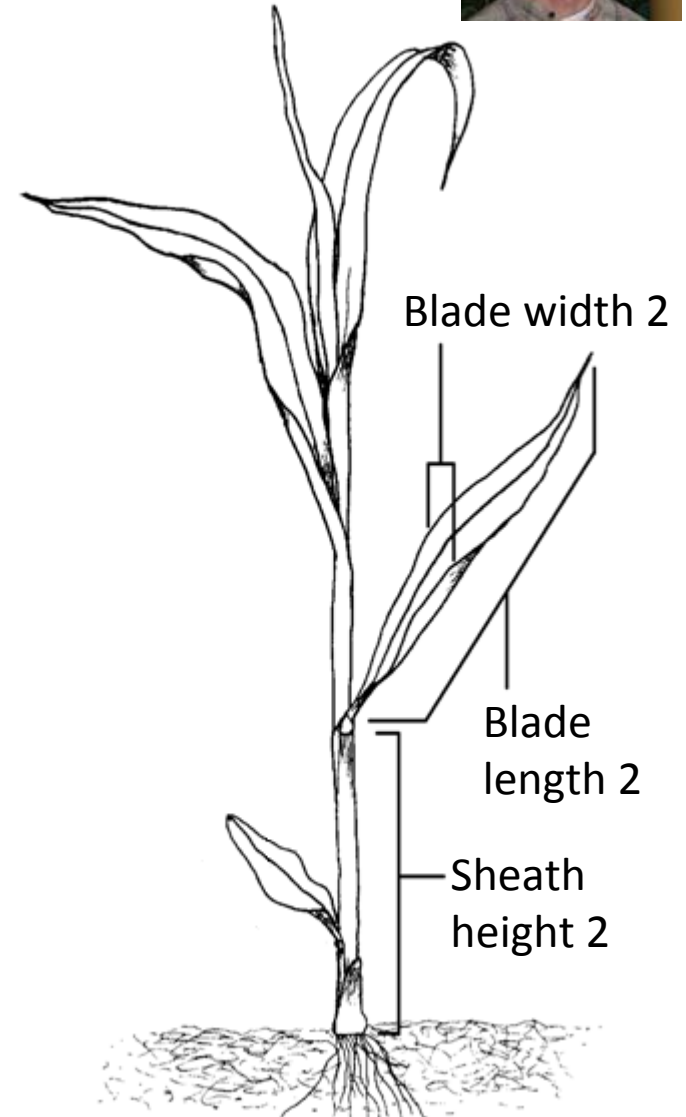
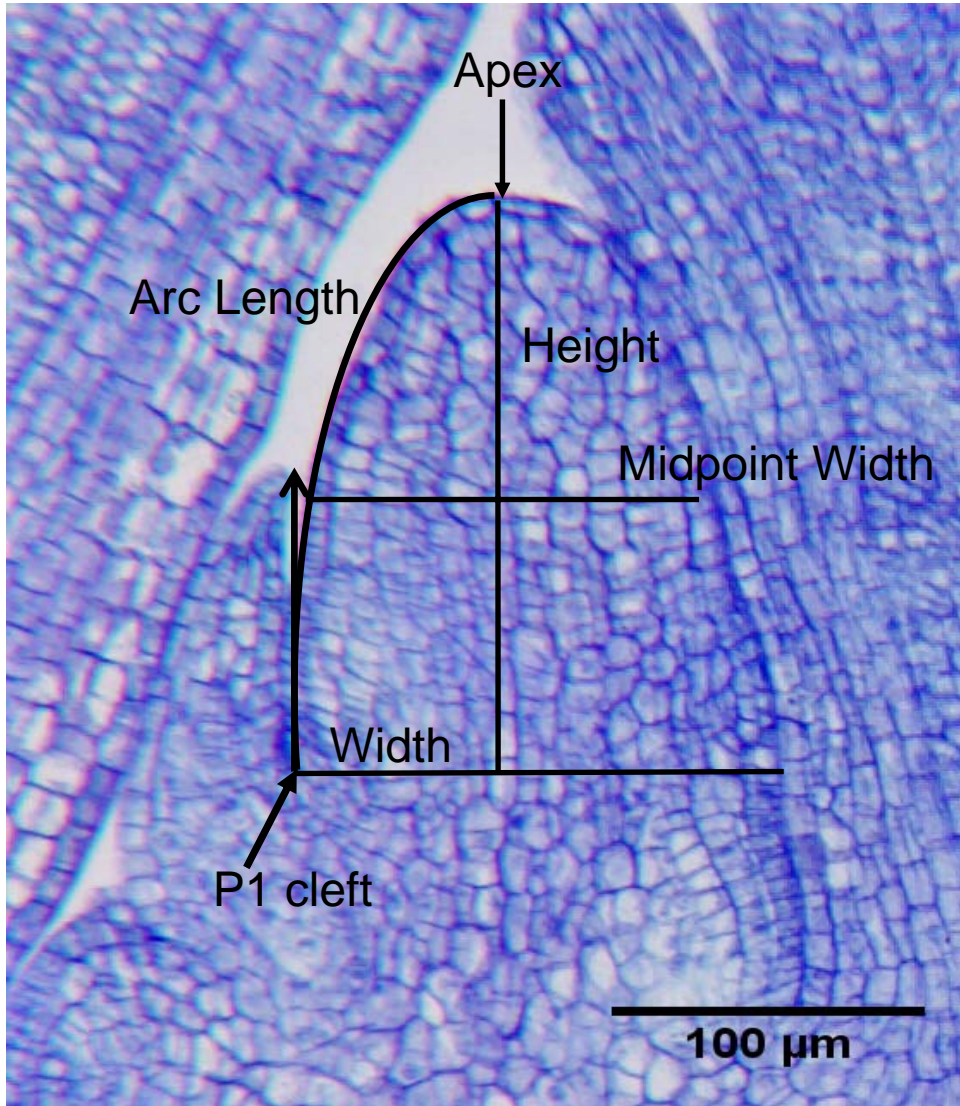
Importance of the Meristem



