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AI-Enhanced Early Detection of Spider Mites

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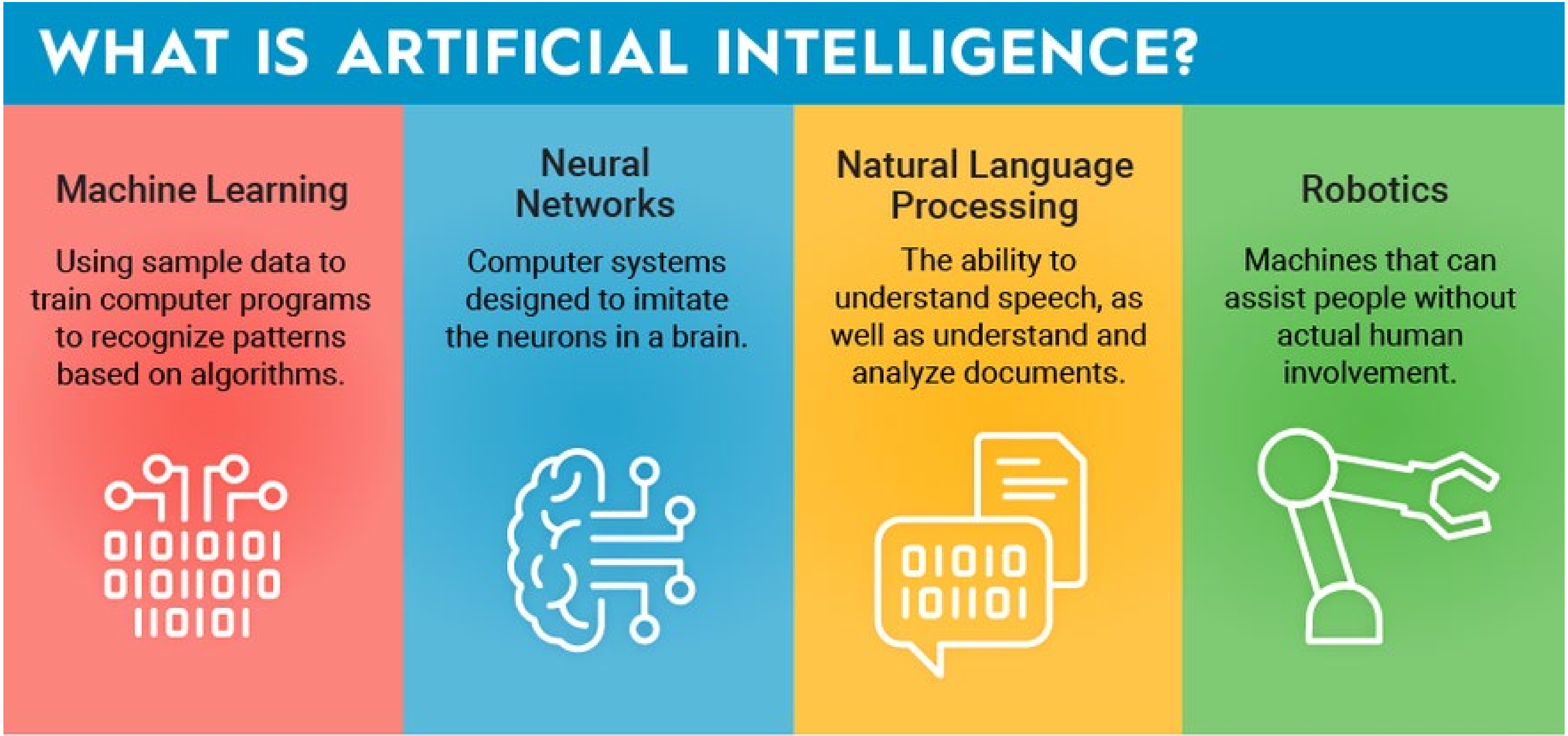
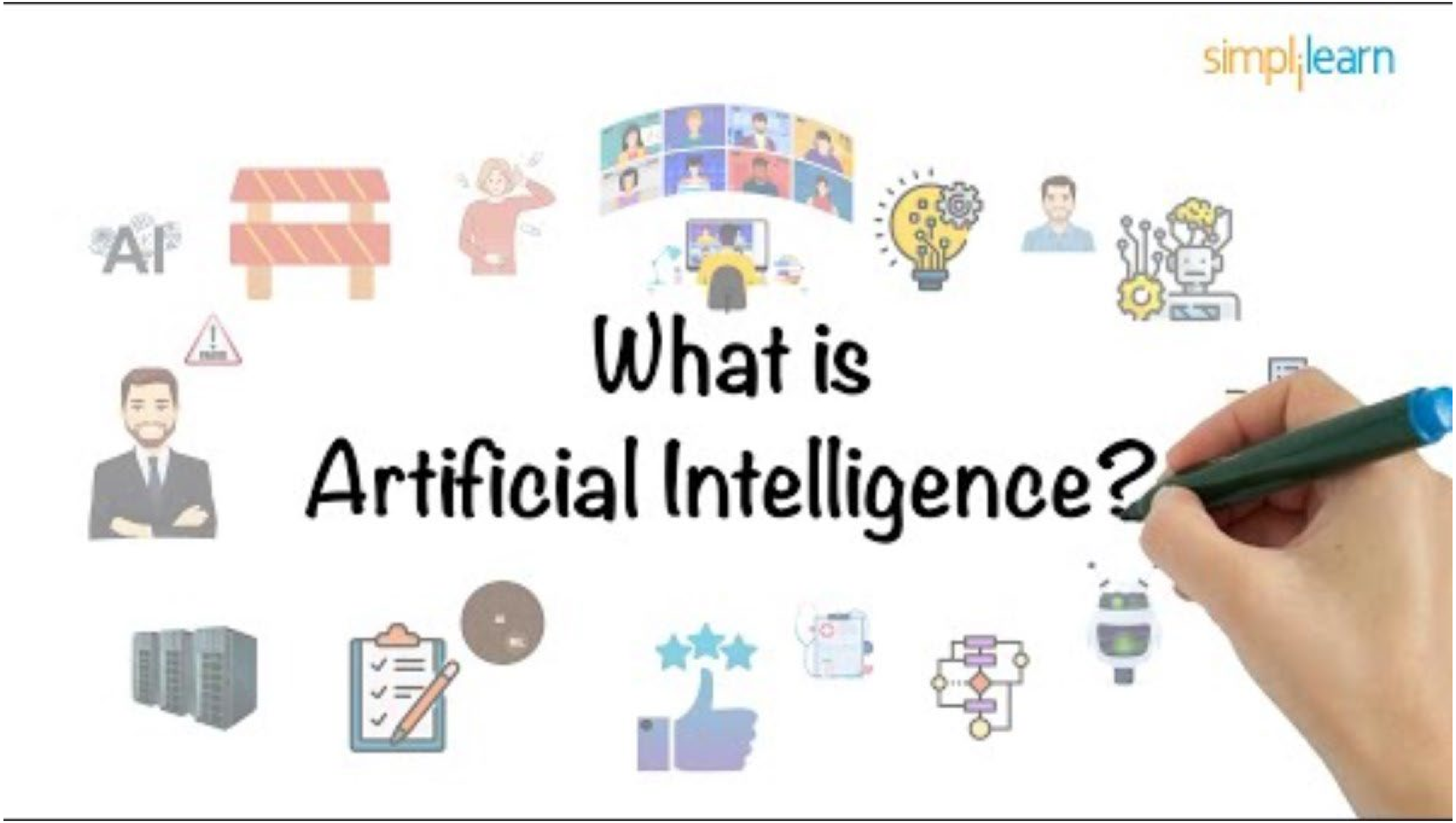


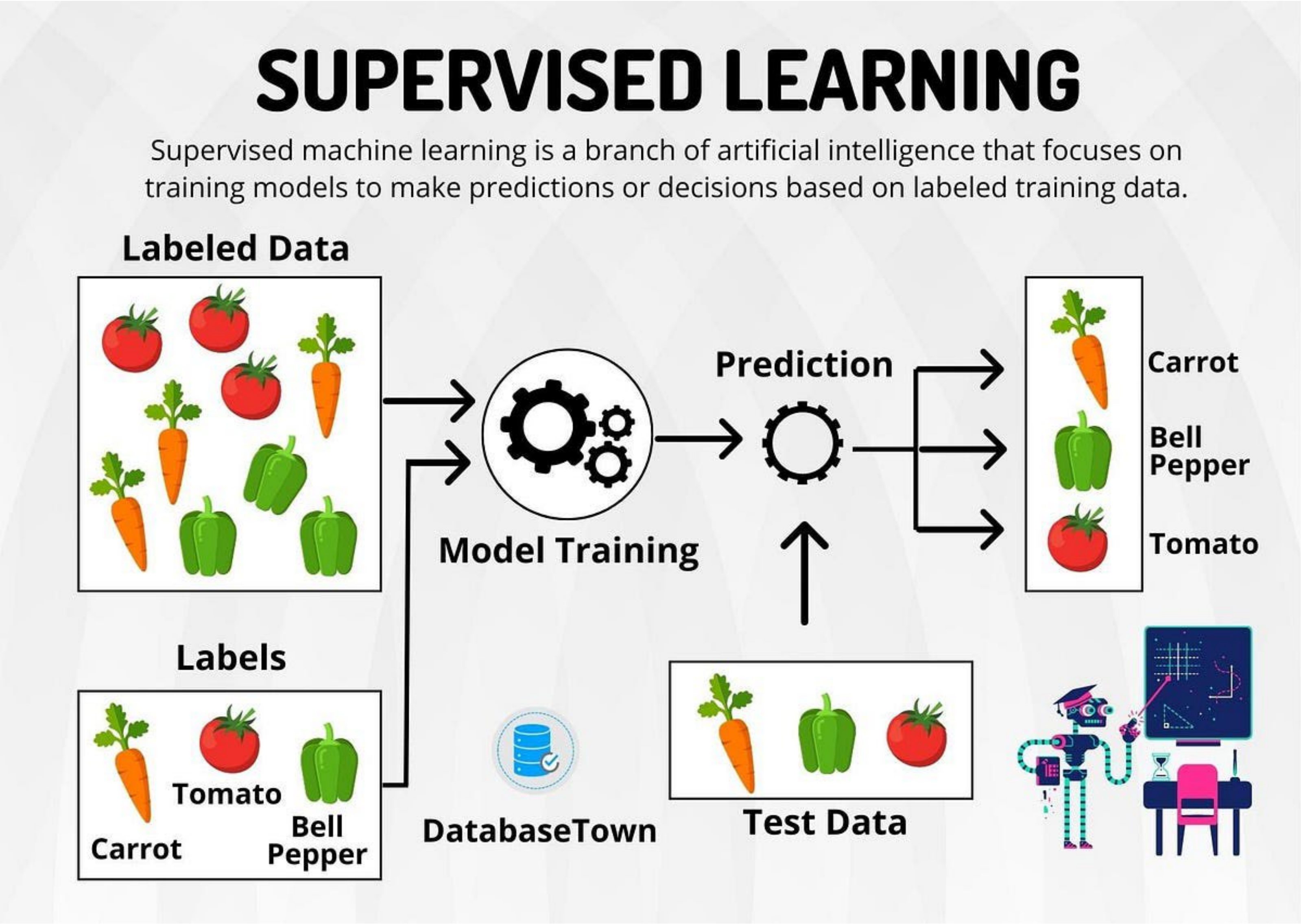
The Motley Fool



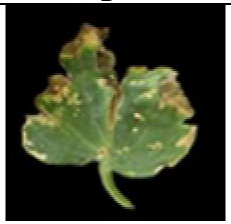
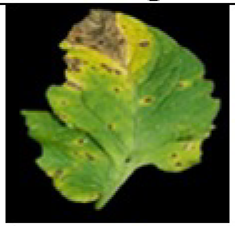
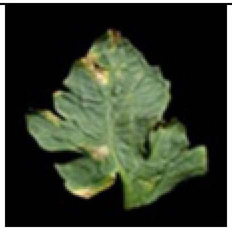
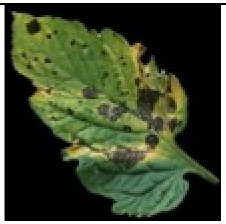
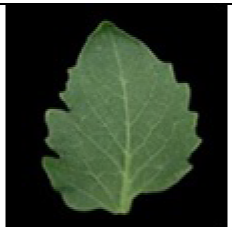
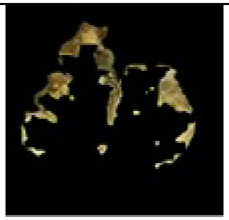
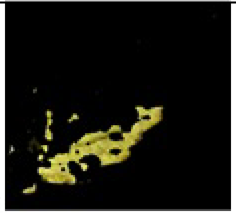
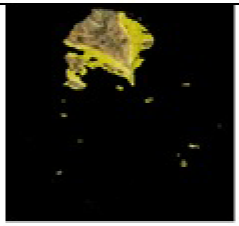
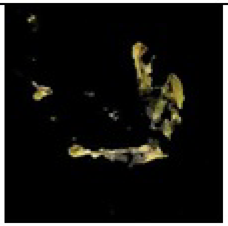
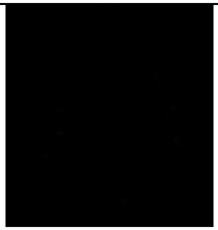
https://www.youtube.com/watch?v=uMzUB89uSxU

