

Update on the Strawberry Disease Smartphone App

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STRAWBERRY DISEASES

STRAWBERRY DISEASES

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- [Colletotrichum Crown Rot \(Anthracnose Crown Rot\) of Strawberry](#)
- [Common Strawberry Diseases in Florida](#)
- [Florida Strawberry Producers' Experiences with Anthracnose and Botrytis Fruit Rot, and Producers' Use of the Strawberry Advisory System](#)
- [Leaf Spot Diseases of Strawberry](#)
- [Pestalotia Leaf Spot and Fruit Rot of Strawberry](#)
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- [Powdery Mildew of Strawberries](#)
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What can we help you with?

LEAF SPOT DISEASES OF STRAWBERRY¹

Juliana S. Baggio, James C. Mertely, and Natalia A. Peres²

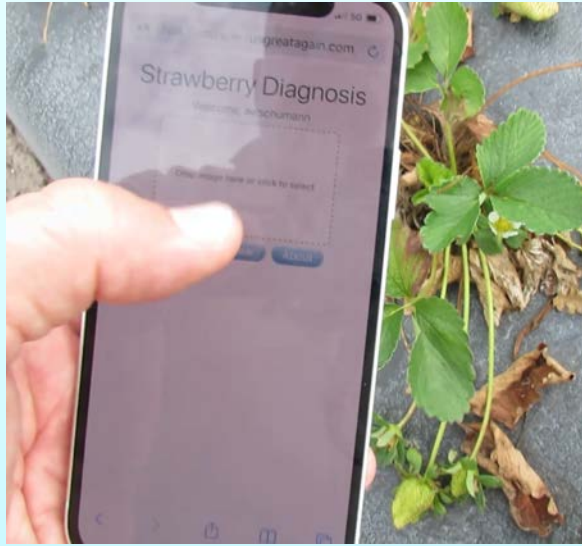
- There are many **leaf spot** diseases, and they are not trivial to identify
- A free smartphone app was developed in 2021/22 to help identify the leaf symptoms with the camera and AI



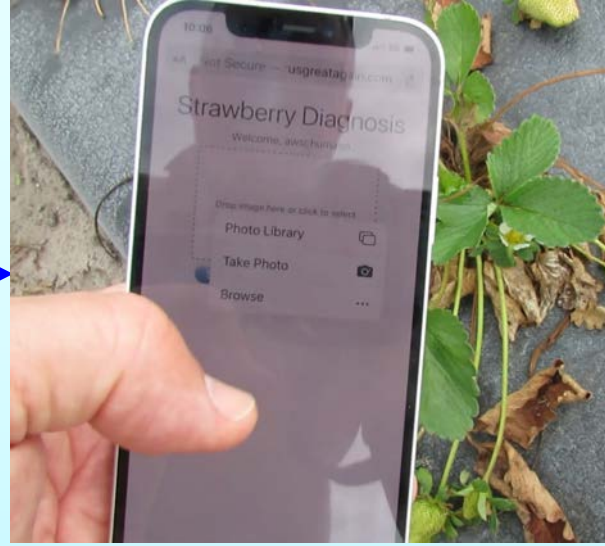
STRAWBERRY DISEASES

- The accurate, timely identification and surveying of disease outbreaks in the Florida strawberry industry is critical for developing the appropriate rapid responses
- Accurate identification of *Pestalotia* leaf spot disease is particularly important, and currently relies on examination by a diagnostic service, which limits the extent of the sampling in the strawberry fields
- Recent advances in artificial intelligence (AI) have greatly improved the accuracy and speed of machine vision applications used to classify images
- Hypothesized that a smartphone app developed with AI can diagnose strawberry diseases as well as human experts

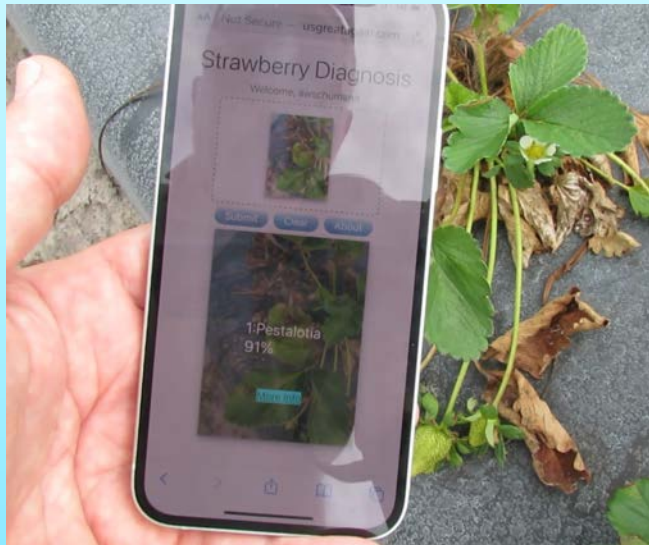
Leaf symptom diagnosis with a smartphone web app:



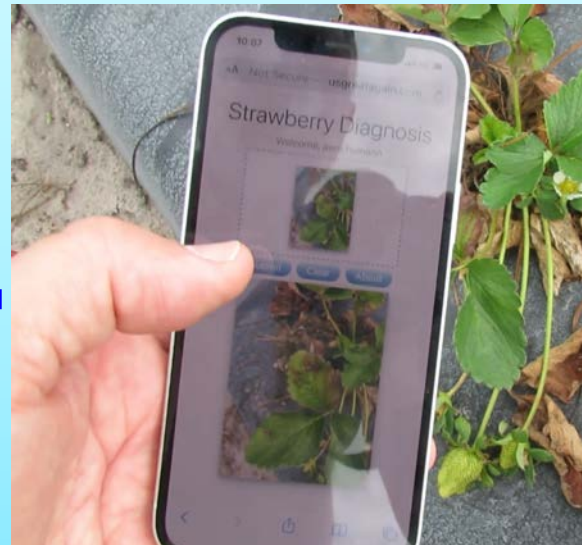
1. Pick a symptomatic plant



2-3. Take a photo



6. Show result



5. Submit photo



4. Use photo

Why did we develop a smartphone *web app* instead of one installed from an app store?

PROS:

1. Cross-platform compatibility: Web apps can be accessed on various devices and platforms, including smartphones, tablets, laptops, and desktop computers, regardless of the operating system.
2. No installation required: Users can access web apps directly through a web browser without the need for downloading or installing any additional software.
3. Easy updates for prototyping: Web apps can be updated centrally on the server-side, ensuring that all users have access to the latest version without requiring individual updates on their devices. App store approval and processing is not required.
4. Images from disease diagnosis can be archived and re-used for model improvement.
5. Harness the additional processing power of a large computer server.

CONS:

1. Dependence on an internet connection: Web apps require an active internet connection to function properly.

We will transition to a fully developed installed app when the web app is completed.

METHODS

Artificial Neural Network training

- Collect digital photos of symptomatic, healthy leaves, and unknowns
- GoPro action video camera, HD resolution, 24 images per second
- ~10,000 images per symptom class, 80% training, 20% validation
- Train EfficientNet-B7 ANN model on a deep learning server

Deploy the trained model to a prototype smartphone web-app

11 classes, 8 disease symptoms trained so far:

Healthy

- asymptomatic

Other

- Powdery mildew
immune
response

Diseases

- Leaf scorch
- Powdery mildew
- Pestalotia leaf spot
- Angular leaf spot (2023)
- Leaf blotch (2023)
- Bacterial spot (2023)
- Common leaf spot (2023)
- Cercospora leaf spot (2023)

