

Mapping Traits in a Soybean Recombinant Inbred Line Population

Gabriela Ortiz,¹ Chris Montes,² and Lisa Ainsworth³

Department of Biology, University of Missouri-St. Louis, MO Biology¹

Department of Plant Biology and Institute for Genomic Biology, University of Illinois at Urbana-Champaign, Urbana, IL²

USDA ARS Global Change and Photosynthesis Research Unit, Urbana, IL³

PRECS Phenotypic Plasticity Research Experience for Community College Students

Introduction

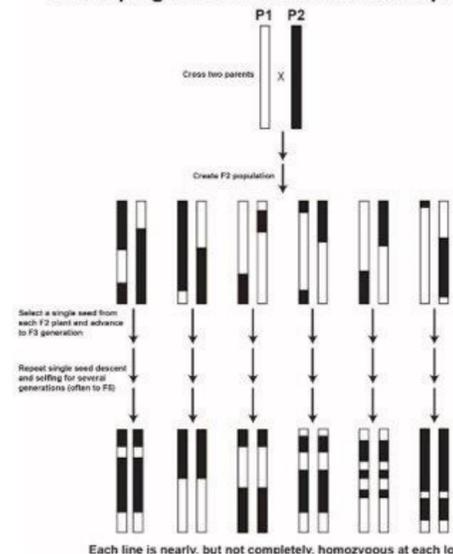
What is SoyFACE?

- Soybean Free Air Concentration Enrichment
- Field conditions mimic the future's atmosphere, temperature, and soil
- Connect physiological responses of crops under these conditions to their genes (aka mapping)

What is a recombinant inbred line population?

- Method for mapping traits [1]
- Two parents with variance in a certain trait (in this case, response to elevated carbon dioxide) [2]
- The parents used: HS93-4118 and Loda
- Allows understanding of what regions (quantitative trait loci) respond to atmospheric change

Developing a Recombinant Inbred Population



Recombinant inbred line between HS93-4118 and Loda [1]

Project Description

- 290 plant population (RIL of HS93-4118 and Loda) analysed weekly (planted 5/6/21)
- Traits measured:
 - Leaf area index
 - Vegetative/reproductive development
 - Stomatal conductance/fluorescence

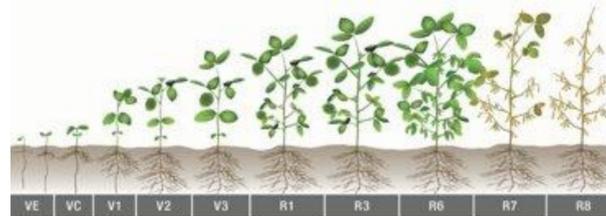
Background

Leaf area index

- Area of leaves per unit area of soil
- Measured with Accupar LP-80 Ceptometer once a week

Plant development

- As each leaf trifoliolate expands, a vegetative stage has been reached [3]
- Reproductive stages begin when flowers bloom on the 3rd to 6th node [3]
- Reproductive stage 3 (R3) begins when a pod that is 5 mm long emerges in the first 4 nodes [3]
- Scored twice a week



Soybean vegetative and reproductive development process [3]



R1 stage (left) and early R3 stage (right)

Stomatal conductance and fluorescence

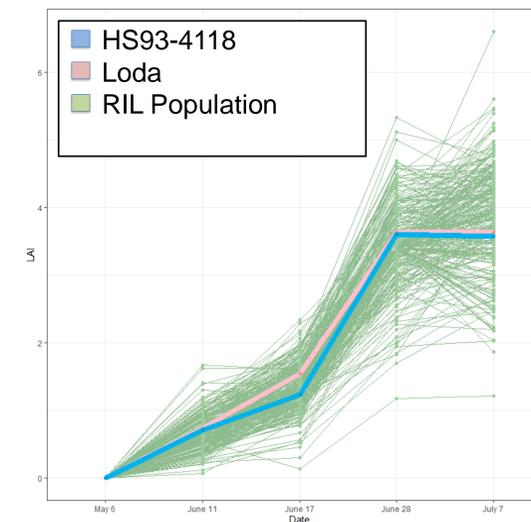
- Stomatal conductance is the molar flux of carbon dioxide and water vapor exiting the stomata [4]
- Fluorescence is the light emitted by the chlorophyll during transition from excited to non-excited state [4]
- Measured using LI-600 Porometer/Fluorometer