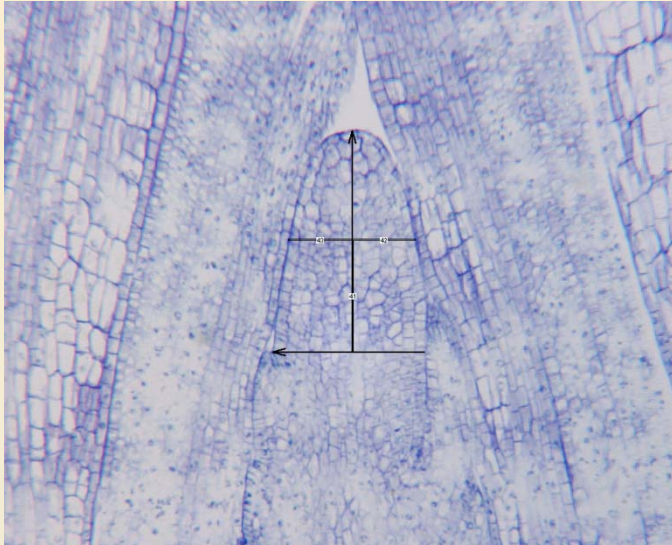
Objectives

- Determine the relationship of SAM architecture with whole-plant traits
- Map QTL to determine genetic architecture of SAM morphology
- Compare genetic architecture of SAM traits and morphological traits
- Identify potential regulatory genes using expression-QTL analysis

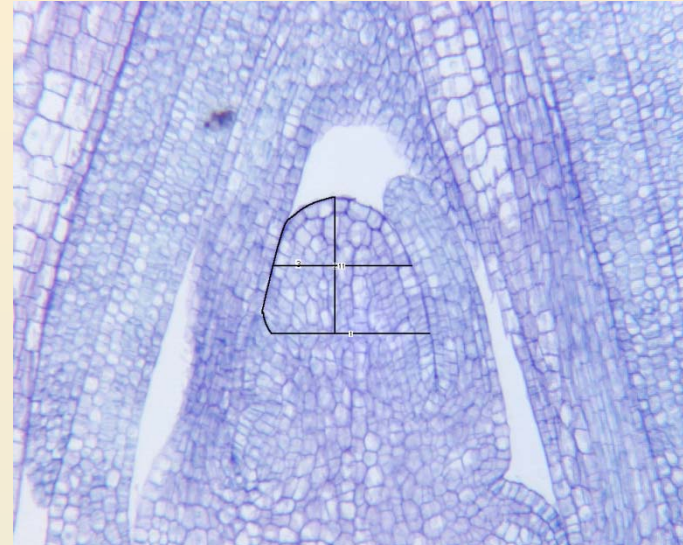
Seedling Measurements



Natural Variation in the SAM



B73

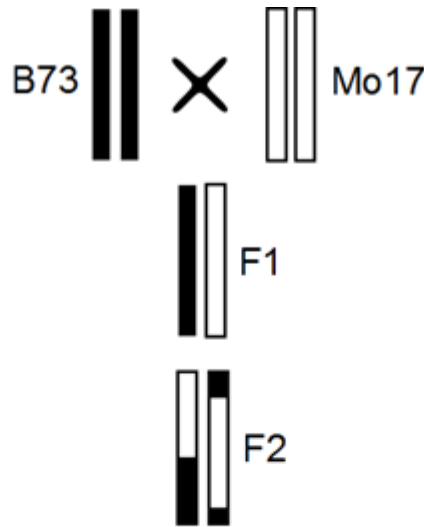


Mo17

	B73	Mo17
SAM height	188 (um)	104
SAM arc	216	140
SAM width	138	142
SAM midpt width	116	120