AI-enhanced Disease Classification: Symptom Based

Supervised Machine Learning



Tomato Leaf Diseases Classification using Weighted Ensemble Learning

Disease Name	Bacterial Spot	Late Blight	Leaf Mold	Sectorial Leaf Spot	Target Spot	Early Blight	Healthy leaf
Removed Background							
Disease Segmented with *K*-Means Clustering							

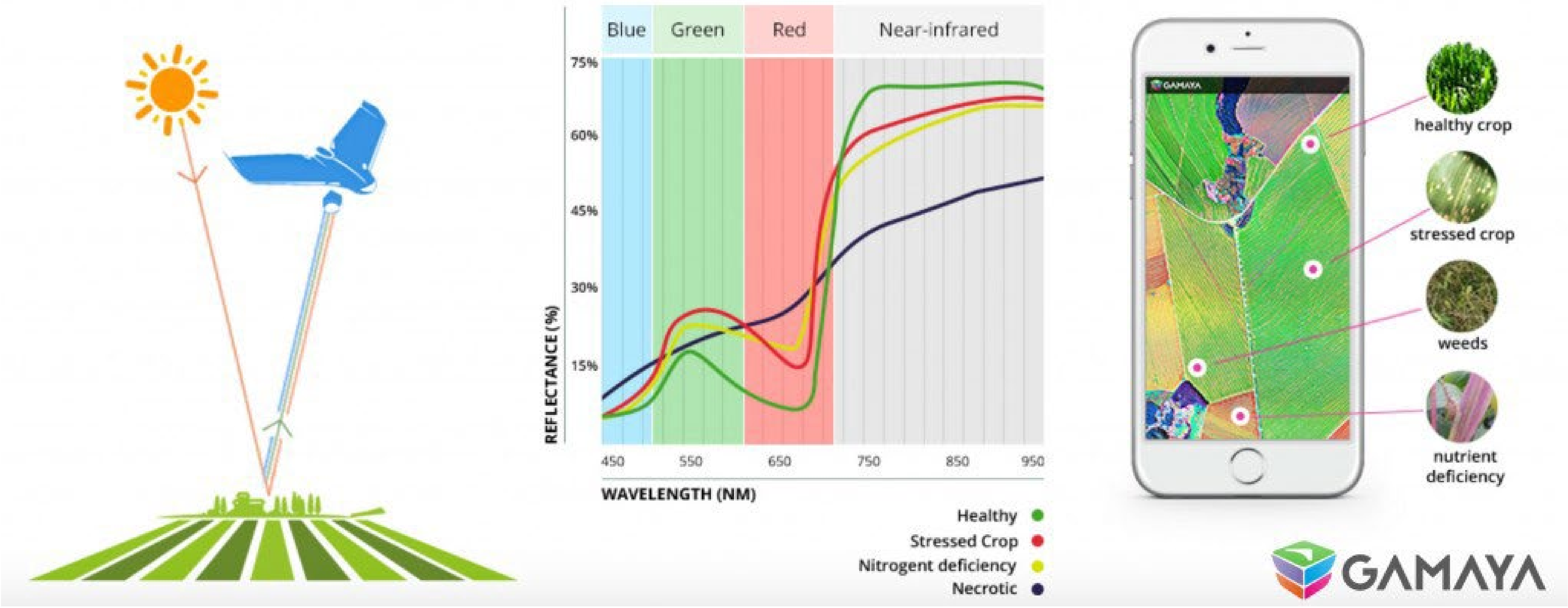
Row	Classifier	Accuracy with color features	Accuracy with textural features	Accuracy with shape features	Total Accuracy
1	Support Vector Machine (Linear)	0.5353	0.6753	0.6270	0.8981
2	Decision Tree	0.4758	0.7451	0.6735	0.7981
3	Random Forest	0.8191	0.9116	0.7949	0.9153
4	k-Nearest Neighbors	0.5274	0.5614	0.6437	0.8591
5	Naive Bayes	0.4665	0.4484	0.3921	0.4442
6	Discriminant Analysis	0.4451	0.5674	0.6735	0.8284
7	Simple Ensemble	0.8279	0.9186	0.7419	0.9349
8	**Weighted Vote Majority Ensemble**	**0.8535**	**0.9233**	**0.7744**	**0.9558**

AI-enhanced Disease Classification: Early Detection

Measure relectance of your crop using proprietary hyperspectral imaging camera mounted on drones or manned aircrafts

Analyze spectrum of reflected light and correlate it with crop and soil characteristics

Identify potential problems of your farmland (diseases, nutrient deficiencies, weeds, environmental stresses)



UAV-based Disease Detection utilizing Hyperspectral Imaging and AI

Laboratory spectral measurements of squash leaves using a benchtop hyperspectral imaging system.

UAV-based imaging data collection with a hyperspectral Resonon camera

- Abdulridha J., Ampatzidis Y., Roberts P., Kakarla S.C., 2020. Detecting powdery mildew disease in squash at different stages using UAV-based hyperspectral imaging and artificial intelligence. *Biosystems Engineering*, 135-148; doi.org/10.1016/j.biosystemseng.2020.07.001.

Early detection of tomato bacterial spot disease in transplant tomato seedlings utilising remote sensing and artificial intelligence

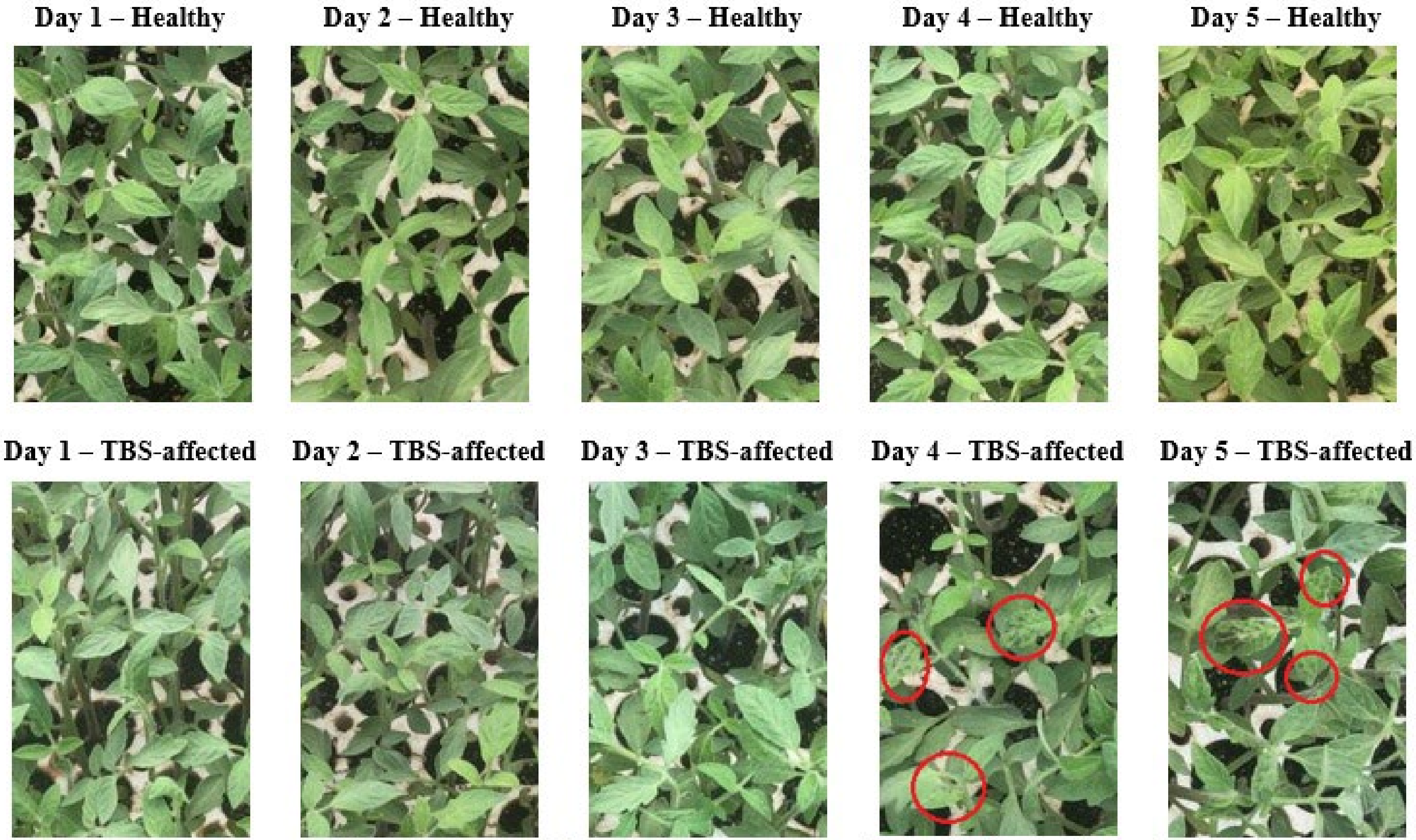


Fig. 1. Healthy and TBS-affected plants over a 5-day period after inoculation.

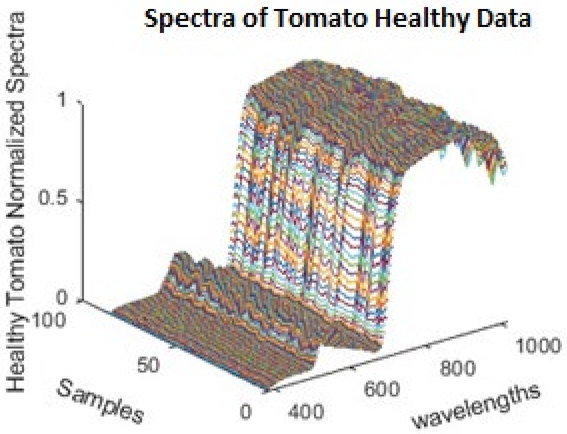
Early detection of tomato bacterial spot disease in transplant tomato seedlings utilising remote sensing and AI

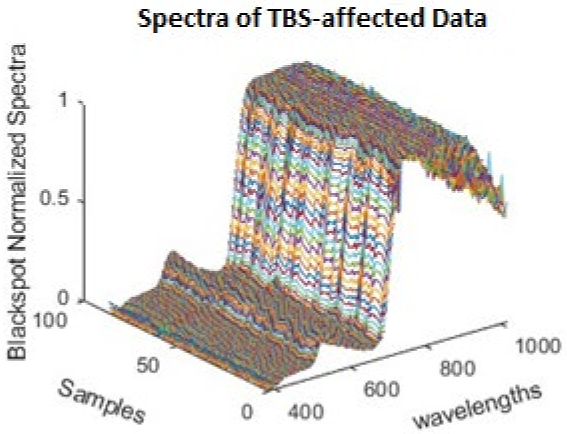
Partial Least Squares Discriminant Analysis (PLSDA)

Days	True Pos.	False Pos.	True Neg.	False Neg.	Precision	Recall	F1 Score
1	97	25	54	57	79 %	63 %	70%
2	125	33	82	85	79 %	60 %	68%
3	263	24	250	36	92 %	88 %	90%
4	136	10	135	8	93 %	94 %	93%
5	161	0	266	5	100 %	97 %	98%

