Parameterization of the DSSAT Sorghum Model to Simulate Sweet Sorghum Growth and Dry Matter Partitioning

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Figure 1. Grain sorghum (left) and Sweet sorghum (right)

Introduction

- Crop models can help us better understand the effects of different crop traits and environmental conditions on crop growth and yield.
- Efforts to model sweet sorghum growth and yield have been limited despite recent global interest in sweet sorghum as a bioenergy crop (Fig. 1).
- Our objective was thus to calibrate and validate the DSSAT grain sorghum model to simulate sweet sorghum growth, partitioning, and dry matter yield.

Materials and Methods

- Cultivar: 'M81E' sweet sorghum
- Data sets:
  - Growth sampling over 2012-13 in Citra, FL.
  - Planting Date Study in two locations in FL[1].
  - Nitrogen fertilization study two locations in FL[2]
- Parameter values for DSSAT Sweet Sorghum for SLW, G2 and PHINT are based on the growth sampling measurements collected in Citra Florida. We measured leaf weight, leaf area, leaf number, and panicle weight over time.
- Parameter values for RUE and RTPC are from sweet sorghum experiments from literature[3,4].
- The partitioning parameter for stem and panicle growth during grain filling was derived from experiments.

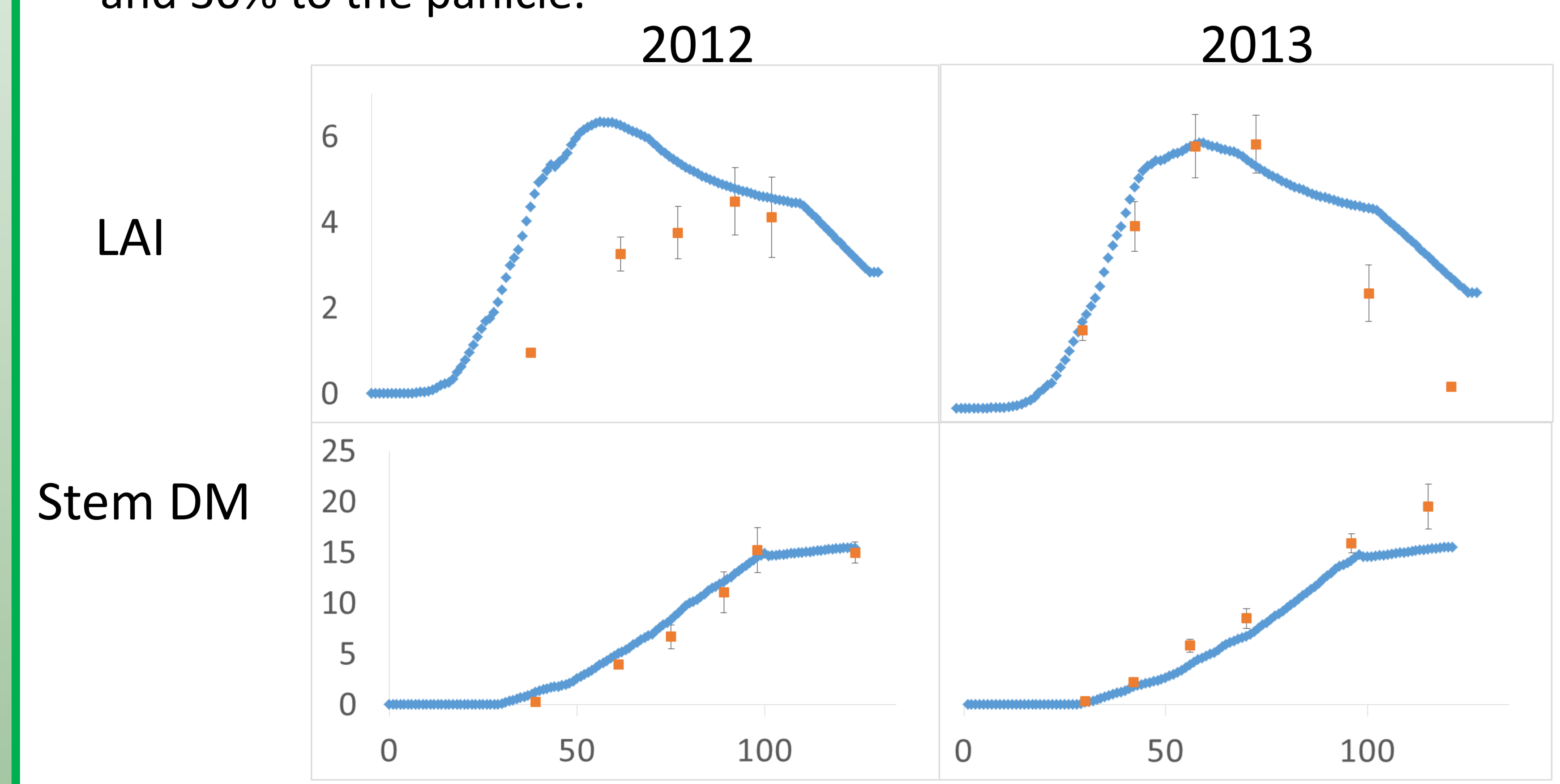
Results

Calibration

Table 1. Genetic parameters of grain sorghum and sweet sorghum. [a] Radiation Use efficiency. [b] Specific Leaf Weight. [c] Partitioning to root growth as a fraction of available carbohydrates. [d]Scalar for partitioning of assimilates to the panicle.[e] Thermal time between successive leaf tip appearances. [f]Stem growth per degree day above base temperature from anthesis to grain filling in grams per plant.

