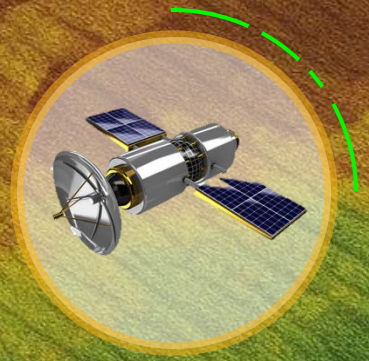
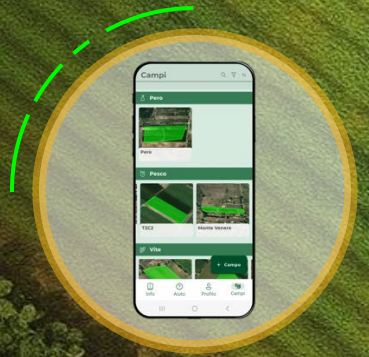
CROP MANAGEMENT CONFERENCE

DECEMBER 9–10, 2025





Integrating Cutting-Edge Technologies for Crop Monitoring and Management

Marcelo Barbosa

Post-Doctoral Associate

marcelojragro@gmail.com

University of Georgia

Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference | CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Bachelor in Agronomy
Irriga Group
Federal University of Alagoas
Arapiraca Campus

[2014 – 2019]

Master's Degree in Agronomy
Machinery and Mechanization Lab
São Paulo State University
Jaboticabal Campus

[2019 – 2021]

PhD in Agronomy
Machinery and Mechanization Lab
São Paulo State University
Jaboticabal Campus

[2021 – 2024]

Research Assistant
Precision Agriculture Team
Louisiana State University
Baton Rouge Campus

[2022 – 2023]

Post-Doctoral Associate
Precision Horticulture Lab
University of Georgia
Tifton Campus

[2024 – 2025]

Assistant Research Professor & State Extension Specialist for PA
University of Missouri
FD-REEC

[Start in January 2026]

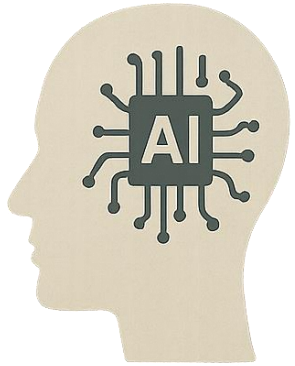
Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Imaging drones

Satellite



AI

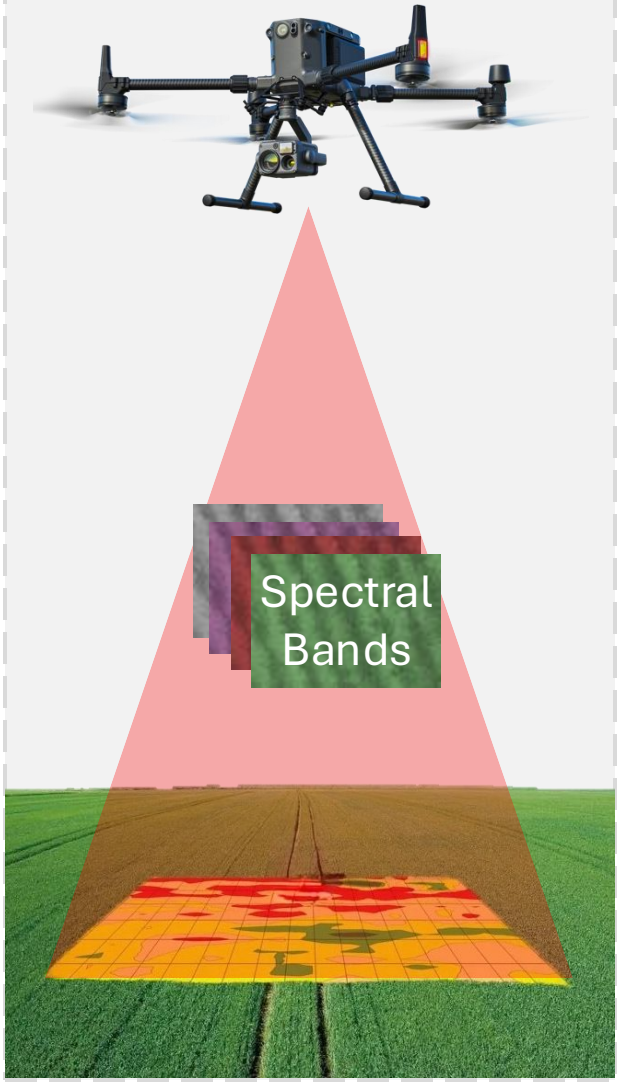
Ag Robots

Spraying drones

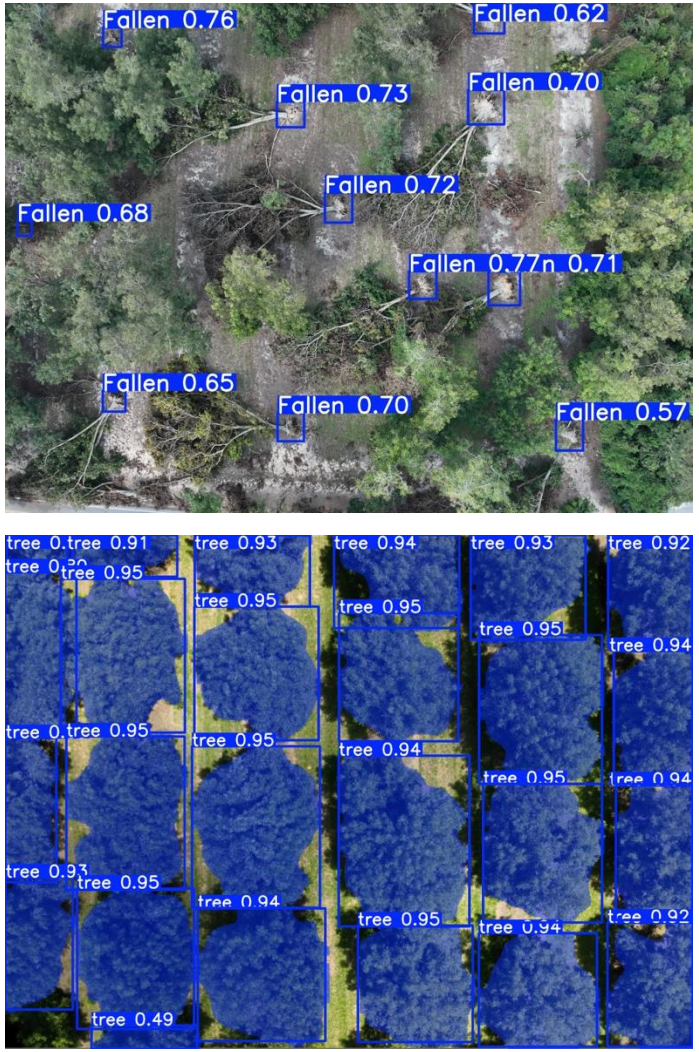
Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference | CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

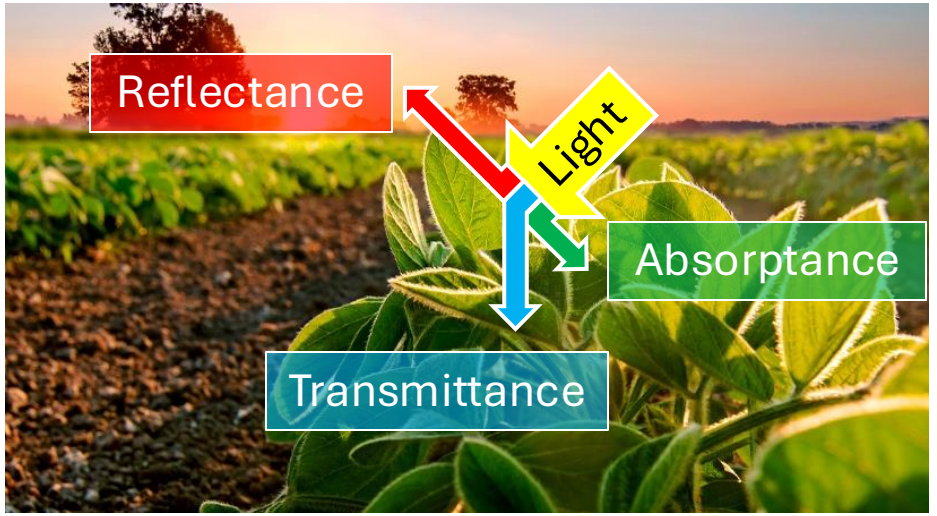
Drone application

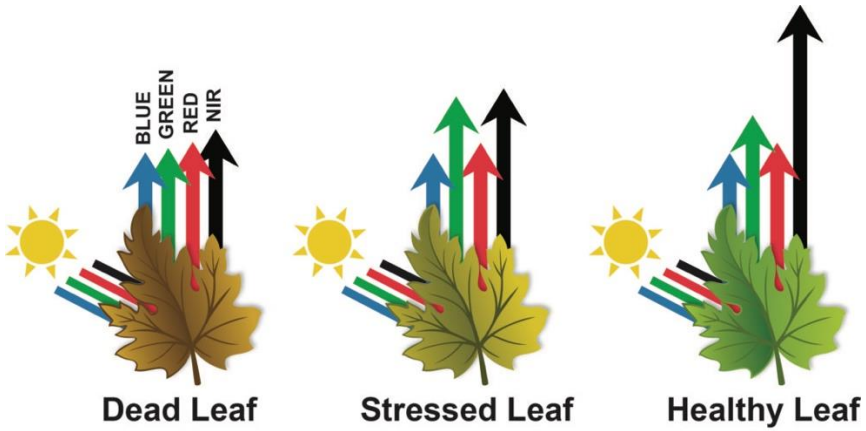


Object detection/measurement



Spectral response





$$NDVI = \frac{NIR-Red}{NIR+Red}$$

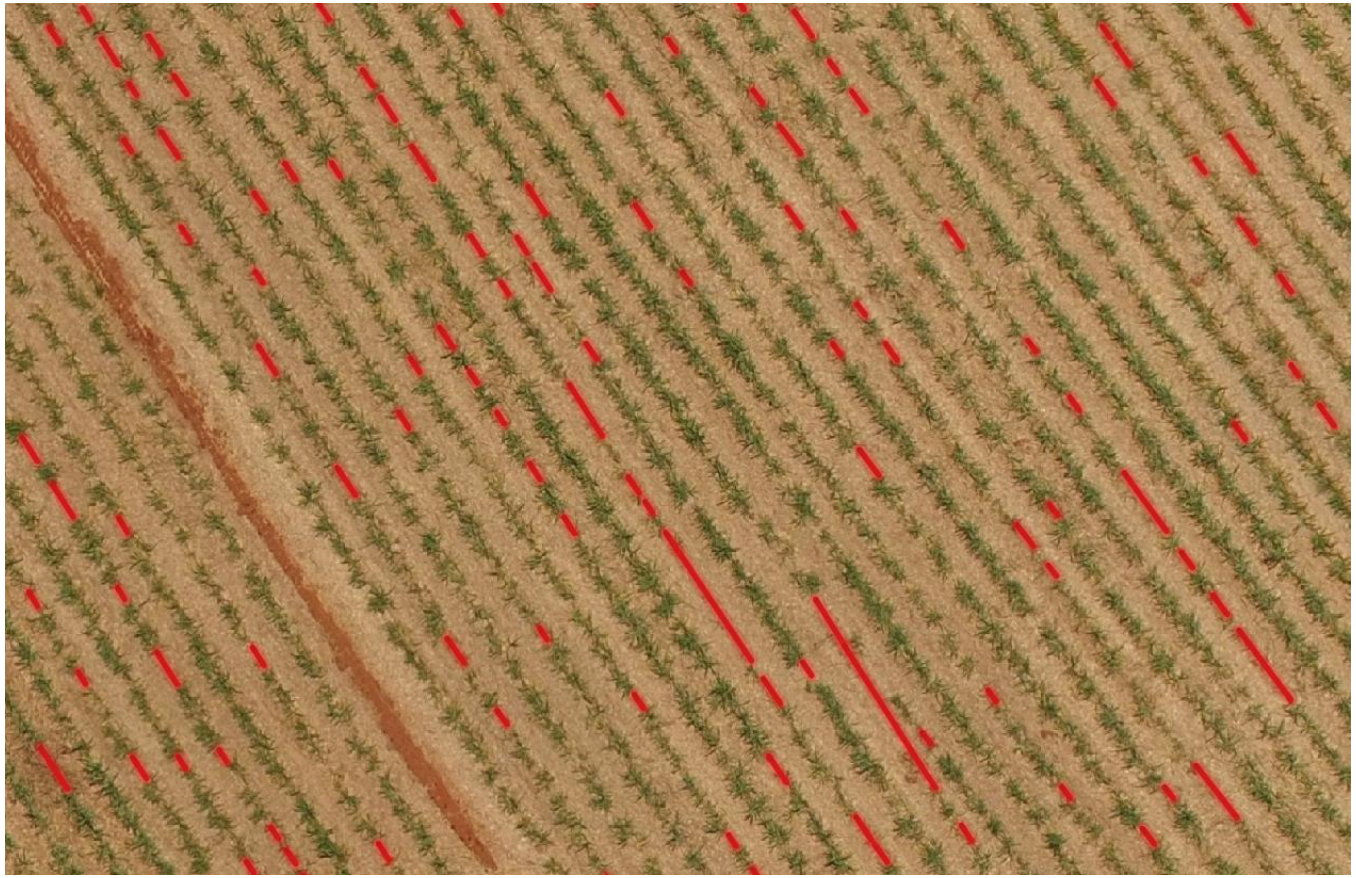
The closer to 1, the healthier.

Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

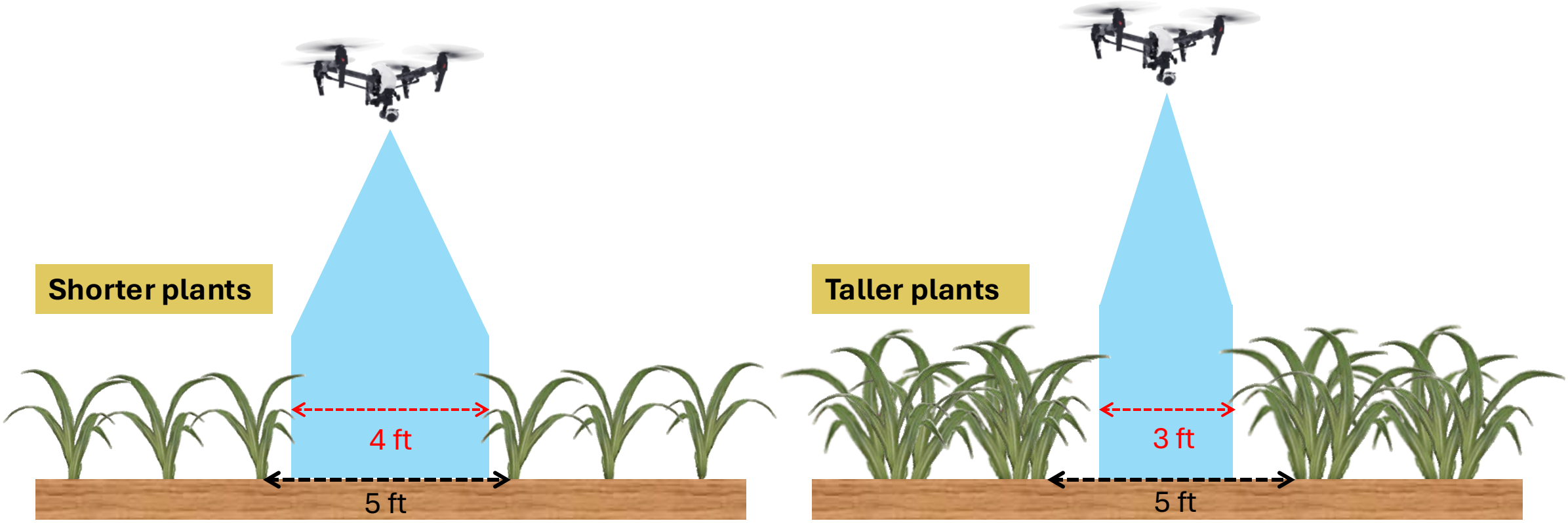
Mapping Gaps in Sugarcane by UAV RGB Imagery: The Lower and Earlier the Flight, the More Accurate



Research questions

- Can I detect all the gap lengths through drone images?
- How high should I fly the drone?
- How late in the season should I fly the drone?
- How accurate the measurements are?