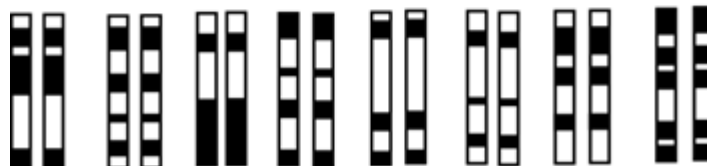
Population: Intermated B73 x Mo17

Recombinant Inbred Lines



Intermating and
recombination

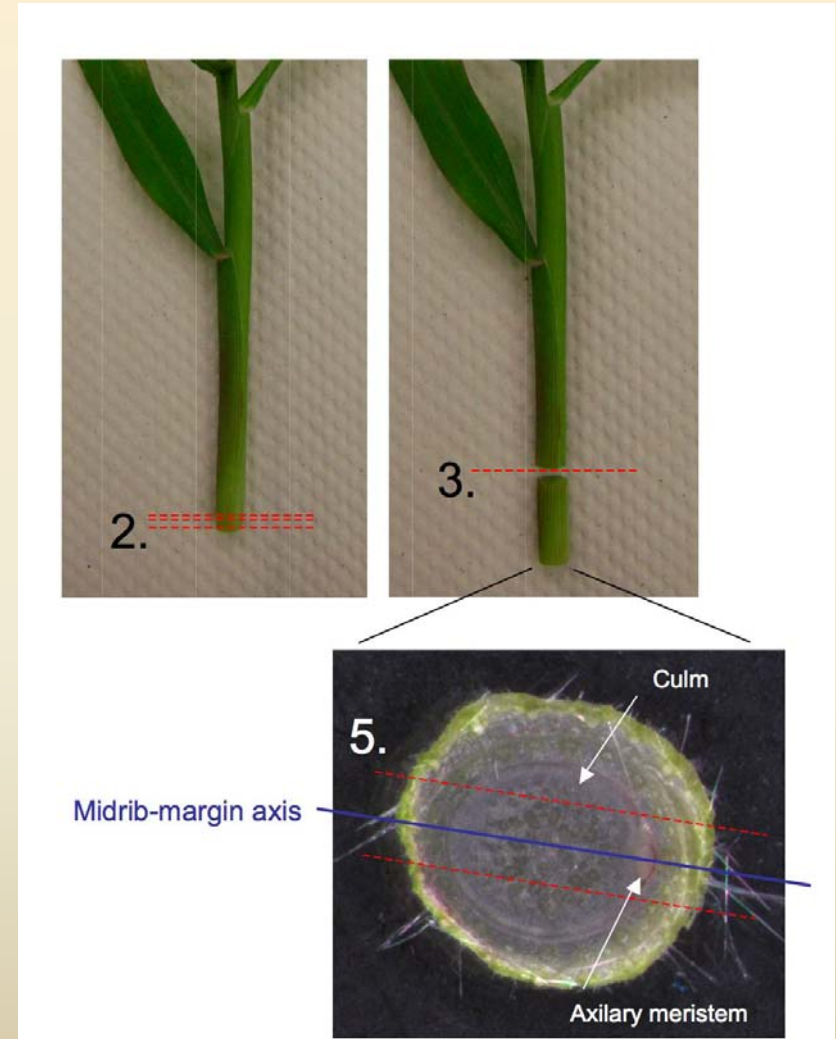
Selfing



Recombinant Inbred Lines

Experimental Design

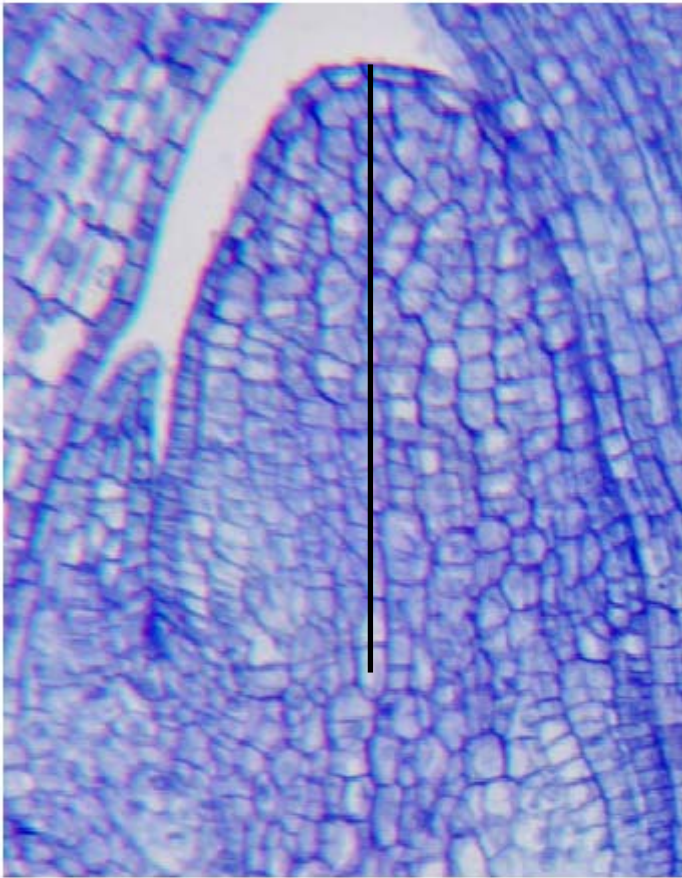
- 2 environments, 2 reps each
- 94 lines + 3 B73 + 3 Mo17
- 10 plants per line
- $2 \times 2 \times 100 \times 10 = 4000$ total plants
- Meristematic region dissected by hand, embedded in paraffin and sectioned longitudinally



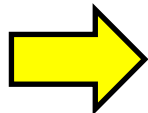
Additional Trait Datasets

- Plant morphology
 - Stem diameter
 - Internode length
 - Node number
 - Plant height
 - Height of ear on plant
- Adult leaf traits
 - Length, width for leaves 9, 11, 13, 15, maximum, and average
 - Leaf angle
 - Total number of leaves and number of leaves below the ear
- Flowering time
 - Days to anthesis
 - Days to silking
 - Anthesis-silking interval

