Genotype by environment interaction in the 2014 Inbred Study

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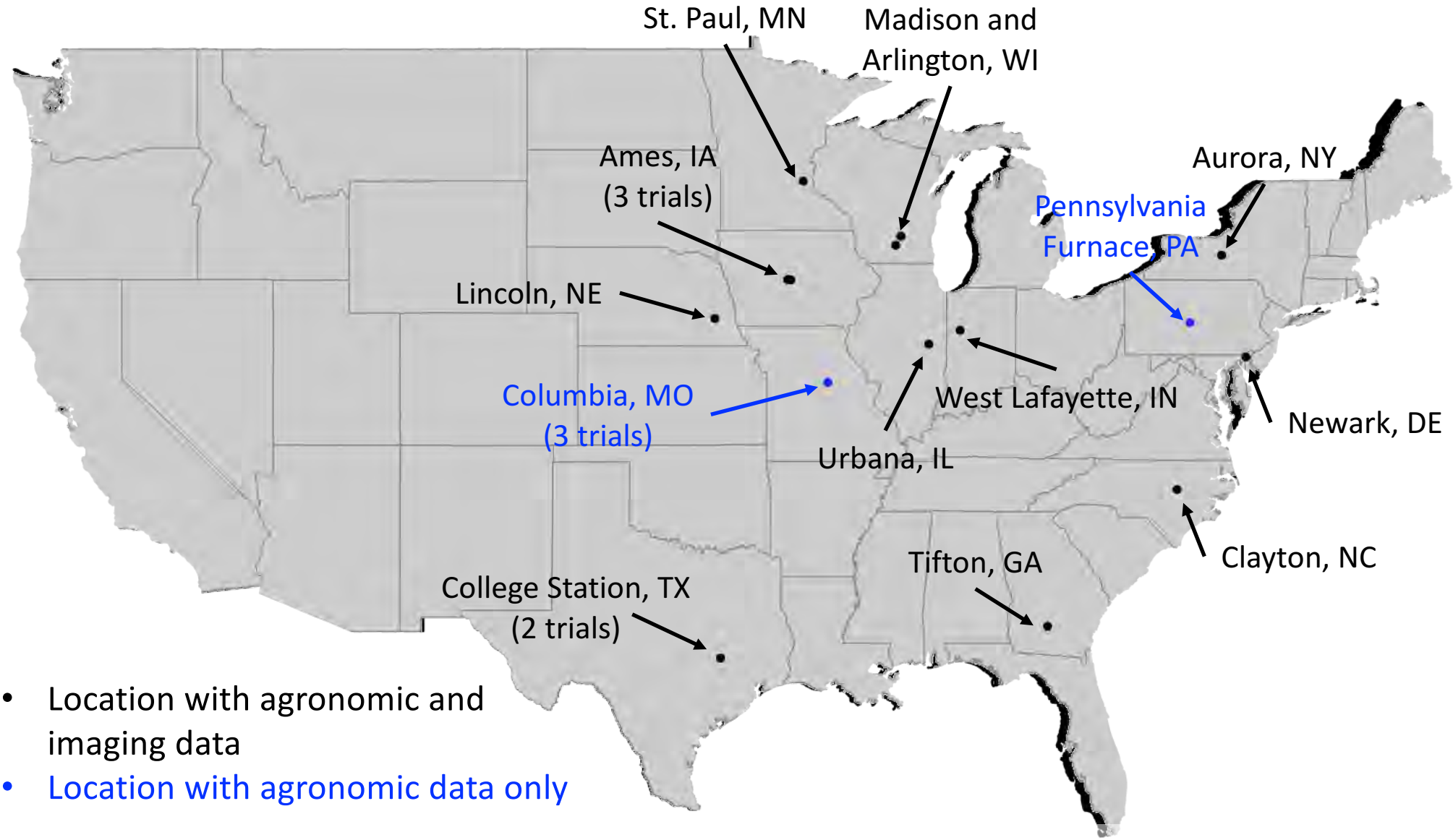
2014 GxE inbred study—Questions to explore

- What correlations do we observe among agronomic and yield component traits?
- How do trait means change with respect to inbreds' year of release?
- For which traits does GxE interaction explain a significant portion of variation observed?
- What is the distribution of GxE among traits?
- Which inbreds show the most stability?
- How does GxE change with respect to inbreds' year of release?

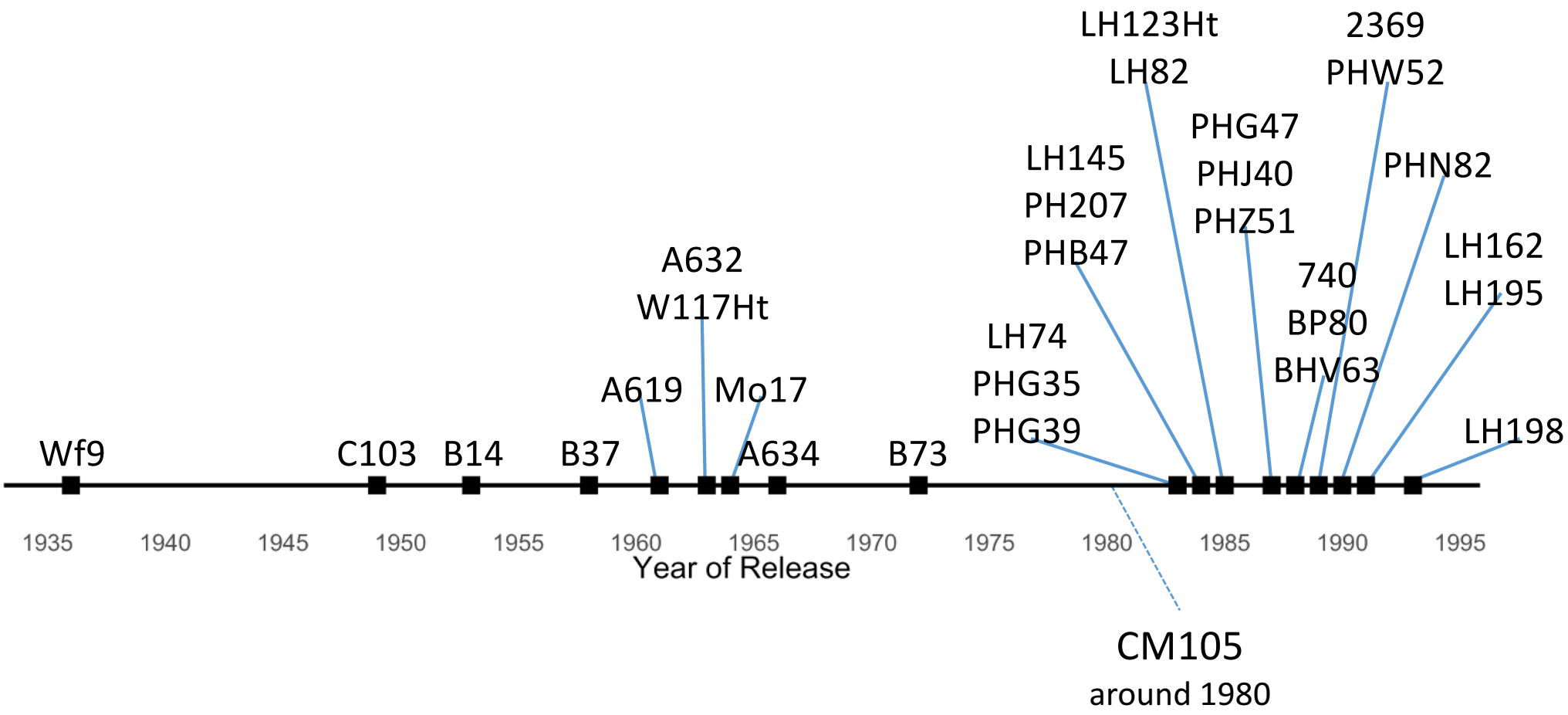
2014 Inbred trials



- Location with agronomic and imaging data
- Location with agronomic data only

- 19 locations across 13 states
- 2 replicates per environment

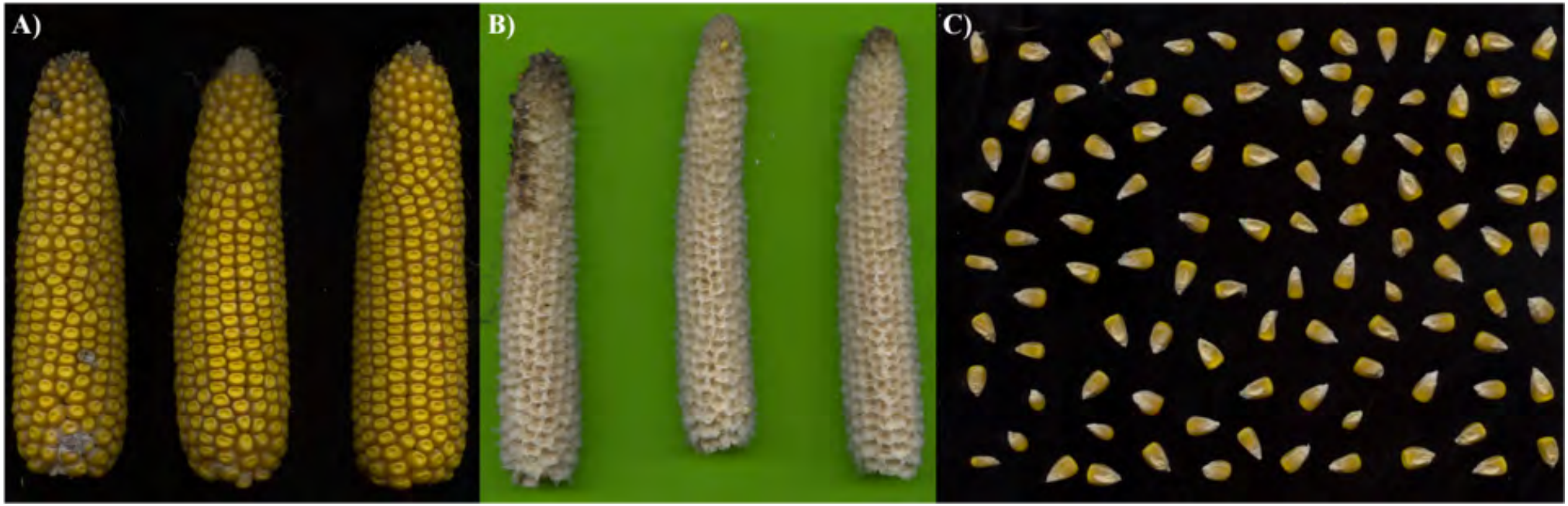
Population: 31 inbred lines selected to represent range of locations and release date