Mapping Gaps in Sugarcane by UAV RGB Imagery: The Lower and Earlier the Flight, the More Accurate



Mapping Gaps in Sugarcane by UAV RGB Imagery: The Lower and Earlier the Flight, the More Accurate

Gap lengths

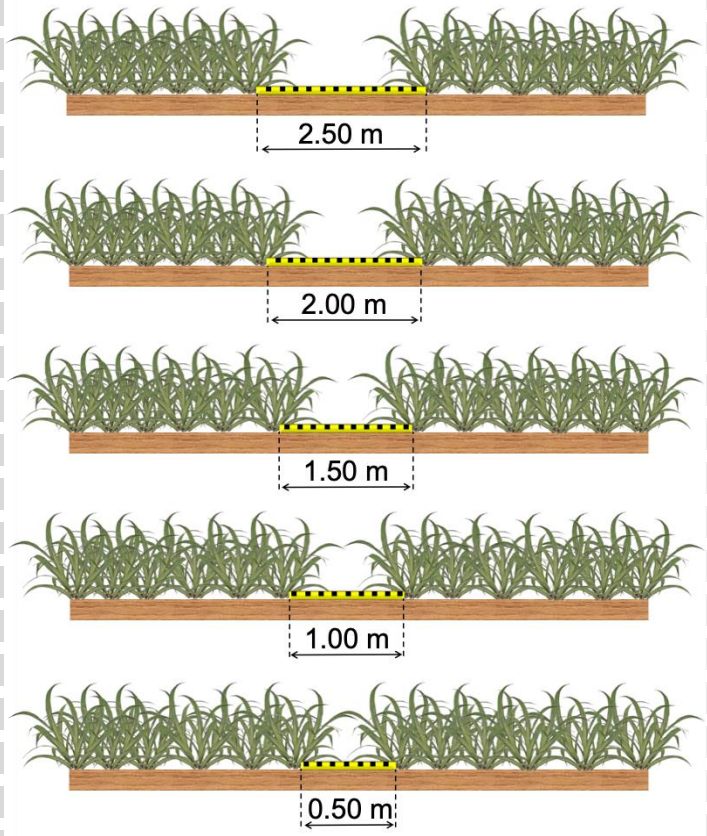
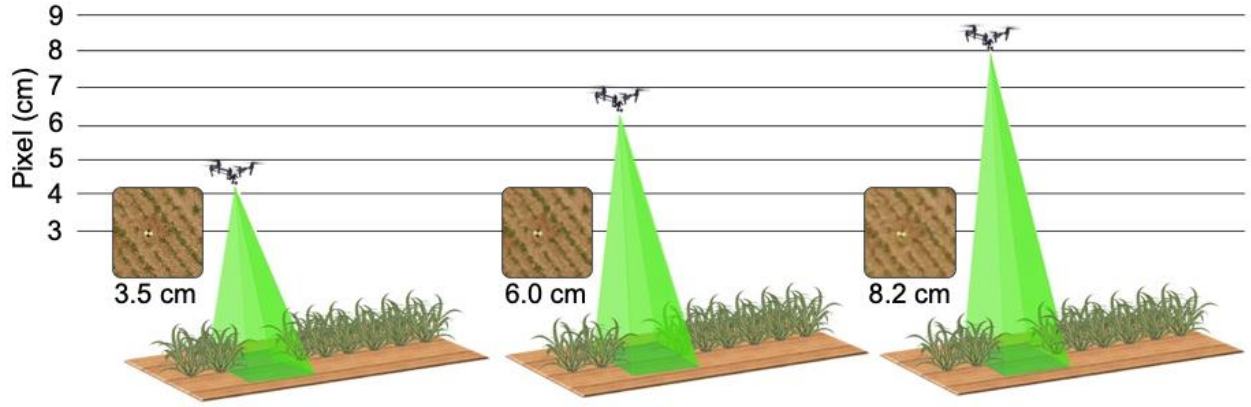
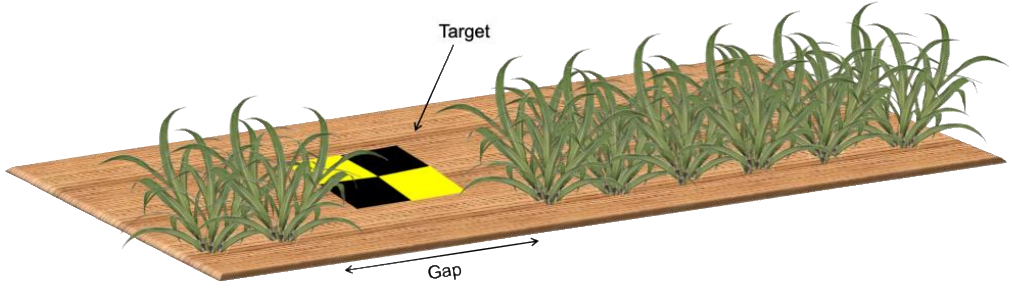


Image resolution



Ground truth

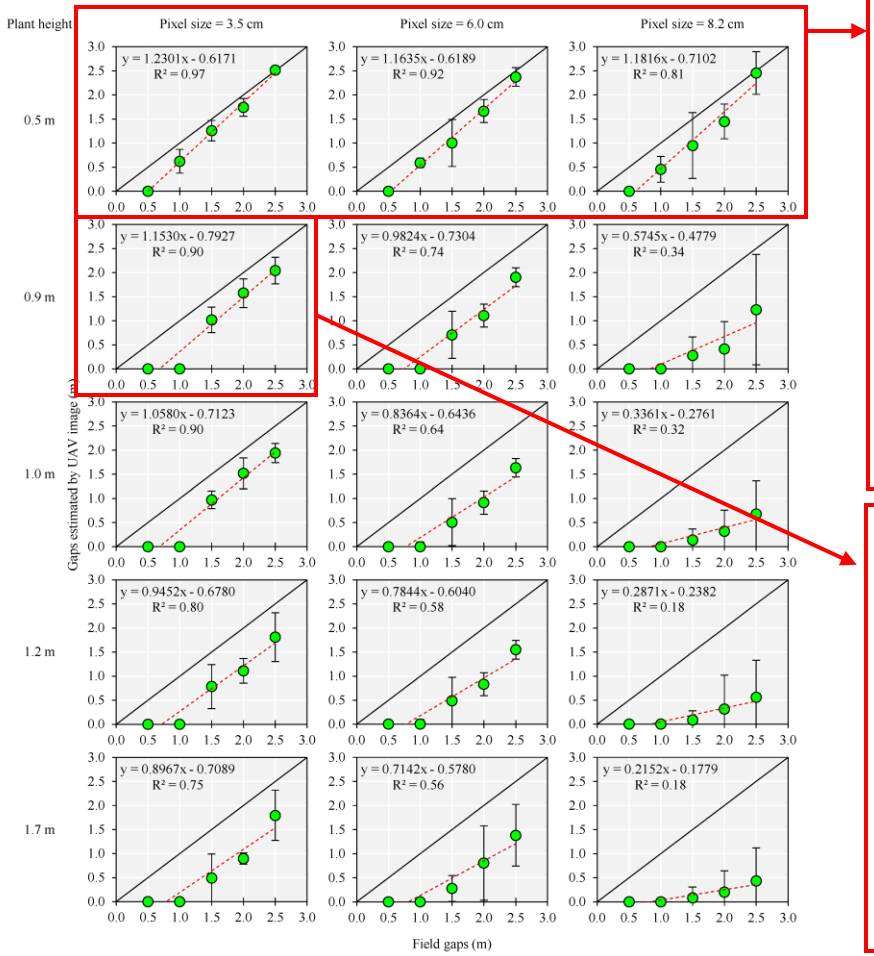


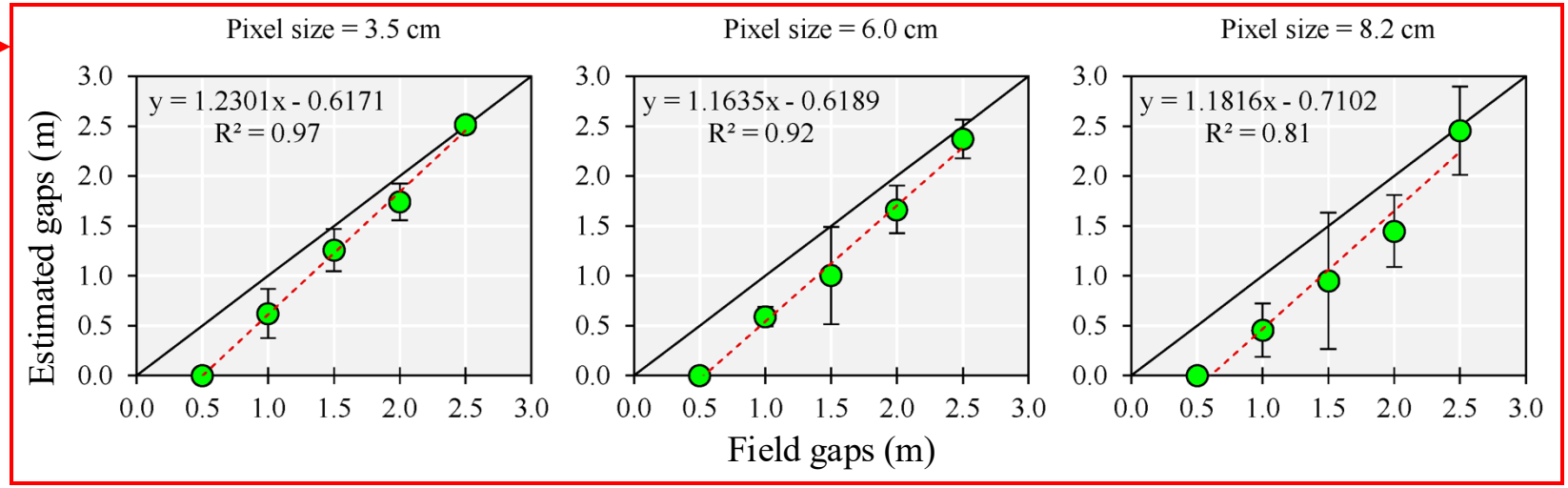
Integrating Cutting-Edge Technologies for Crop Monitoring and Management

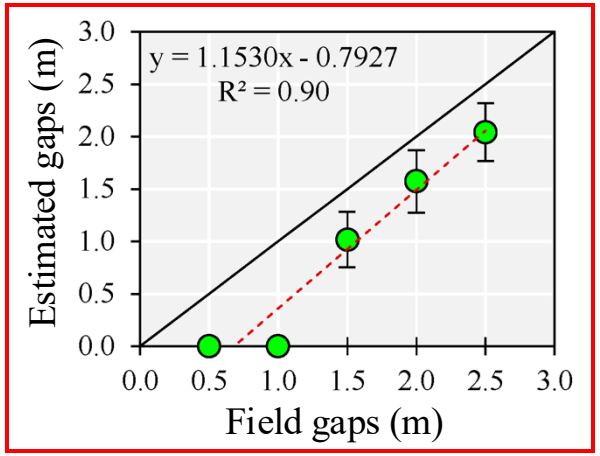
CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Mapping Gaps in Sugarcane by UAV RGB Imagery: The Lower and Earlier the Flight, the More Accurate







- Gaps > 1 m (3.28 ft) in length were detected.
- Image resolution should be < 6.0 cm/pixel.
- We should fly when plants are max 0.9 m (~3 ft) tall.
- Measurements were 97% precise and 81% accurate.

Automated Crop Measurements with UAVs: Evaluation of an AI-Driven Platform for Counting and Biometric Analysis

Height measurements

Canopy area measurements

- Young trees

- Mid-age

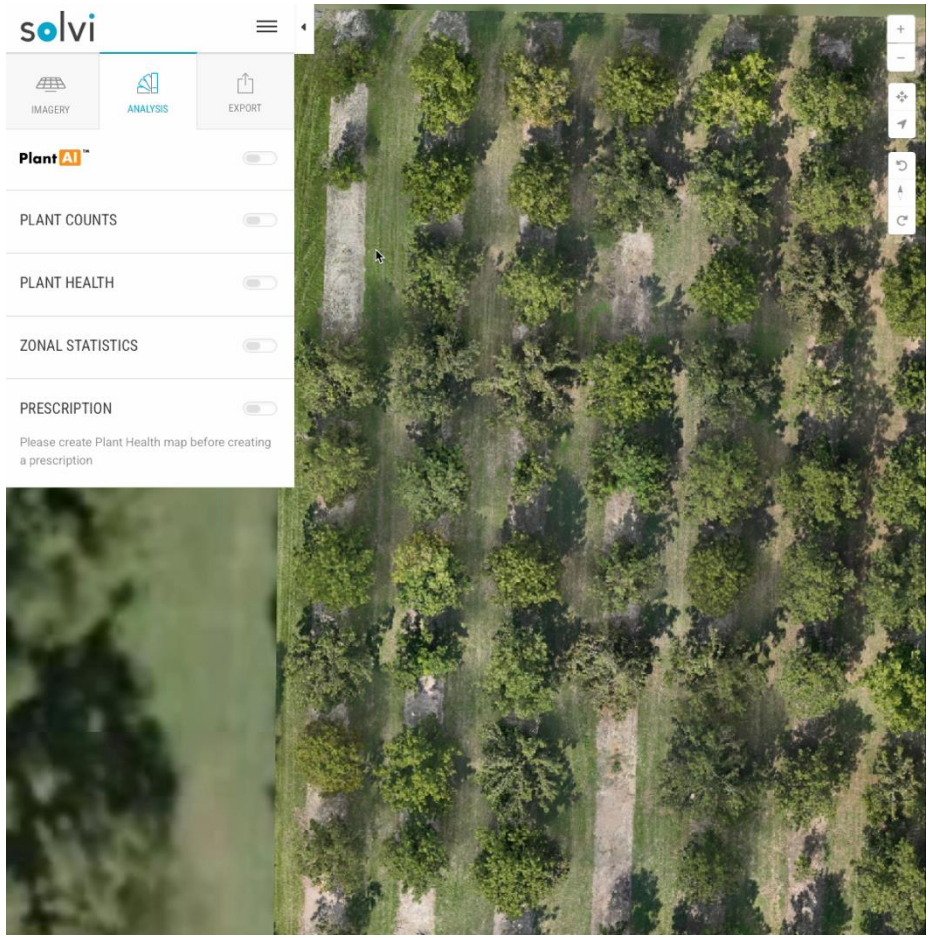
- Mature

Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Automated Crop Measurements with UAVs: Evaluation of an AI-Driven Platform for Counting and Biometric Analysis



Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference | CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

