# Evaluation of UAV-Based Imagery for Drought Stress Traits in St. Augustinegrass

Greta Rockstad[1], Robert Austin[1], Xingwang Yu[1], Esdras M. Carbajal[1], Jeffrey C. Dunne[1], Grady L. Miller[1], David Jespersen[2] and Susana R. Milla-Lewis[1]

(1) Crop and Soil Sciences, North Carolina State University, Raleigh, NC, (2) Crop and Soil Sciences, University of Georgia-Griffin, Griffin, GA

## Background

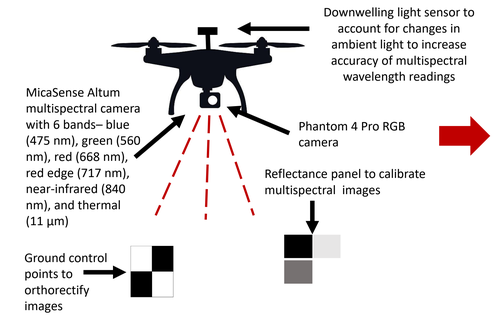
- Of the warm-season grasses, St. Augustinegrass has one of the lowest drought resistances, similar to that of the cool-season grass tall fescue (1)
- Collecting data on drought stress traits such as green cover (%) and NDVI often requires different passes across plots using both a lightbox and a normalized difference vegetation index (NDVI) meter
  - Because drought stress progresses quickly in the summer heat, collecting data on as many traits in as little time is imperative to reduce temporal variation
- Unmanned aerial vehicles (UAVs) have seen increasing use for phenotyping in other crops, but their use in turfgrass is still somewhat limited
- A strong correlation between aerial and ground NDVI in both bermudagrass and zoysiagrass was observed (2), but no such study has been conducted in St. Augustinegrass

**The extent of turfgrass plots at the Jackson Springs, North Carolina research station where drought stress quickly progresses in the sandy soils**

### OBJECTIVES

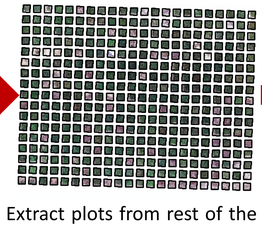
1) Evaluate the relationship between ground-based and aerial-based drought stress evaluation methods in St. Augustinegrass
2) Develop an image processing pipeline for warm-season turfgrass UAV imagery

## Methods & Image Processing Workflow



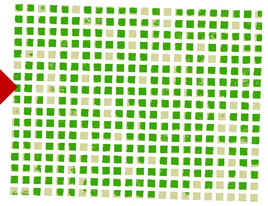

Stitch together orthomosaic in Agisoft Metashape using UAV photos taken with GPS data. Rectify images using ground control points

Load individual bands in ArcMap & combine RGB bands into a composite, load a shapefile containing plot dimensions and labels



Extract plots from rest of the image to remove background and alleyways.

For multispectral imagery, bands are combined using the raster algebra tool to create new layers of band indices such as NDVI. Plot extraction removes background and alleyways. Zonal statistics are calculated for each plot to obtain a mean value of NDVI



To train samples for supervised classification (classifying each pixel into a category) in ArcMap, draw polygons around areas of green grass, brown grass, soil, weeds, etc. Tabulate area of each plot and calculate % of green pixels

- A 'Raleigh' x 'Seville' mapping population of 115 individuals organized in an RCBD with 3 reps was used to measure drought stress at Jackson Springs and Raleigh, NC
- All data was collected within 2 hours of solar noon. Data was taken 3 times at each location, but one date was dropped from the Jackson Springs location due to poor quality UAV data
- Green cover % (PGC) was measured
  - On the ground: using a lightbox and analyzed using TurfAnalyzer (3)
  - Aerially: using a Phantom 4 Pro camera (SZ DJI Technology Co., Ltd) flying at 30 ft AGL with 75% image overlap and processed in Agisoft Metashape (Agisoft LLC) and ArcGIS (Esri)
- NDVI was measured
  - On the ground: using a GreenSeeker handheld (Trimble Inc.)
  - Aerially: using a Micasense Altum multispectral camera flying at 52 ft AGL with 75% image overlap and processed similarly to PGC
- Pearson correlations were calculated in R Studio (4) and heatmaps were produced using the packages ggplot2 (5) and reshape2 (6)

## Preliminary Results

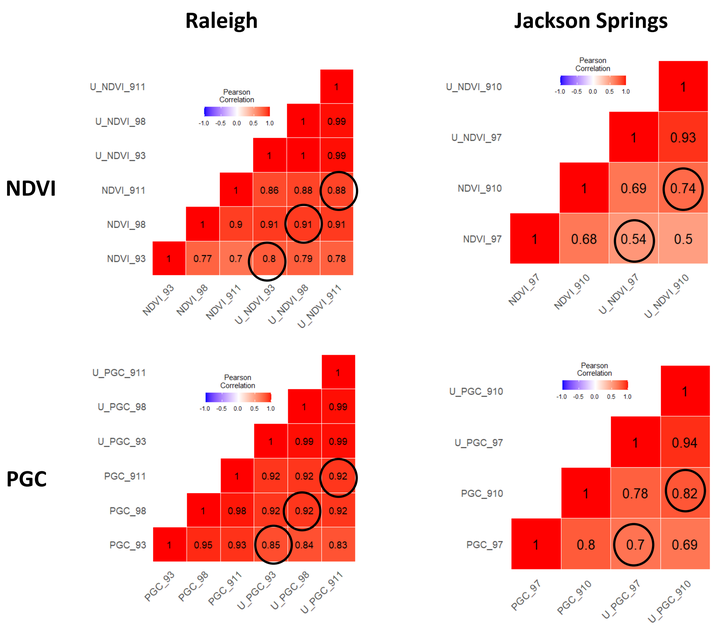



**Figure 1.** Pearson correlation coefficients between NDVI and green cover % (PGC) data collected both aerially and on the ground across three dates and two locations. Correlations of most interest, those within a date between aerial and ground data, are circled. Note the label indicates the date the data were taken (e.g. 910 = 9/10/20), and a preceding U indicates data were taken with a UAV.

- First year of data showed strong, positive correlations between aerial and ground data, similar to those seen in bermudagrass and zoysiagrass
- Across locations, higher correlation coefficients were observed for PGC than for NDVI
- Jackson Springs correlations were lower overall, possibly due to data extraction method differences

## Future Work

- A second year of data will be collected on this trial in summer of 2021
- The pipeline will be streamlined and potentially shared among universities participating in the warm-season turfgrass Specialty Crops Research Initiative grant
- Drought stress phenotypic data will be analyzed in combination with genotypic data on the mapping population to identify QTL associated with drought resistance

## References

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