Phenotypic data

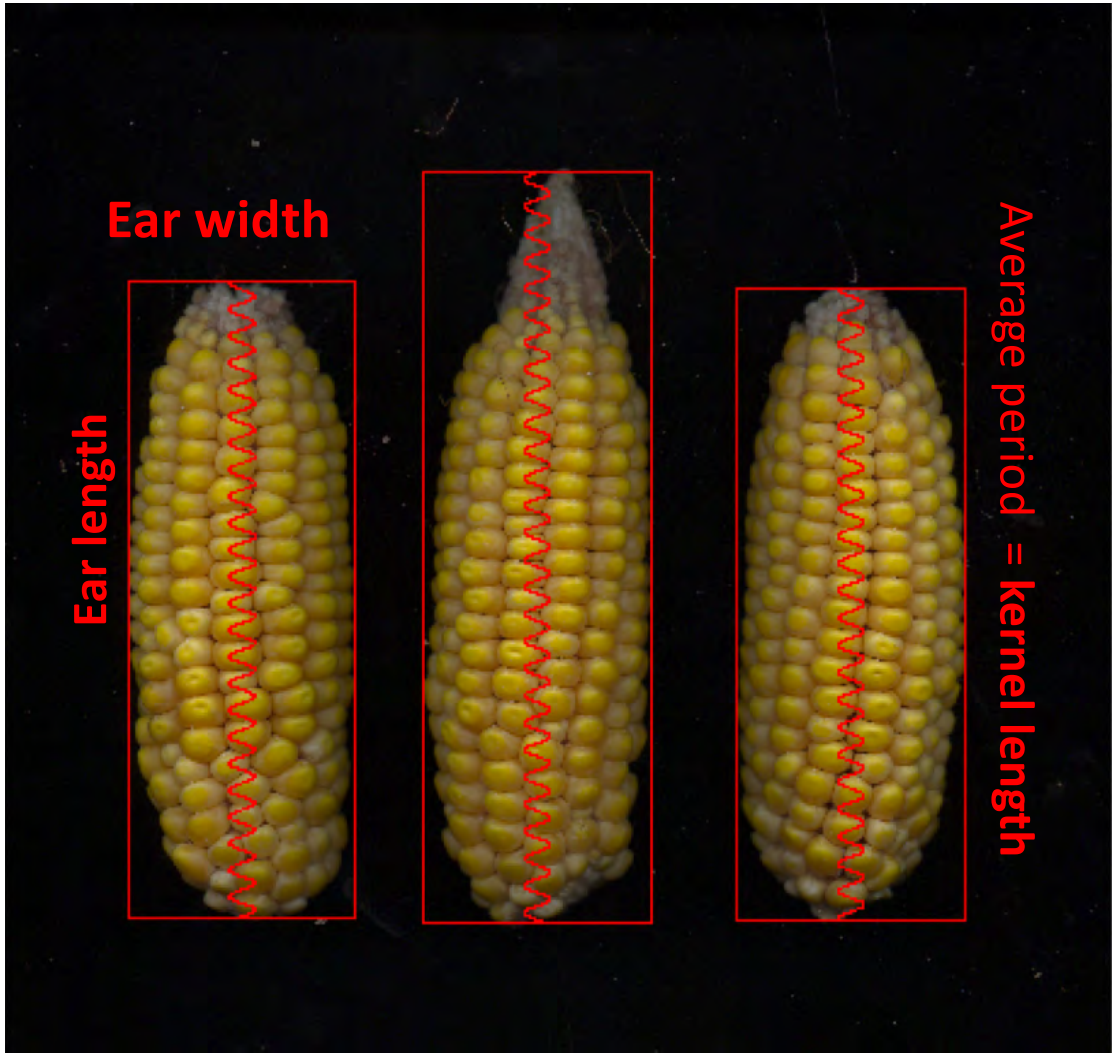
- Agronomic traits
  - Anthesis date (DAP)
  - Silking date (DAP)
  - Plant height
- Yield component traits
  - Ear length
  - Ear width
  - Kernels per row
  - Kernel row number
  - Kernel weight

Yield Components: Imaging Output



Miller et al. 2016 – The Plant Journal

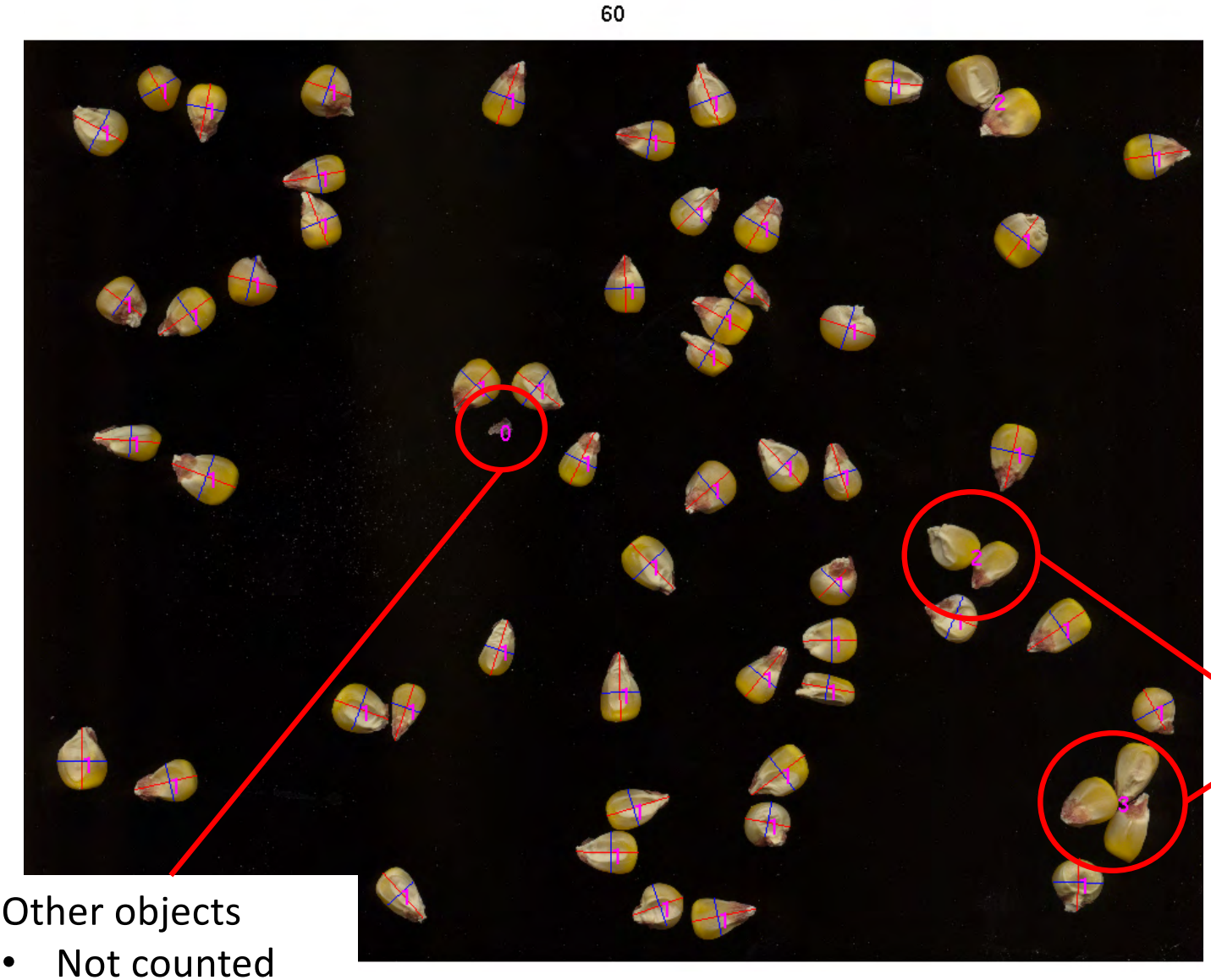
Imaging Output: Ears



- **Kernel row number**: counted manually
- **Kernels per row** = Ear length / Kernel length

Miller et al. 2016 – The Plant Journal

Imaging Output: Kernels



- **Kernel weight** = Cup weight / kernel count

Grouped kernels:

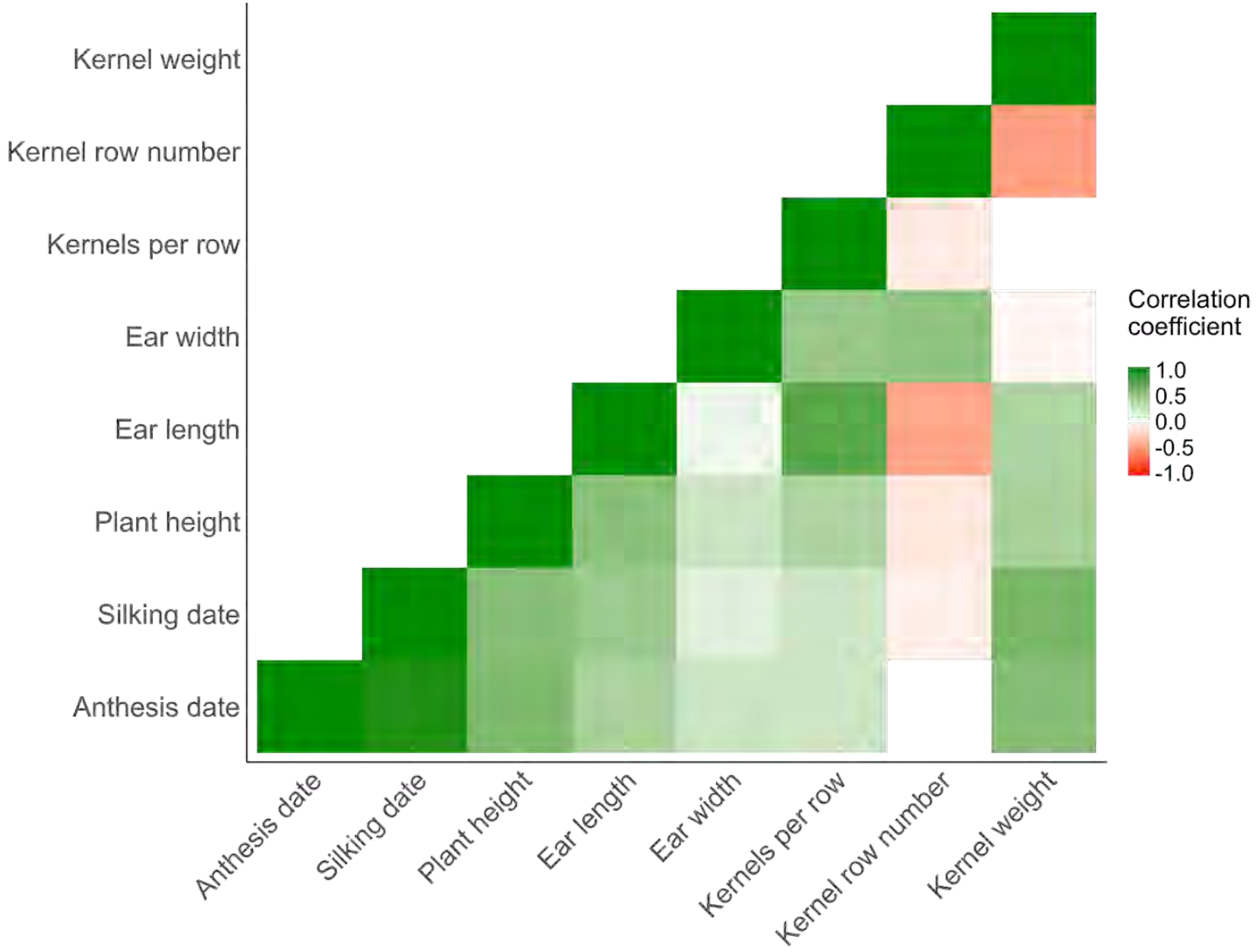
- Counted accurately
- No measurements recorded

