Assessing UAV-Based Imagery for Drought Stress Phenotyping in St. Augustinegrass [*Stenotaphrum secundatum* (Walt.) Kuntze]

Greta Rockstad, Robert Austin, Grady L. Miller, and Susana R. Milla-Lewis, Crop & Soil Sciences, NC State University, Raleigh, NC

NC STATE
TURFGRASS BREEDING & GENETICS

INTRODUCTION

- Breeding for drought resistance is increasing in importance in the face of more sporadic weather patterns in the future with the potential for more severe droughts (1).
- Visual rating of turf quality under drought is especially hard as dry down within a plot is uneven (2). Thus, data is supplemented with quantitative measures including normalized difference vegetation index (NDVI) and digital percent green cover (PGC). These methods are time-consuming and limited by the size of plots they can capture.

Figure 1. St. Augustinegrass plots experiencing drought symptoms, exemplifying how unevenly plots dry down

OBJECTIVES

1) Assess the relationship between ground-based and aerial-based phenotypic evaluation methods for drought stress traits in St. Augustinegrass
2) Develop an efficient image processing pipeline that can handle variable plot size
3) Assess the usefulness of low-resolution aerial canopy temperature data for evaluating response to drought stress

MATERIALS & METHODS

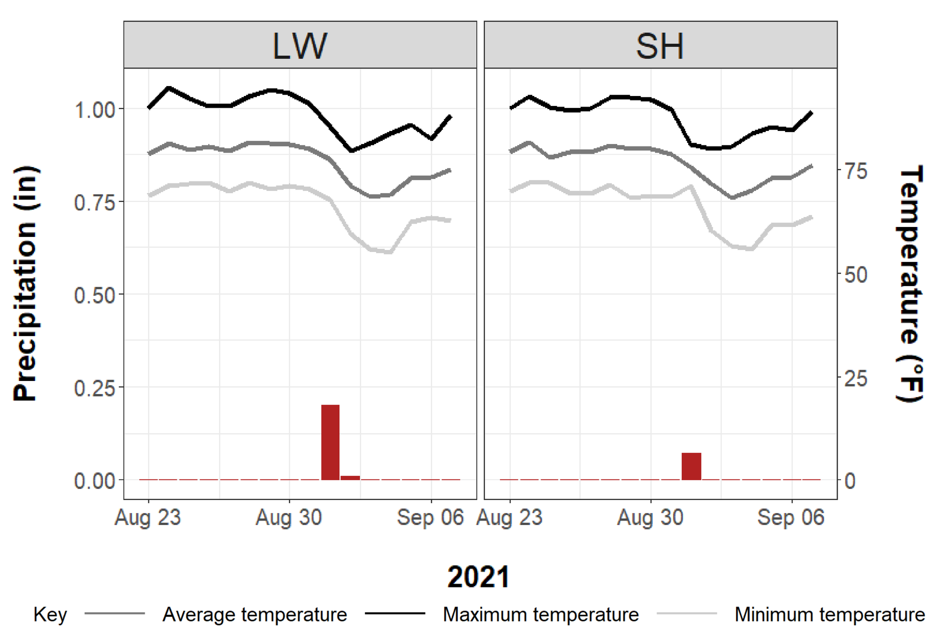
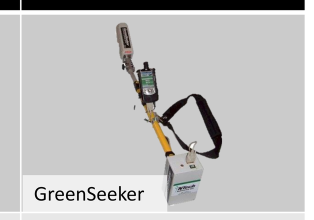
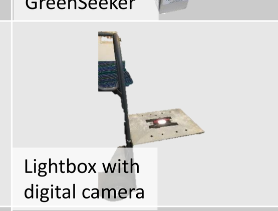


Figure 2. Weather conditions during drought data collection at each location. LW = Lake Wheeler Turf Field Lab, SH = Sandhills Research Station

Table 1. Equipment used to collect each trait

Trait	Aerial Collection	Ground Collection
NDVI	 Matrice 210 V2 with Micasense Altum	 GreenSeeker
Percent Green Cover	 Phantom 4 Pro V2	 Lightbox with digital camera
Canopy Temperature	 Matrice 210 V2 with Micasense Altum	No ground equivalent

- A mapping population of 115 ‘Raleigh’ x ‘Seville’ progeny established in a field trial with 3 reps at two locations, the Sandhills Research Station (SH) in Jackson Springs, NC and the Lake Wheeler Field Lab (LW) in Raleigh, NC was used to measure drought stress.
- Drought was initiated by withholding irrigation during a period of no rain, and data collection occurred every 3 days. Traits collected included NDVI, percent green cover, and canopy temperature. All data were collected within two hours of solar noon during dry down.