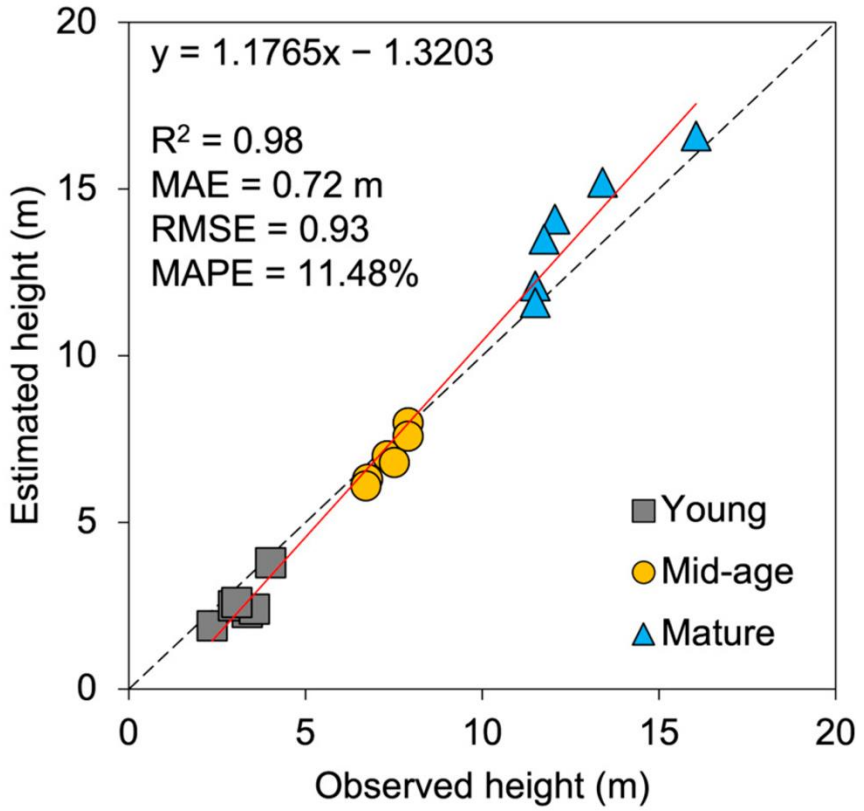
Automated Crop Measurements with UAVs: Evaluation of an AI-Driven Platform for Counting and Biometric Analysis

Plant count

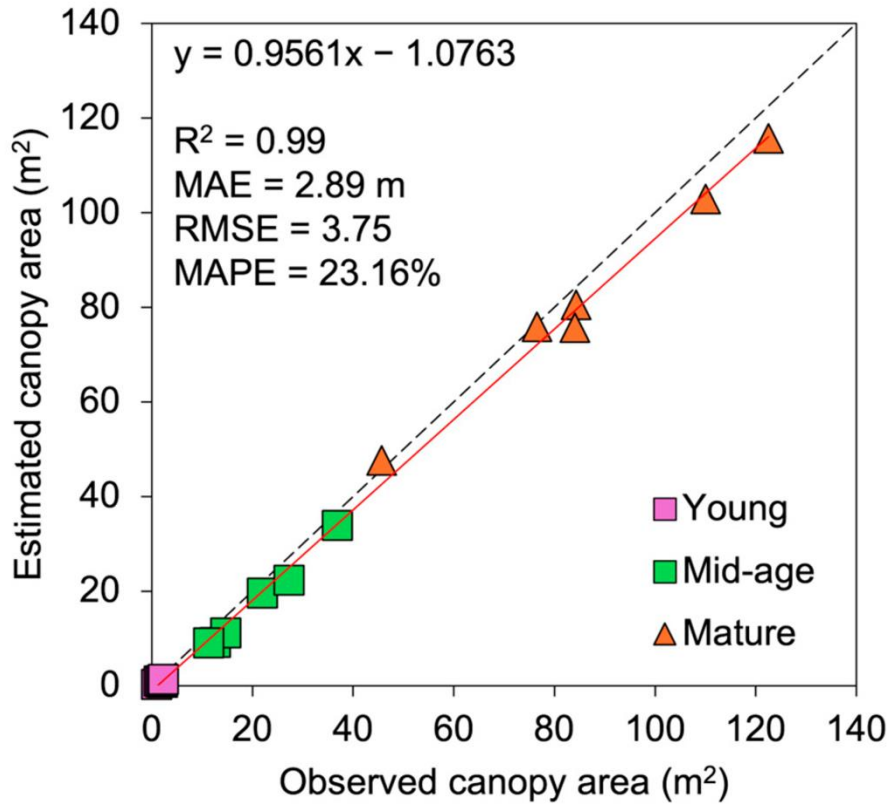
Metric	Value
Precision	0.988
Recall	0.992
F1 Score	0.990

> 99%

Plant height



Canopy area



Integrating Cutting-Edge Technologies for Crop Monitoring and Management

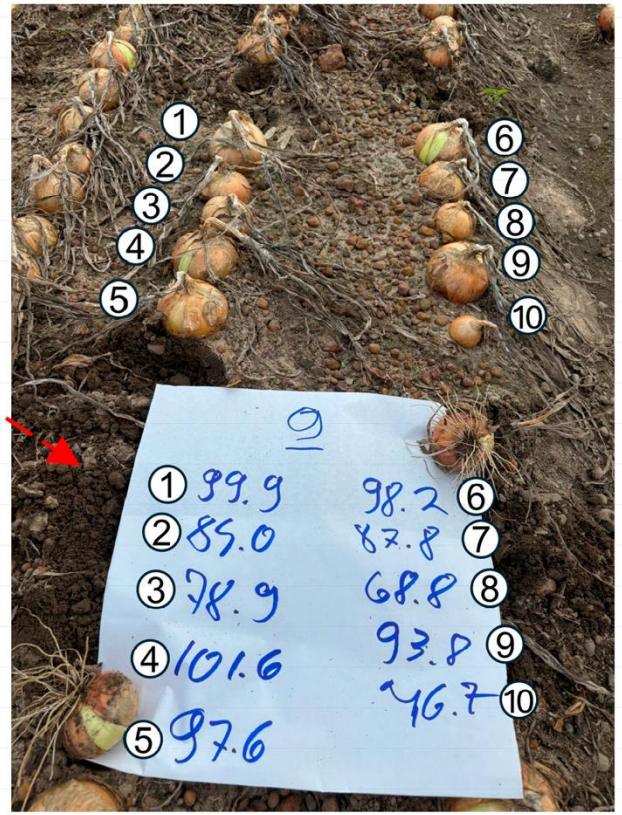
CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Automated Crop Measurements with UAVs: Evaluation of an AI-Driven Platform for Counting and Biometric Analysis

Orthomosaic

Sample point (ID 9)



Data classification

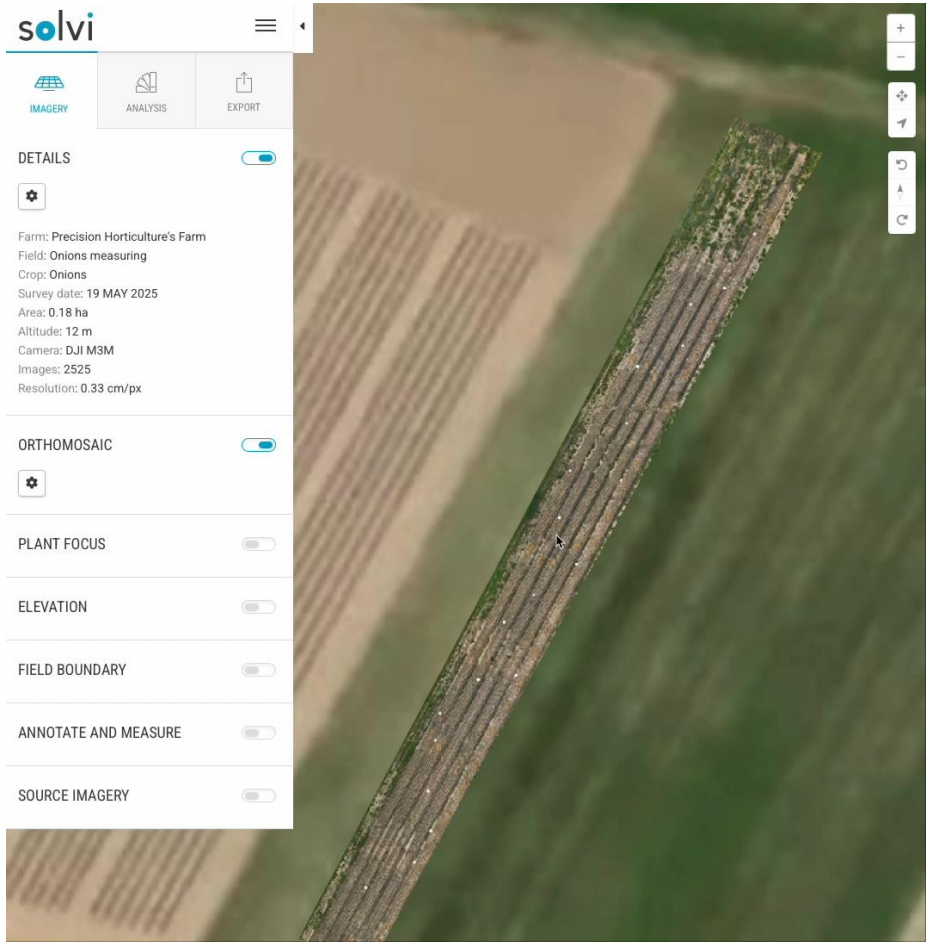
ID	Diameter (mm)	Class
1	99.9	Colossal
2	85.0	Jumbo
3	78.9	Jumbo
4	101.6	Colossal
5	97.6	Colossal
6	98.2	Colossal
7	87.8	Jumbo
8	68.8	Medium
9	93.8	Jumbo
10	46.7	Medium

Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Automated Crop Measurements with UAVs: Evaluation of an AI-Driven Platform for Counting and Biometric Analysis



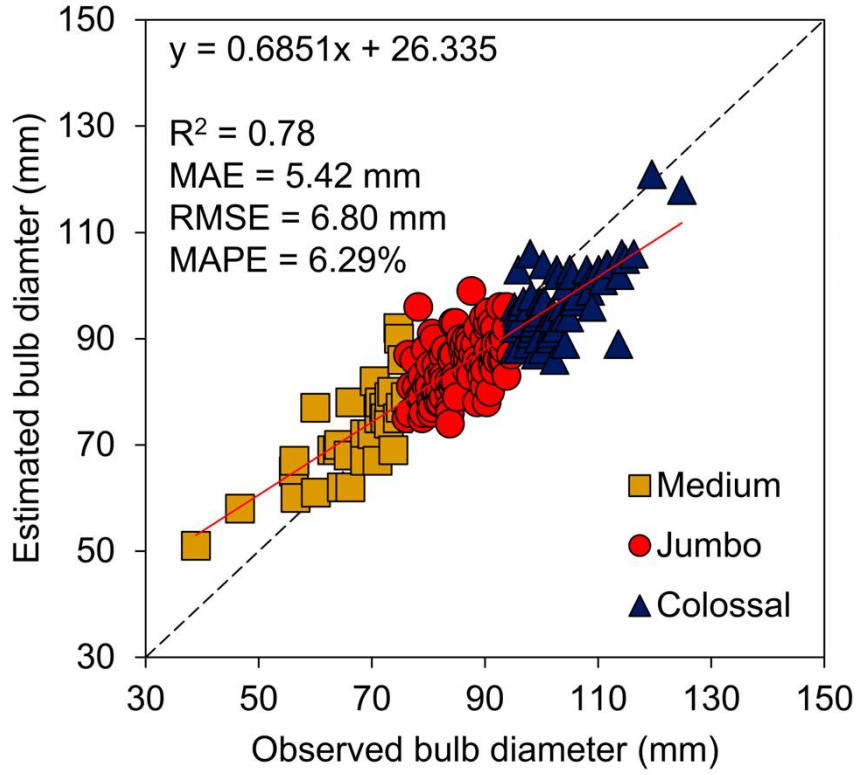
Automated Crop Measurements with UAVs: Evaluation of an AI-Driven Platform for Counting and Biometric Analysis

Bulb count

Metric	Value
Precision	0.985
Recall	0.970
F1 Score	0.978

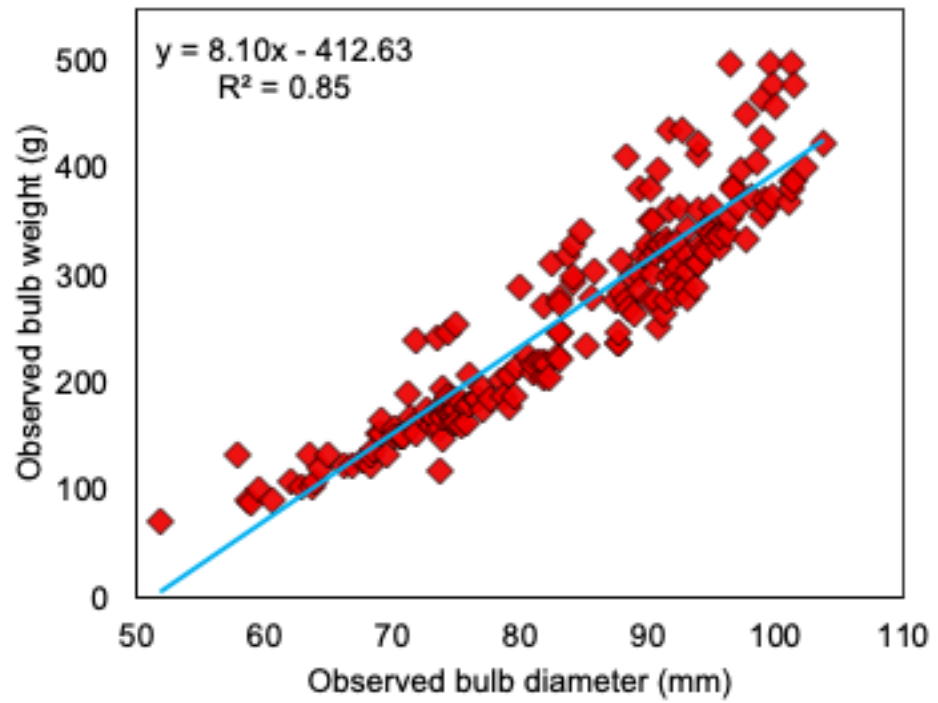
> 97%

Plant height

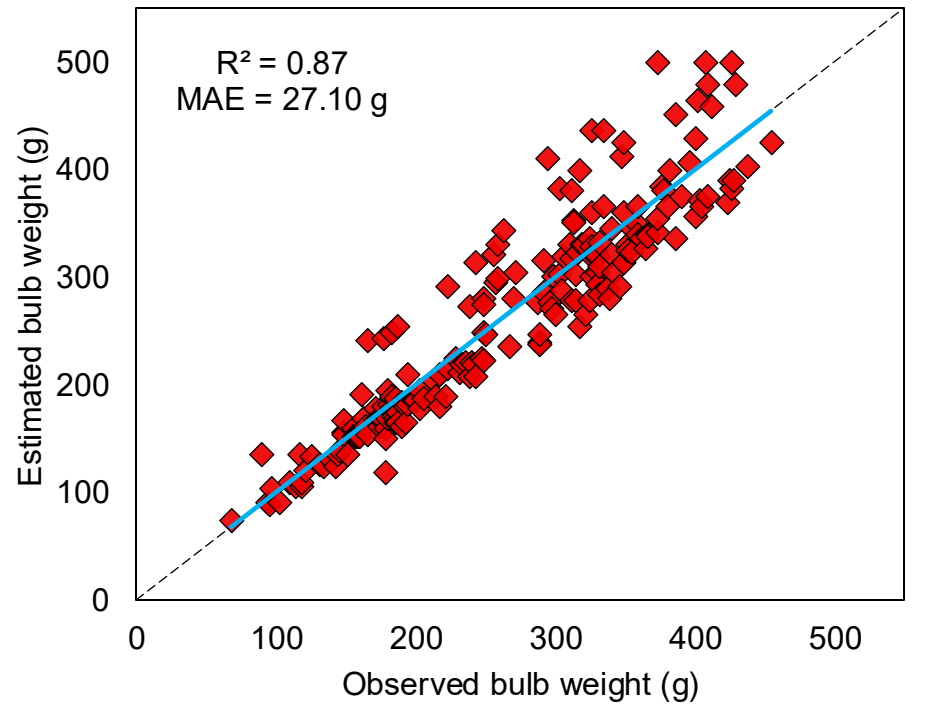


Automated Crop Measurements with UAVs: An AI-Driven Platform for Counting and Biometric Analysis