Other objects

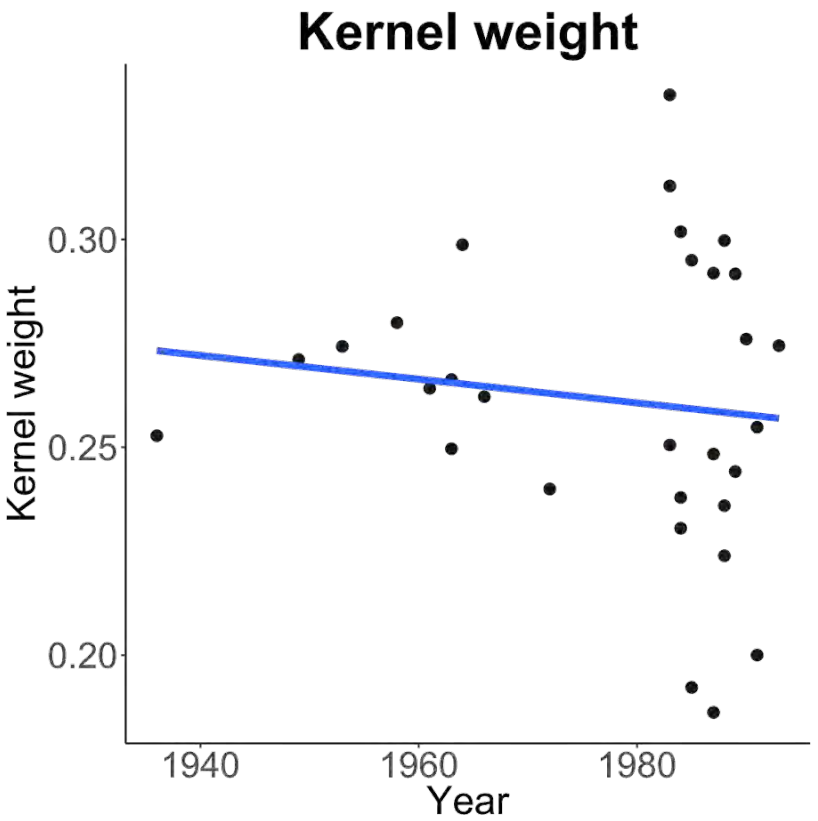
- Not counted
- Not measured

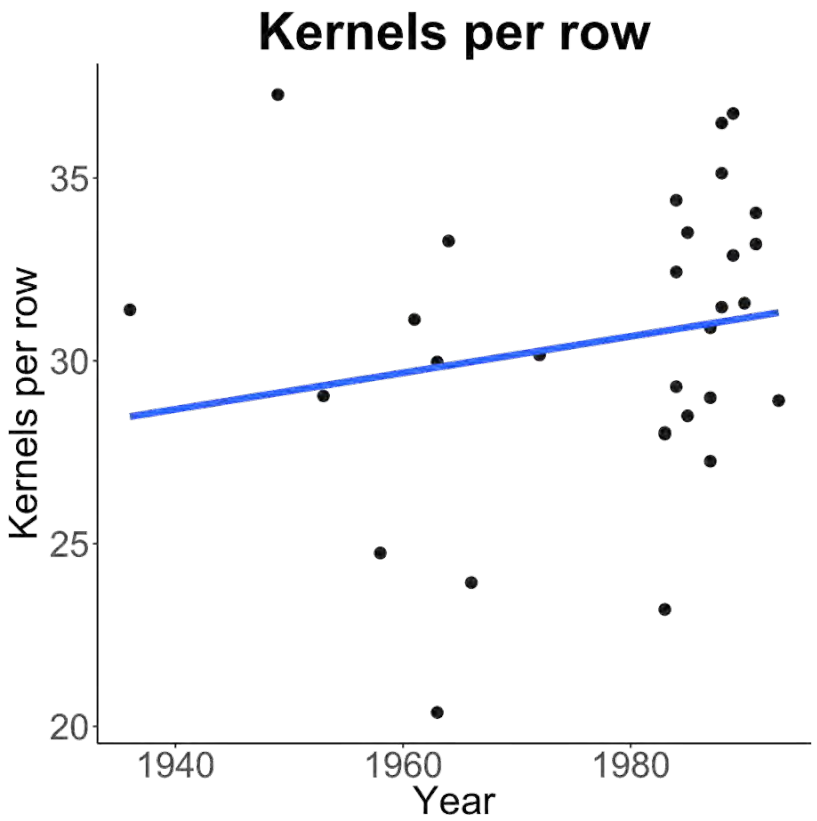
Miller et al. 2016 – The Plant Journal

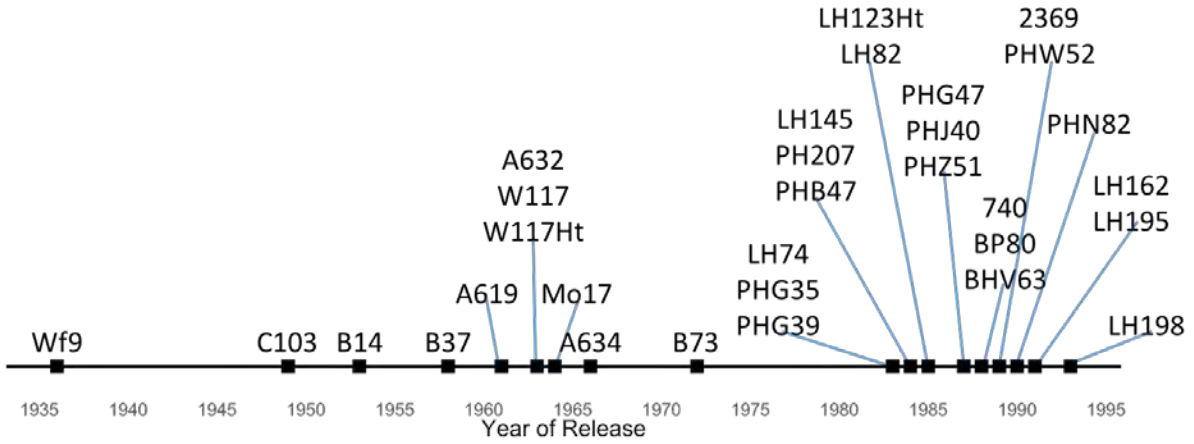
What correlations do we observe among agronomic and yield component traits?



How do trait means change w.r.t. year of release?







Quantifying GxE interaction

- Slope
  - = 0: Type I stability
    - consistent across environments
    - Ex) Genotype A
  - = 1: Type II stability
    - mean response to environments
    - Ex) Genotype B
- Mean square error
  - Low MSE: Type III stability
    - predictable performance across environments
    - Ex) Genotype A has lower MSE in comparison to Genotype C

Standardized MSE =
MSE / mean trait value^2

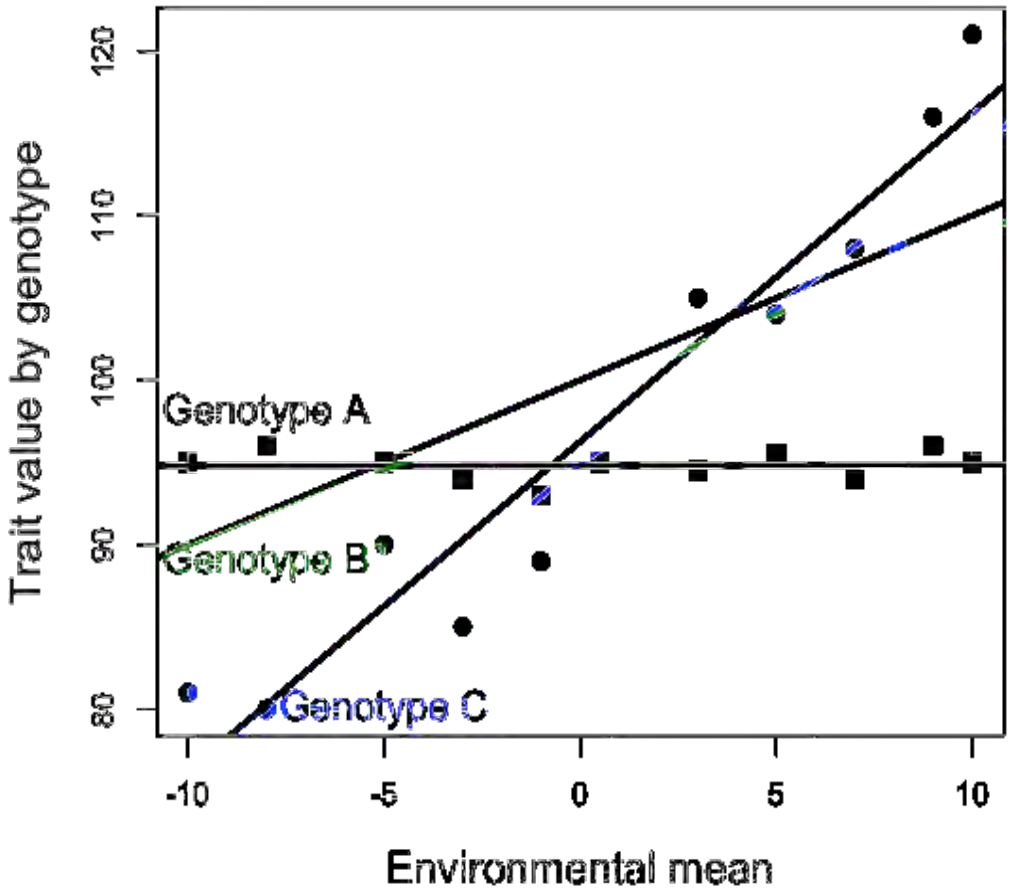
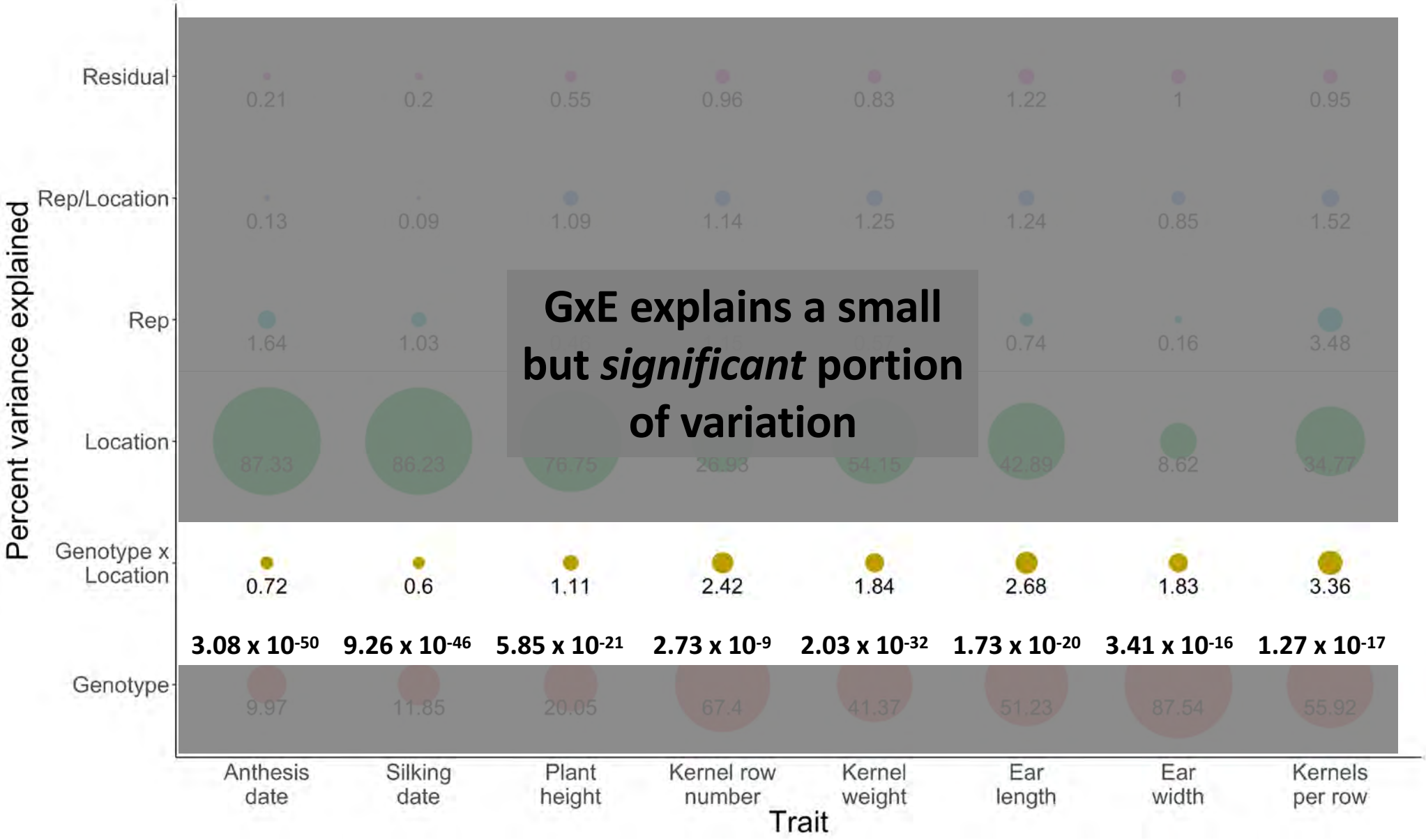
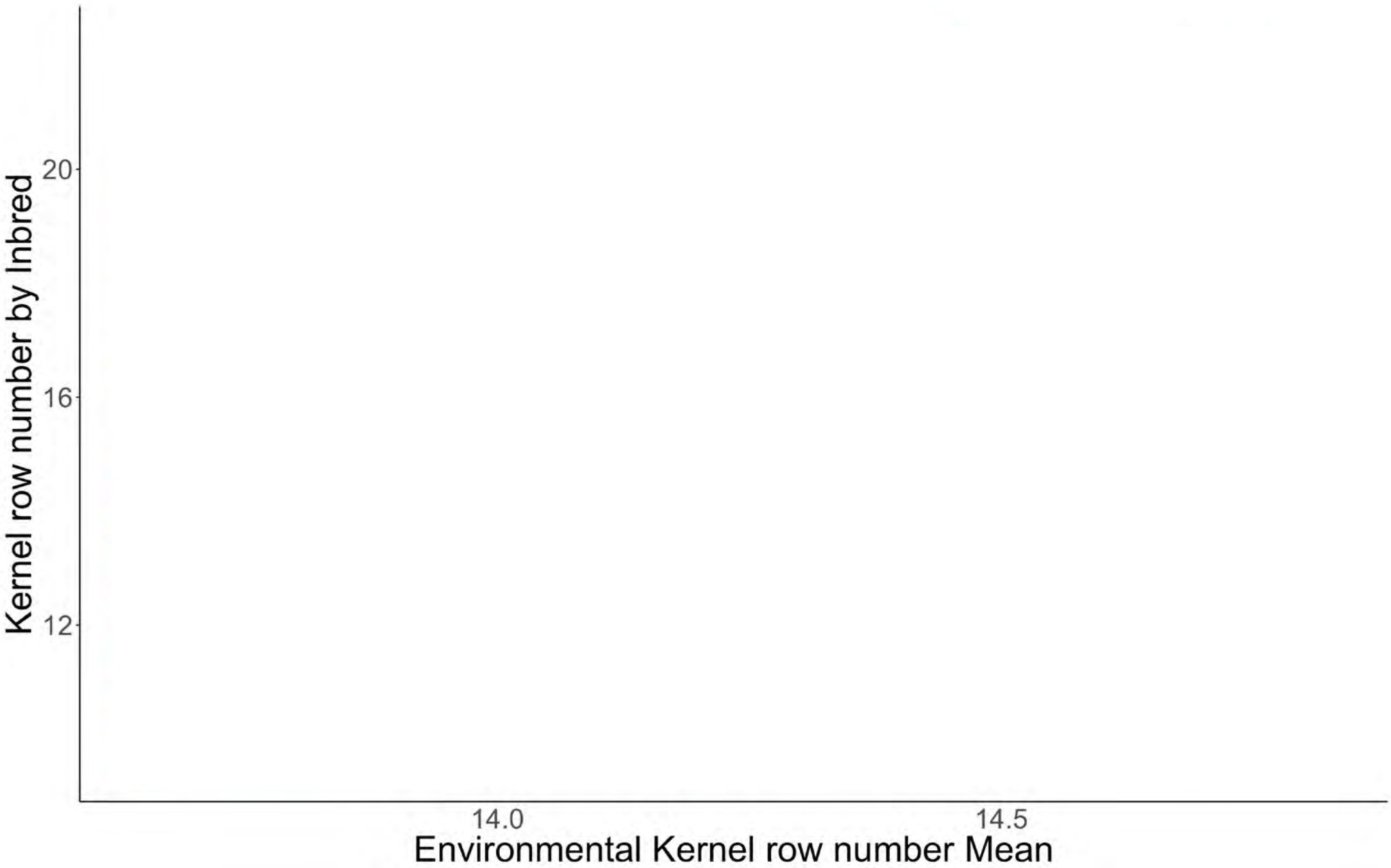