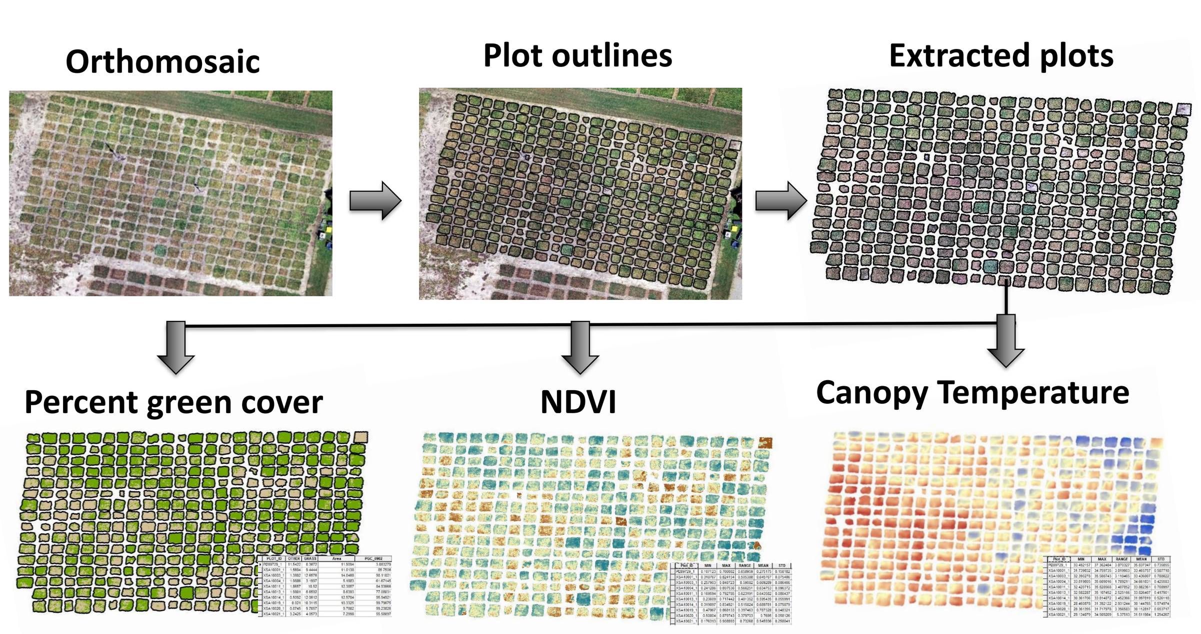


Figure 3. Image processing pipeline

- Image processing began with stitching UAV photos with GPS data in Agisoft Metashape (Agisoft LLC).
- Orthomosaics were then transferred to ArcGIS (Esri) for trait extraction.
- Statistical analysis was done in SAS (SAS Institute) and the ggplot2 package (3) was used to create figures