Bulb diameter vs Bulb weight



Bulb weight: Observed vs Estimated

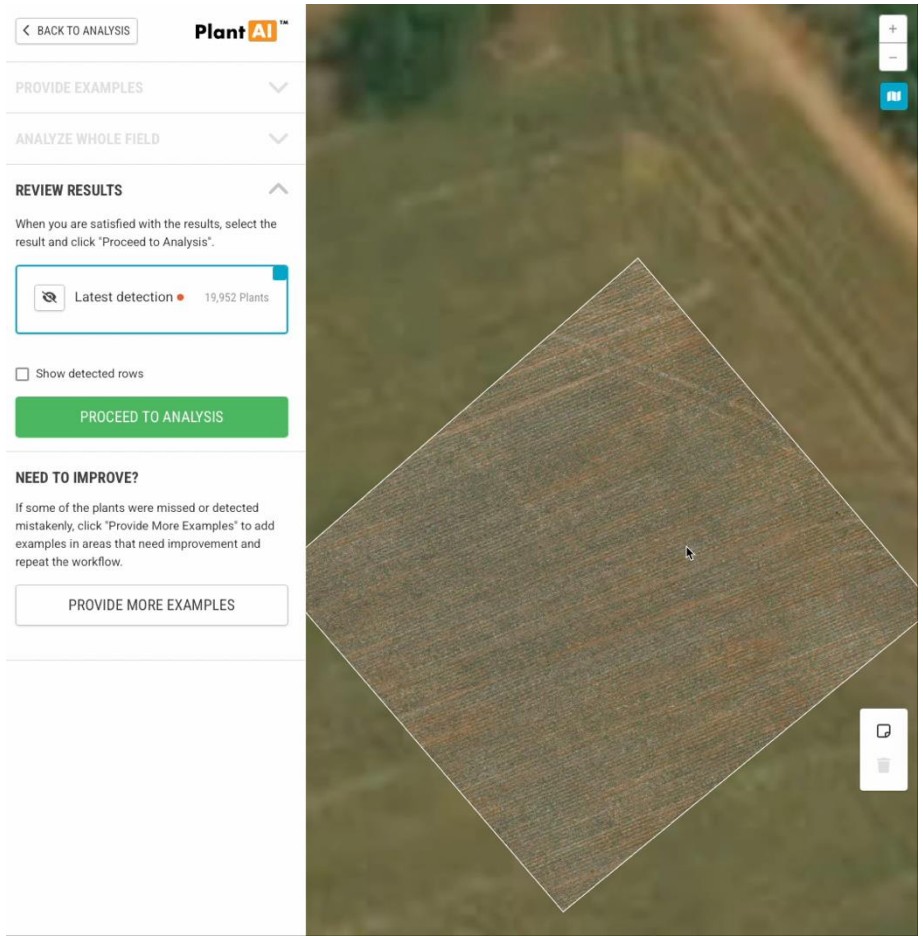


Integrating Cutting-Edge Technologies for Crop Monitoring and Management

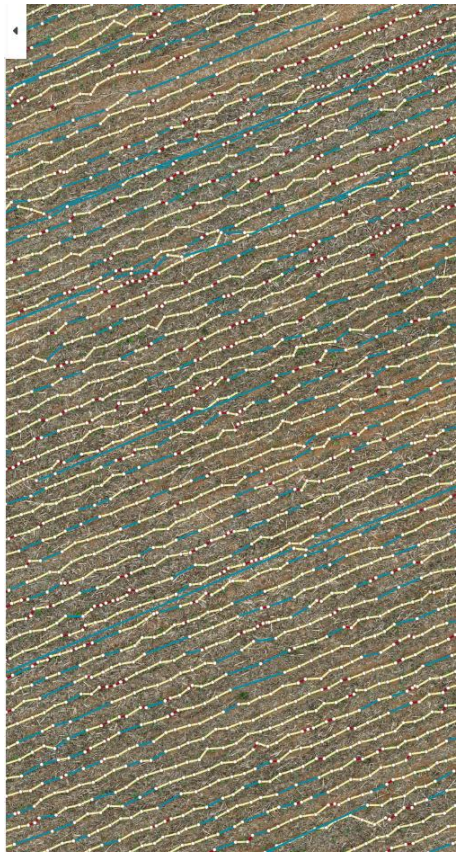
CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

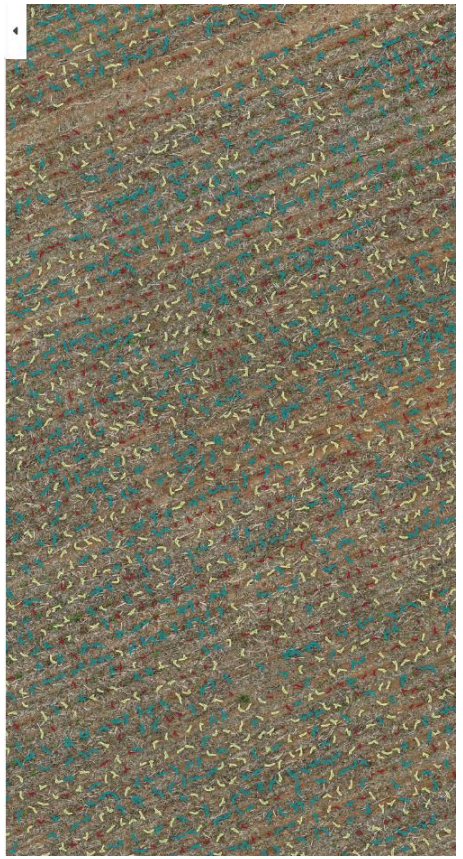
Automated Crop Measurements with UAVs: An AI-Driven Platform for Counting and Biometric Analysis



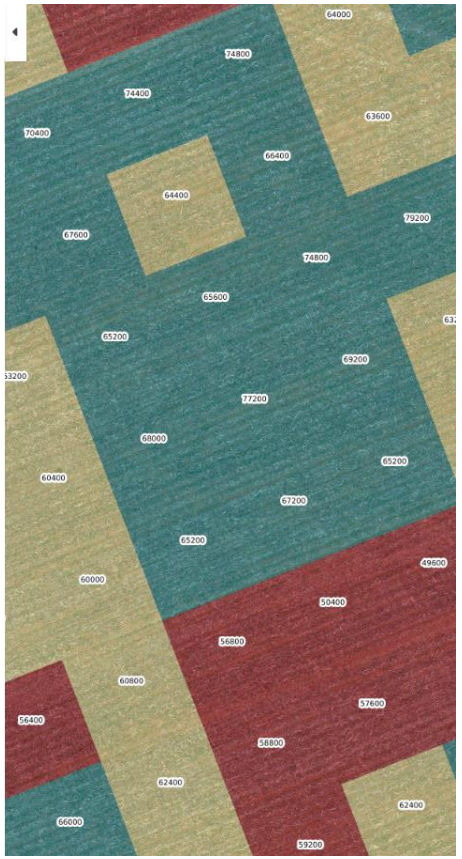
Plant distance



Plant diameter



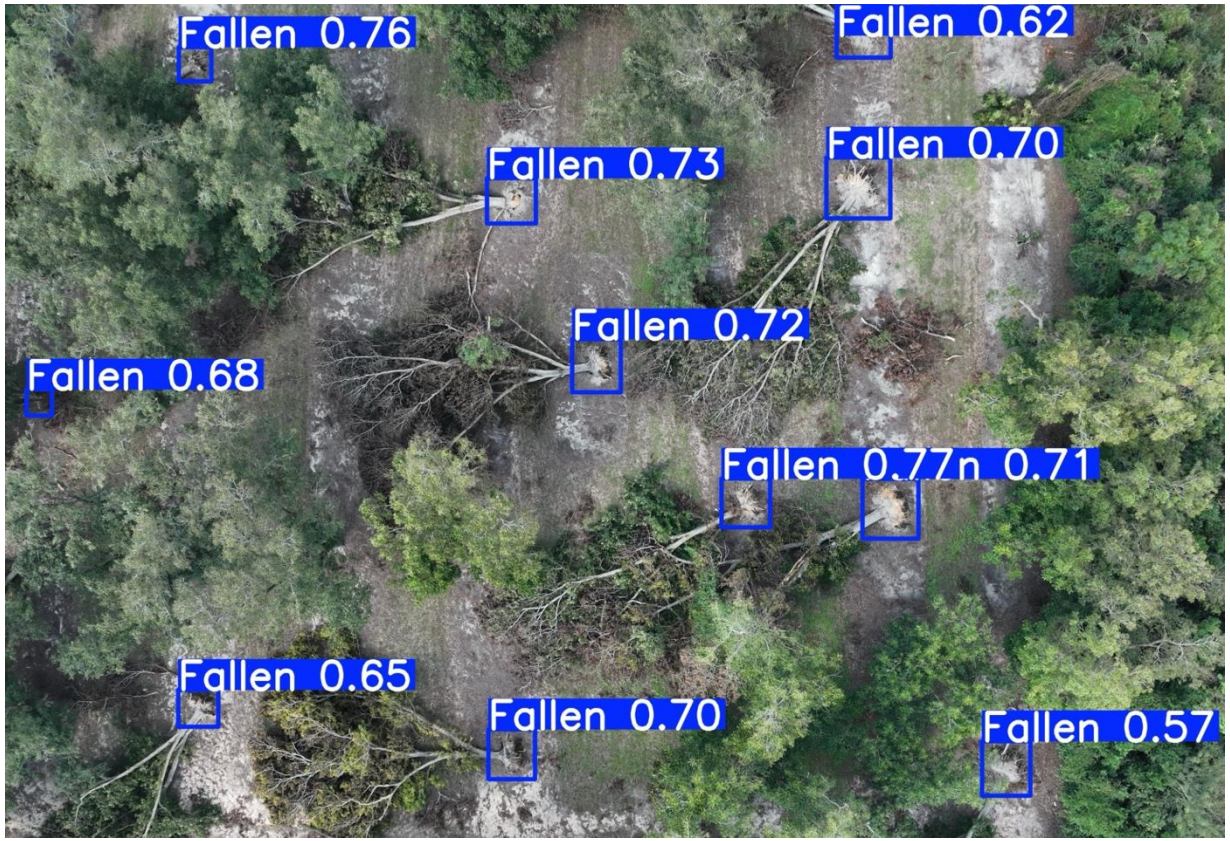
Plant population



Monitoring Hurricane Effects in Pecan Fields: An Object Detection Framework to Detect Fallen Trees

Pecan trees affected by Hurricane Helene

Automatic fallen tree identification (Drone and AI)

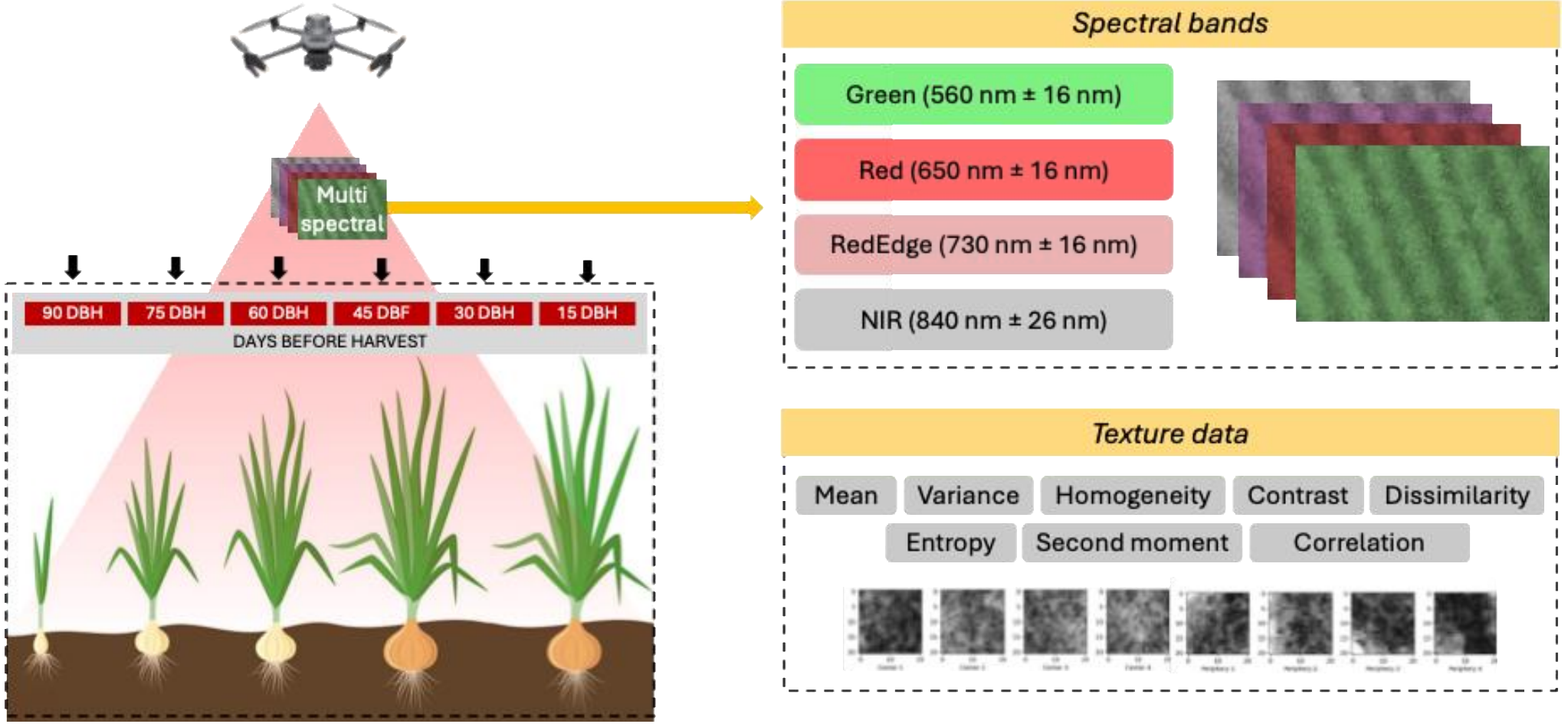


Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Forecasting yield and market classes of Vidalia sweet onions: A UAV-based multispectral and texture data-driven approach

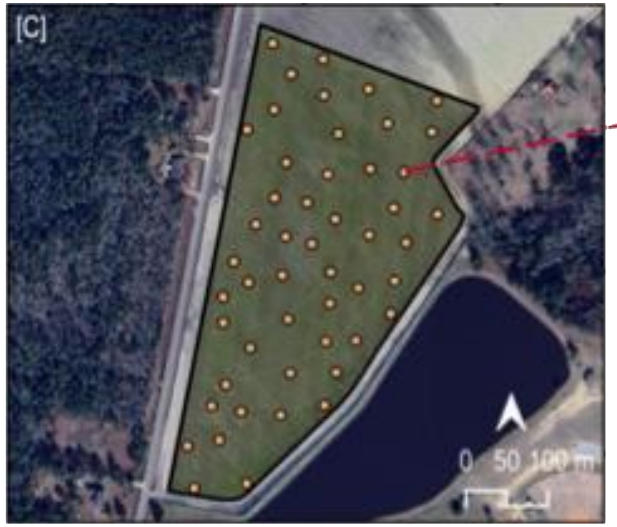


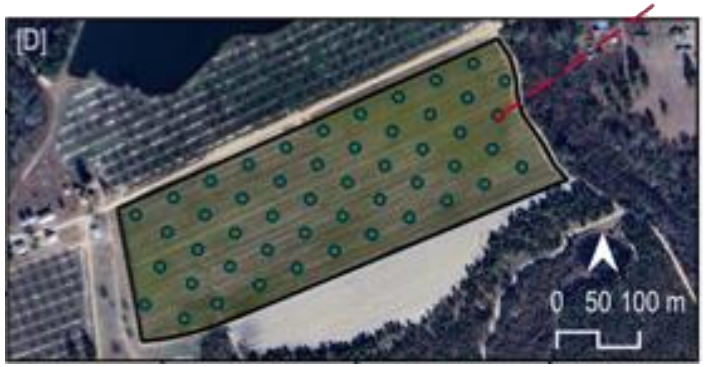
Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Forecasting yield and market classes of Vidalia sweet onions: A UAV-based multispectral and texture data-driven approach