Figure adapted from Bernardo 2010

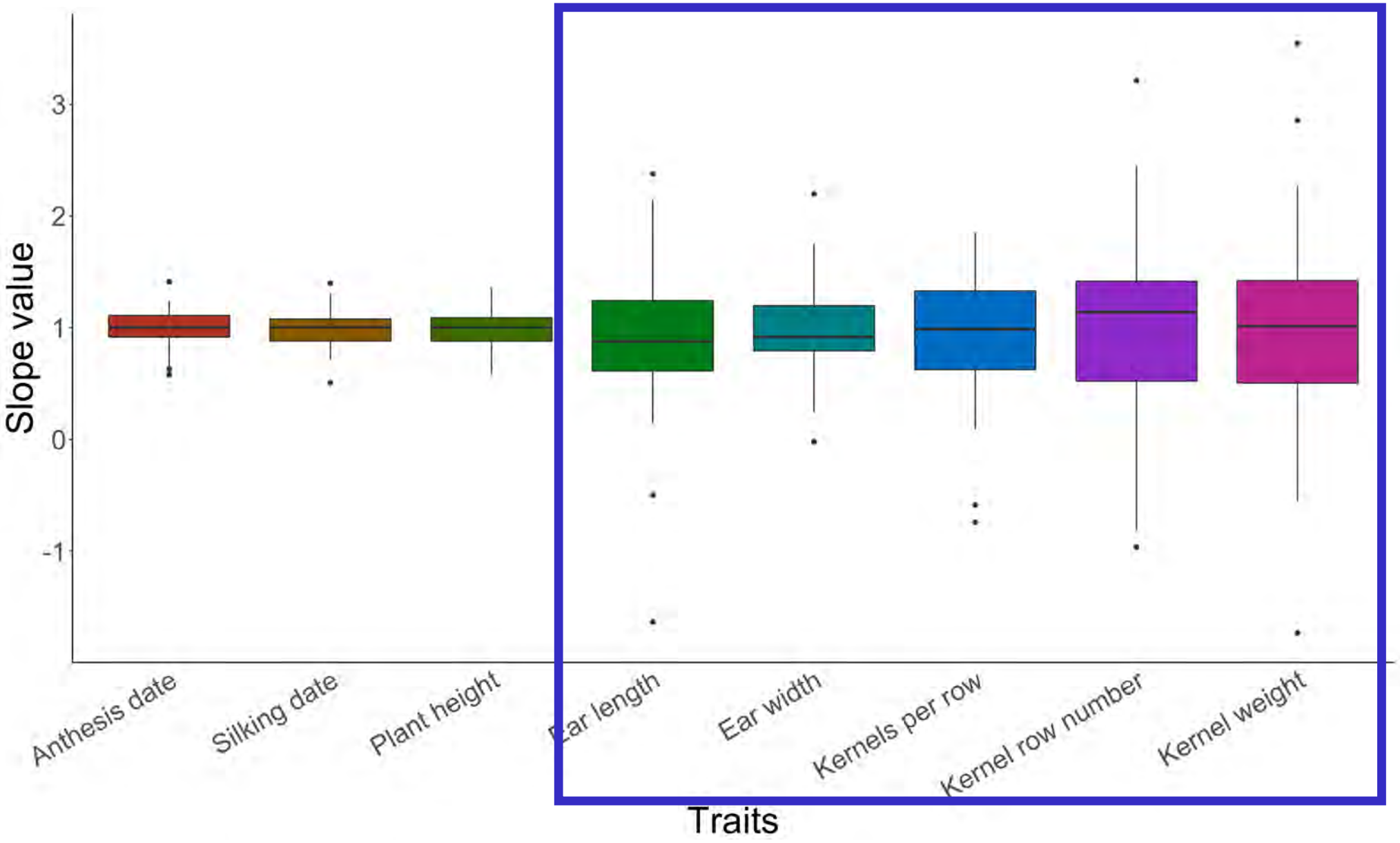
For which traits does GxE interaction explain a significant portion of variation observed?



GxE Regression Plot



What is the distribution of GxE among traits?



