BRC Science Highlight
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Understanding Growth Dynamics and Yield Prediction of Sorghum Using High Temporal Resolution UAV Imagery Time Series and Machine Learning

Background/objective

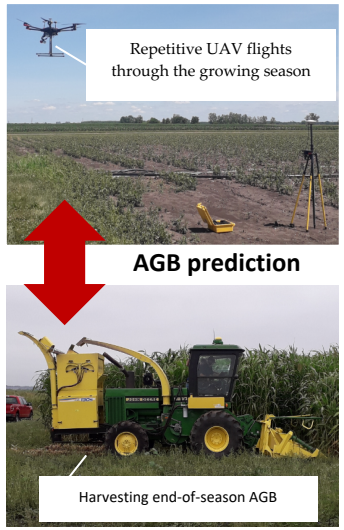
Unmanned aerial vehicles (UAV) carrying multispectral cameras are increasingly being used for high-throughput phenotyping (HTP) genetic diversity in above-ground traits of crops. C4 bioenergy crops with high biomass yield potential, such as sorghum, could be further enhanced with precise HTP screening of large populations using UAVs. This study tested the use of high-resolution time-series imagery (5 or 10 sampling dates) to understand the relation between growth dynamics, temporal resolution and end-of-season above-ground biomass (AGB) in 869 diverse accessions of highly productive, photoperiod-sensitive sorghum.

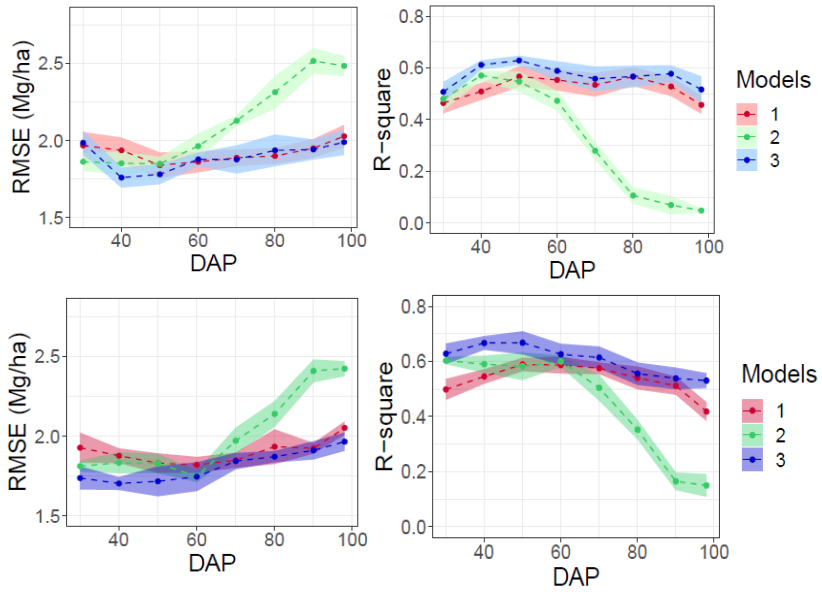
Approach

- Orthophotos of each plot were generated from multispectral data collected on multiple dates
- Geometric and spectral features were extracted from the images of each plot and sampling date to estimate time-point and dynamic growth variables.
- The Random Forest (RF) method was used to determine variable importance and to predict end-of-season AGB.

Results

- Early- and midseason measurement of dynamic growth traits can be combined with individual timepoint trait data to improve prediction of end-of-season AGB.
- Data on the rate of change of geometric and spectral features extracted from multispectral imagery of biomass sorghum canopies resulted in more accurate predictions of end-of-season AGB at much earlier dates in the growing season.





Evaluation of AGB prediction in testing data for time-point (models 1), dynamic (2), and time-point and dynamic variables (3) via RMSE and R^2 for full (upper panels) flights (n=10), and for reduced (lower panels) flights (n=5) .

Significance

- This study demonstrated the use of high temporal resolution UAV imagery to understand the relative importance of dynamic and single-date static information throughout the season to make predictions of final harvestable AGB.
- The potential to roughly predict variation in end-of-season AGB from dynamic traits at midseason or earlier could be valuable for selecting for desirable characteristics, and the improvement of bioenergy crops would also benefit from this strategy.

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U.S. DEPARTMENT OF ENERGY