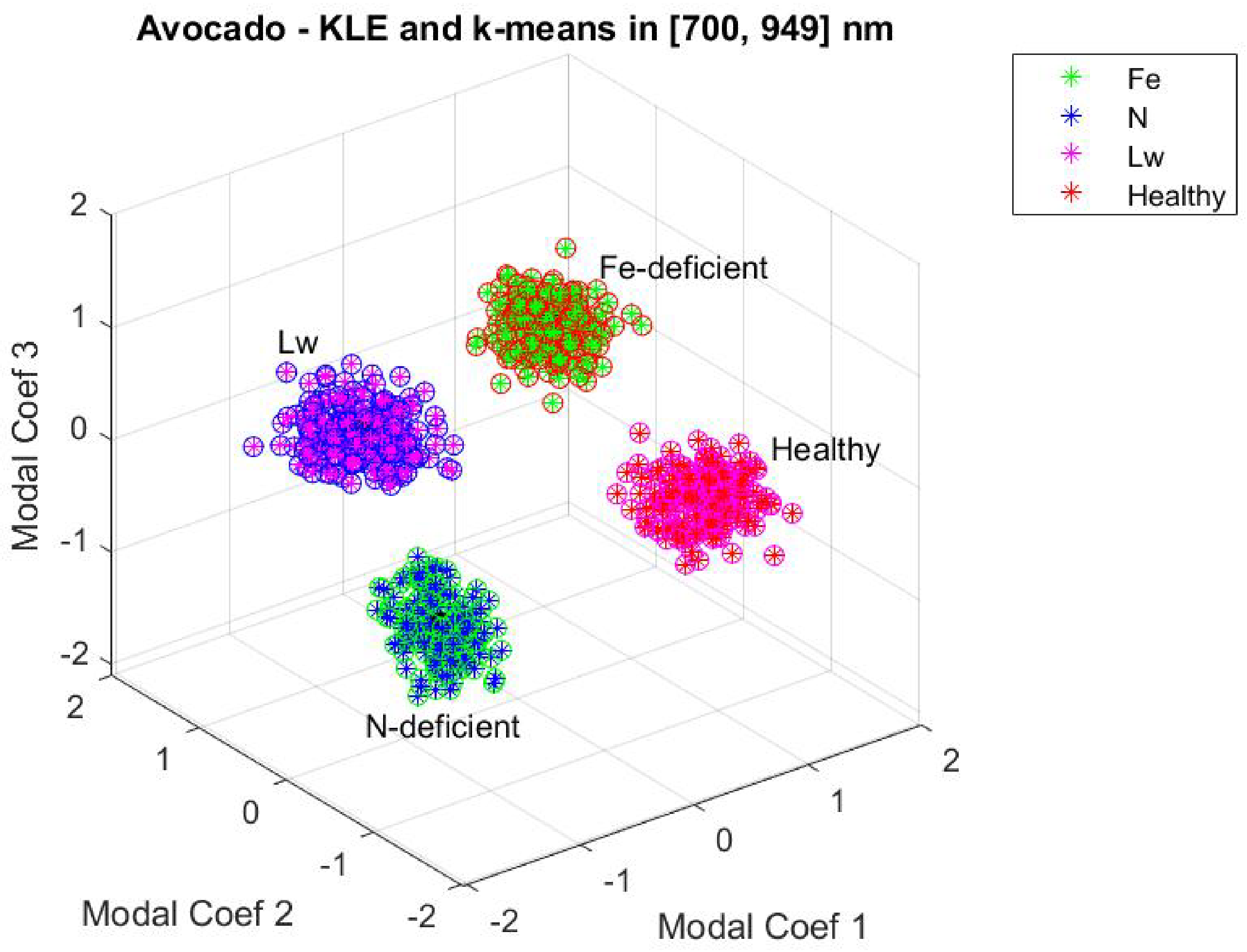
da Cunha V.G., A. Hariharan J., Ampatzidis Y., Roberts P., 2023. Early detection of tomato bacterial spot disease in transplant tomato seedlings utilizing remote sensing and artificial intelligence. Biosystems Engineering, 234, 172-186, https://doi.org/10.1016/j.biosystemseng.2023.09.002

Normalized reflectance signature of the healthy and diseased plants



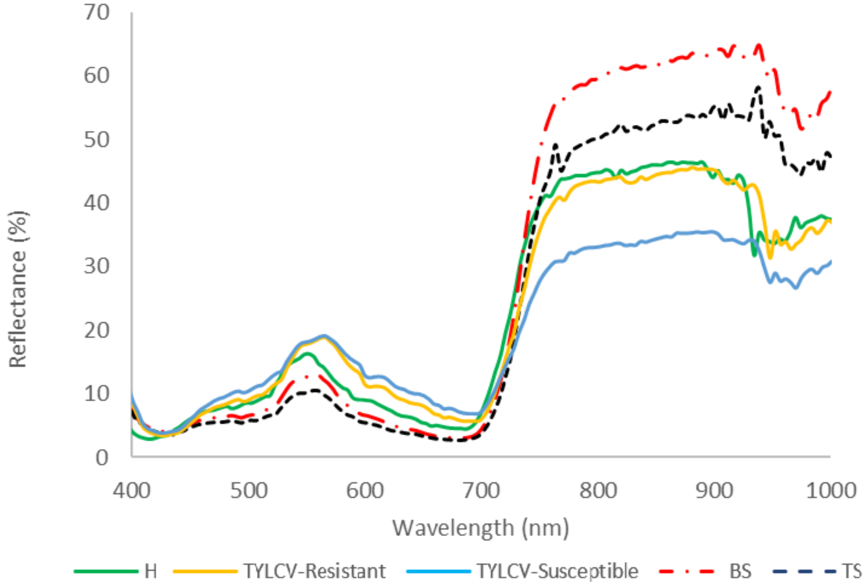


Applied KLE for 3-dimensional characterization of four avocado signatures

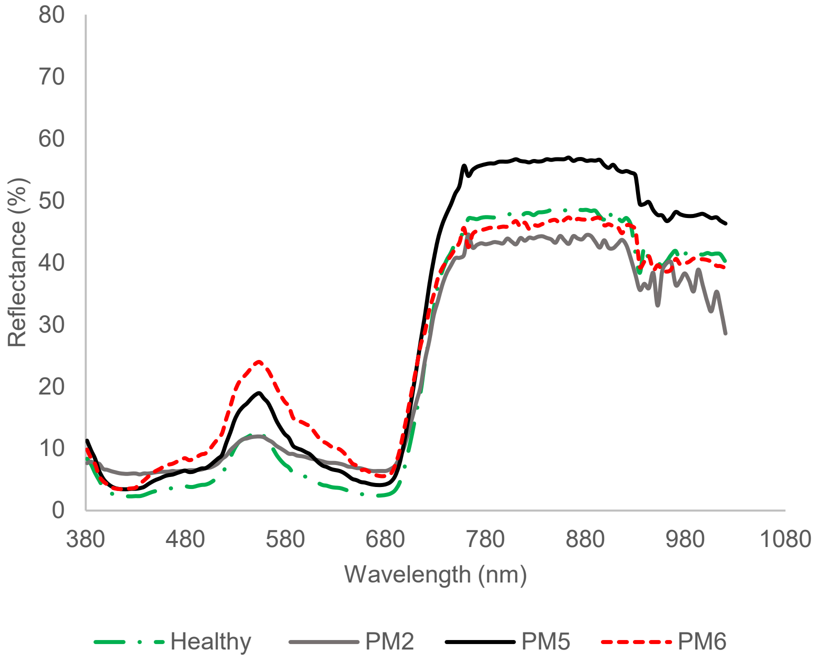


Hariharan J., Fuller J., Ampatzidis Y., Abdulridha J., Lerwill A., 2019. Finite difference analysis and bivariate correlation of hyperspectral data for detecting Laurel wilt disease and nutritional deficiency in avocado. *Remote Sens.* 2019, *11*(15), 1748; https://doi.org/10.3390/rs11151748.

UAV-based Disease Detection utilizing Hyperspectral Imaging and AI



Spectral reflectance signatures of *Tomato yellow leaf curl virus* (TYLCV, on susceptible and resistant tomato varieties), Bacterial Spot (BS), and Target Spot (TS) infected tomato plants.

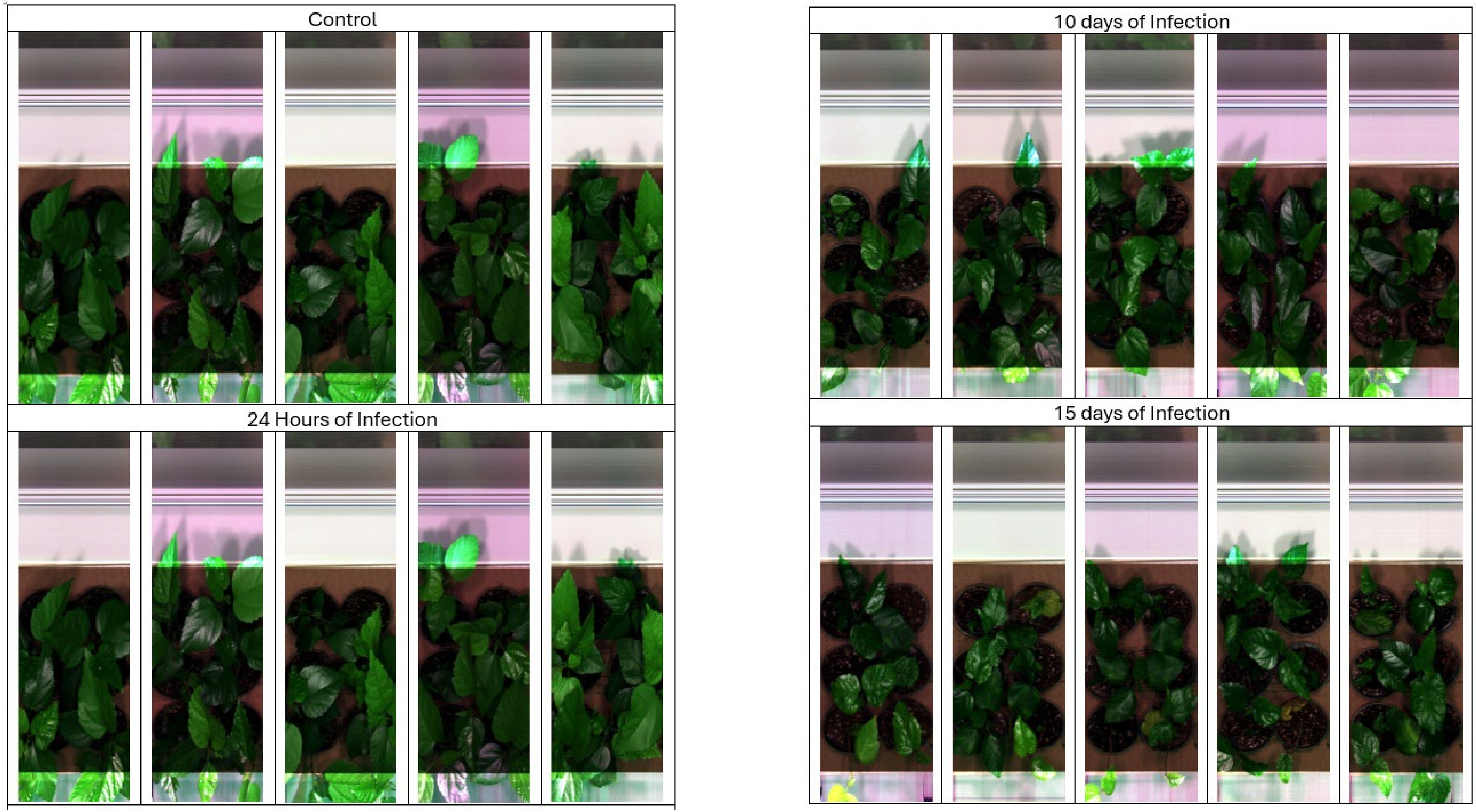


Spectral reflectance signatures of healthy squash plants and Powdery Mildew (PM) infected plants in different disease development stages (asymptomatic, early and late stages).