AccuPAR LP-80 [5] (left) and LI-600 Porometer/Fluorometer [6] (right)

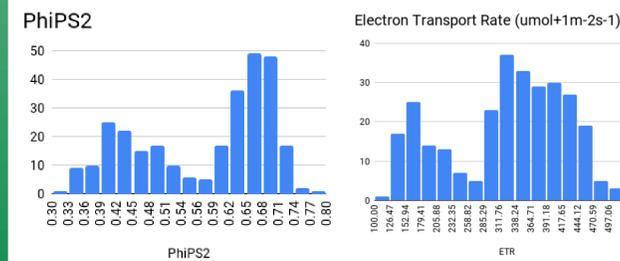
Results

Leaf Area Index

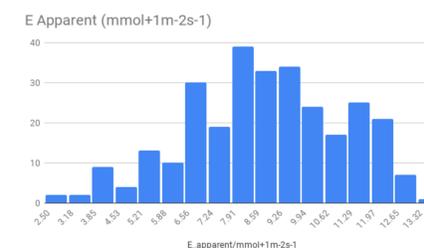
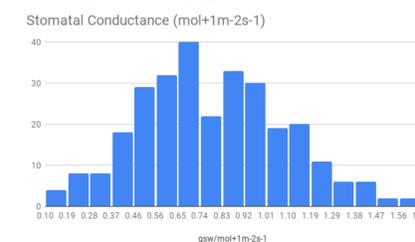


Parents HS93-4118 and Loda fall in the middle of the LAI measurements, with RIL population falling above and below (transgressive segregation)

Fluorescence



PhiPS2 and ETR measurements are bimodal, not following the expected normal distribution



Stomatal conductance measurements follow the expected normal distribution

Conclusions & Future Work

- Variation in the biparental population is apparent for the measured traits
- A better understanding of soybean responses to elevated CO₂ can be utilized to secure future food supply
- Plant and leaf traits will be genetically mapped to determine the regions of the genome influencing the observed differences
- These results will be used in preparation of this population to be grown in future studies

References

- [4] Baker, N. R. (2008). Review of *Chlorophyll Fluorescence: A Probe of Photosynthesis In Vivo*. *The Annual Review of Plant Biology*, 59.
- [6] Licor. (n.d.). LI-600 Porometer/Fluorometer. <https://www.licor.com/env/products/LI-600/>.
- [1] NDSU. (n.d.). *Mapping Populations*. Mapping Population. <https://www.ndsu.edu/pubweb/~mcclean/plsc731/Mapping%20Populations.pdf>.
- [3] Reese, J., Specht, J., & Elmore, R. (2021, July 1). *Soybean Growth and Development*. DEKALBASgrowDeltapine United States. <https://www.dekalbasgrowdeltapine.com/en-us/agronomy/soybean-growth-stages.html>.
- [2] Sanz-Sáez, Á., Koester, R. P., Rosenthal, D. M., Montes, C. M., Ort, D. R., & Ainsworth, E. A. (2017). Leaf and canopy scale drivers of genotypic variation in soybean response to elevated carbon dioxide concentration. *Global Change Biology*, 23(9), 3908–3920. <https://doi.org/10.1111/gcb.13678>
- [5] TMS. (2019). METER ACCUPAR LP-80 Canopy Interception and Leaf Area Index. <https://www.tms-lab.com/product/canopy-interception-and-leaf-area-index-meter-accupar-lp-80/>.

Acknowledgments

Financial support was provided by the National Science Foundation under grant #NSF REU 1950819/1950786, as part of the Phenotypic Plasticity Research Experience for Community College Students, through the University of Illinois at Urbana-Champaign Institute for Genomic Biology and Parkland College. <http://precs.igb.illinois.edu/>

Acknowledgements to the SoyFACE farm for planting and maintenance help, Chris Montes for mentorship, Dr. Lisa Ainsworth for funding, project PIs Dr. Nathan Schroeder and Dr. C. Britt Carlson, and technical/support staff at the Institute for Genomic Biology.