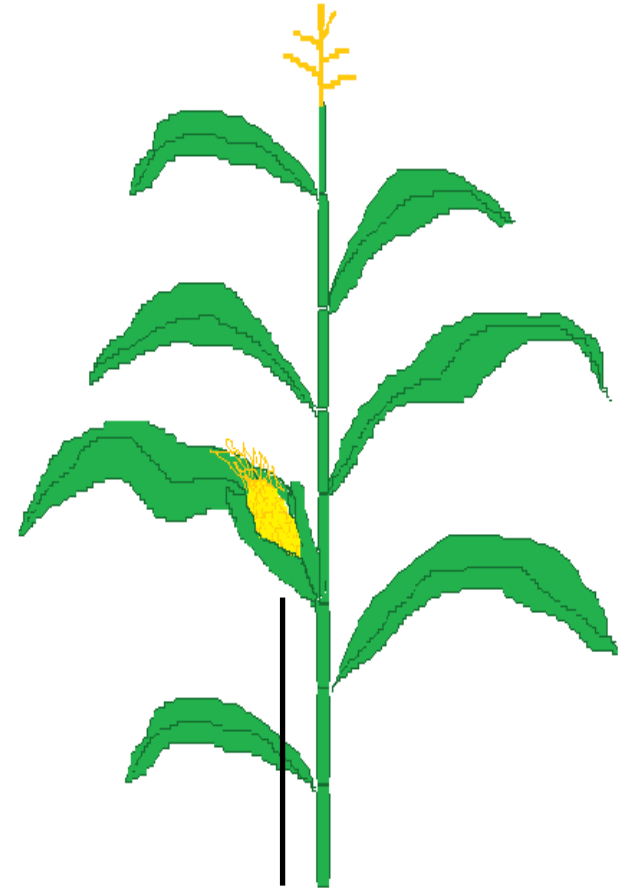
Correlation of SAM Architecture with Other Morphological Traits



Tall, large volume
Meristem

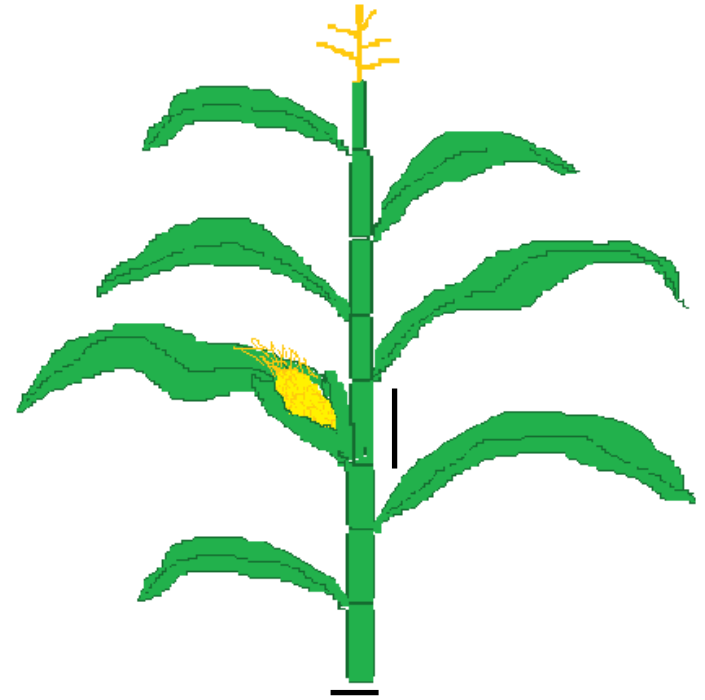
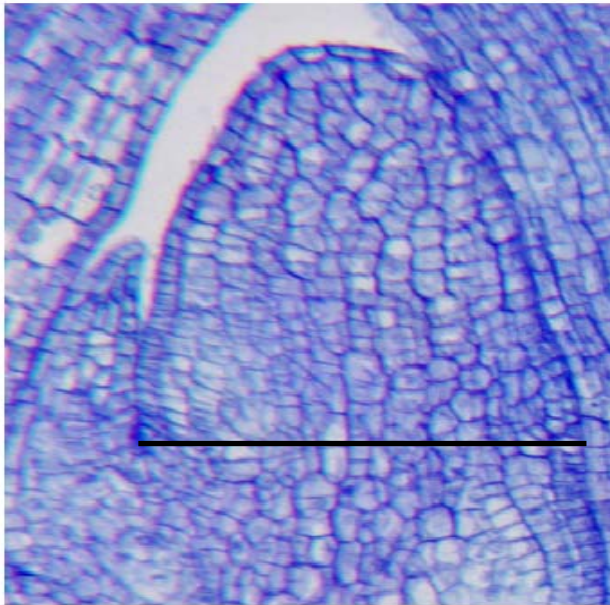


Longer leaves



Lower ear height on plant

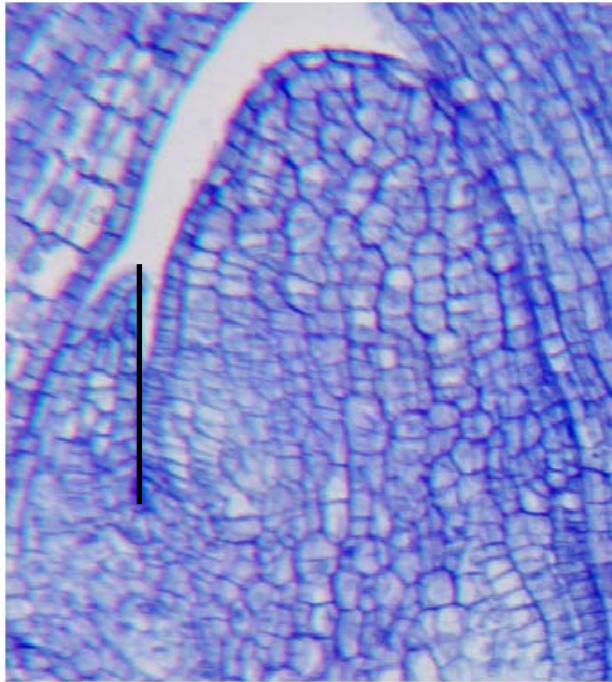
Correlation of SAM Architecture with Other Morphological Traits