- Abdulridha J., Ampatzidis Y., Roberts P., Kakarla S.C., 2020. Detecting powdery mildew disease in squash at different stages using UAV-based hyperspectral imaging and artificial intelligence. *Biosystems Engineering*, 135-148; doi.org/10.1016/j.biosystemseng.2020.07.001.
- Abdulridha J., Ampatzidis Y., Kakarla S.C., Roberts P., 2019. Detection of target spot and bacterial spot diseases in tomato using UAV-based and benchtop-based hyperspectral imaging techniques. *Precision Agriculture,* (November) 1-24.

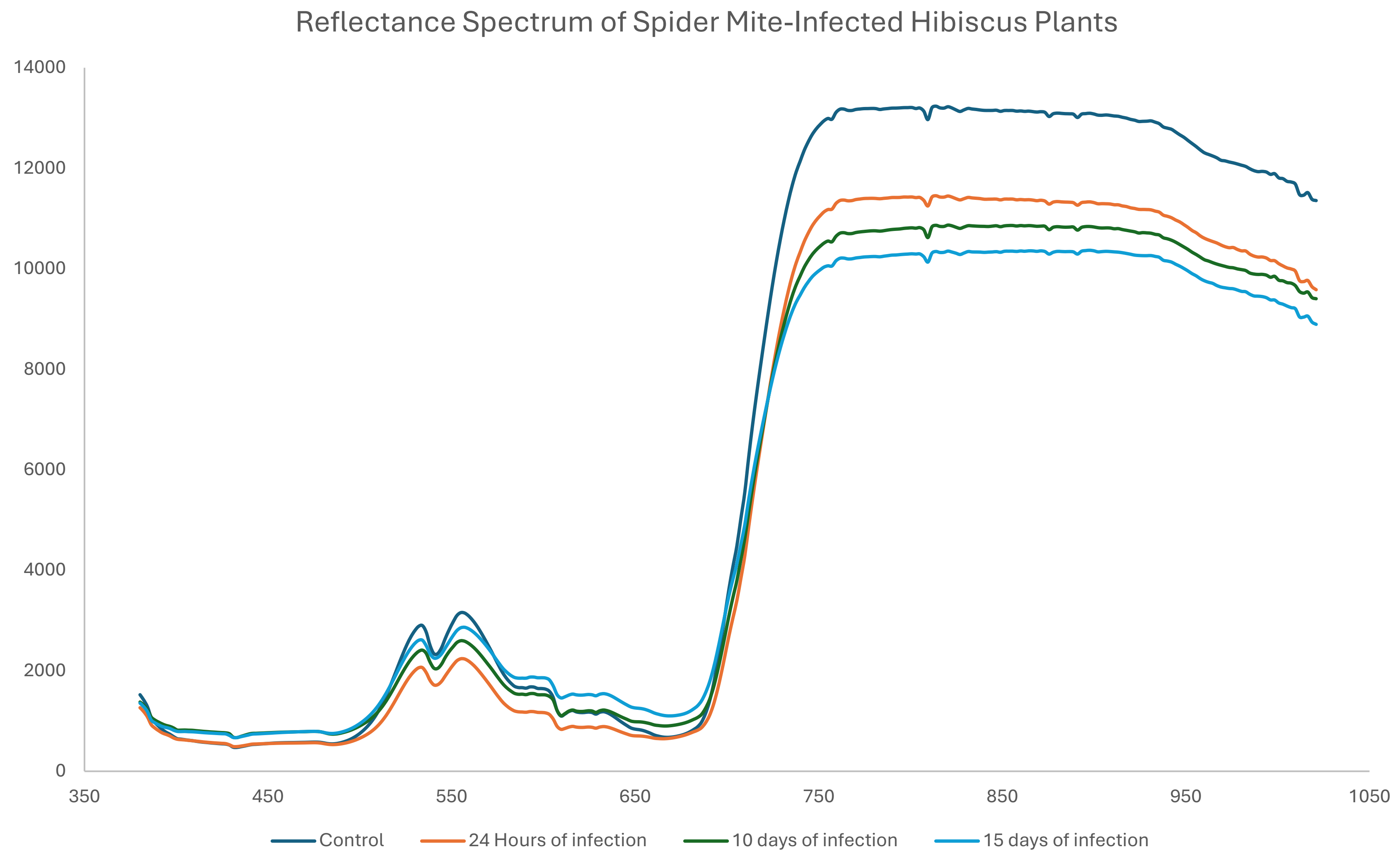
AI-enhanced Sustainable Management of Spider Mites

Florida Specialty Crop Block Grant Program



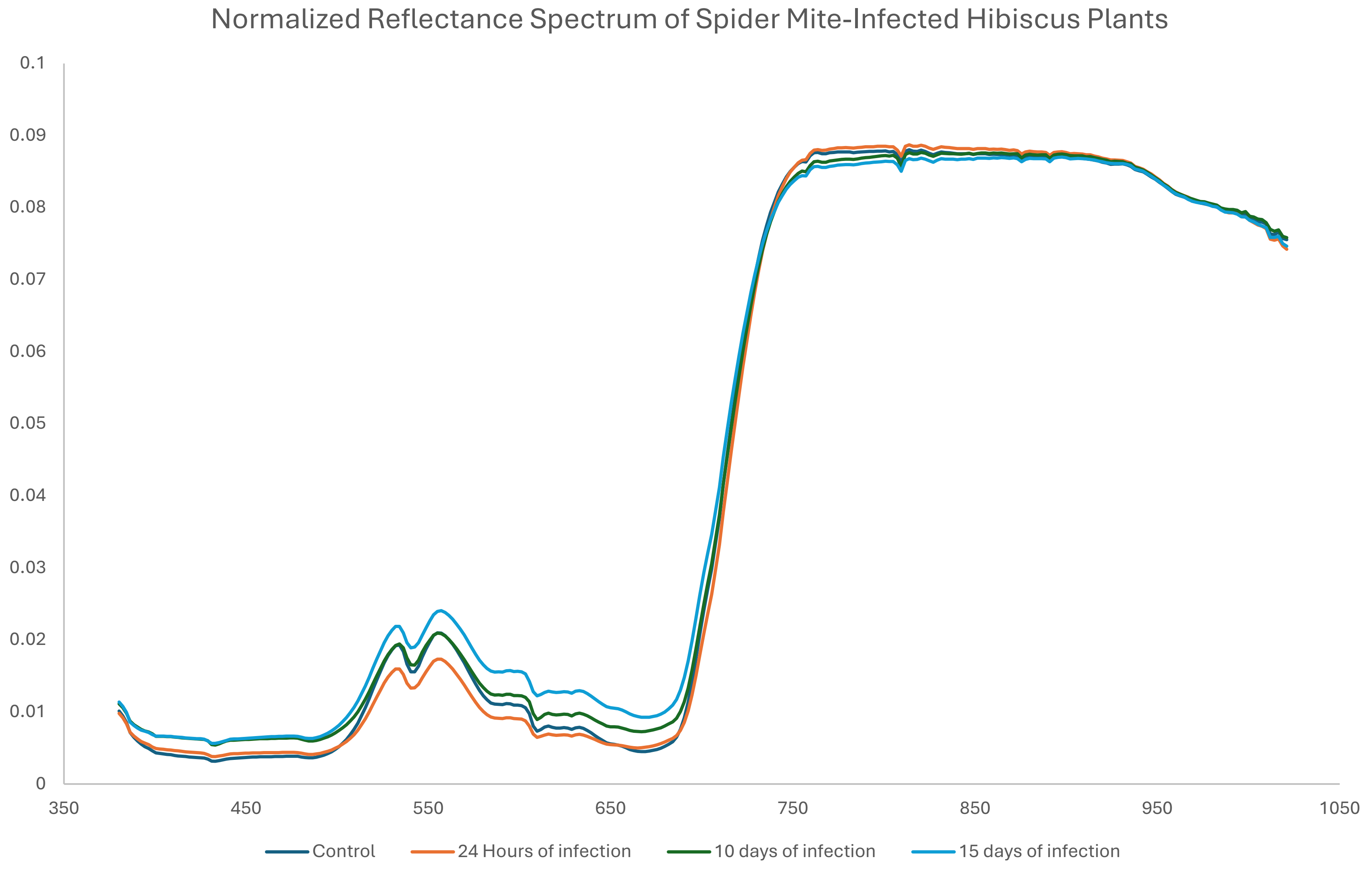
AI-enhanced Sustainable Management of Spider Mites

Florida Specialty Crop Block Grant Program



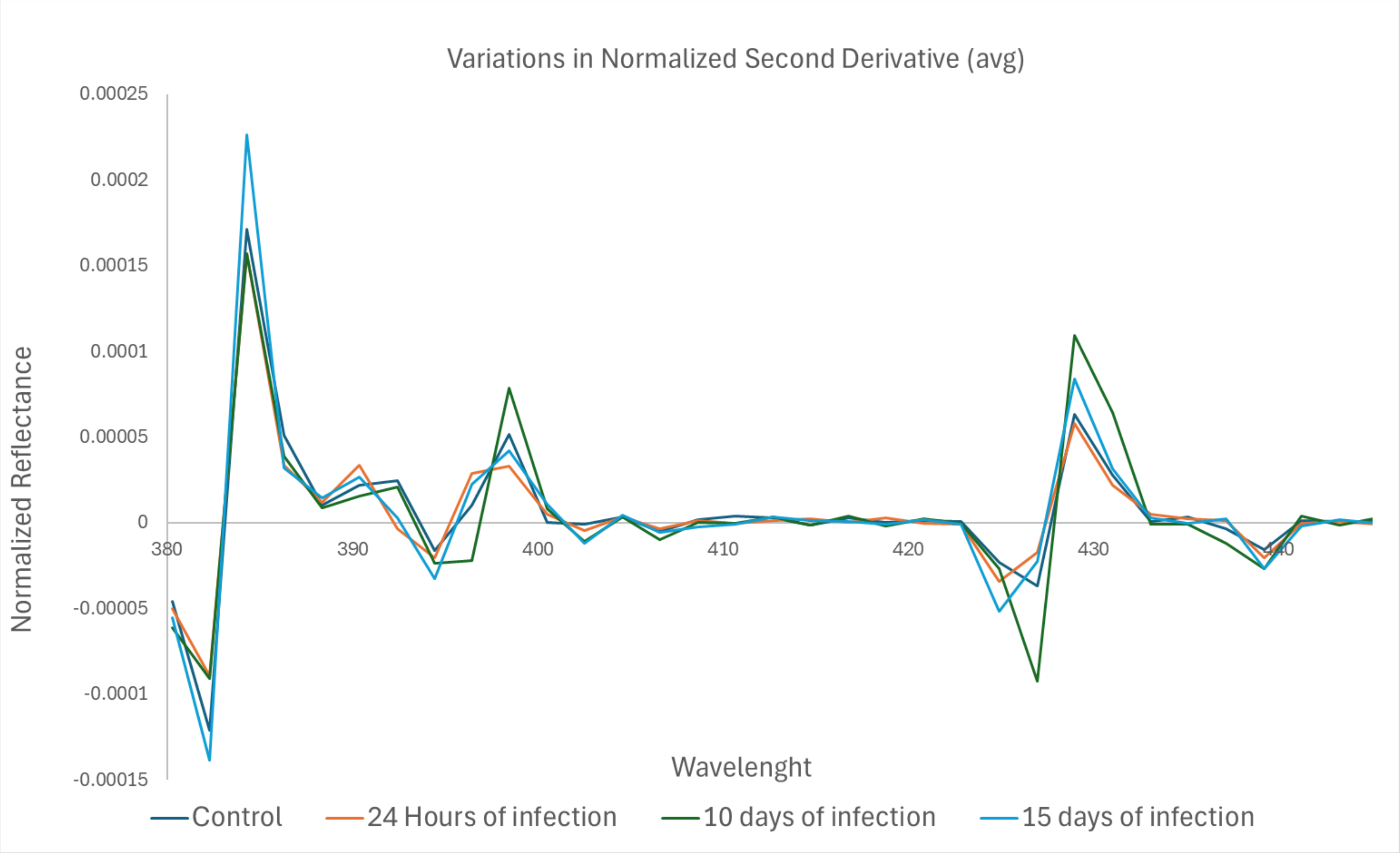
AI-enhanced Sustainable Management of Spider Mites