Parameter	Grain Sorghum	Sweet sorghum
RUE[a3]	3.4	3.6
SLW[b]	0.0053, 0.0078	0.0038, 0.0054
RTPC[c4]	0.25	0.16
G2[d]	5 to 6	0.4
PHINT[e]	49	80
K (GS4)[f]	0.07	0.35

◊Grain filling: In contrast to grain sorghum, sweet sorghum stems continue to accumulate sugars during grain filling[5]. During this growth stage the DSSAT grain sorghum model assumes no stem growth, with 80% of assimilates partitioned to panicle and 20% to roots. To account for increased partitioning to stem growth in sweet sorghum, we assigned 20% of assimilates during grain filling to stem growth and 30% to the panicle.



Validation

Table2. Root Mean Square Error (RMSE in kg/ha) and Relative Root mean Square error (RRMSE) of the simulated and observed data.

Plant Part	RMSE	RRMSE
Shoot Dry Weight	3733	0.18
Stem Dry Weight	3705	0.23
Head Dry Weight	1585	0.61
Leaf Dry Weight	1387	0.44

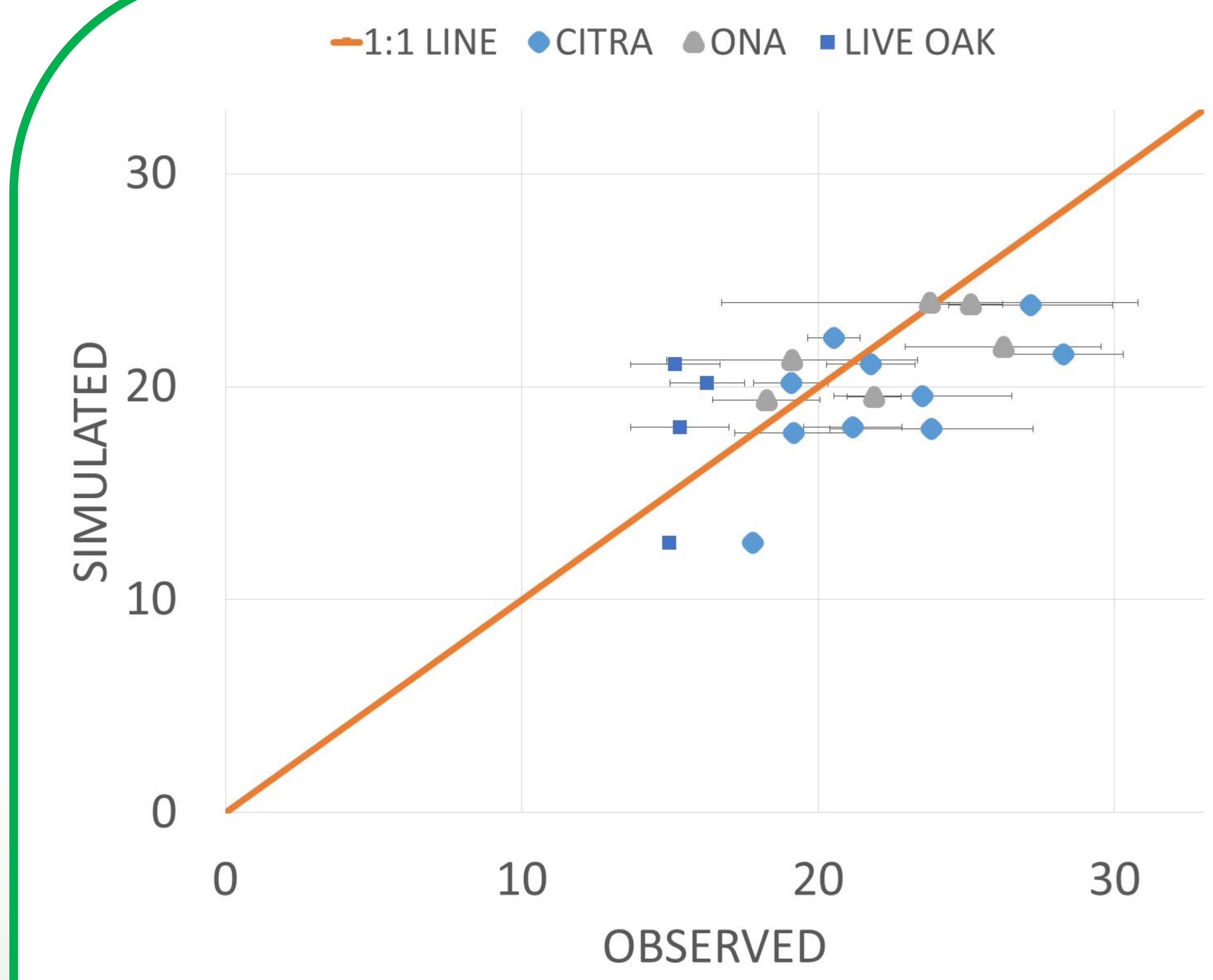


Figure 3. Validation results for simulated versus observed final harvest data (ton/ha) from Ona, Citra and Live Oak from 2009 and 2010.

Discussion

- Five parameters were calibrated from the grain sorghum model to account for the differences between sweet and grain sorghum (Table 1).
- As oppose to grain sorghum, sweet sorghum stem continues growing during grain filling (Figure 2).
- Simulations results for stem and leaf weight where better than simulations for grain (Table 2).
- The equation to simulate partitioning to grain head needs to be improved.
- The model does not account for losses in leaf weight due to senescence.

Conclusion

- The parameterized CERES sorghum model can simulate sweet sorghum yield within an acceptable RMSE of 0.18.

Acknowledgements

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