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

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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 FL¹.
- Nitrogen fertilization study two locations in FL².

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.

The partitioning parameter for stem and panicle growth during grain filling was derived from experiments.

Results

Calibration


<table>
<thead>
<tr>
<th>Parameter</th>
<th>Grain Sorghum</th>
<th>Sweet sorghum</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUE⁴⁺</td>
<td>3.4</td>
<td>3.6</td>
</tr>
<tr>
<td>SLW⁵⁺</td>
<td>0.0053, 0.0078</td>
<td>0.0038, 0.0054</td>
</tr>
<tr>
<td>RTPC⁶⁺</td>
<td>0.25</td>
<td>0.16</td>
</tr>
<tr>
<td>G²⁷⁺</td>
<td>5 to 6</td>
<td>0.4</td>
</tr>
<tr>
<td>PHINT⁧⁺</td>
<td>49</td>
<td>80</td>
</tr>
<tr>
<td>K (GS4)⁨⁺</td>
<td>0.07</td>
<td>0.35</td>
</tr>
</tbody>
</table>

Grain filling: In contrast to grain sorghum, sweet sorghum stems continue to accumulate sugars during grain filling. 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

Table 2. Root Mean Square Error (RMSE in kg/ha) and Relative Root mean Square error (RRMSE) of the simulated and observed data.

<table>
<thead>
<tr>
<th>Plant Part</th>
<th>RMSE</th>
<th>RRMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoot Dry Weight</td>
<td>3733</td>
<td>0.18</td>
</tr>
<tr>
<td>Stem Dry Weight</td>
<td>3705</td>
<td>0.23</td>
</tr>
<tr>
<td>Head Dry Weight</td>
<td>1585</td>
<td>0.61</td>
</tr>
<tr>
<td>Leaf Dry Weight</td>
<td>1387</td>
<td>0.44</td>
</tr>
</tbody>
</table>

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 (Fig. 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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References