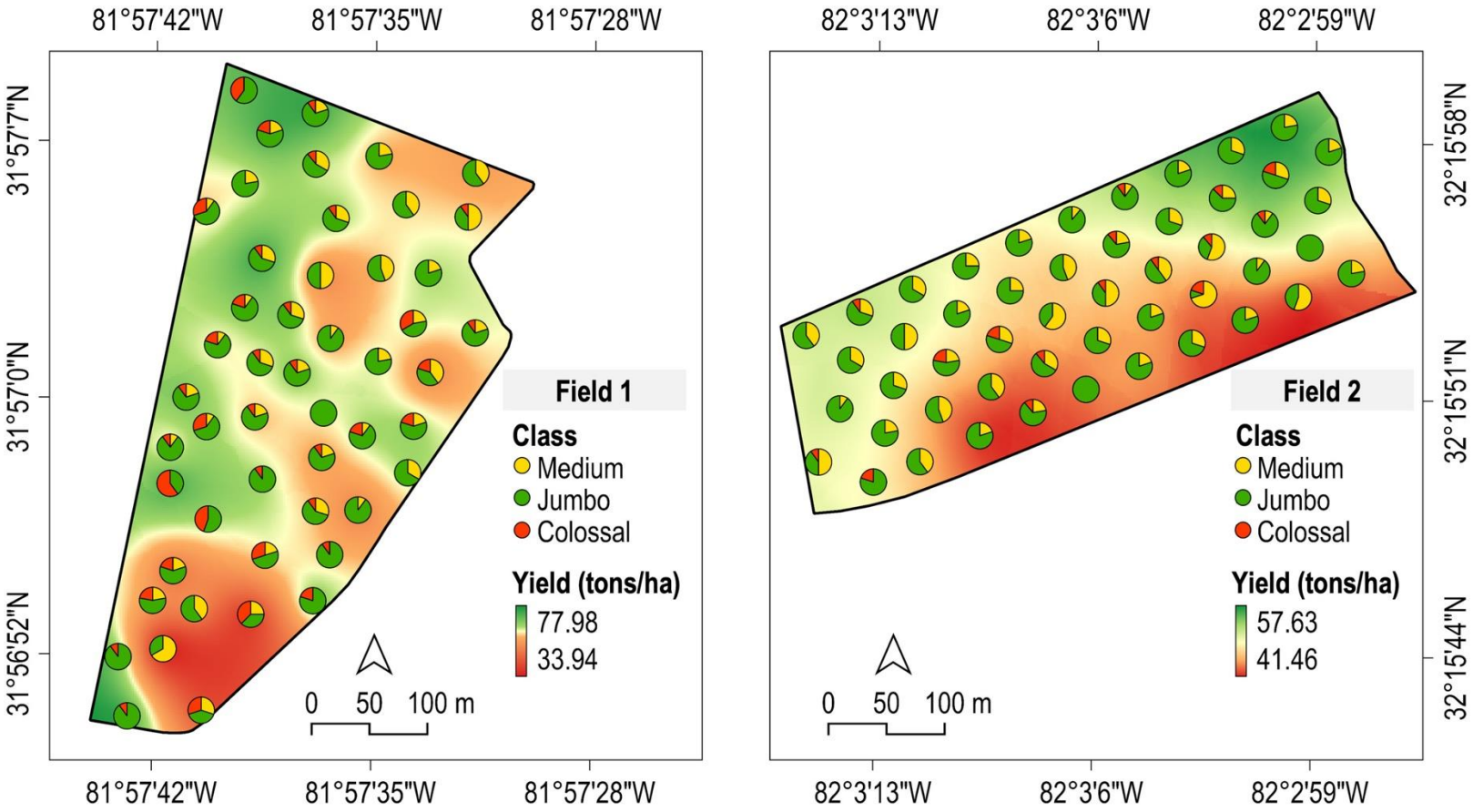
Field 1 [C] and Field 2 [D]

- Sample plots: 50 in each field
- Plot dimension: 5 x 5 m
- Harvest date: April 22 and 30, 2024
- Measurements: Weight and Size

Outputs: Yield and Market class

- **Medium** (~3 inches wide | 7.6 cm)
- **Jumbo** (~3.75 inches wide | 9.5 cm)
- **Colossal** (~4.25 inches wide | 10.8 cm)

Forecasting yield and market classes of Vidalia sweet onions: A UAV-based multispectral and texture data-driven approach

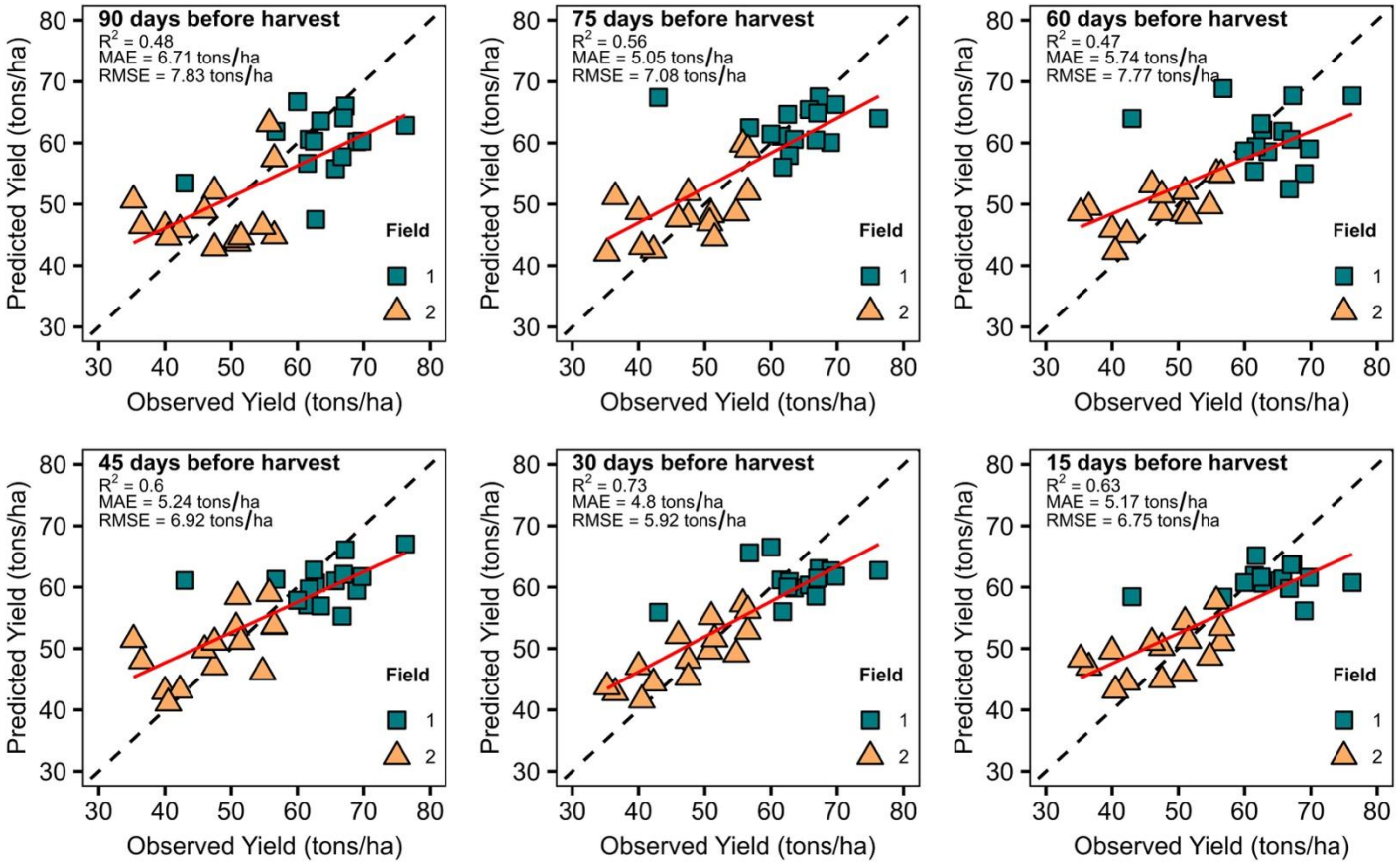


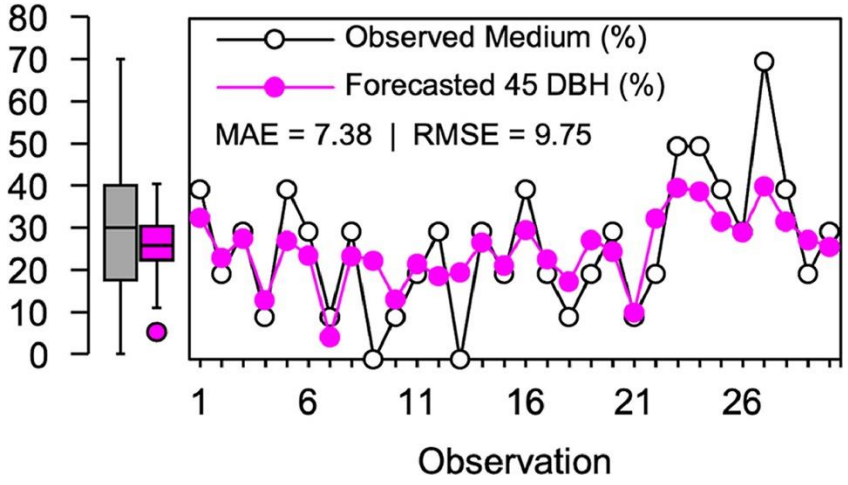
Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Forecasting yield and market classes of Vidalia sweet onions: A UAV-based multispectral and texture data-driven approach



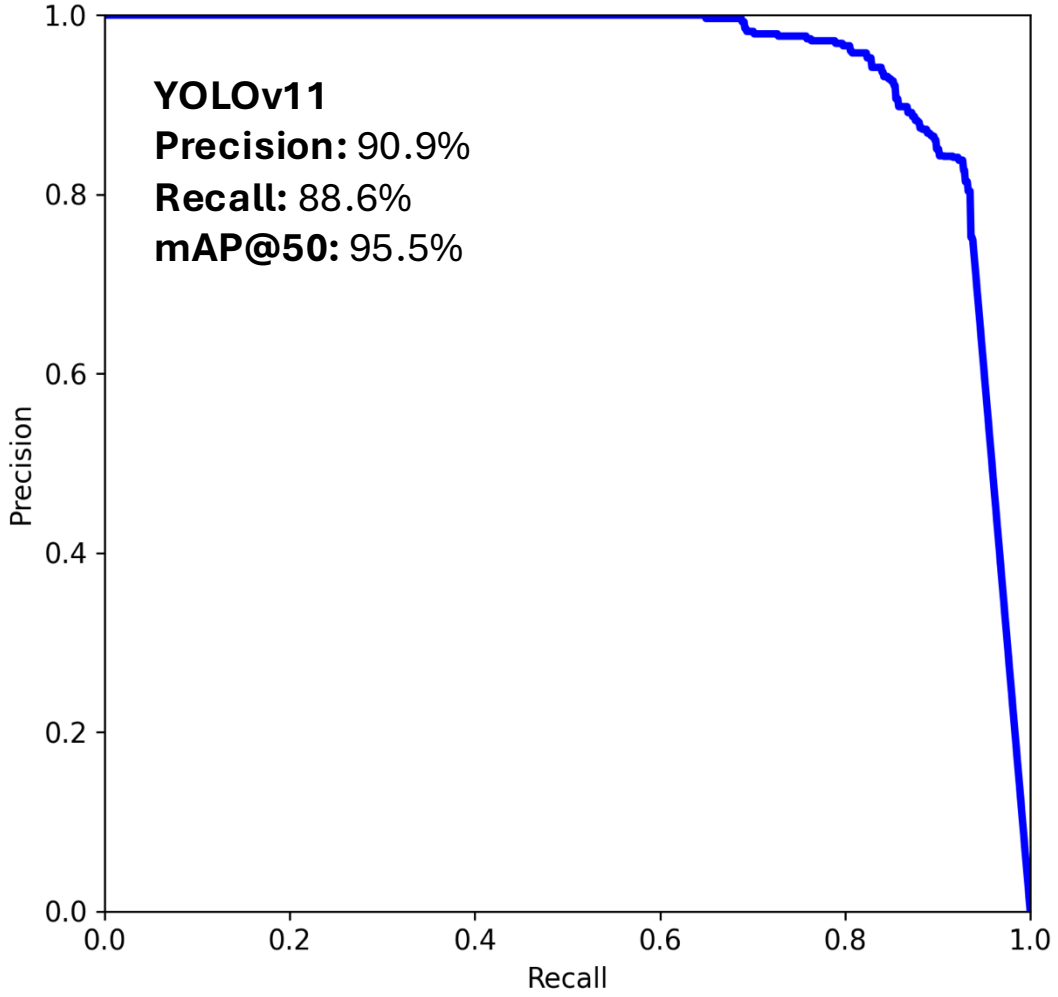


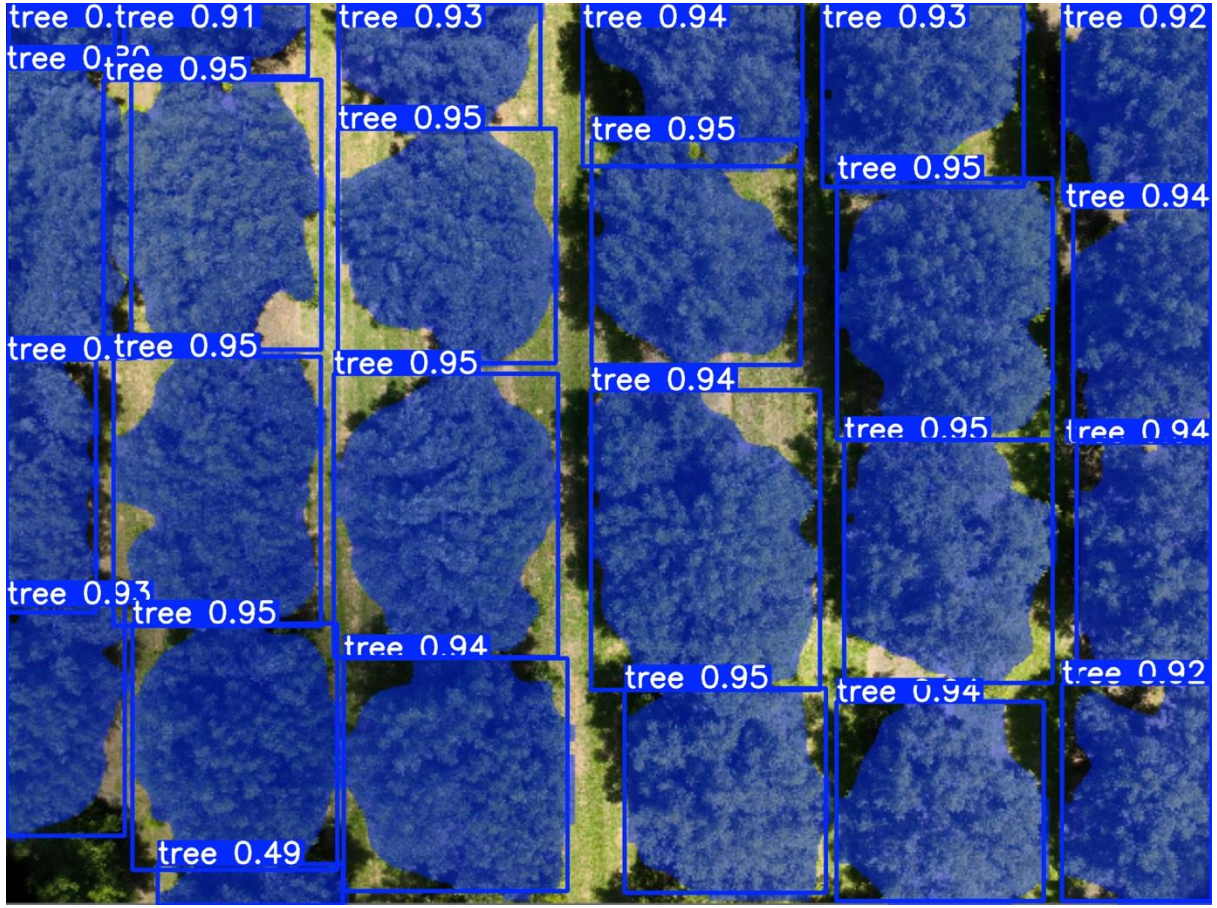
Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