Unknown

- Other plants (not
strawberry) and
everyday
scenes

Healthy leaves



Leaf scorch



Powdery mildew



Pestalotia leaf spot and fruit rot



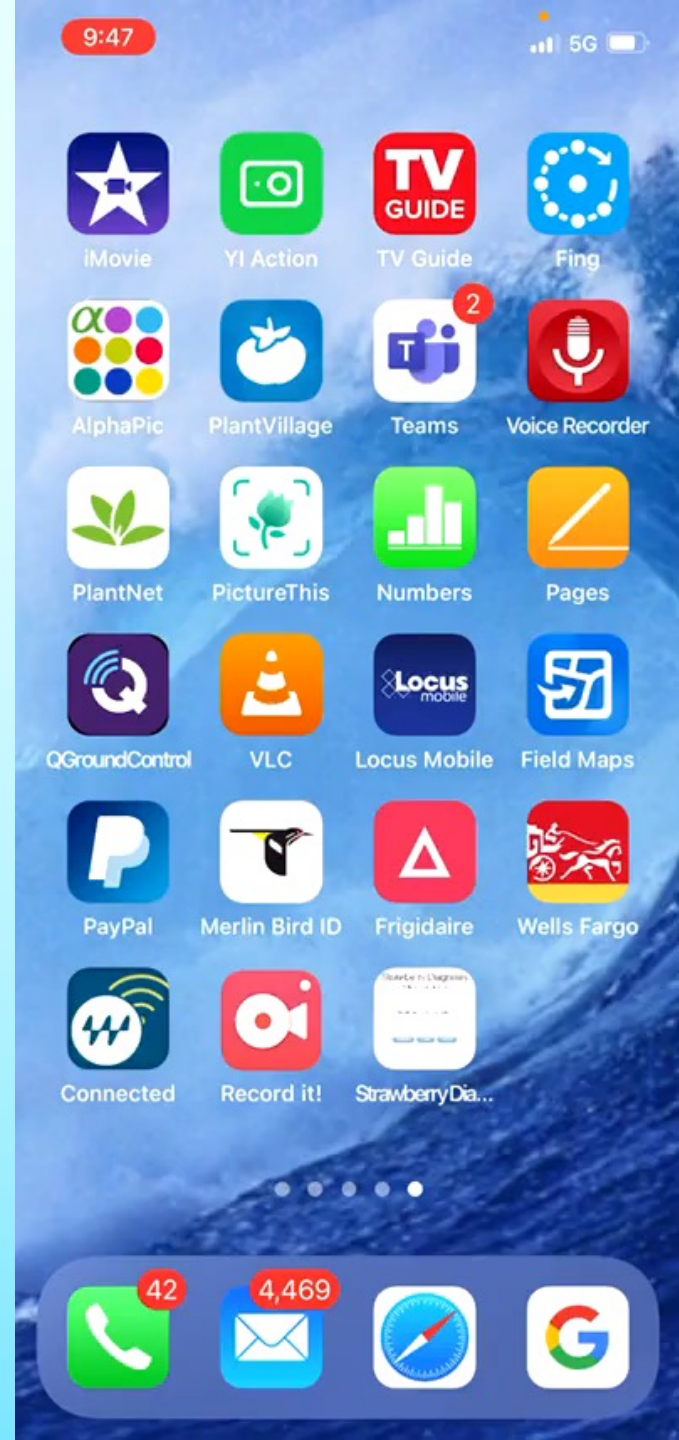
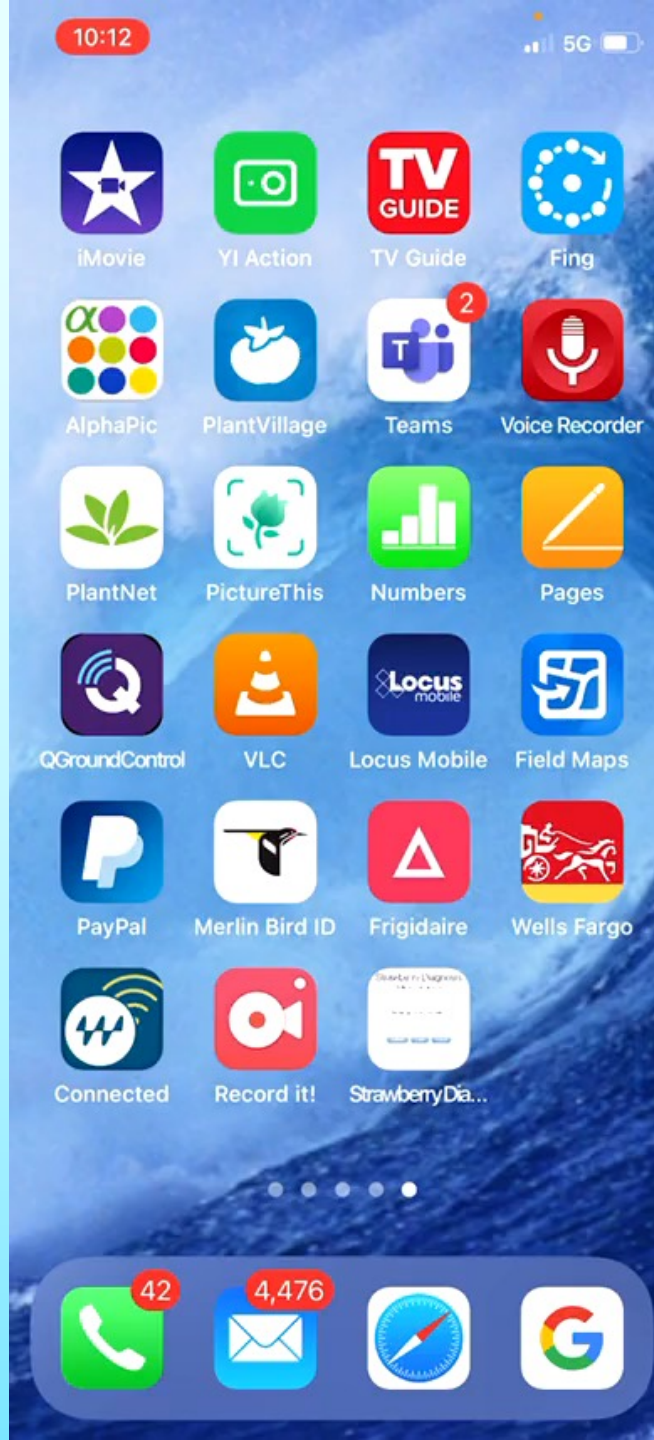
Powdery mildew immune response