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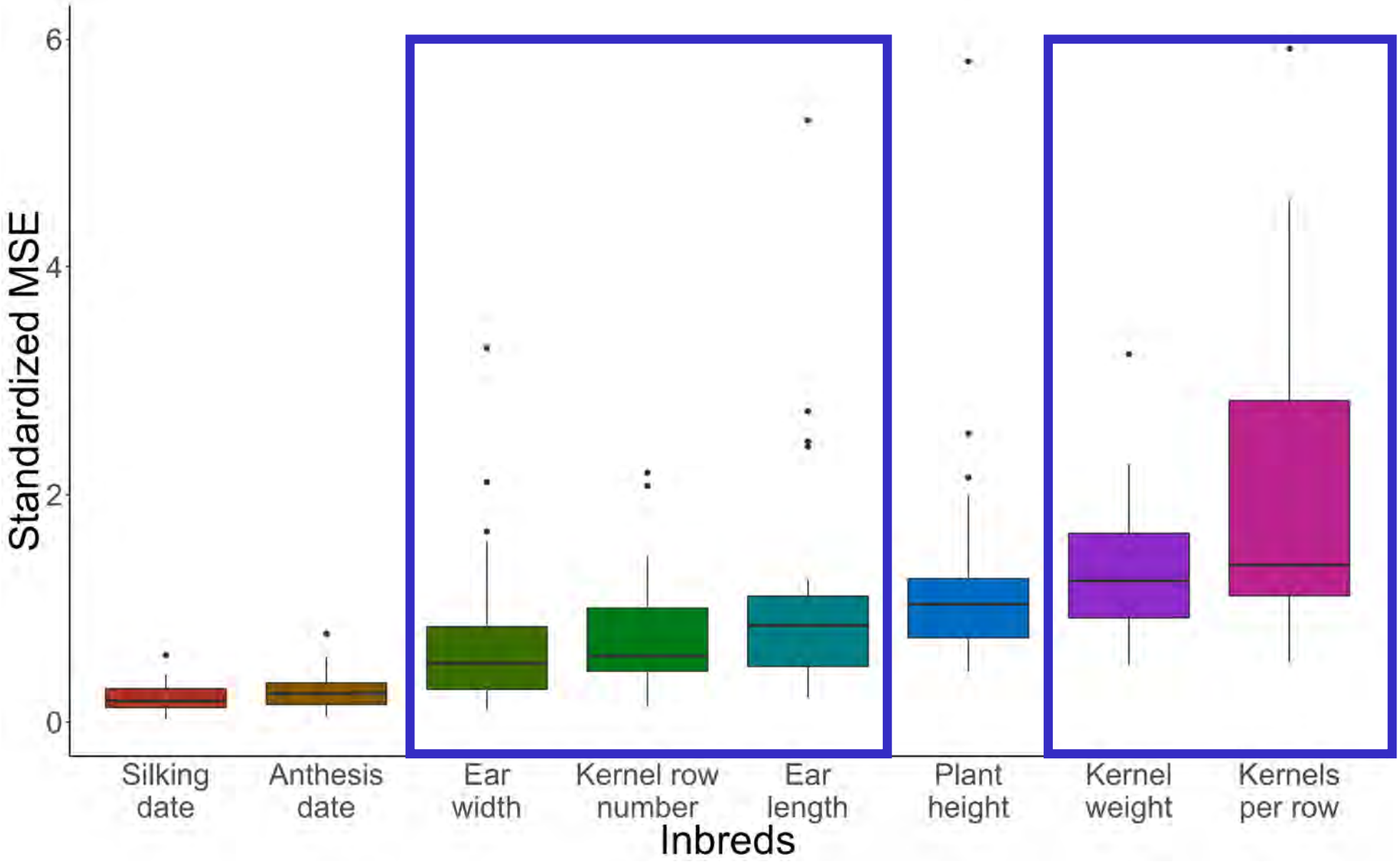
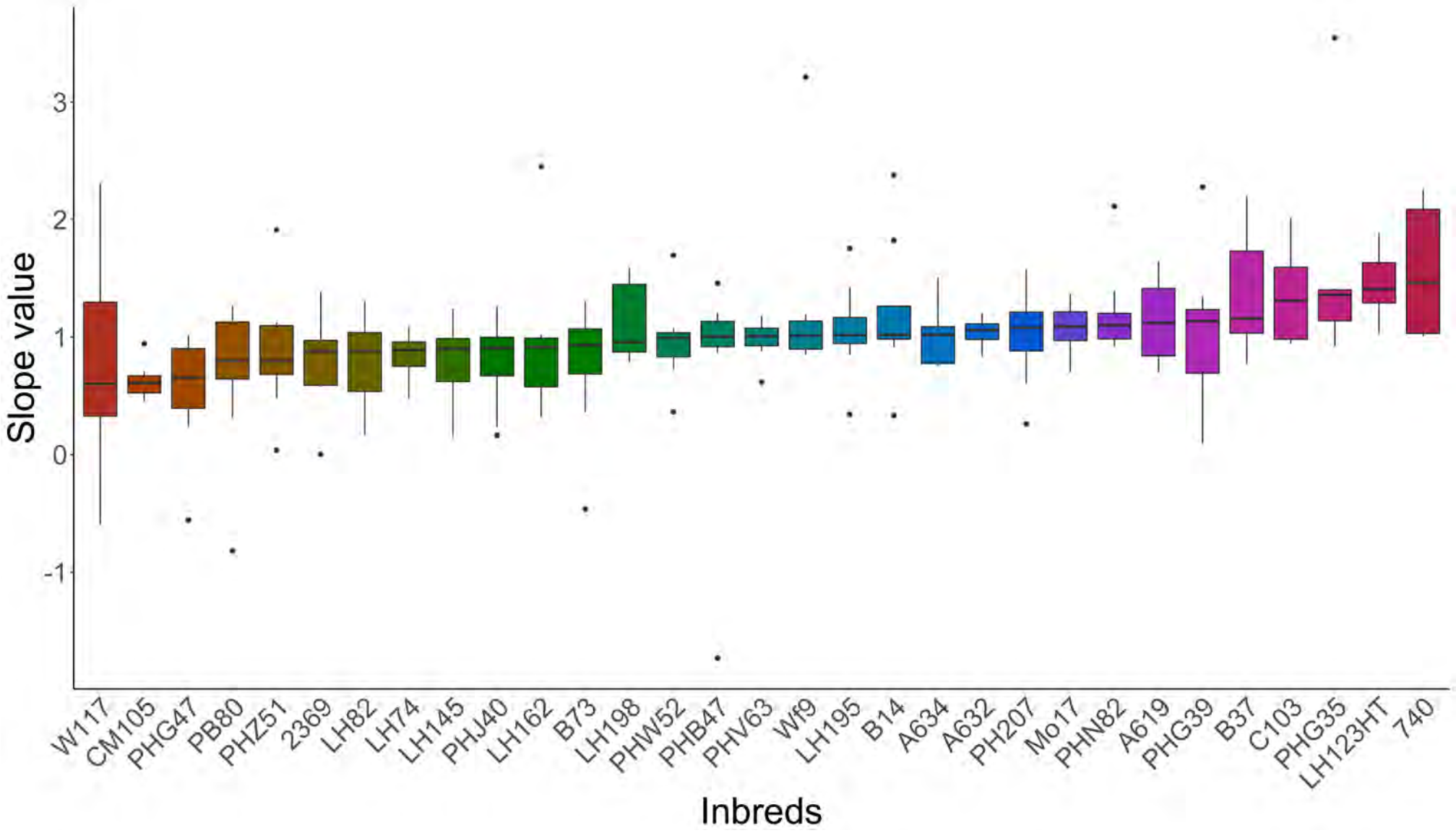


Which inbreds show the most stability?



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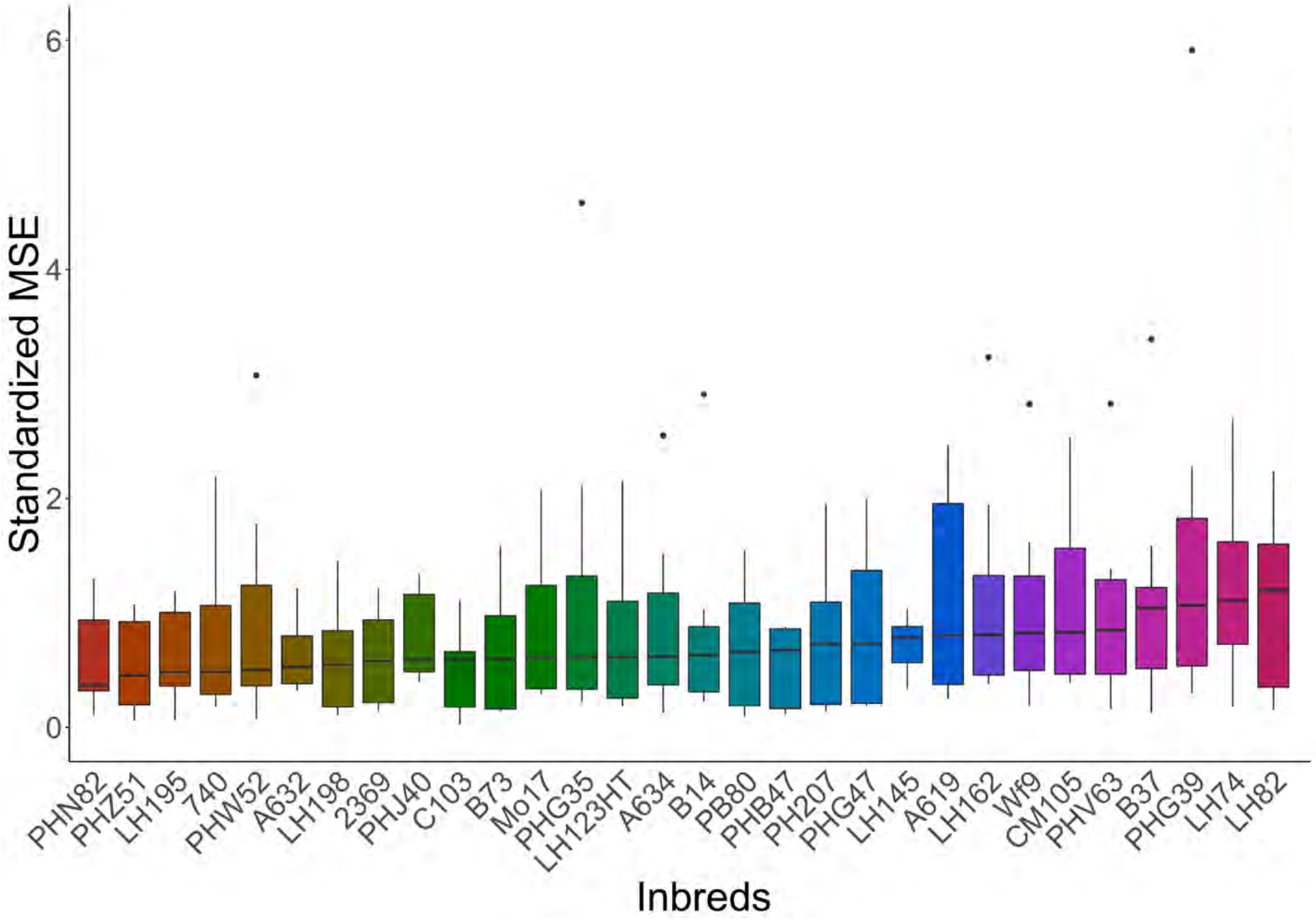
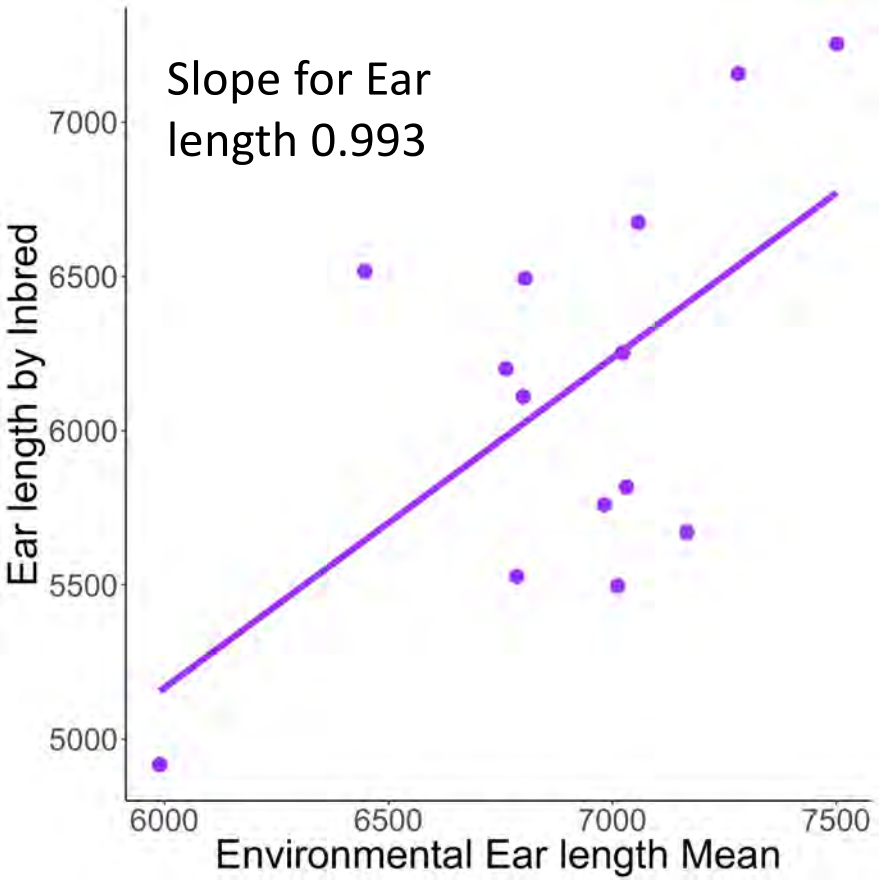
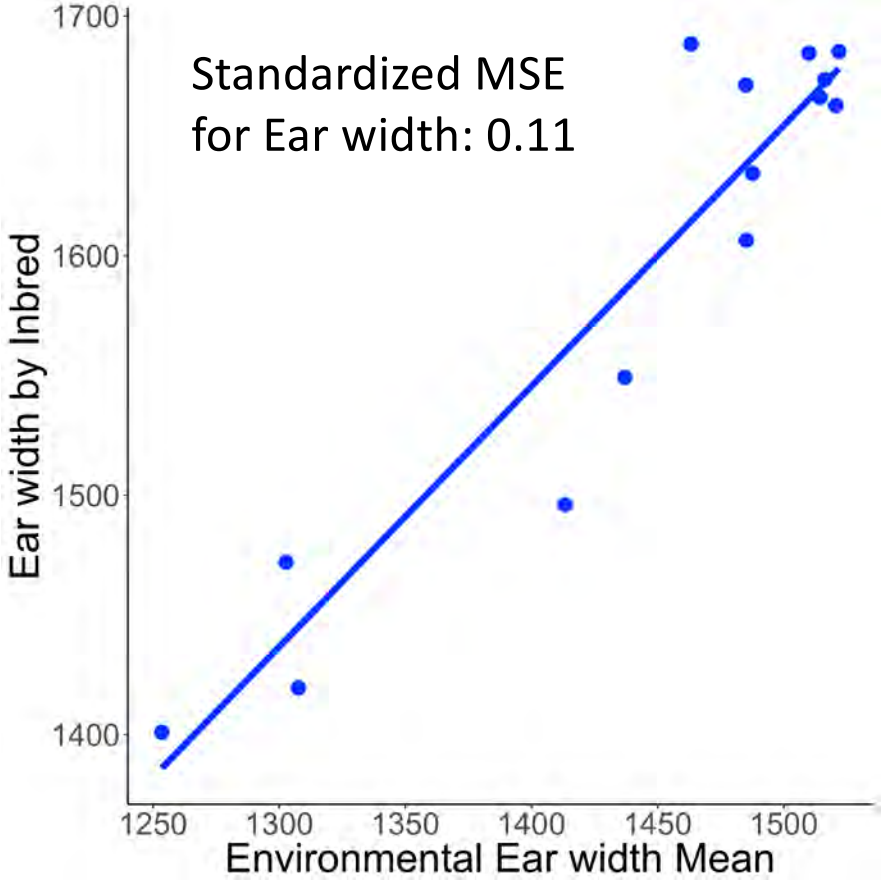


Which inbreds show the most stability?