Florida Specialty Crop Block Grant Program



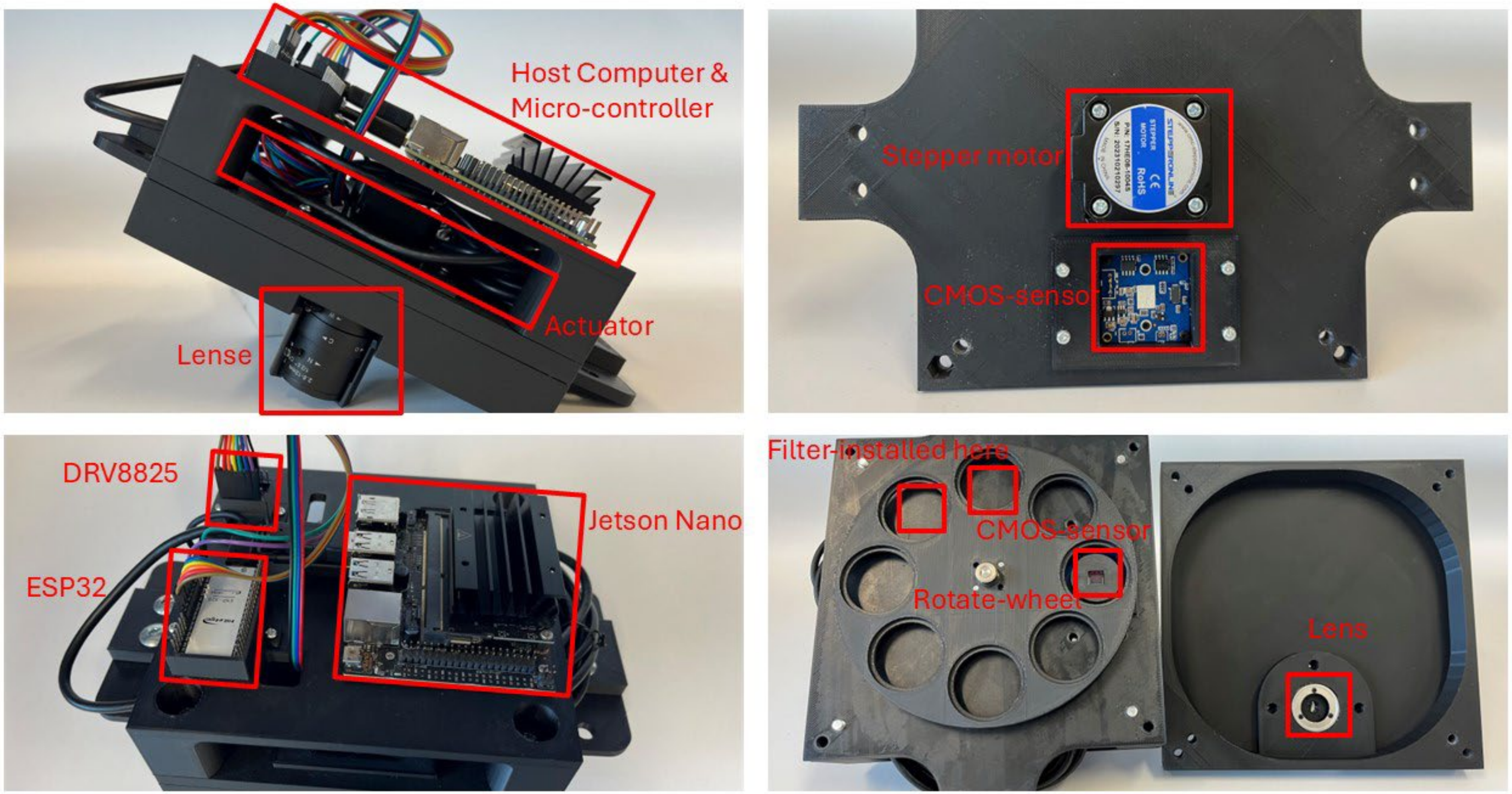
AI-enhanced Sustainable Management of Spider Mites