AI-Driven Yield Forecasting Using UAV-Based Imagery: Insights from a Pecan Orchard



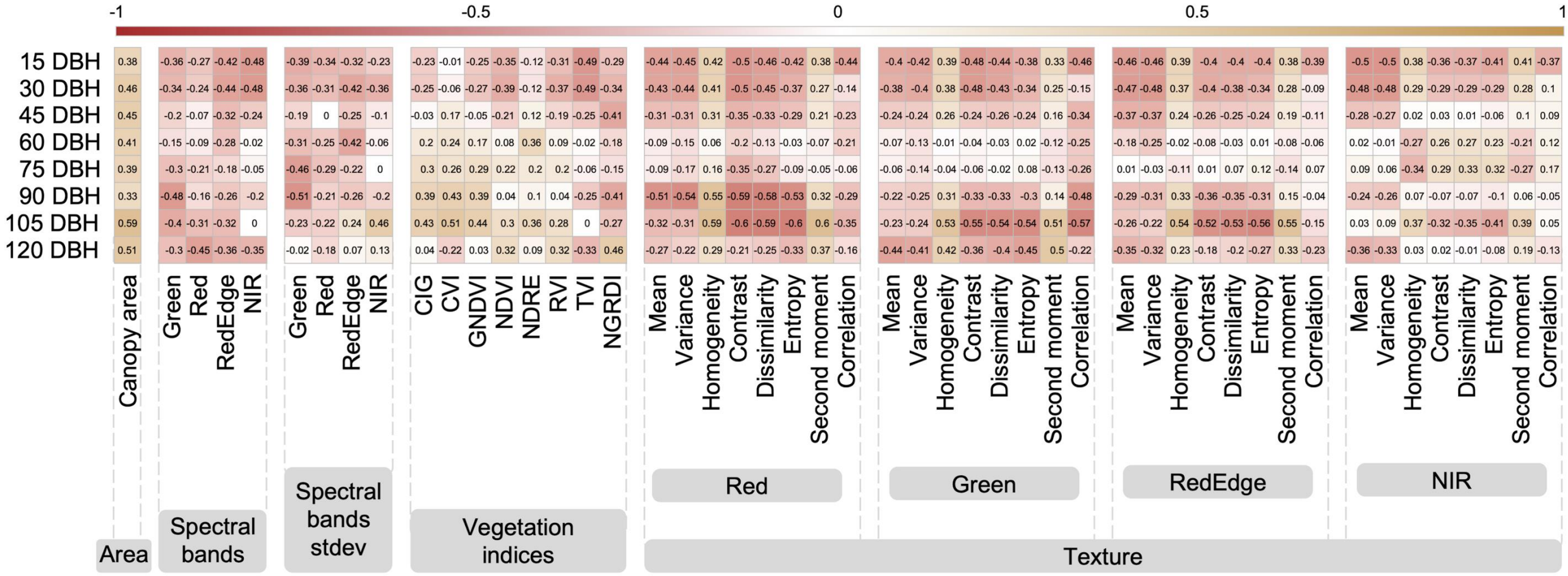


Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

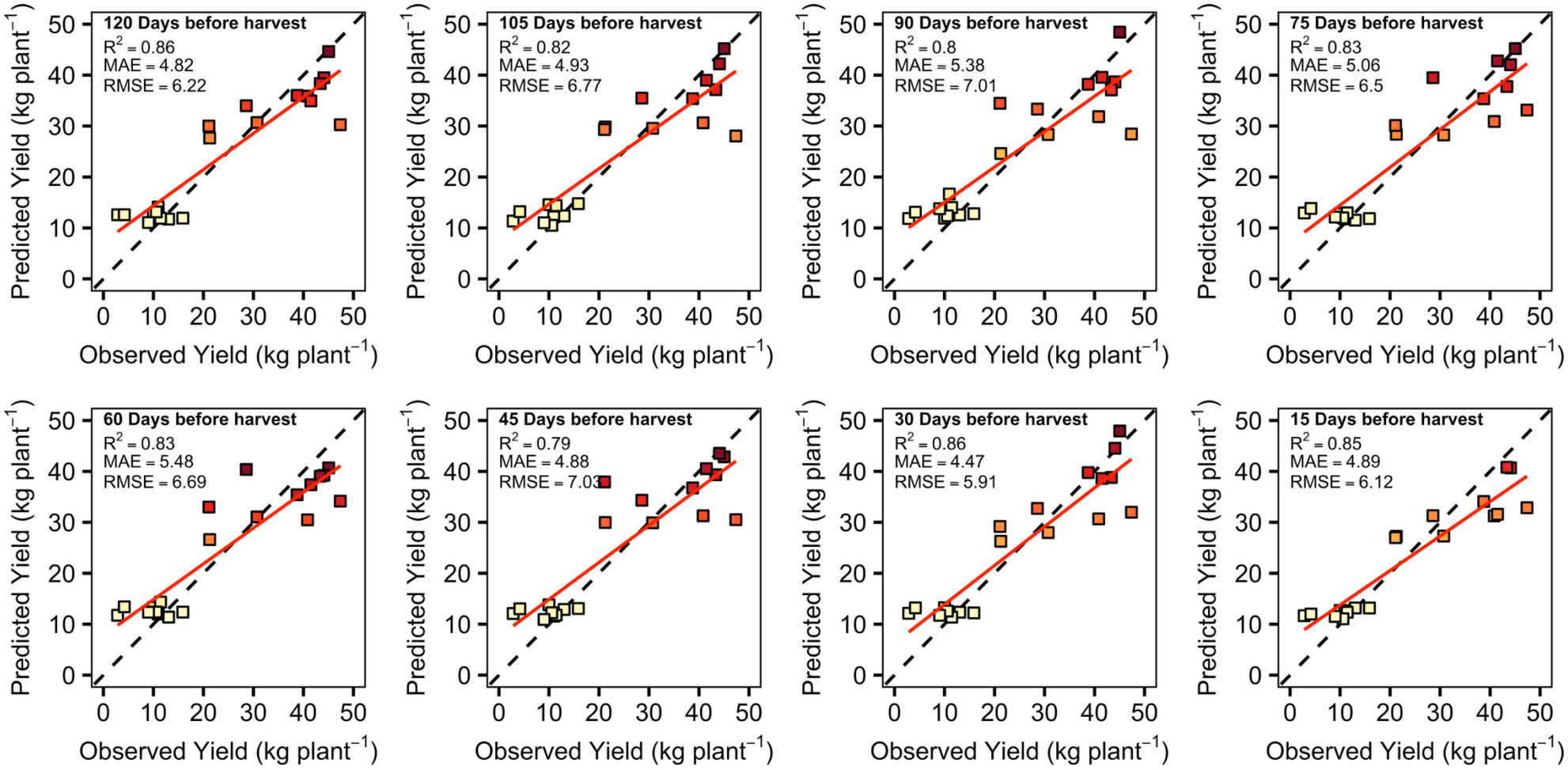
AI-Driven Yield Forecasting Using UAV-Based Imagery: Insights from a Pecan Orchard



Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference | CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

AI-Driven Yield Forecasting Using UAV-Based Imagery: Insights from a Pecan Orchard



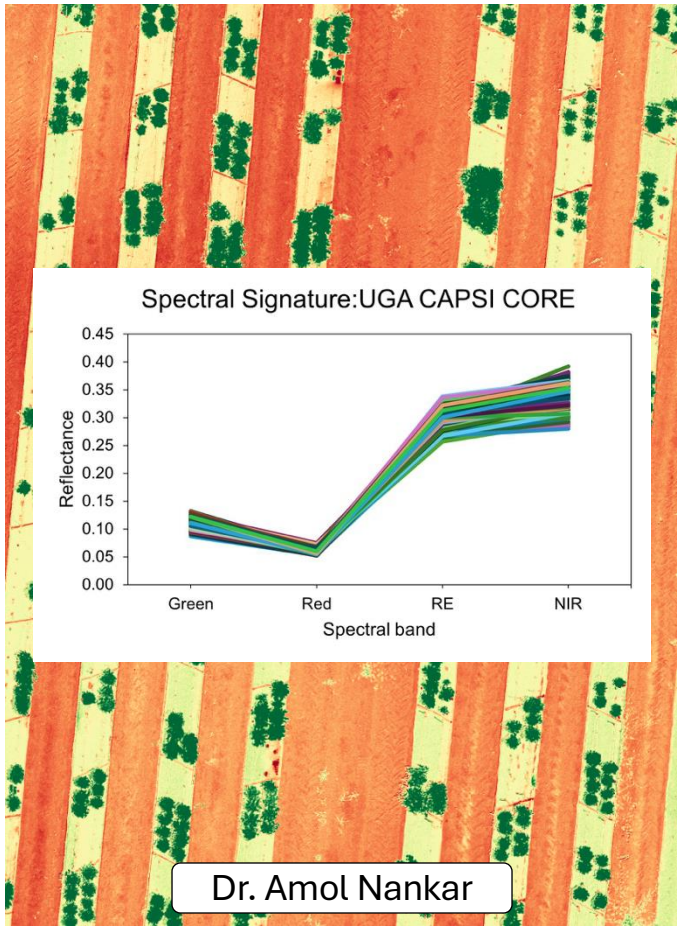
Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

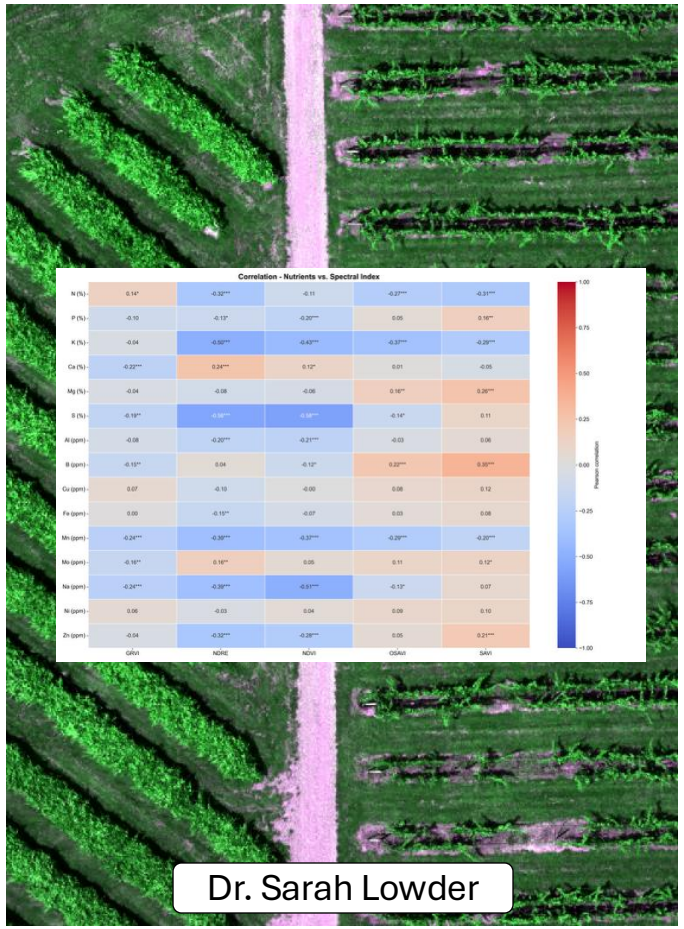
Drone applications to support plant breeding and plant nutrition

Peppers (breeding)



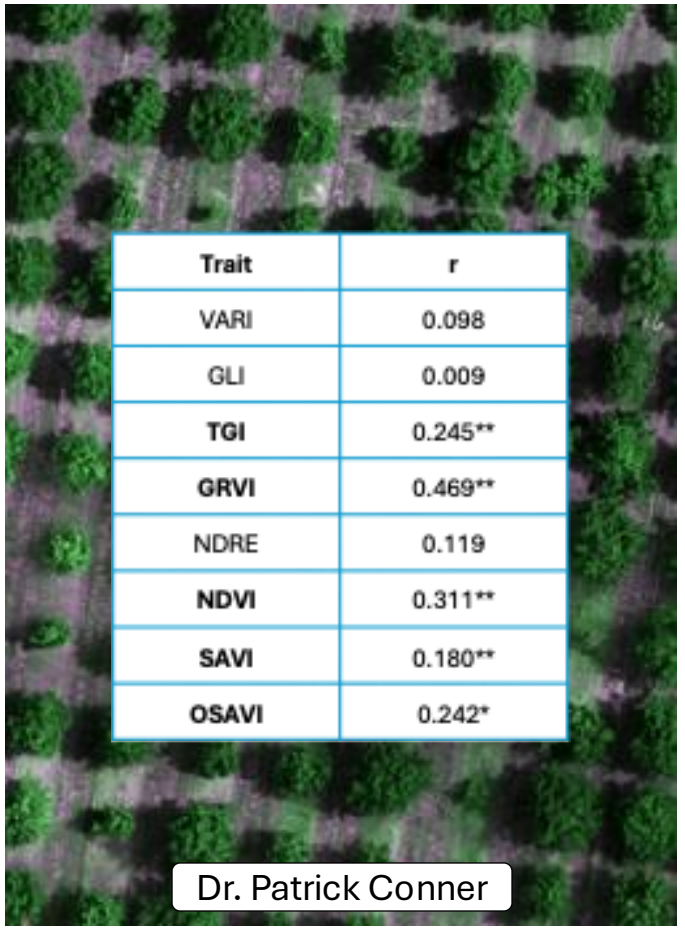
Dr. Amol Nankar

Grape (nutrition)



Dr. Sarah Lowder

Pecan (nutrition-zinc)