A634
Mean slope: 1.007

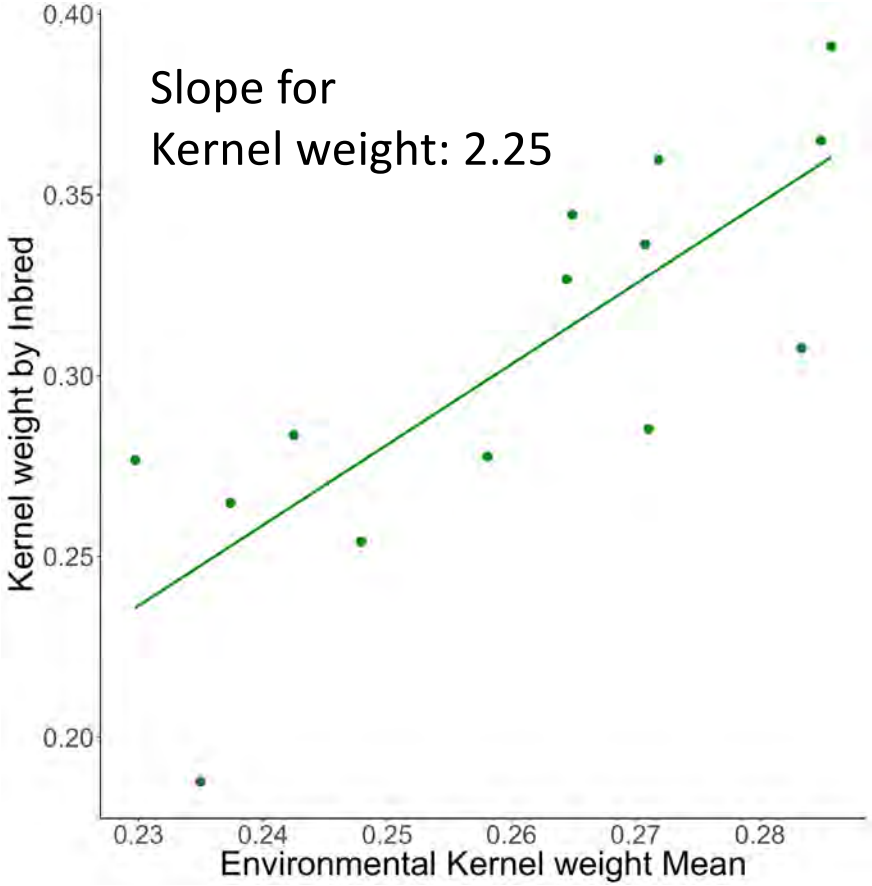


PHN82
Mean standardized MSE: 0.60

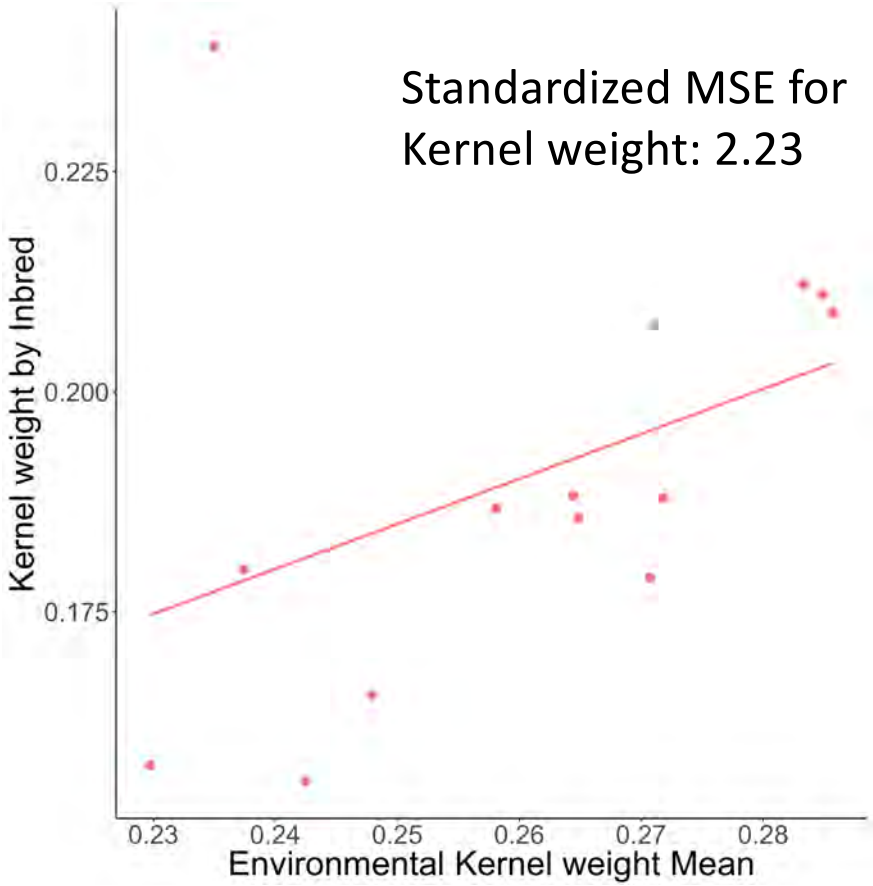


Which inbreds show the least stability?