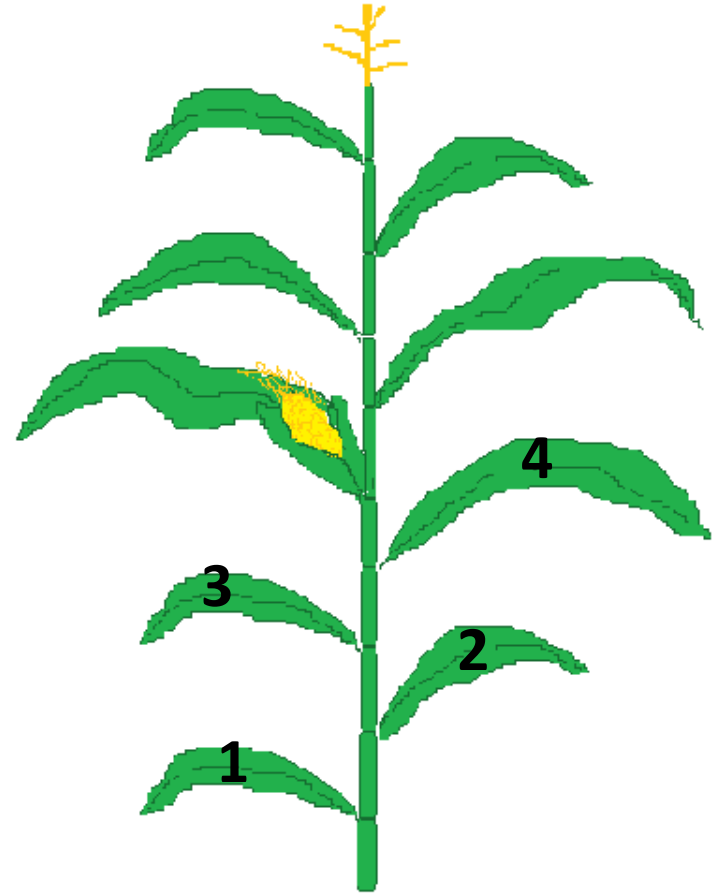
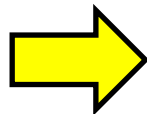
Wide Meristem → Wider leaves

