Arid-Land Cotton Growth Analysis Using Drone Image Classification

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
COLLEGE OF ENGINEERING
Biosystems Engineering

Alanna Zubler[1*], Kelly Thorp[2], and Kamel Didan[1]

[1]Biosystems Engineering Department, The University of Arizona [2]USDA Agricultural Research Service – ALARC
*avzubler@email.arizona.edu

INTRODUCTION

- The integration of technology with agricultural practices is becoming more prevalent.
- Remote sensing technologies have potential for providing large amounts of important information about croplands.
- Unmanned Aerial Systems (UASs) equipped with sensors can collect images of agricultural fields and assist in the process of management and decision making [1].

An important parameter for plant productivity is Leaf Area Index (LAI). LAI captures:

- Total surface area of one side of a leaf per unit area of ground [2]

It can be measured directly at the leaf level or estimated using radiation transmission through the canopy [2] via LAI sensors.

Objective/Question: Can drone images be used to monitor plant growth and derive LAI with similar results to ground-based LAI methods?

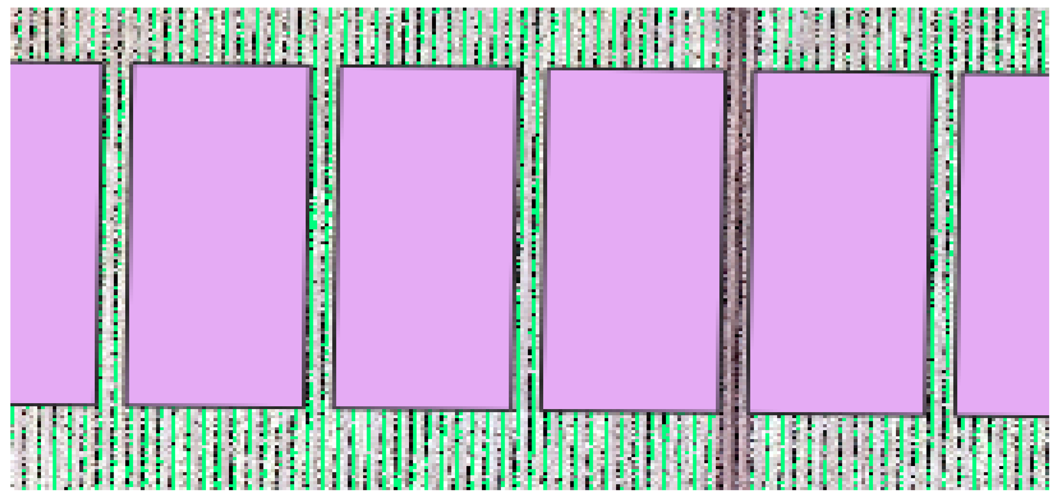
DRONE IMAGING AND LAI

Drone images and LAI field data were collected weekly at the USDA ARS Arid-Land Agricultural Research Center in Maricopa, AZ.

- The field was planted with cotton that was part of an irrigation rate study.
- Plants have different heights and canopy densities.
- LAI data were acquired using a non-destructive LI-COR LAI-2200C Plant Canopy Analyzer.
- Aerial images of the field were taken at a height of 200ft using a DJI Phantom 4 Pro drone with an RGB camera.

To derive the fractional vegetation cover (FVC):

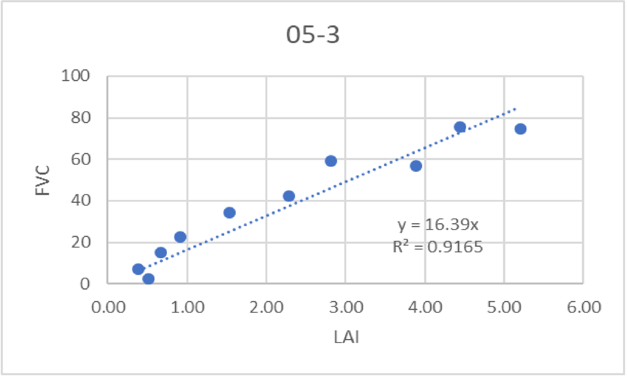
- Individual drone images were stitched together into a large 2D image map of the entire field.
- The image was then analyzed using Quantum Geographical Information System (QGIS).
- A semi-automatic classification plugin with a Minimum Distance algorithm was used to identify plant pixels and calculate the percentage of plant pixels within each irrigation plot.



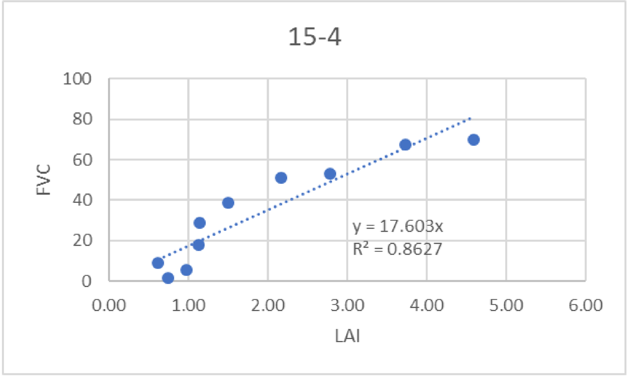
FVC calculation:

$$FVC\ (\%) = \frac{(plant\ pixels)}{(total\ pixels)} * 100$$

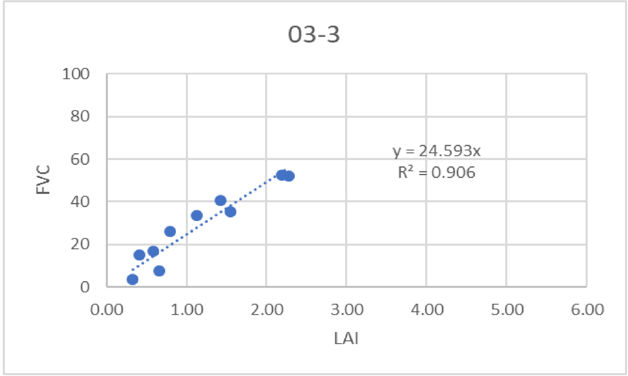
RESULTS



Plot 05-3: 120% Recommended Irrigation Treatment



Plot 15-4: 100% Recommended Irrigation Treatment



Plot 03-3: 60% Recommended Irrigation Treatment

DISCUSSION

Overall, the derived fractional vegetation cover correlates very well with the ground-based LAI measurements.

The correlation was generally weaker earlier in the season, and we hypothesize that this is due to small plants being harder to detect with drone-based image sensors and inconsistencies in early ground-based LAI measurements. Errors could be resulting from:

- Variation in outdoor light intensity
- Use of unrepresentative plant samples
- Over-exposure of drone images
- Incorrect pixel classification

Since these results were based on a single season, more data are needed to produce more conclusive observations.

Drone-based imaging and techniques are nonetheless proving to be effective in assessing and monitoring croplands.

REFERENCES

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2. Bréda, N. J. J. 2003. Ground-based methods of leaf area index: a review of methods, instruments and current controversies. DOI: 10.1093/jxb/erg263

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