Trait	r
VARI	0.098
GLI	0.009
TGI	0.245**
GRVI	0.469**
NDRE	0.119
NDVI	0.311**
SAVI	0.180**
OSAVI	0.242*

Dr. Patrick Conner

Integrating Cutting-Edge Technologies for Crop Monitoring and Management

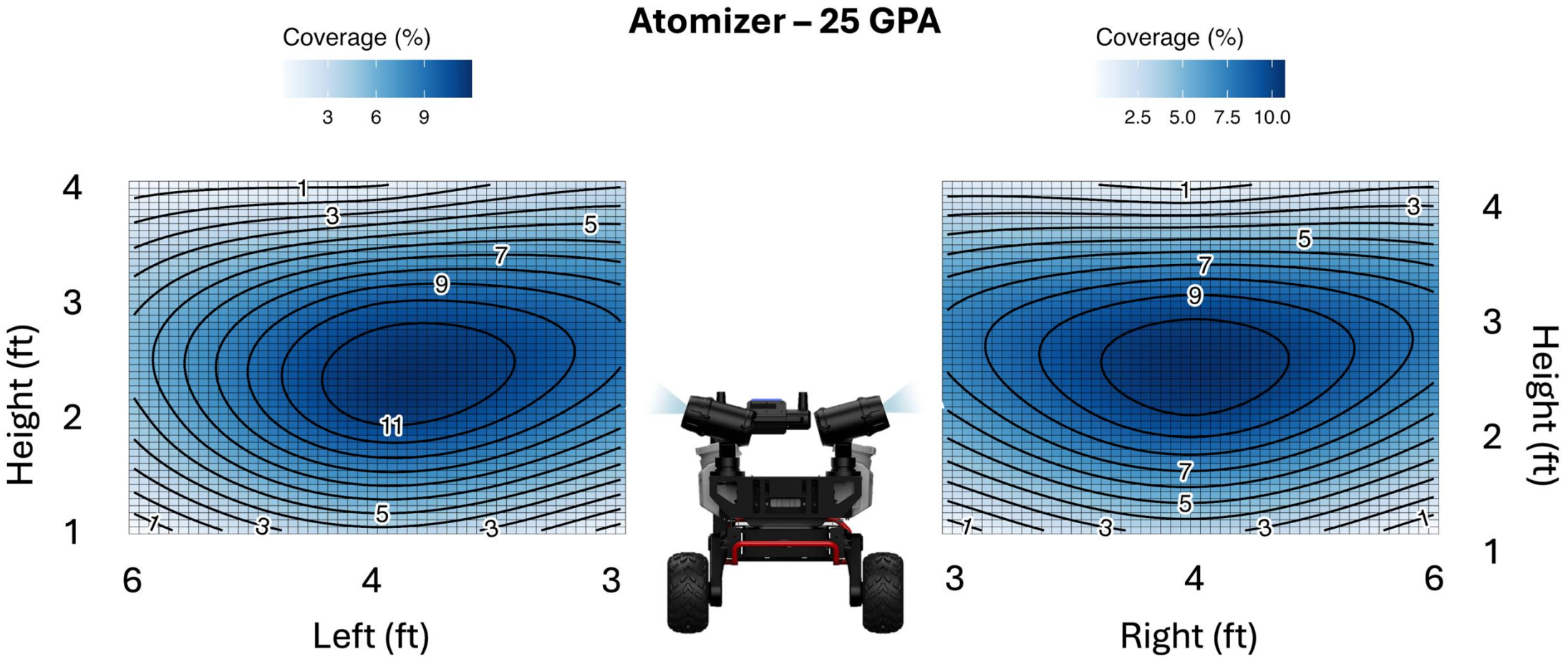
CM conference | CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Robot (mower)

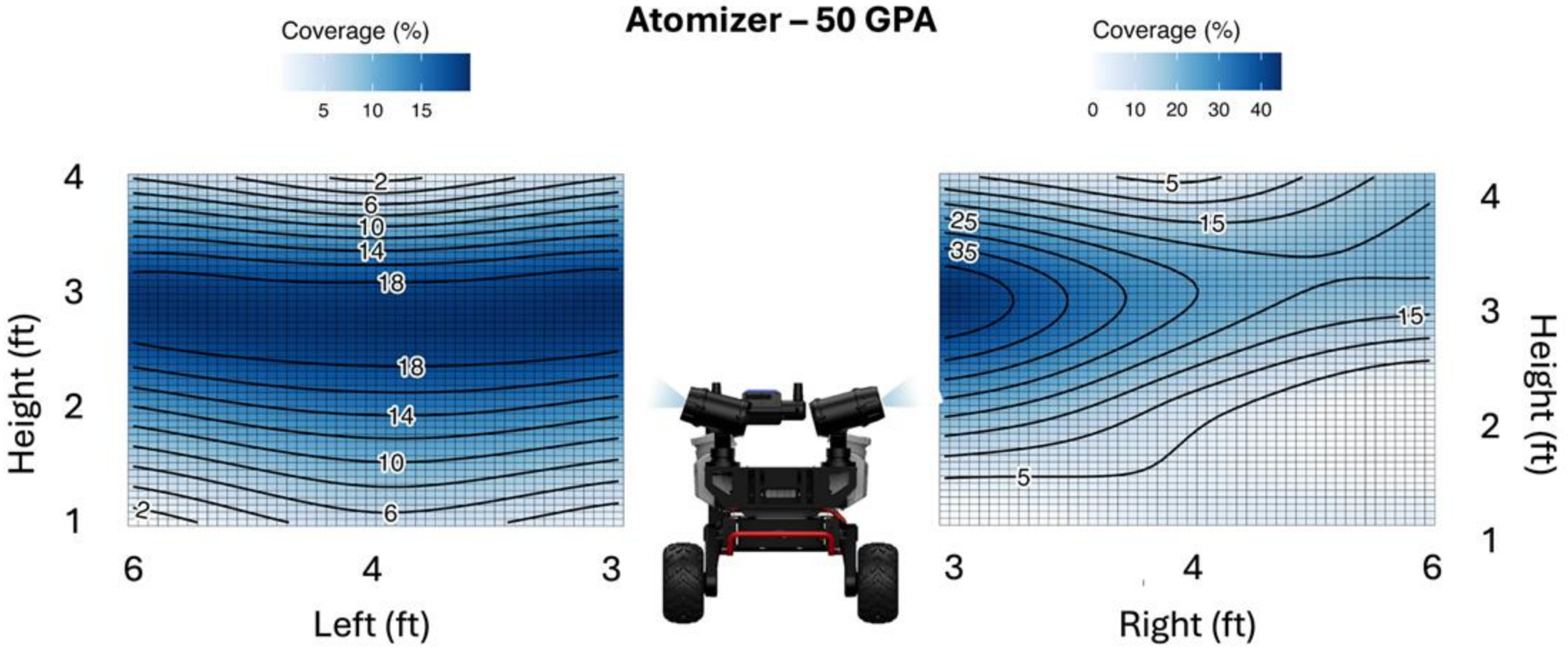
Robot (spray – bar system)

Robot (spray - atomizer)

Integrating Cutting-Edge Technologies for Crop Monitoring and Management



Integrating Cutting-Edge Technologies for Crop Monitoring and Management

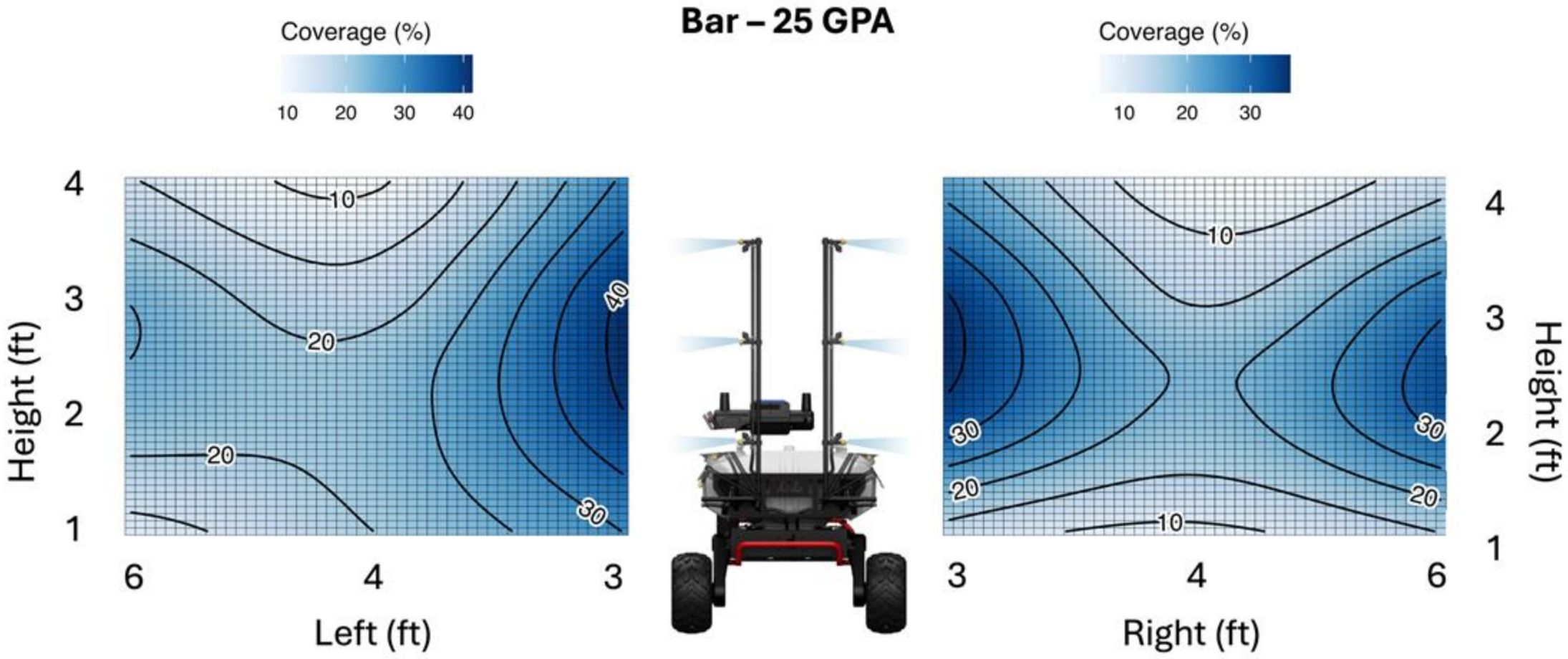


Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE

DECEMBER 9–10, 2025



Integrating Cutting-Edge Technologies for Crop Monitoring and Management

Integrating Cutting-Edge Technologies for Crop Monitoring and Management

Robot (spot spray)

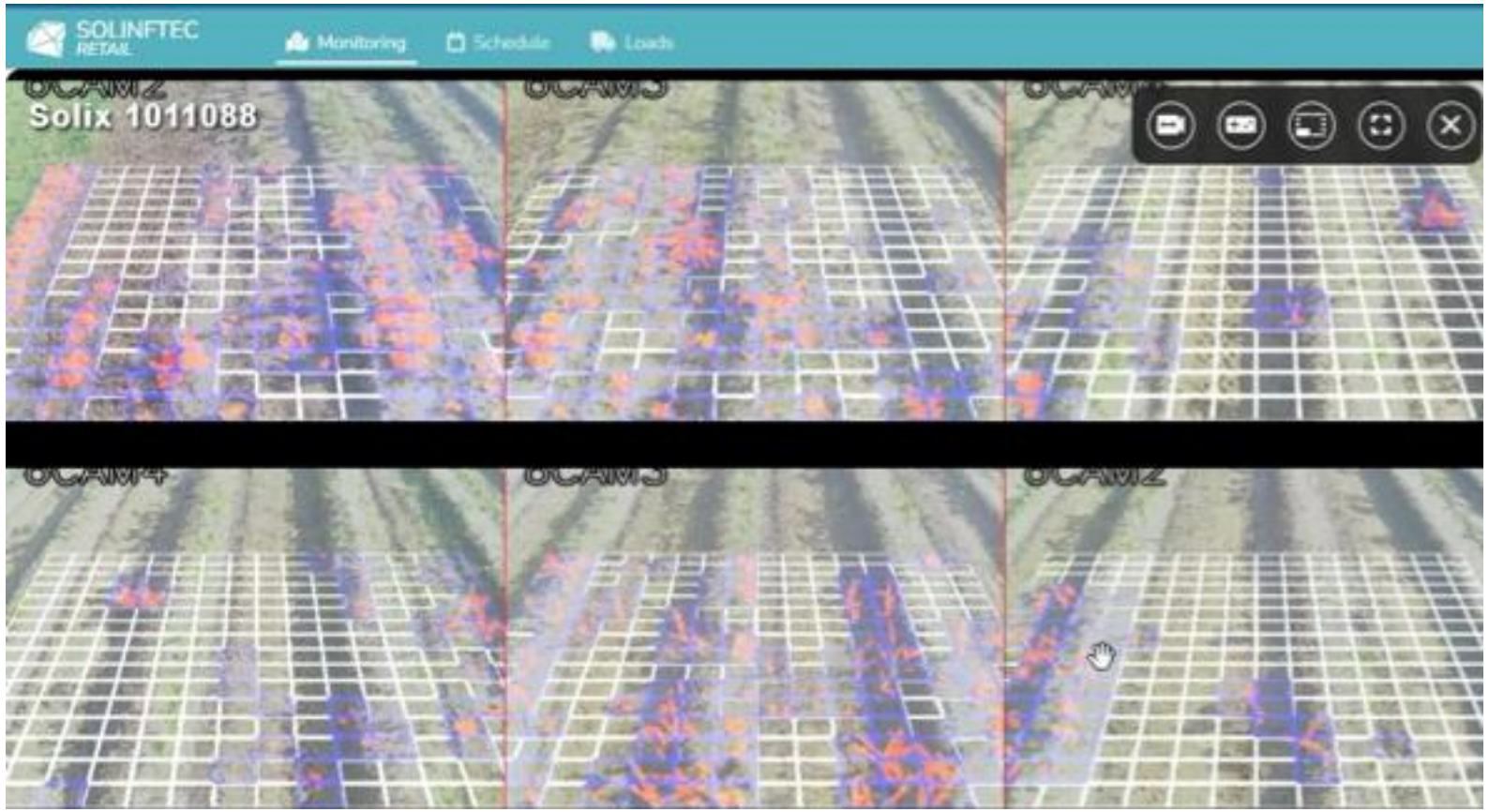
Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Robot (spot spray)

Robot (vision system – data collection)



Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

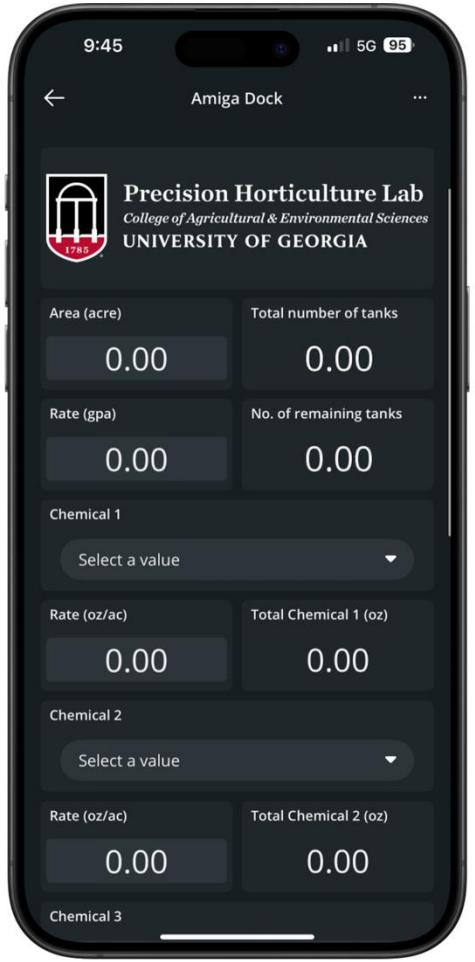
Designing and Implementing a Ground-Based Robotic System to Support Spraying Drone Operations: A Step Toward Collaborative Robotics

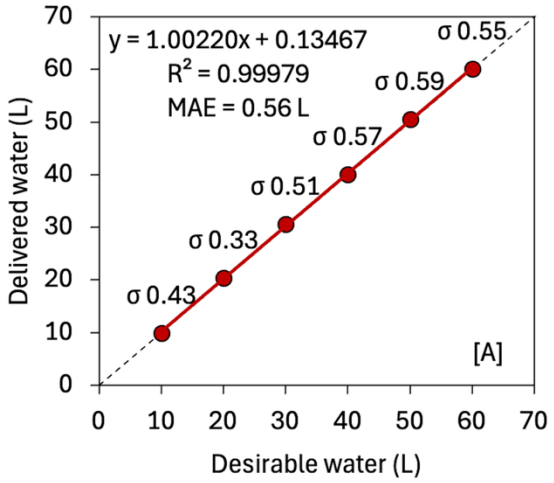
Integrating Cutting-Edge Technologies for Crop Monitoring and Management