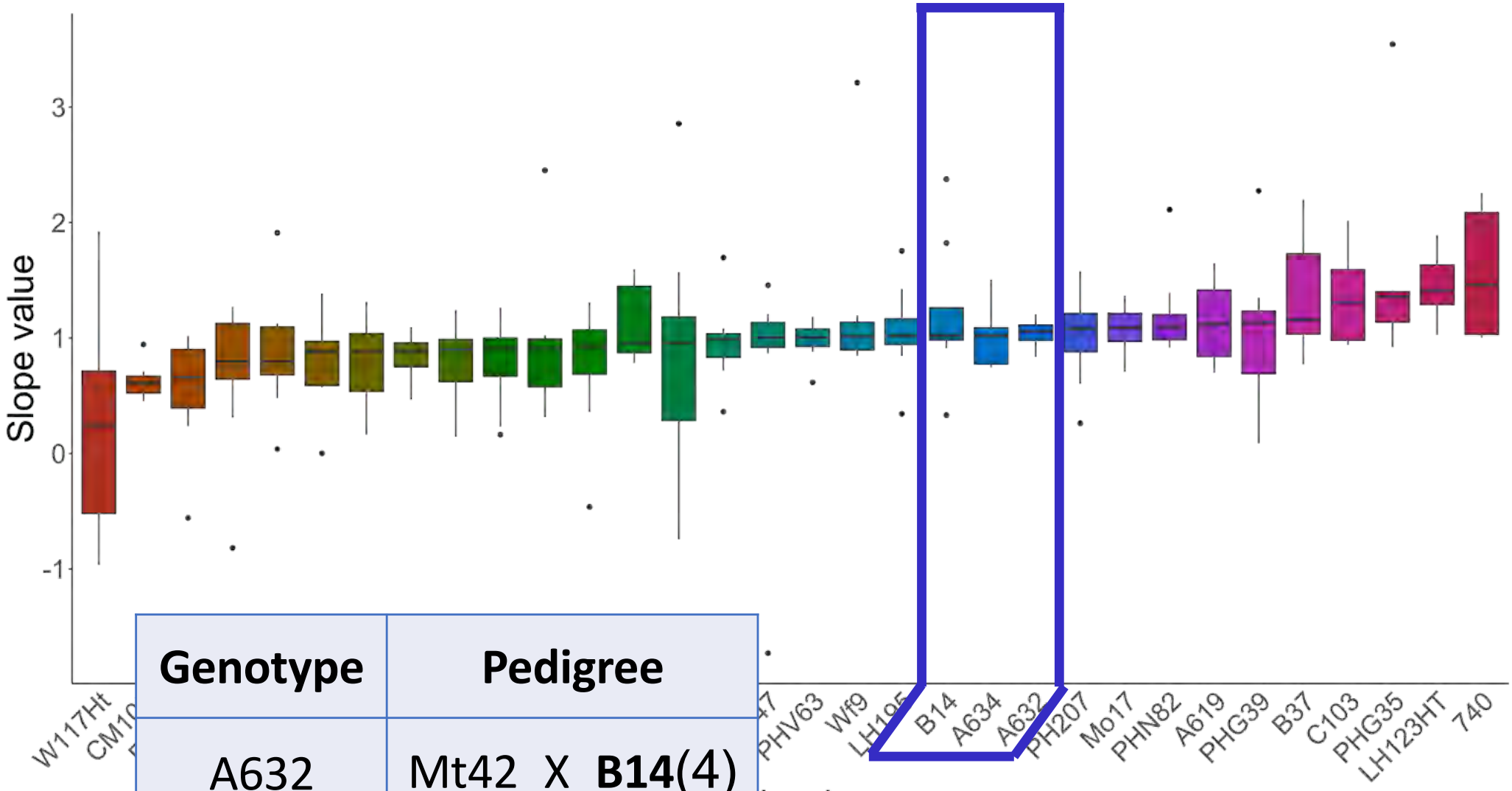
740
Mean slope: 1.56



LH82
Mean standardized MSE: 1.12

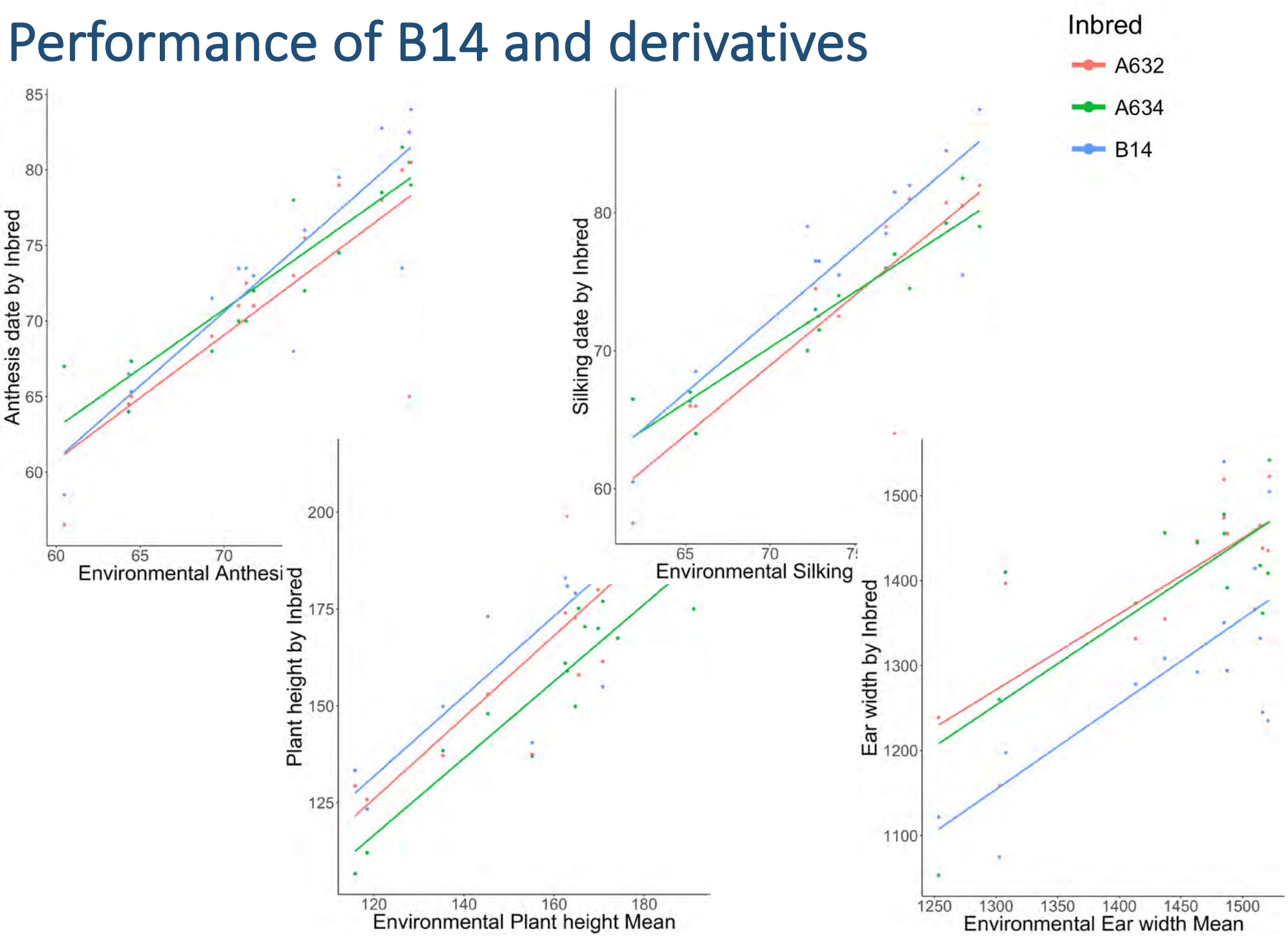


Which inbreds show the most stability?



Genotype	Pedigree
A632	Mt42_X_**B14**(4)
A634	Mt42_X_**B14**(4)

Performance of B14 and derivatives



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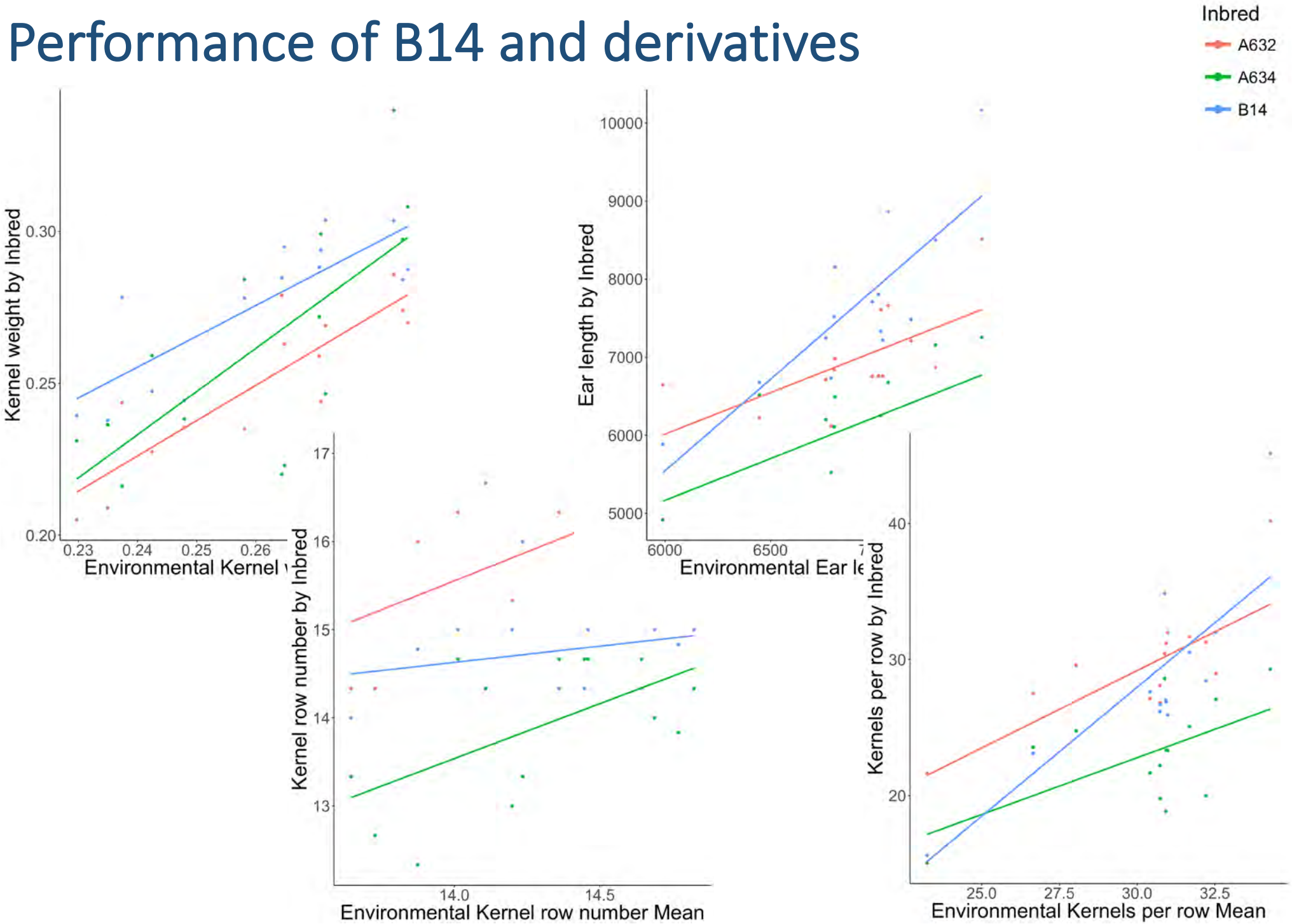
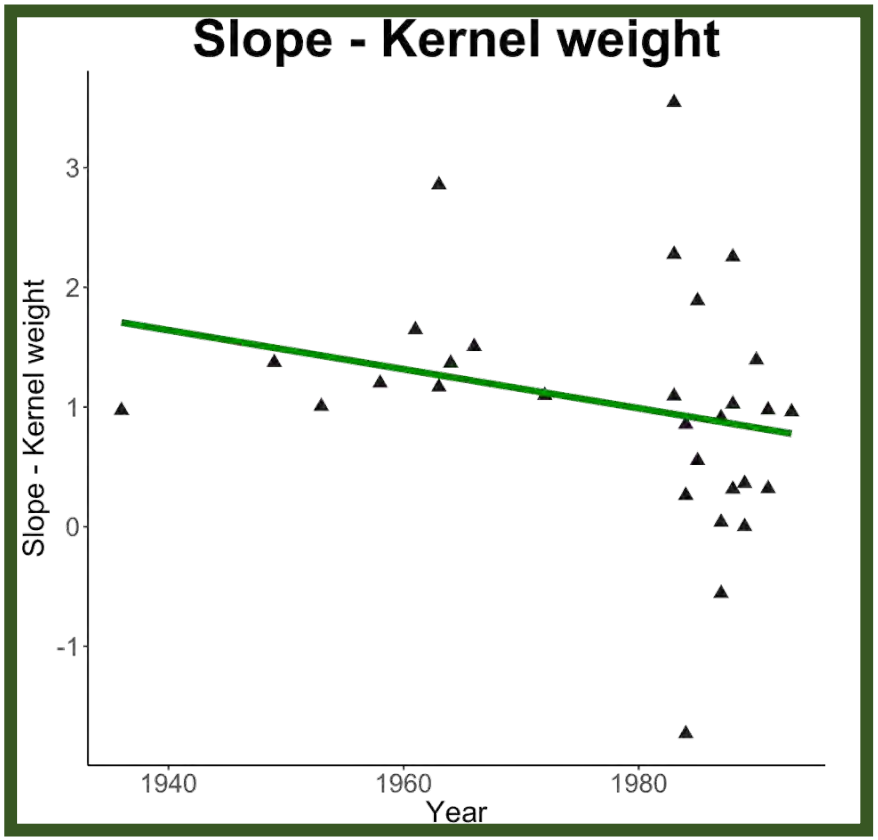
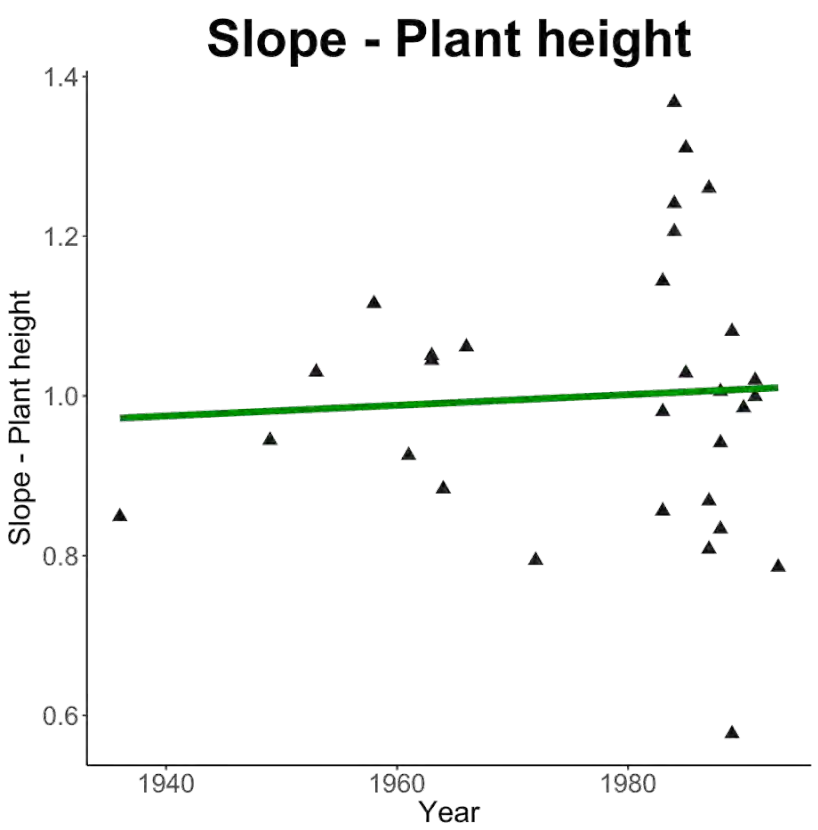
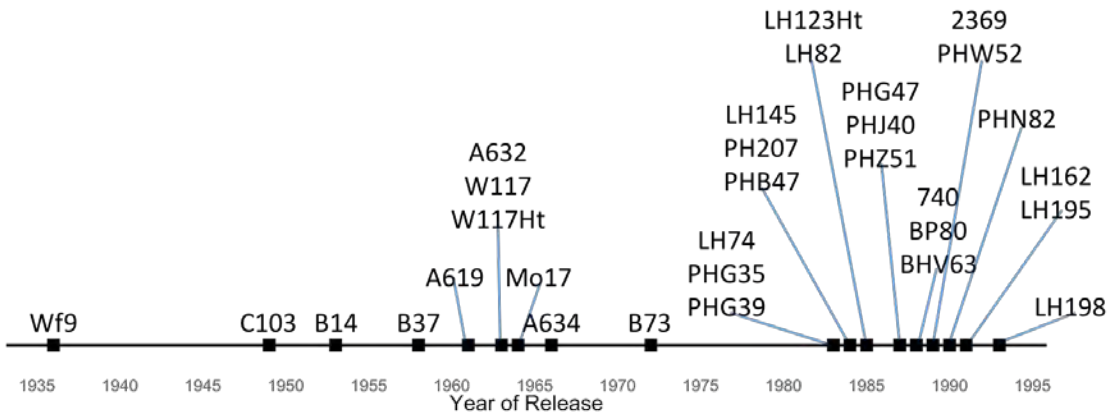


How does GxE change w.r.t. inbreds' year of release?