Wider stem diameter
Shorter internode length

Correlation of SAM Architecture with Other Morphological Traits



Shorter P1

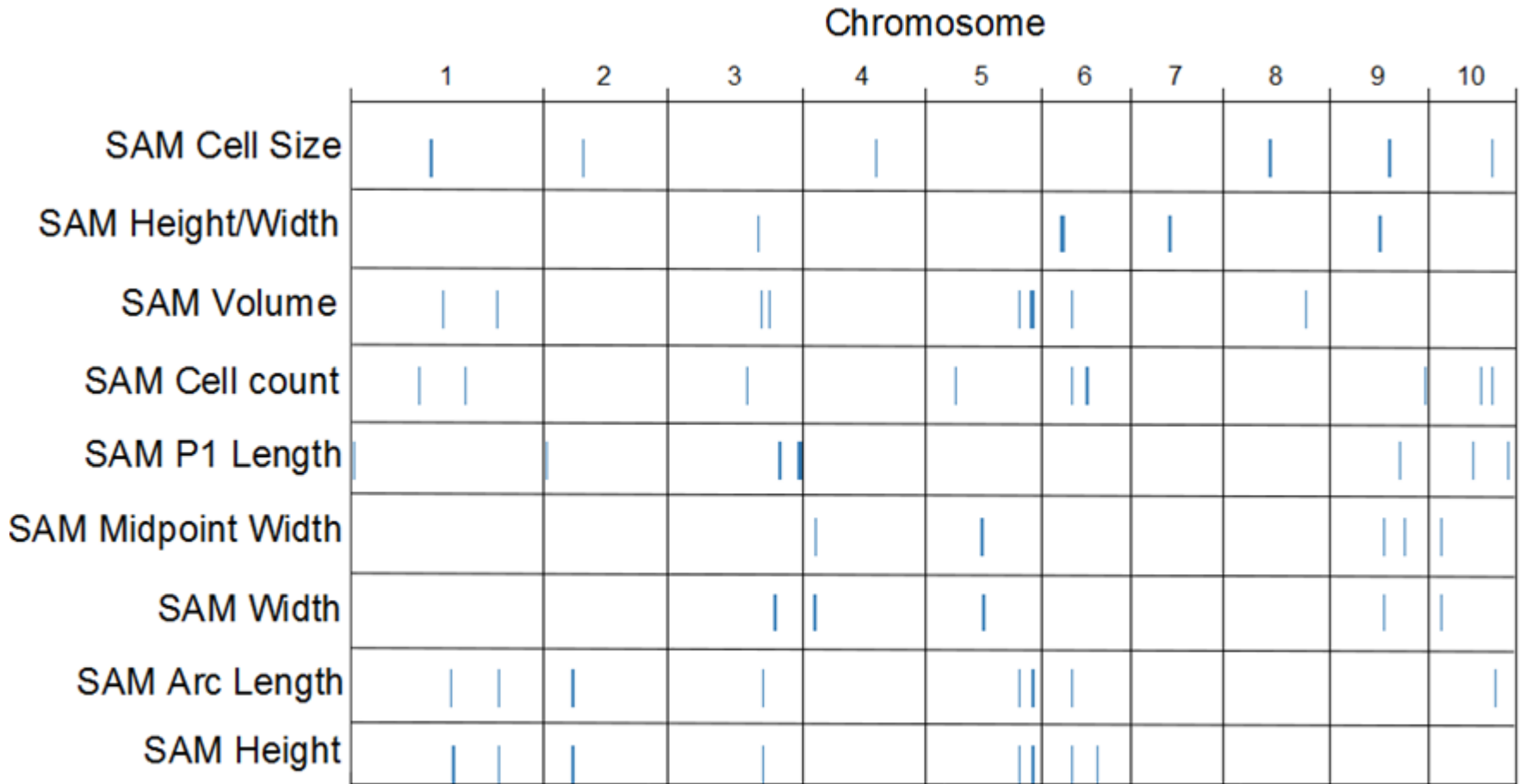


More leaves below ear

QTL Mapping of SAM Architecture

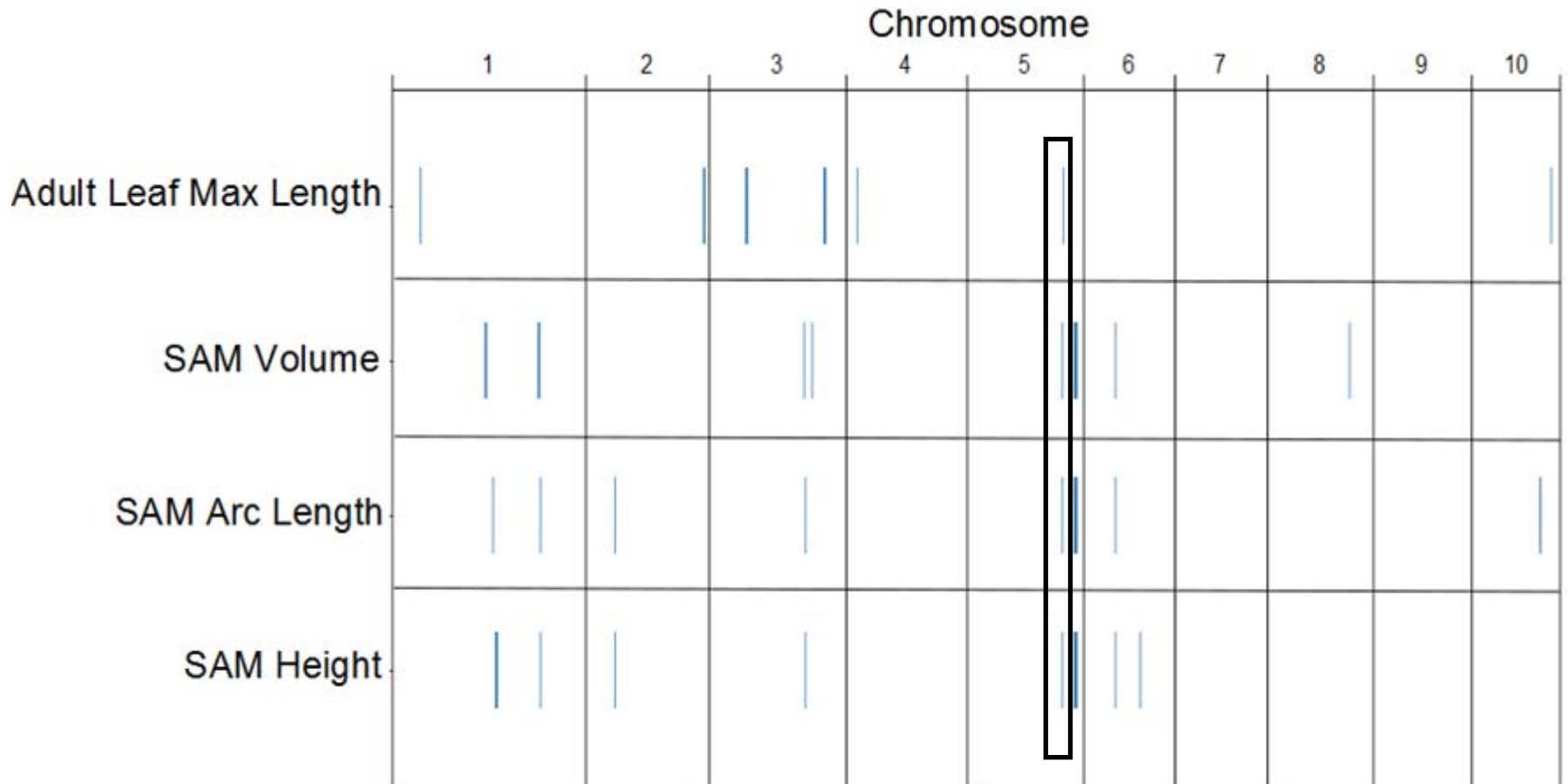
- SNP map
 - Developed from RNA-seq of IBMRILs
 - Over 7800 high-quality SNPs
- Many small-effect SAM QTL