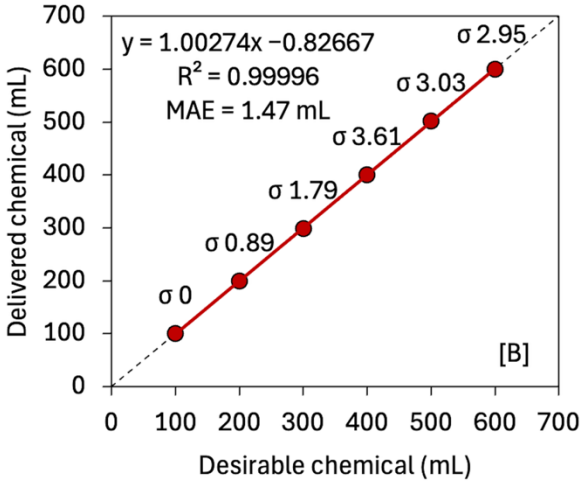
CM conference

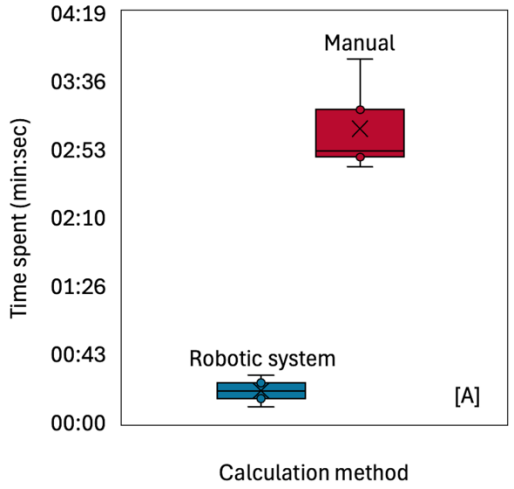
CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

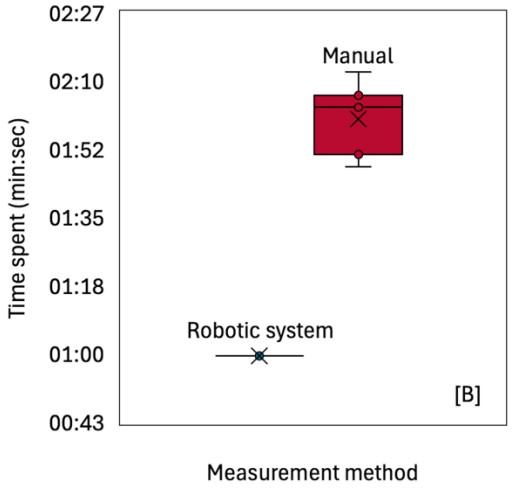
Designing and Implementing a Ground-Based Robotic System to Support Spraying Drone Operations: A Step Toward Collaborative Robotics











Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference

CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

ARA Field Sprayer: AI-powered spot spray

Integrating Cutting-Edge Technologies for Crop Monitoring and Management

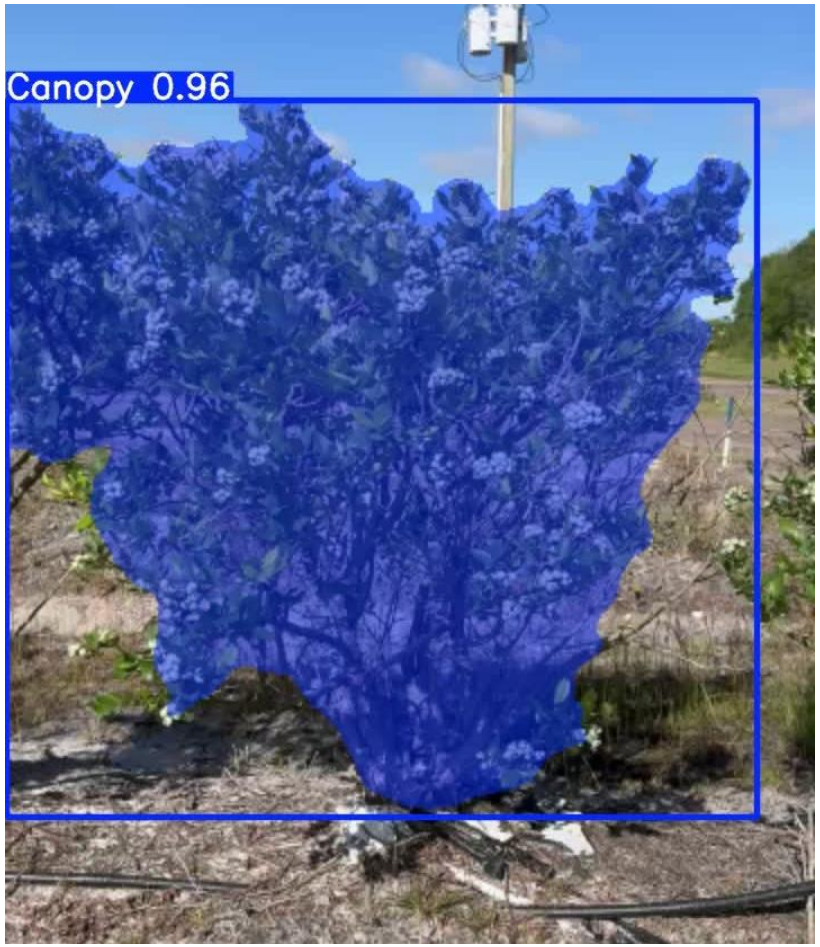
CM conference | CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Microwave system mounted on a robotic platform for nematode control

Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference
CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Blueberry plant and fruit monitoring using machine vision and robotic system



Integrating Cutting-Edge Technologies for Crop Monitoring and Management

CM conference
CROP MANAGEMENT CONFERENCE
DECEMBER 9–10, 2025

Spraying drone

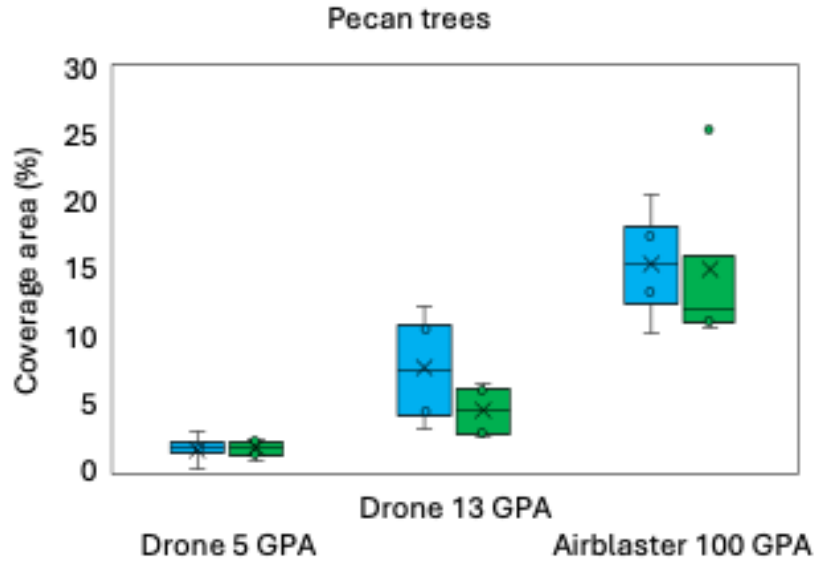
Conventional spraying system

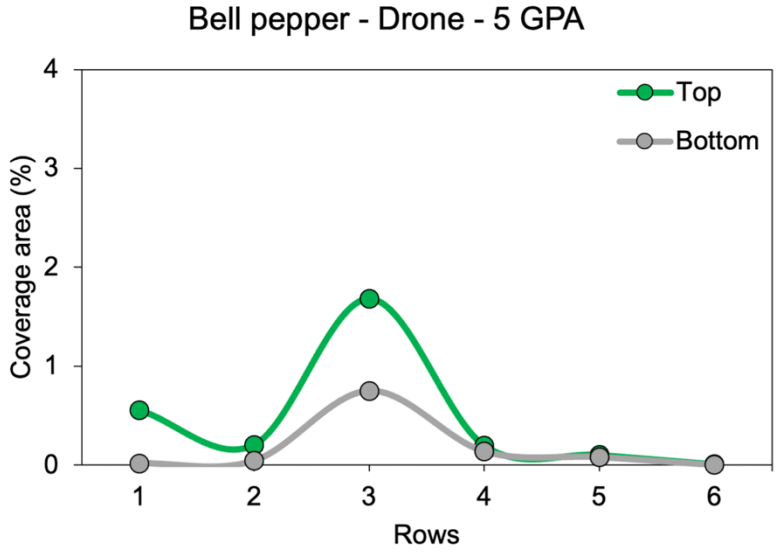
Integrating Cutting-Edge Technologies for Crop Monitoring and Management

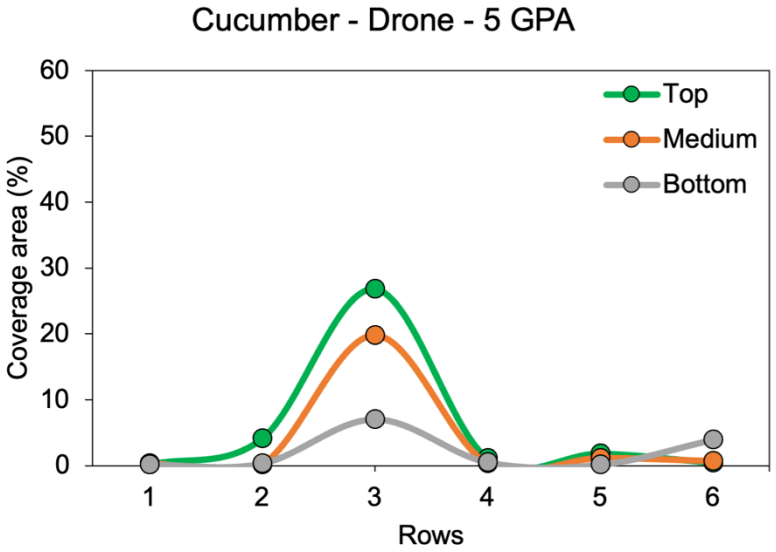
CM conference

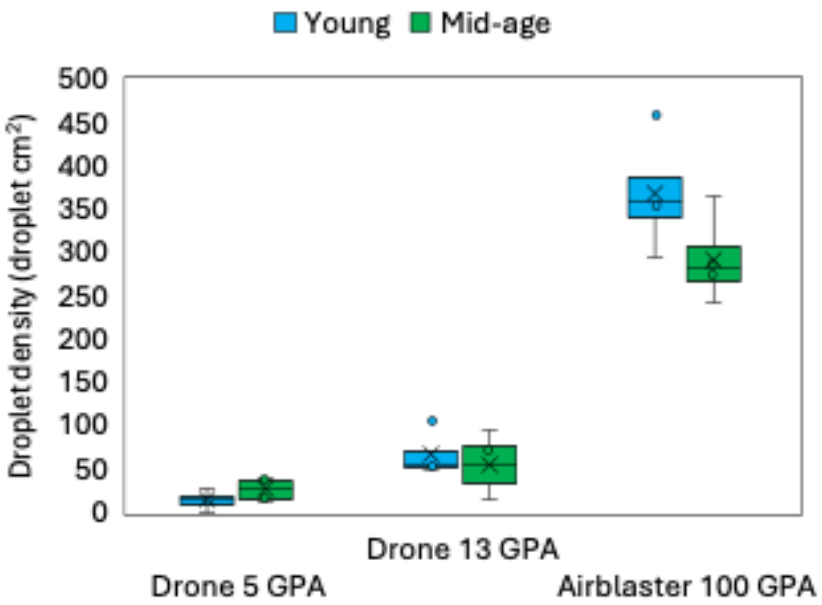
CROP MANAGEMENT CONFERENCE

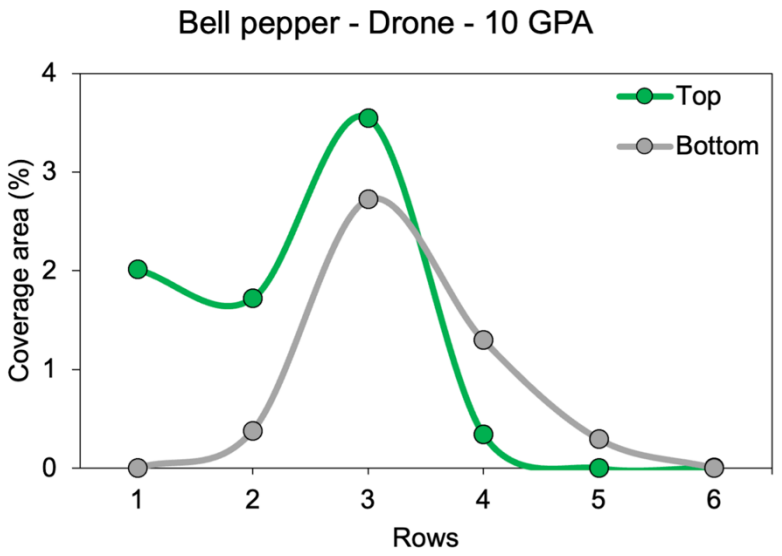
DECEMBER 9–10, 2025

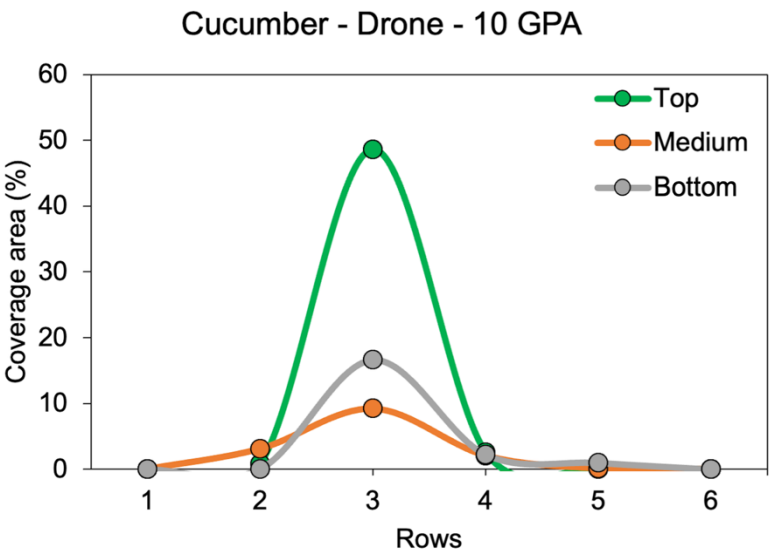








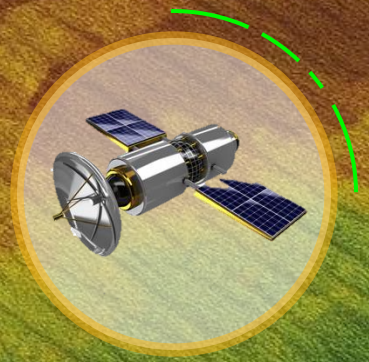


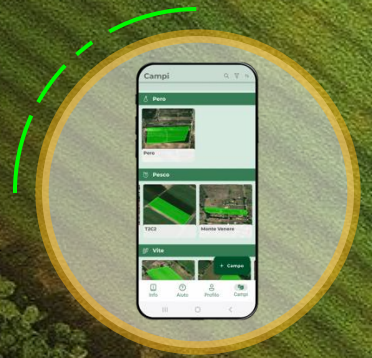


CROP MANAGEMENT CONFERENCE

DECEMBER 9–10, 2025

Questions?





Marcelo Barbosa
Post-Doctoral Associate
marcelojragro@gmail.com
University of Georgia