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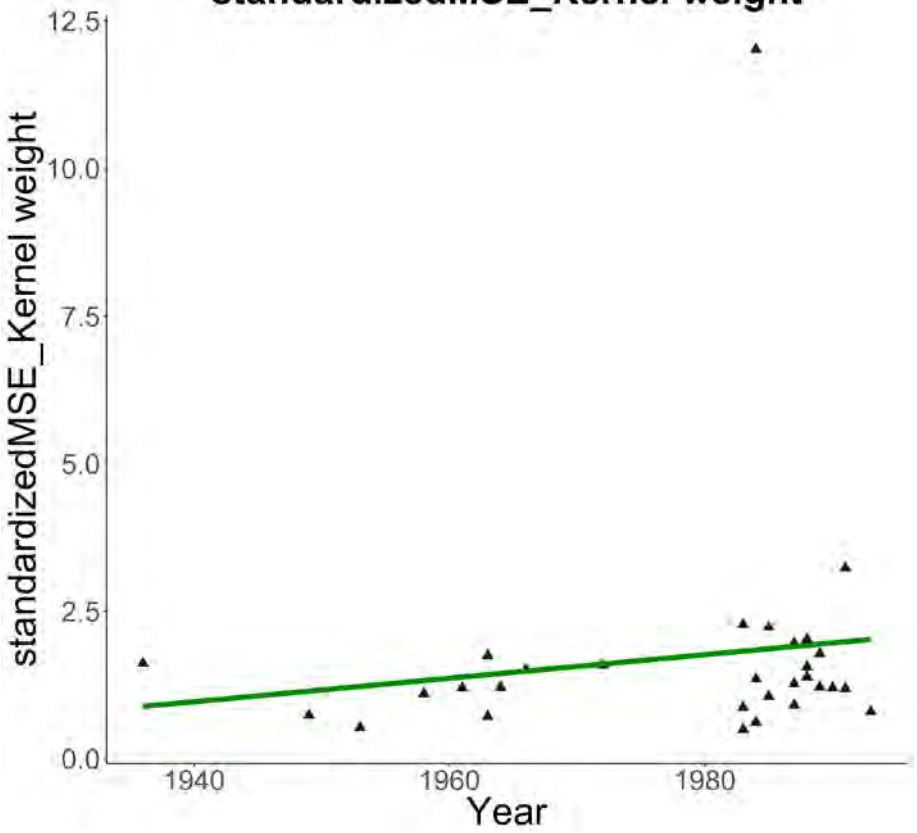

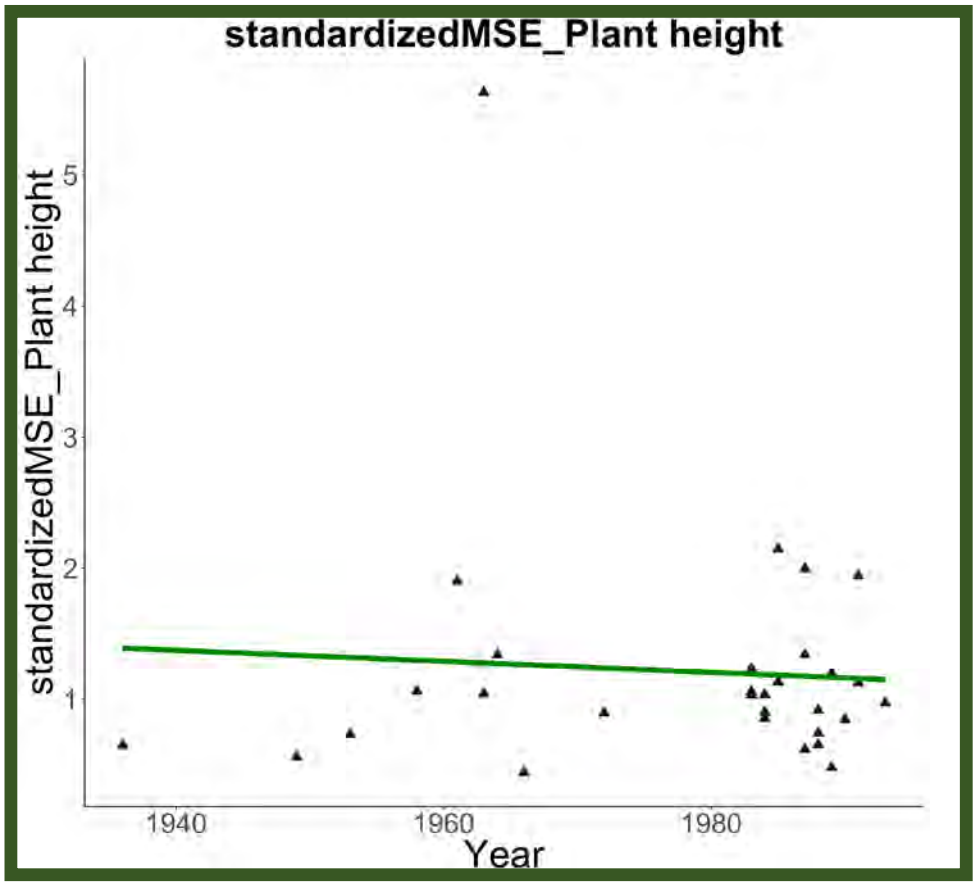

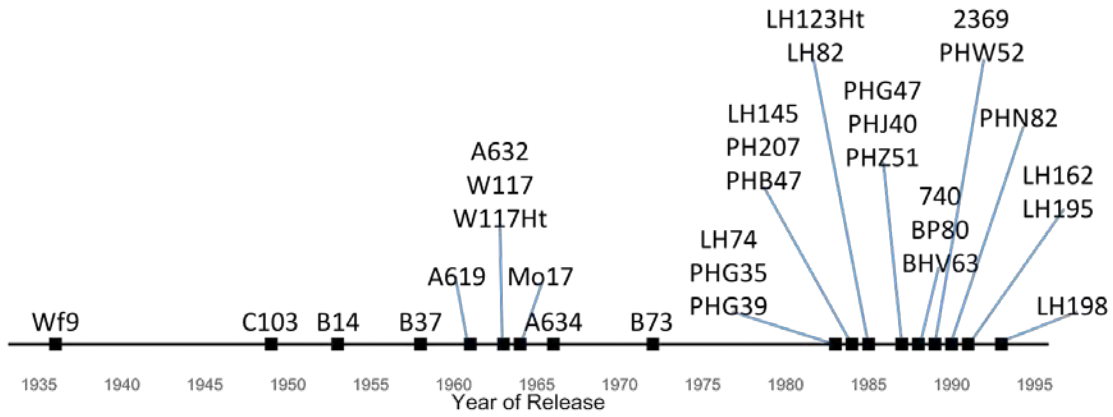

Final remarks

- ✧G x E interaction contributes significantly to trait values, making it important to consider in predictions
- ✧Ear/kernel traits showed greater GxE interaction—good “indicator traits” for future experiments
- ✧Some inbreds show better stability than others with exceptions for certain traits
- ✧More recent inbreds show greater stability and improved predictability
- ✧Much more to explore within this dataset and through incorporating the environmental data collected for each location

GxE Consortium: Data Usage Disclaimer

This presentation includes data analysis and interpretation conducted by the presenter and does not necessarily reflect the observations and conclusions of the GxE Consortium.

Acknowledgements

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  - Jonathan Lynch
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  - Joe Knoll
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  - Torbert Rocheford
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  - Jim Holland
  - Aaron Lorenz
  - Ed Buckler
  - Margaret Smith
  - Rebecca Nelson
  - Mike Gore
  - Wenwei Xu
  - Natalia de Leon
  - Shawn Kaeppler
  - Candy Hirsch
  - Nathan Springer
  - Martin Bohn
  - Seth Murray
- University of Wisconsin collaborators
  - Nathan Miller
  - Edgar Spalding
  - Jane Petzoldt
  - Jonathan Renk

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- Kurt Thelen (MSU)
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- Randy Wisser (UDel)
- Wenwei Xu (TAMU)

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Penn State

Texas A&M University

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Any questions?

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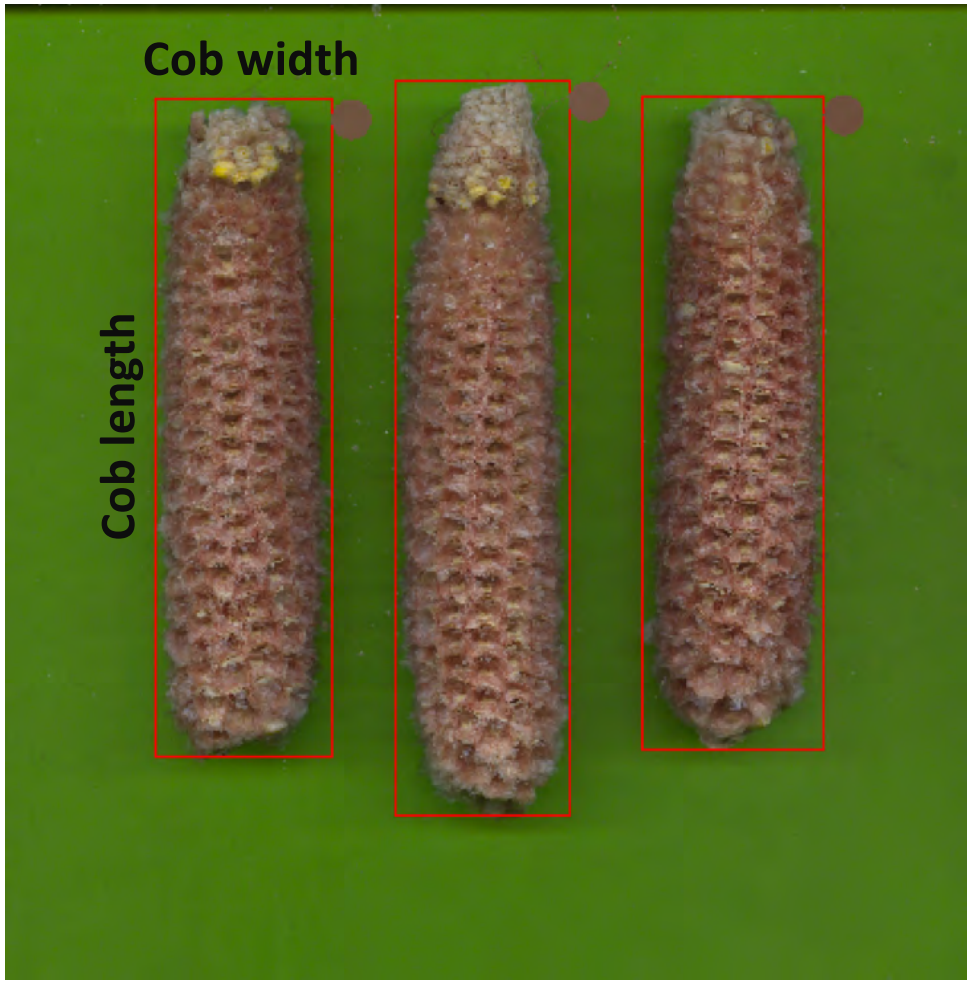

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- Miller, N.D., N.J. Haase, J. Lee, S.M. Kaeppler, N. de Leon, and E.P. Spalding. 2016. A robust, high-throughput method for computing maize ear, cob, and kernel attributes automatically from images. Plant J. Available at http://doi.wiley.com/10.1111/tpj.13320.