Smartphone web app for strawberry diseases



Smartphone web app for strawberry diseases





Pestalotia



Strawberry disease leaf symptoms that are difficult to identify on a field scale



Leaf blotch



What can we do about “difficult” symptoms

- We need to be 100% certain that the photos of leaf disease symptoms are correctly identified BEFORE we train the classification models;
Incorrect image labeling = bad data = bad predictions
- The best method (?) for positive identification of the causal pathogens is testing their DNA with q-PCR
- It is not feasible to test every leaf sample matching 10,000 images!
- It is feasible to thoroughly inspect, photograph and q-PCR test a smaller sample of symptomatic plants and leaves ~20 to 30 per disease symptom
- Then use their images to synthesize thousands of new representative images using generative AI technology

Pestalotia REAL



Use generative AI to create large datasets of images for training disease symptoms

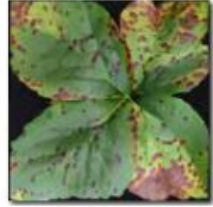
Pestalotia SYNTHETIC



Generating 5,000 synthetic Leaf scorch images takes about an hour



leafscorch6.jpg
49.8 kB



leafscorch7.jpg
46.4 kB



leafscorch8.jpg
43.8 kB



leafscorch9.jpg
42.1 kB



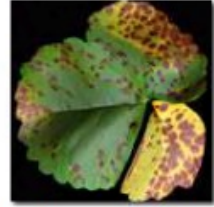
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leafscorch11.jpg
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leafscorch24.jpg
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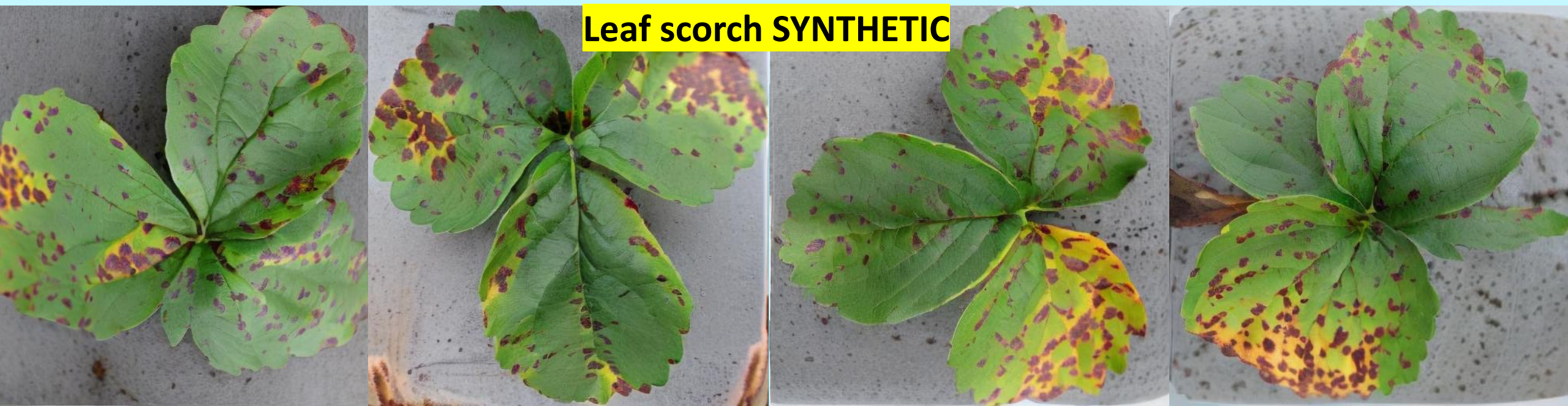
leafscorch25.jpg
43.7 kB

Leaf scorch REAL



Use generative AI to create large datasets of images for training disease symptoms

Leaf scorch SYNTHETIC



Conclusions and next steps

- The prototype smartphone web-app was nearly 100% accurate in identifying three strawberry diseases trained in 2021/23
- Adding five more diseases in 2022/23, especially with similar symptoms, proved challenging: the collection of enough verifiable labeled images for training the AI models to avoid false diagnosis
- The use of generative AI methods to create abundant high-quality data looks promising for new, complex symptoms
- Compare web-app diagnoses with experts' results
- Deploy the validated final diagnostic model as a smartphone app to strawberry growers

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