All SAM QTL



<u>SAM Trait</u>	<u>Number of QTL</u>	<u>Total R2</u>	<u>Total Effect (um)</u>	<u>Effect Range (um)</u>
Height	8	0.632	18.73	-4.57 to 6.1
Width	8	0.885	3.36	-3.58 to 4.87

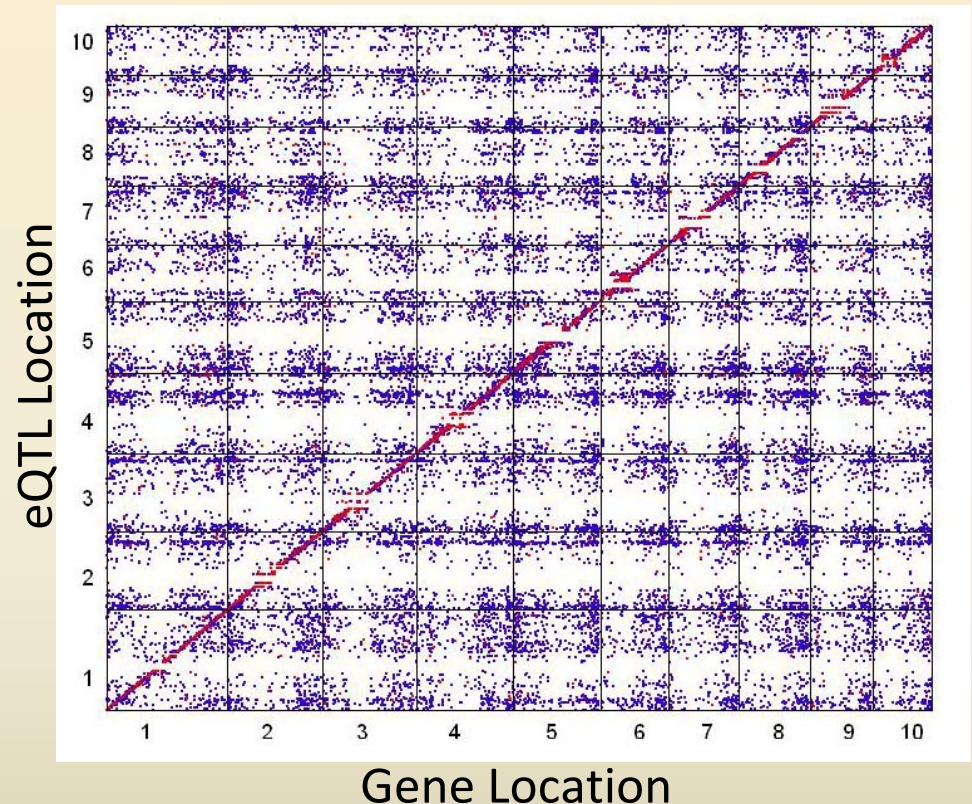
Coincident QTL



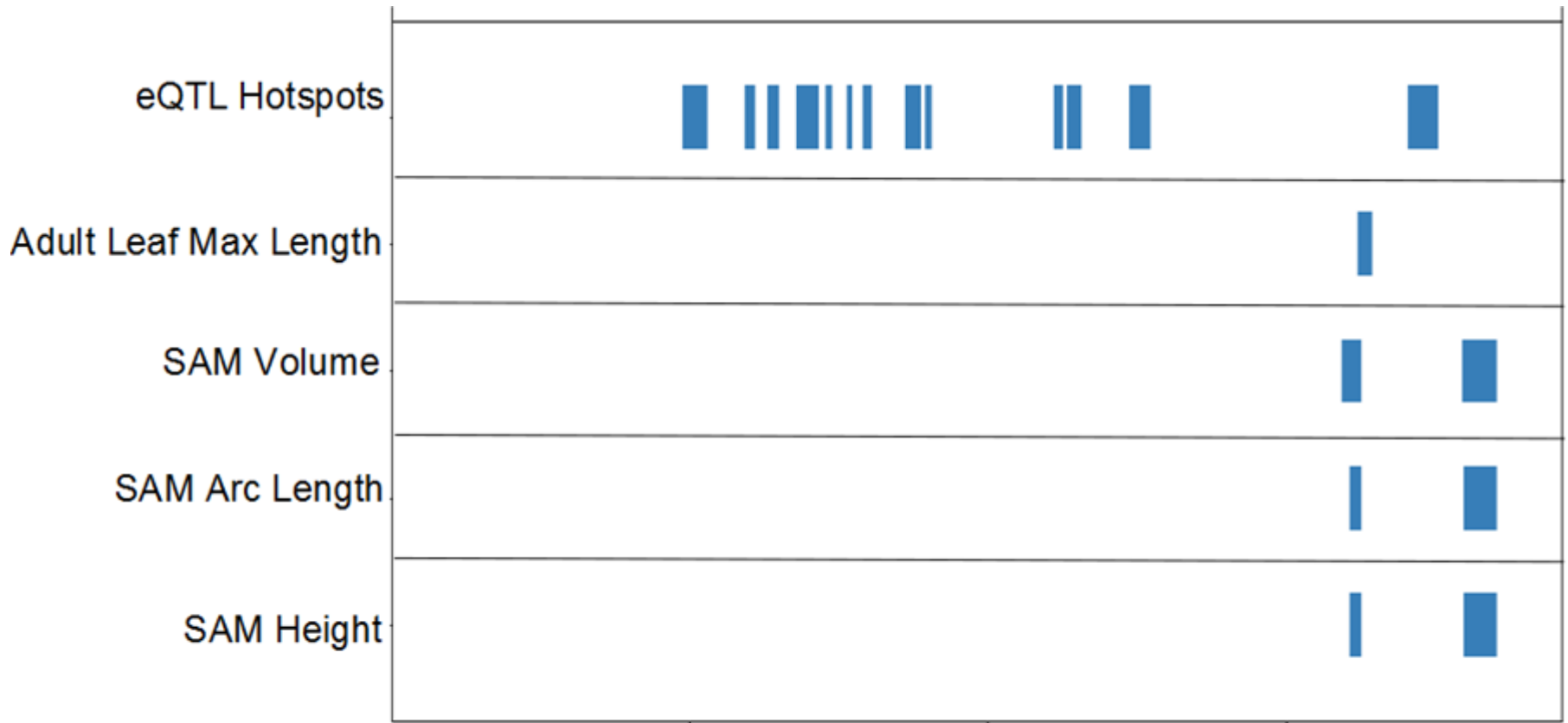
eQTL Mapping



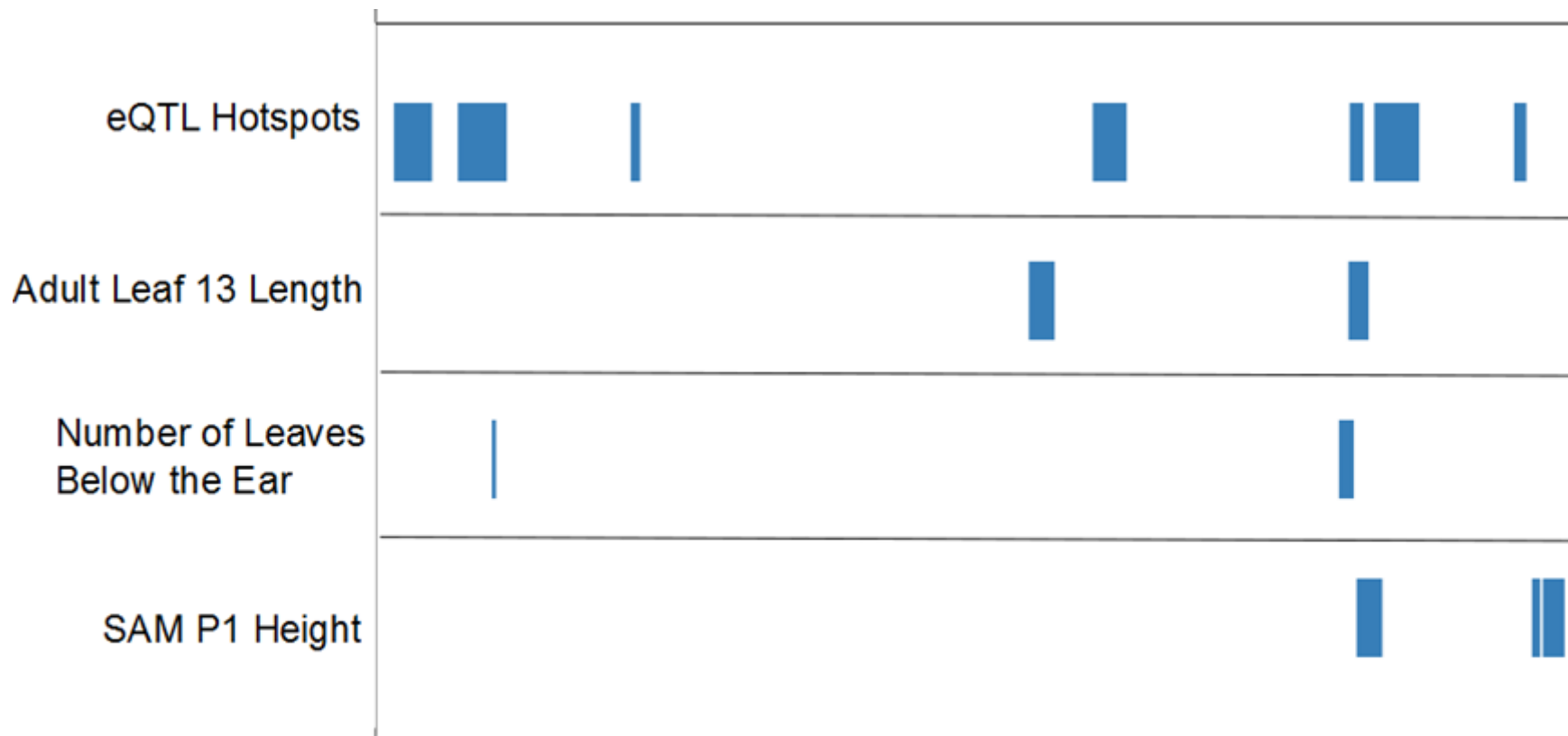
- RNA-seq of SAM-enriched tissue from 120 IBMRIL
- Identified cis, trans, hotspots
 - Chi-sq $p < 0.05$
- Identify regions that may contain master regulators via coincidence of pQTL and eQTL



Chromosome 5



Chromosome 3



Summary

- SAM height and volume are correlated with leaf length and ear height
- SAM width is correlated with leaf width, stem diameter, internode length
- P1 length is correlated with leaf number
- SAM architecture is controlled by many small effect QTL, one-third of which co-localize with other phenotypic QTL
- Half of co-localized physical QTL coincide with trans eQTL hotspots

Acknowledgements

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Maize Trait Datasets

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Jianming Yu

SNP map

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