RESULTS

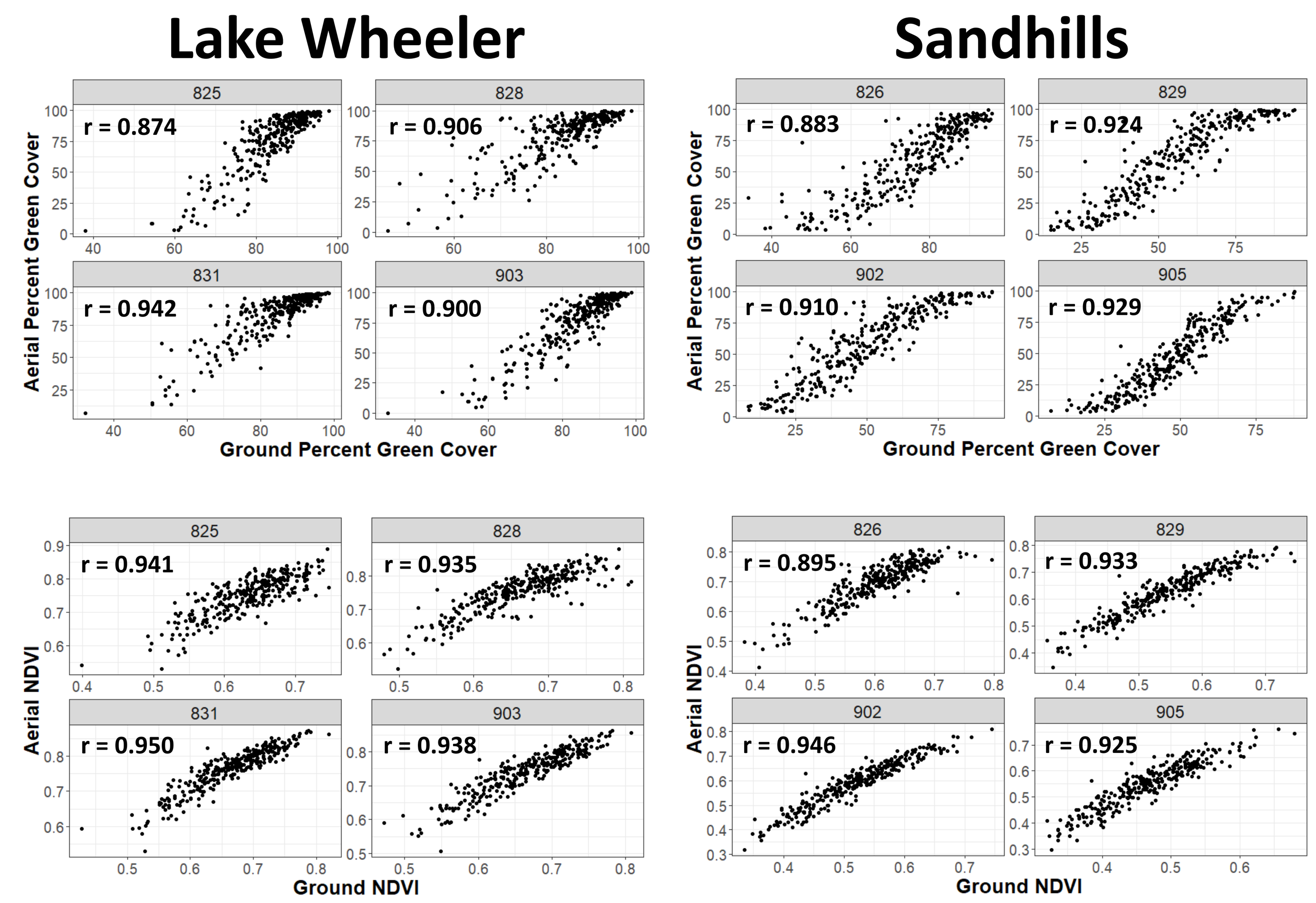


Figure 4. Correlation between aerial and ground data for percent green cover and NDVI at each location and date