Florida Specialty Crop Block Grant Program



Low-cost multispectral camera for early pest and disease detection

Filter Wheel Multispectral Camera



AGROVIEW

FAST

2-3 Days vs 12 Weeks

ACCURATE

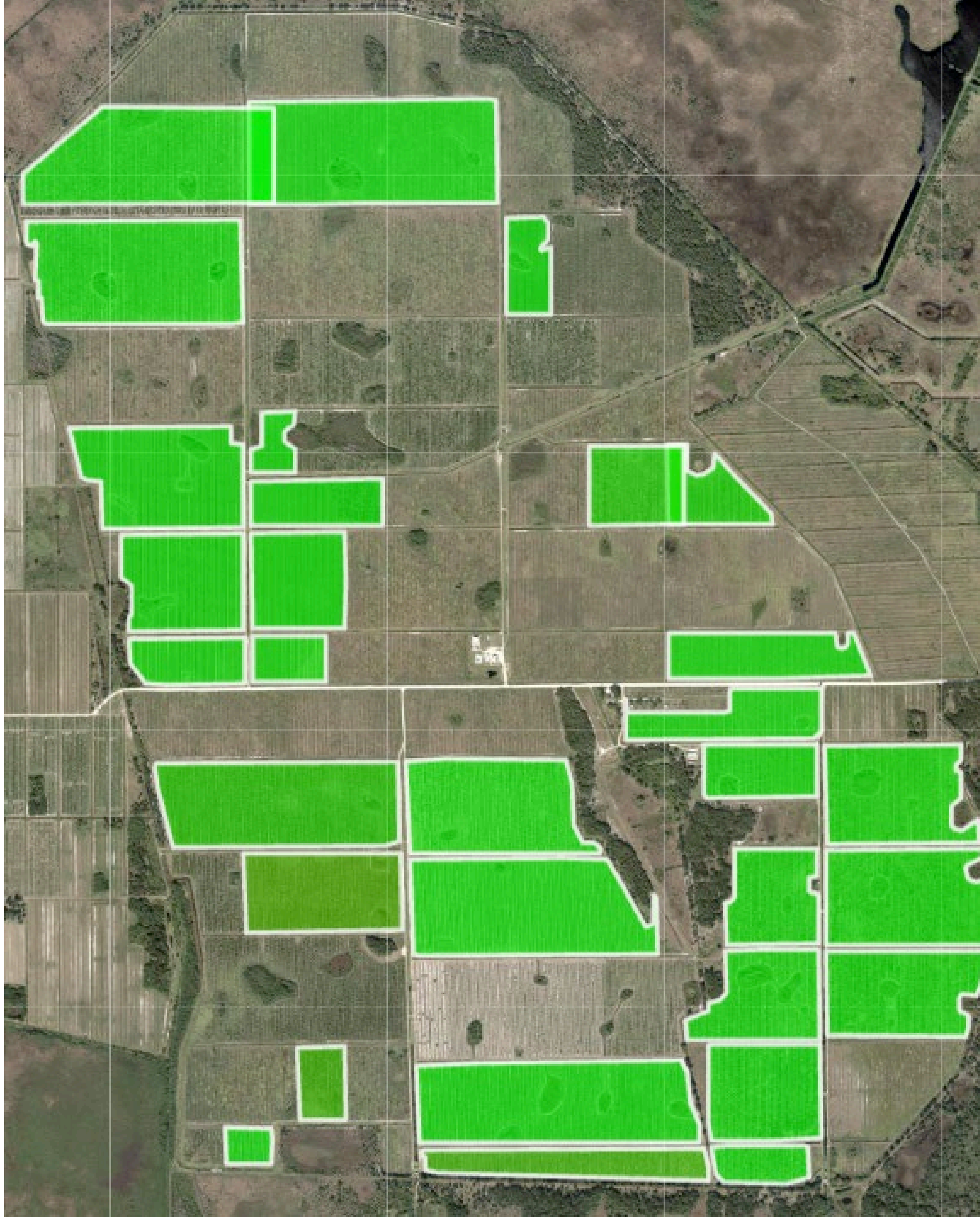
95+% vs. <70%

COST EFFECTIVE

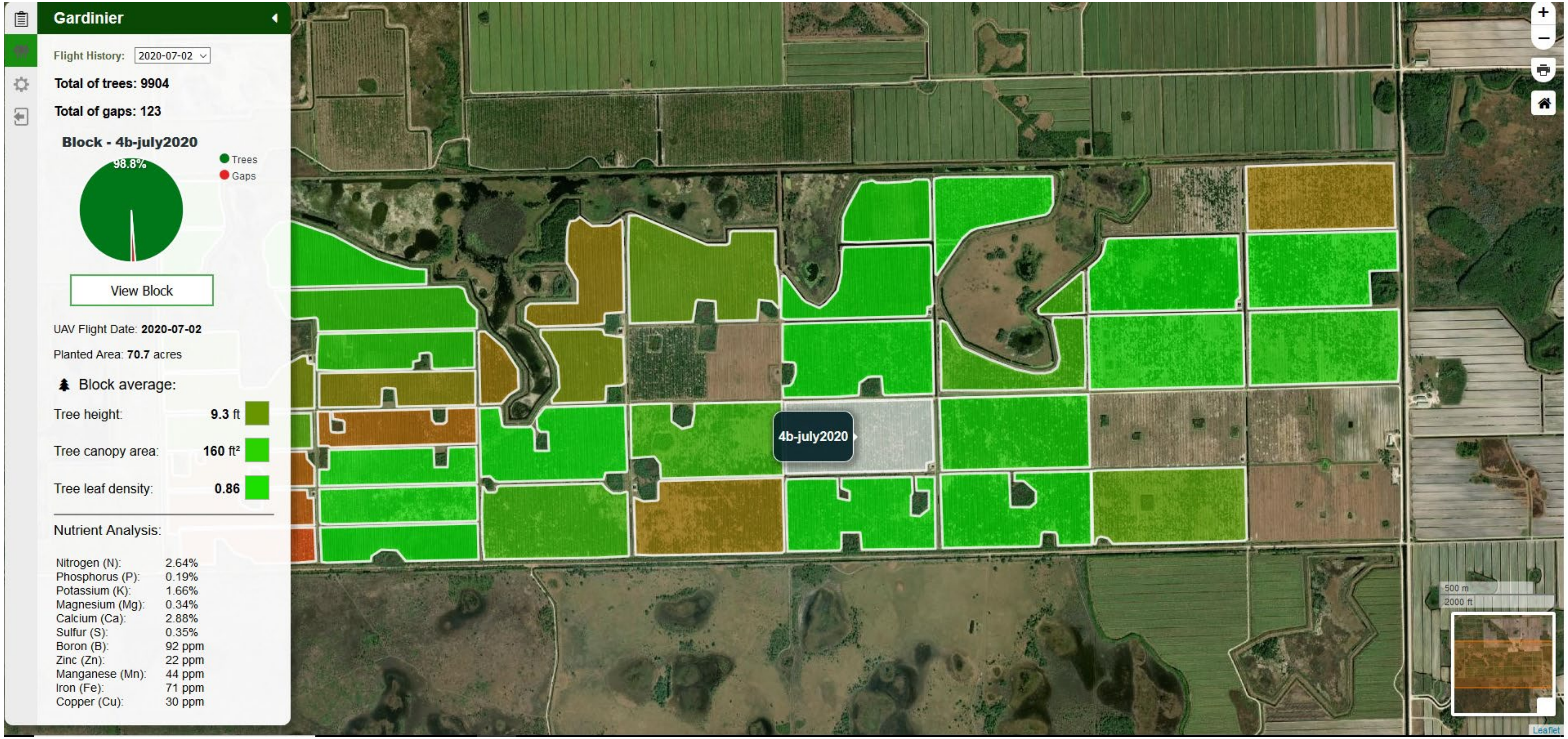
$8/ac vs $15/ac

FULL FIELD

Every Tree, Not Sampled

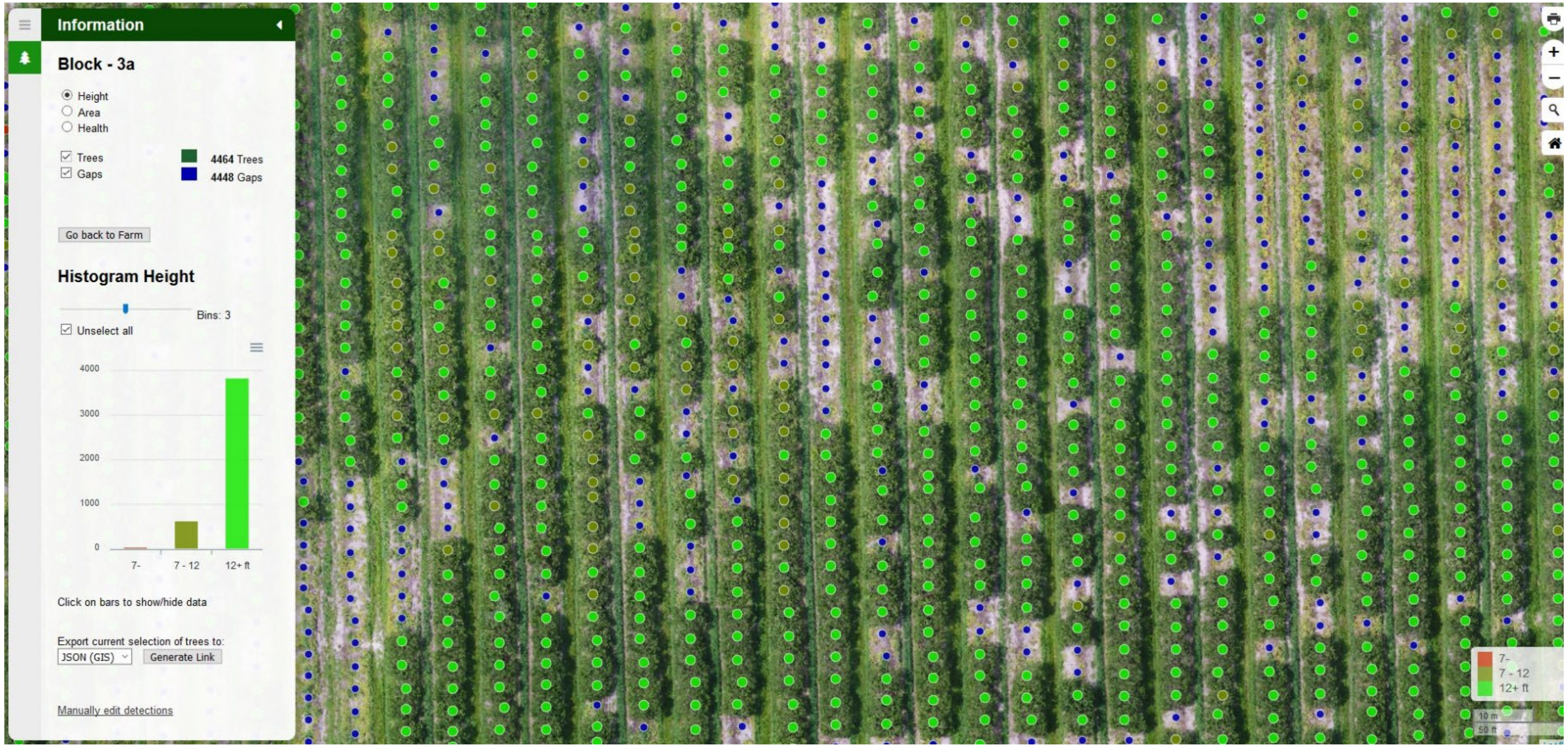


Agroview – farm analytics



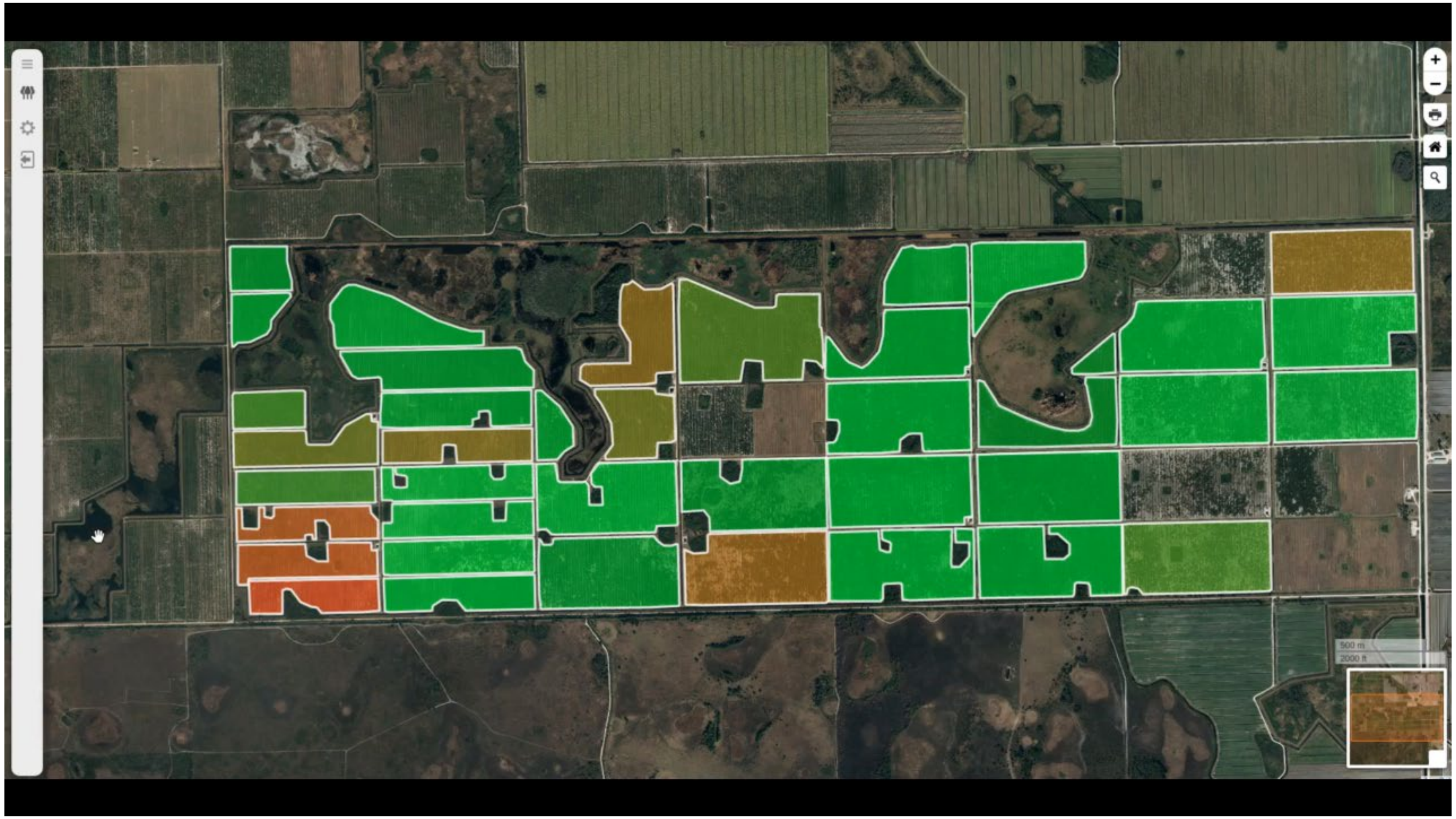
- Ampatzidis Y., Partel V., Costa L., 2020. Agroview: Cloud-based application to process, analyze and visualize UAV-collected data for precision agriculture applications utilizing artificial intelligence. *Computers and Electronics in Agriculture*, 174(July), 105157, doi.org/10.1016/j.compag.2020.105457.
- Costa L., Nunes L., Ampatzidis Y., 2020. A new visible band index (vNDVI) for estimating NDVI values on RGB images utilizing genetic algorithms. *Computers and Electronics in Agriculture*, 172 (May), 105334.

Agroview – field analytics



- ➢ UAV and ground-based high throughput phenotyping in citrus utilizing artificial intelligence. Huanglongbing Multi-Agency Coordination (MAC) Group. Duration: 8/1/2019 – 7/31/2021.
- ➢ UAV-based high throughput phenotyping in specialty crops utilizing artificial intelligence. Florida Specialty Crop Block Grant Program - Farm Bill (SCBGP-FB). Duration: 1/1/2020 – 8/31/2022.

Cloud-based application to process, analyze, and to visualize UAV collected data



https://twitter.com/i/status/1202671242647490560

Best Management Practices
Agroview - Nutrient Management

Agroview
Nutrition Report

AGROVIEW

Farm: Demo Account
Block: Inventory, Health & Fertility 3

Data Collection Date: 12/20/2020
Block area: 12.7 acres

Nitrogen

Range	Average value	Acres	Suggested actions	Application Rate
Deficient	0.535%	3.7	Check yield. Check tree health. Review water management. Review N fertilizer rate.	0
Low	2.358%	1.1	Check yield. Check tree health. Review water management. Review N fertilizer rate.	0
Optimum	2.686%	3.6	No actions	0
High	2.848%	4.3	Check soil organic matter. Review N fertilizer rate.	0

Phosphorus

Range	Average value	Acres	Suggested actions	Application Rate
High	0.181%	12.7	No actions	0

Potassium

Range	Average value	Acres	Suggested actions	Application Rate
Deficient	0.300%	1.2	Increase K fertilizer rate. Apply foliar K fertilizer.	0
Low	0.913%	0.6	Increase K fertilizer rate. Apply foliar K fertilizer.	0
Optimum	1.586%	9.8	No actions	0
High	1.839%	1.1	Decrease K fertilizer rate.	0

Magnesium

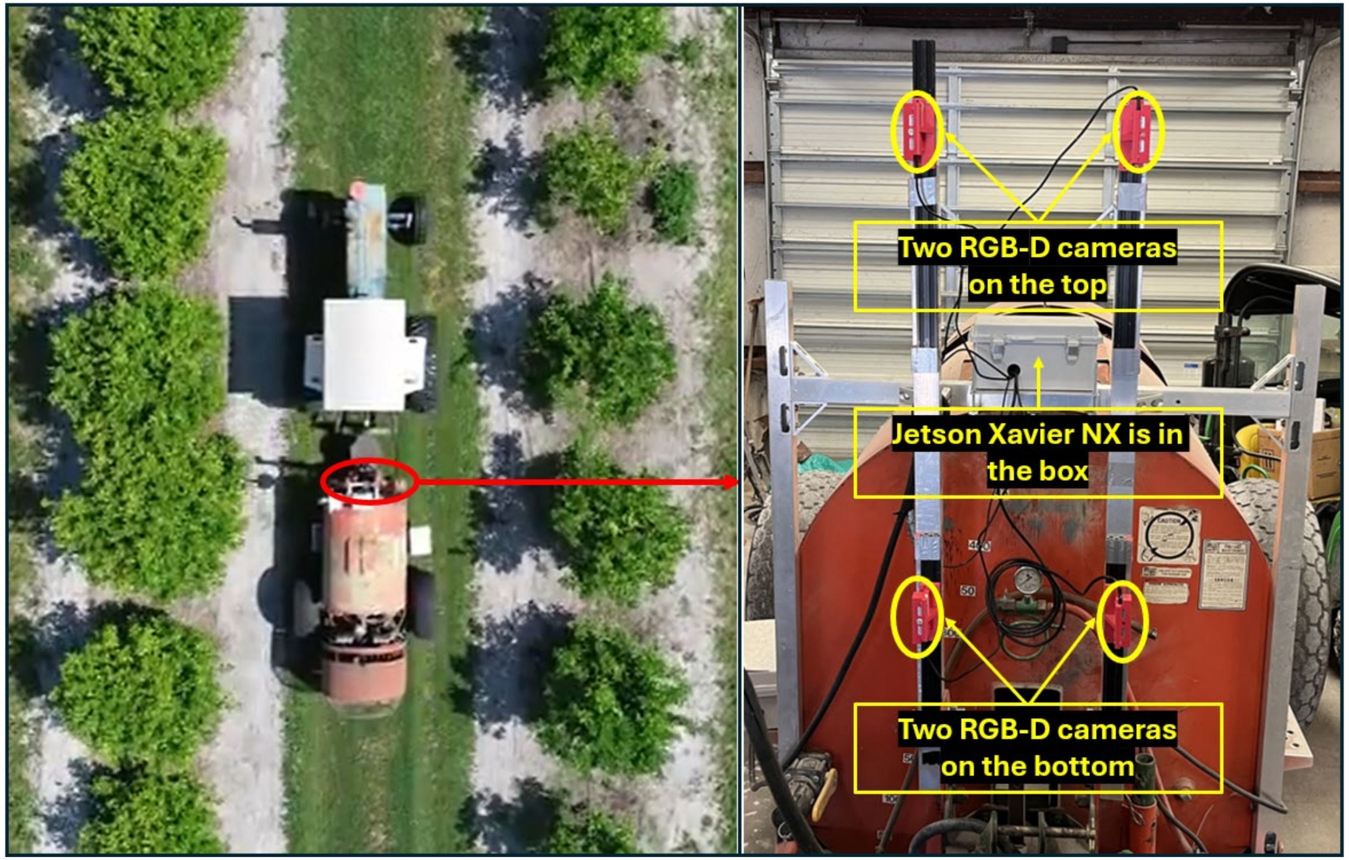
Costa L., Kunwar S., Ampatzidis Y., Albrecht U., 2021. Determining leaf nutrient concentrations in citrus trees using UAV imagery and machine learning. Precision Agriculture, https://doi.org/10.1007/s11119-021-09864-1.

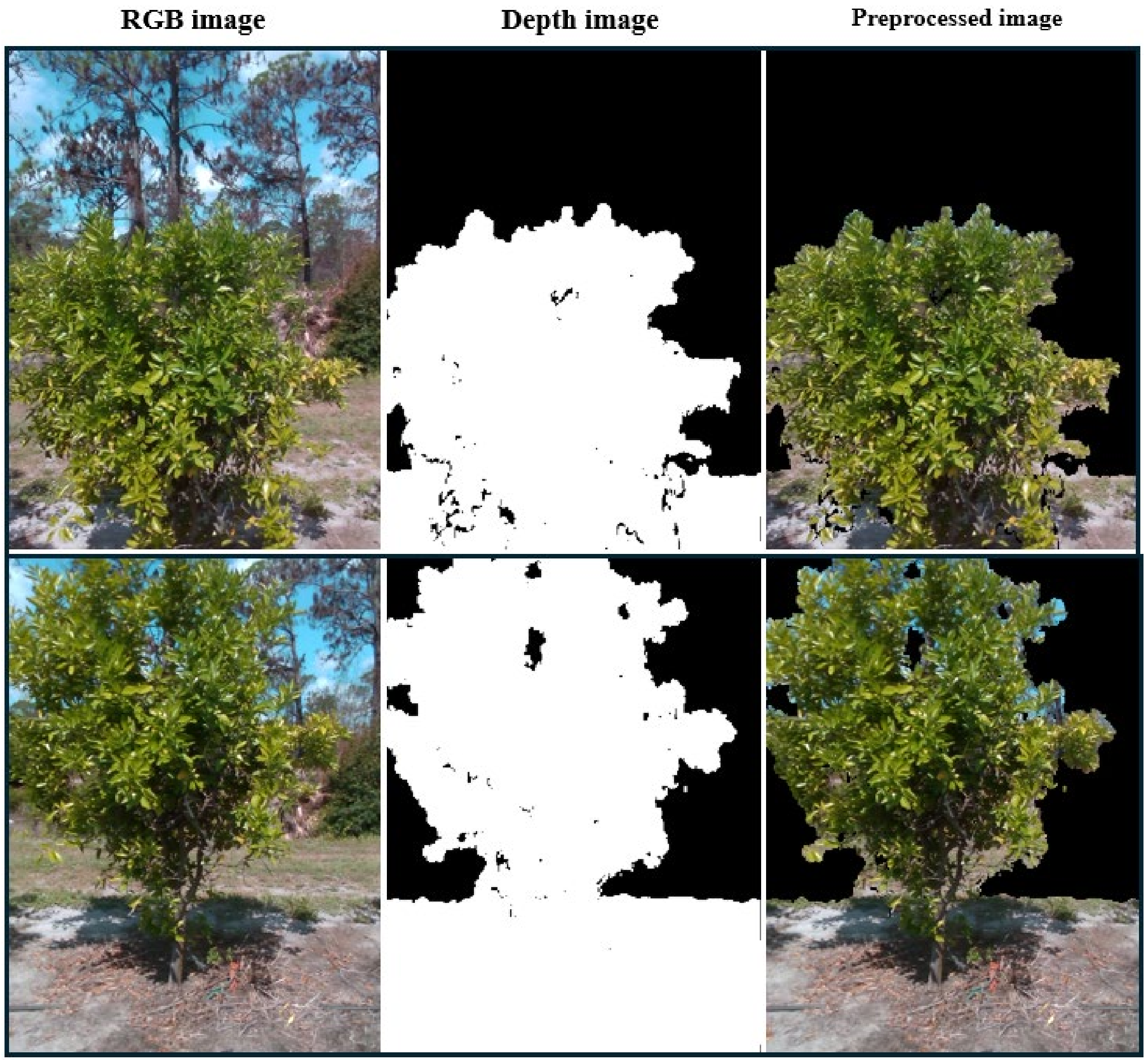
Agrosense

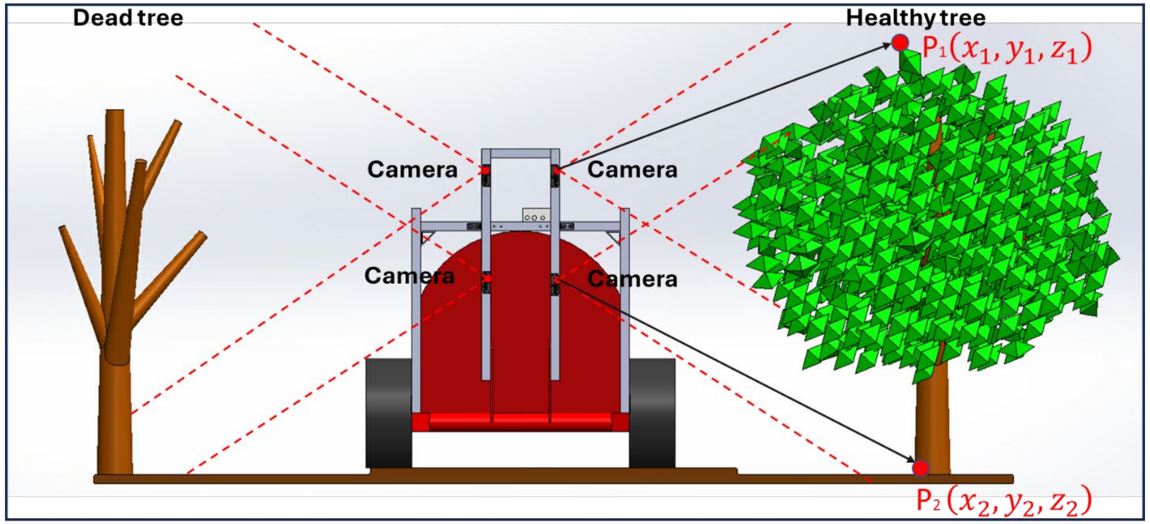
Patented AI-based Software

Agrosense for Smart Tree Crop Sprayer

Zhou C., Ampatzidis Y., Guan H., and Neto A.D.C., Kunwar S., Batuman O., 2024. Agrosense: AI-enabled sensing for precision management of tree crops (poster). 16th International Conference on Precision Agriculture (ICPA), Manhattan, Kansas, USA, July 21-24.

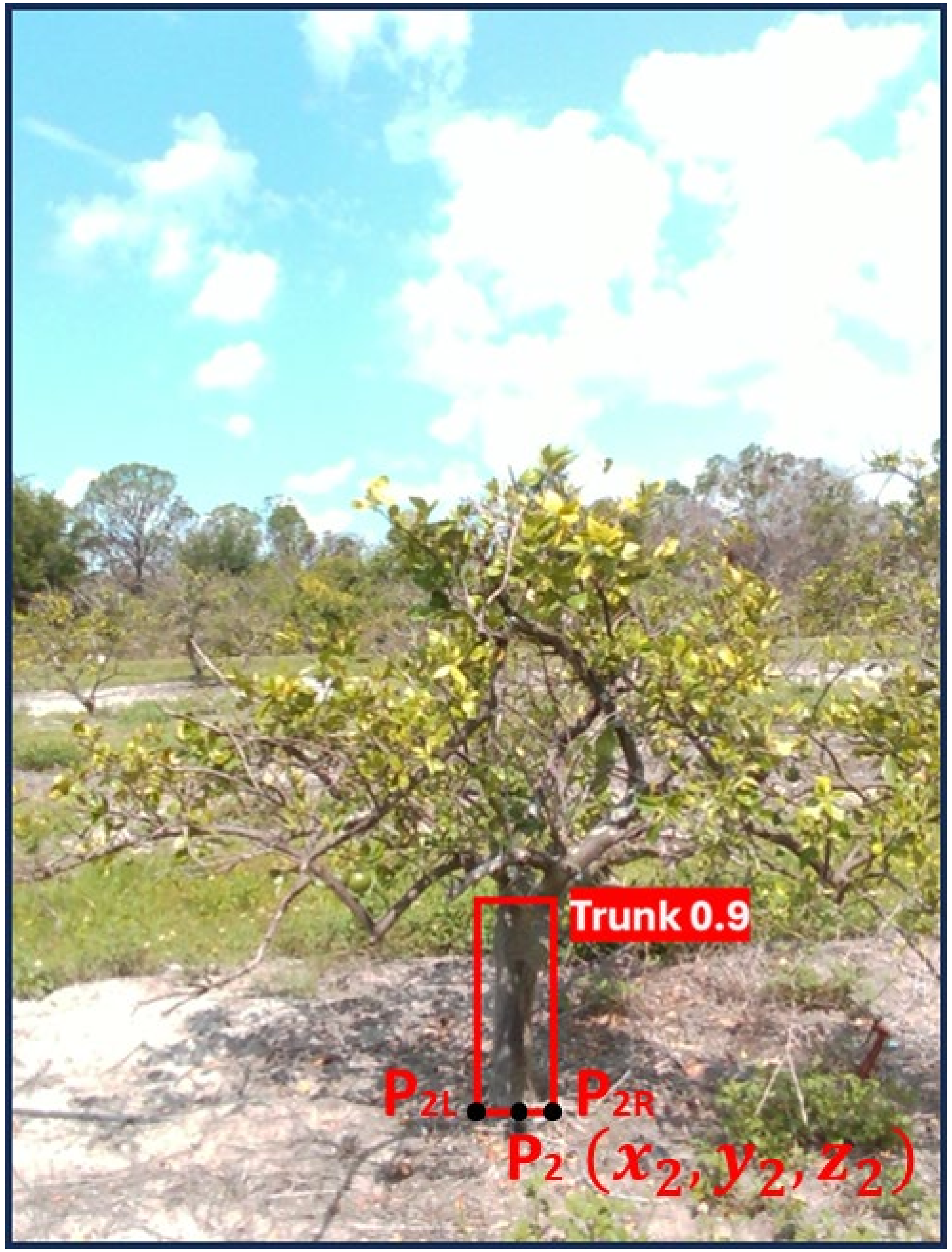



RGB image
Depth image
Preprocessed image



Dead tree
Healthy tree
$P_1(x_1, y_1, z_1)$
Camera
Camera
Camera
Camera
$P_2(x_2, y_2, z_2)$

Density 0
Density 1
Density 2
Density 3
Density 4
Density 5



Trunk 0.9
P_{2L}
P_{2R}
$P_2(x_2, y_2, z_2)$

Smart Tree Sprayer using Artificial Intelligence (AI)