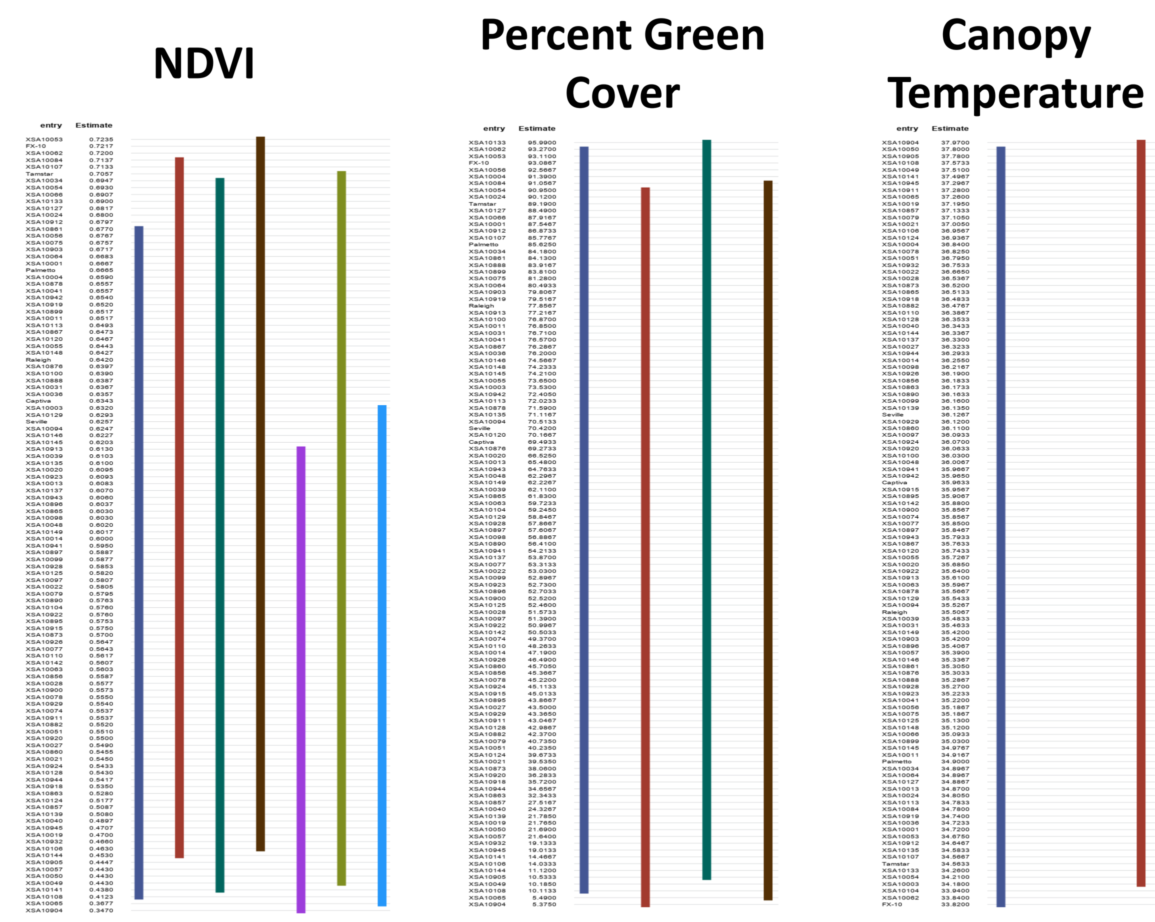


Figure 6. Entry means groupings for aerial traits taken on 9/2. Means separation calculated using Tukey HSD, alpha=0.05. Means covered by the same-colored bar are not significantly different. Entry and rep were significant for each trait at alpha =0.05.

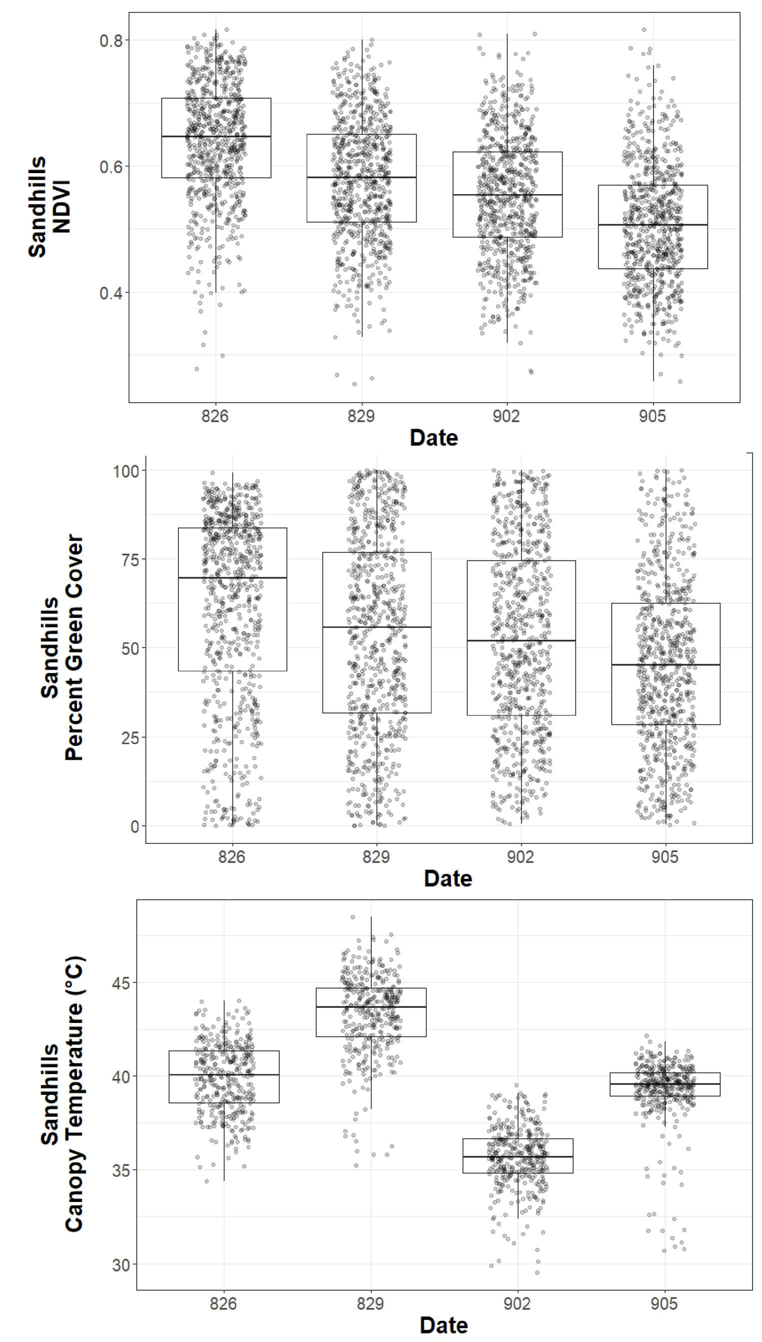


Figure 5. Boxplots for aerial NDVI, percent green cover, and canopy temperature at Sandhills across each date of evaluation.

- Strong correlation between aerial and ground data for NDVI and percent green cover was observed at both locations.
- While all three traits were significant at alpha = 0.05, canopy temperature provided the poorest separation of entries into significance groups.

CONCLUSIONS & FUTURE WORK

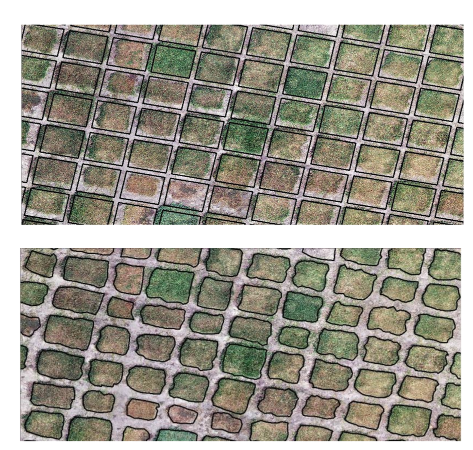


Figure 7. Plot boundaries automatically generated based on plot size and GPS data (top) compared to manually drawn plot boundaries (bottom)

- Despite the resolution differences, trait values collected aerially were strongly correlated with those collected on the ground.
- Although the relationship is not 1:1, aerial values may be more representative as they encompass the edges of plots.
- The lower resolution thermal imagery provided poor separation among genotypes and is more sensitive to time of day than apparent stress.
- Future work is required to automatically detect edges to generate plot boundaries (rather than using expected plot size and GPS data) for higher data quality and time savings

References

1. Kunkel, K.E, et al. 2013. Regional climate trends and scenarios for the U.S. national climate assessment. part 2. Climate of the Southeast U.S., NOAA Technical Report NESDIS 142-2.
2. Morris, K. N., and R.C. Shearman. 2006. NTEP turfgrass evaluation guidelines. Beltsville, MD: National Turfgrass Evaluation Program.
3. Wickham H (2016) ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York. ISBN 978-3-319-24277-4 https://ggplot2.tidyverse.org

This work is supported by a grant from the NC State University Center for Turfgrass Environmental Research and Education and by Specialty Crop Research Initiative grant 2019-51181-30472 from USDA-NIFA.

CENTERE www.TurfFiles.ncsu.edu USDA NIFA United States Department of Agriculture National Institute of Food and Agriculture

Contact: gbrockst@ncsu.edu