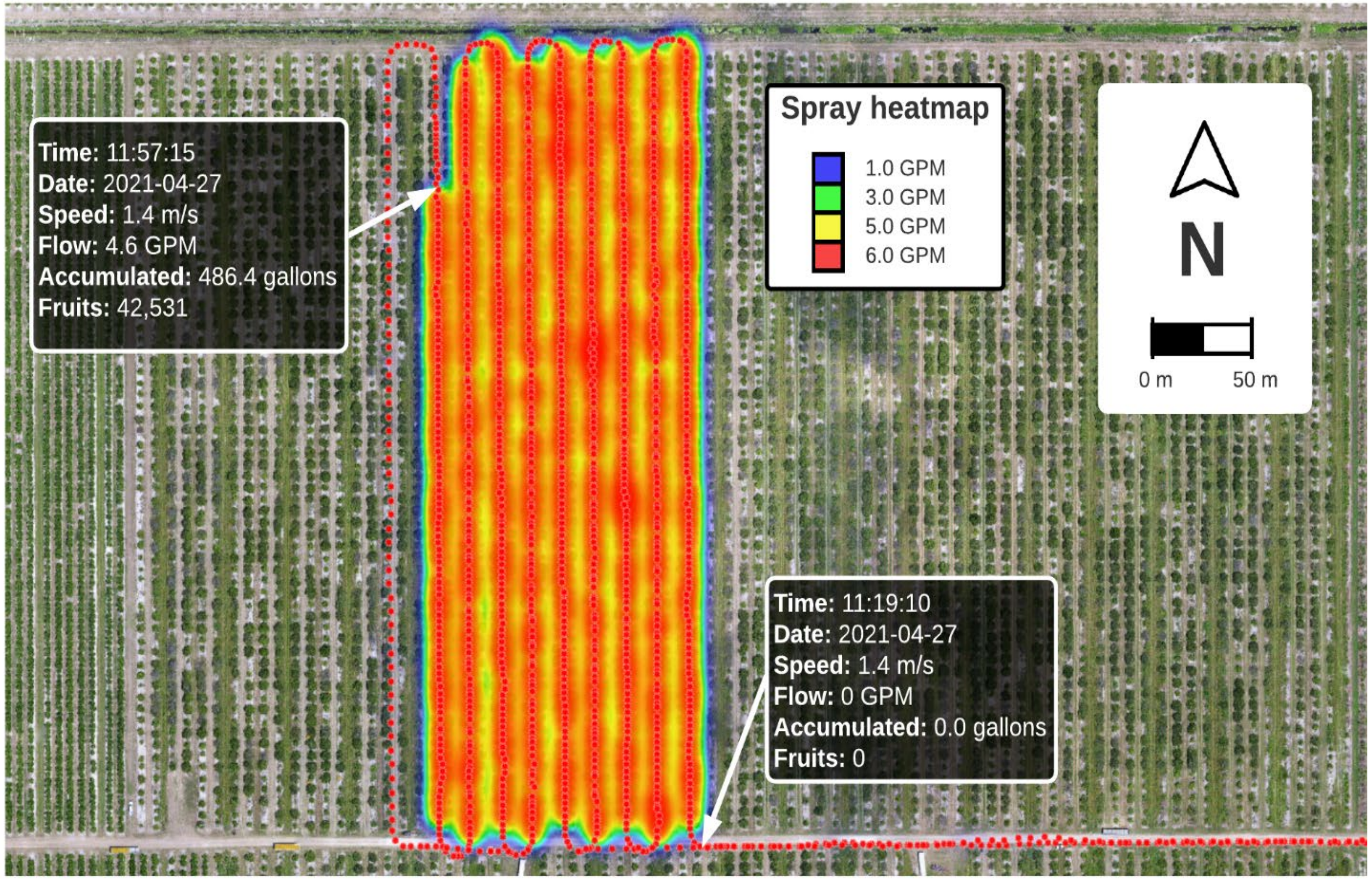
https://youtu.be/SZvmALvoSUQ?list=TLGGlrt2a6JeEp0xODAxMjAyMg

Smart Tree Sprayer using Artificial Intelligence (AI)

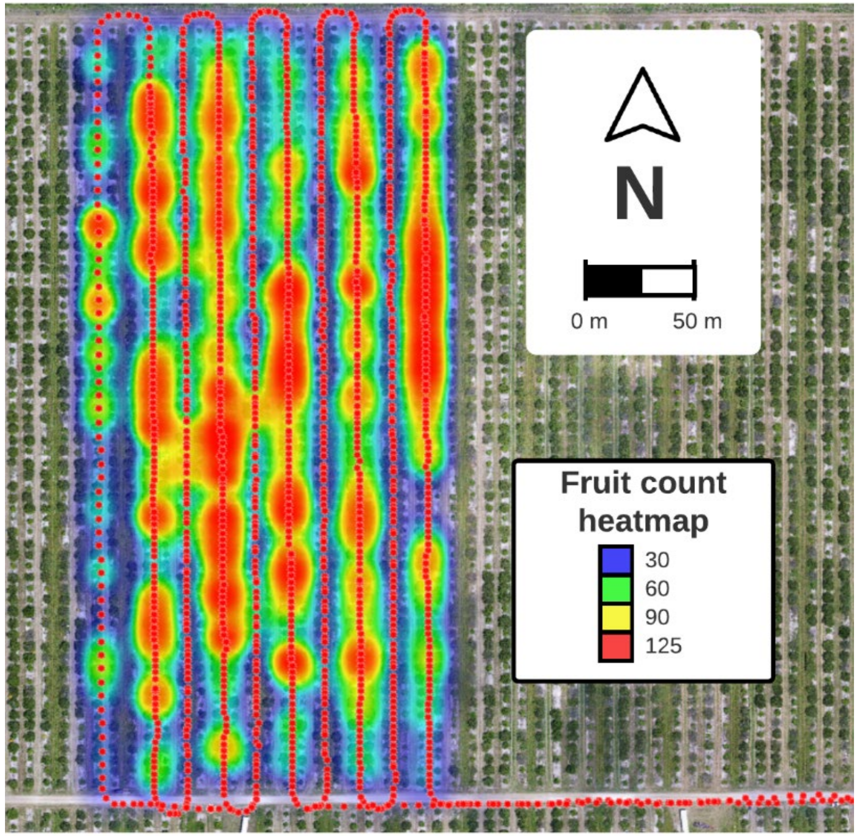
Partel V., Costa L., Ampatzidis Y., 2021. Smart tree crop sprayer utilizing sensor fusion and artificial intelligence. Computers and Electronics in Agriculture 191, https://doi.org/10.1016/j.compag.2021.106556.

Smart Tree Sprayer using Artificial Intelligence (AI)

Spray path and spraying heat-map



Fruit detection and fruit heat-map

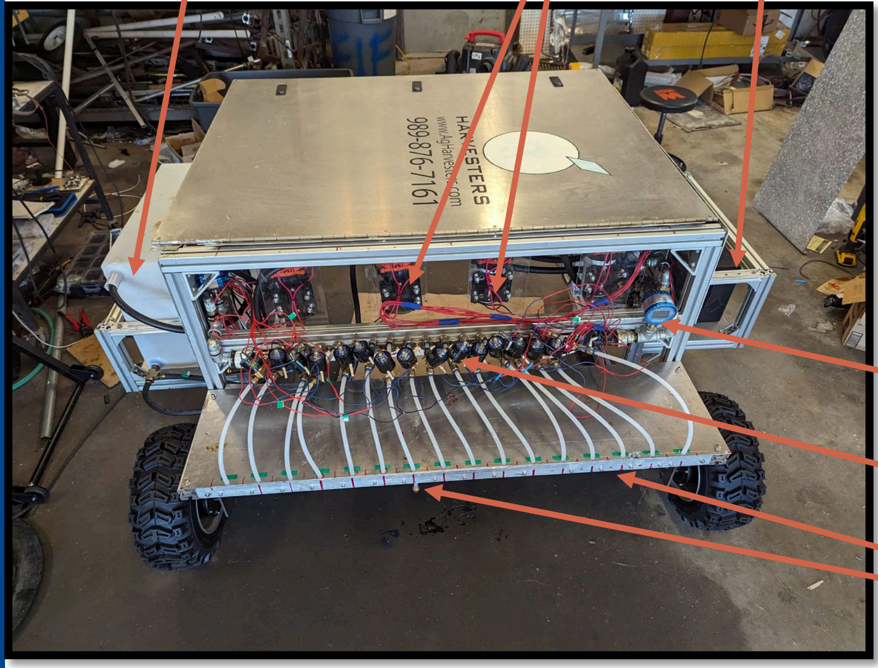


AI-enabled smart spraying platform

Herbicide tank

Pumps

Battery



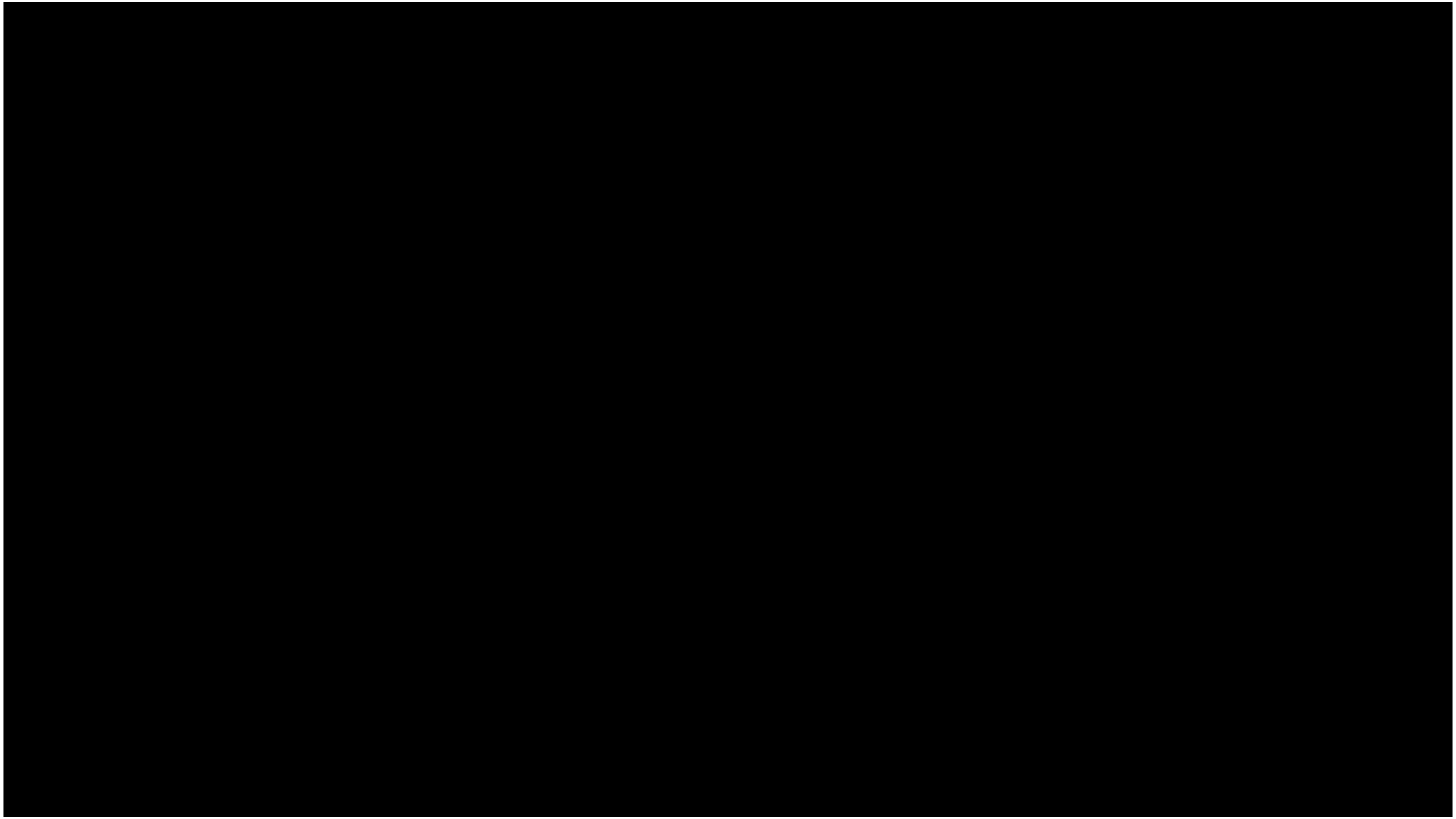
Pressure Gauge

Battery enclosure

Solenoid

Nozzles

3rd prototype



Thanks for your attention!

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