UAS-Enabled Monitoring for Cercospora Leaf Spot Disease in Table Beets

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Introduction

Cercospora leaf spot (CLS) is a significant fungal disease affecting table beets, caused by the fungus *Cercospora beticola* Sacc. It is the primary disease impacting table beet yields, leading to frequent outbreaks and reduced harvests. Initial CLS symptoms appear as small, grayish spots on foliage and stems, surrounded by reddish-brown borders, typically measuring 2-5 mm across. Under favorable conditions, these lesions may enlarge and merge, ultimately covering the leaf and causing defoliation.

The primary concerns related to CLS:

- Defoliation reduces the efficacy of mechanical harvesters
- Leads to yield loss

Objective:

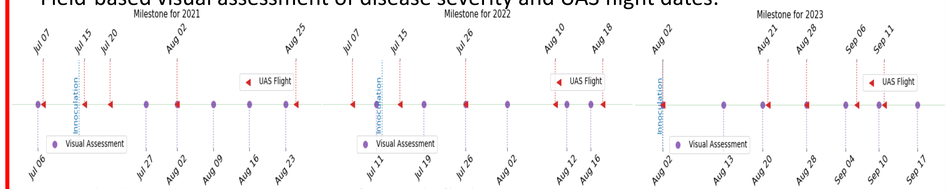
Exploit the operational simplicity, adaptability, and rapid data acquisition capabilities inherent to unmanned aerial systems (UAS) to conduct aerial imaging of extensive agricultural crop areas and estimate the disease severity (DS) of CLS (the percentage area of CLS covered by the leaf) across the crop.

Data Collection

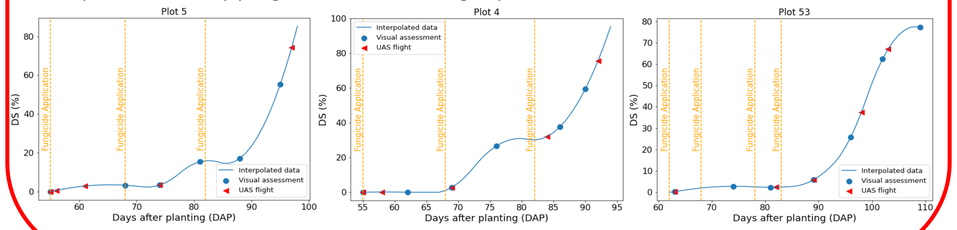
- Study location: Geneva, New York, USA, at Cornell AgriTech.
- 2021 & 2022 flights: DJI Matrice-600 with a MicaSense RedEdge-M camera capturing five-band multispectral images (**475, 560, 668, 717, & 840 nm**).
- 2023 Flight: DJI Mavic 3m was used to capture four band multispectral images **(560, 650, 730, & 860 nm)**

Milestones and disease progression

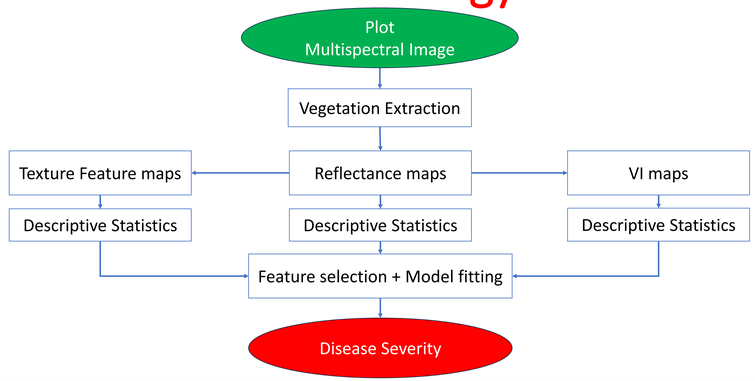
Field-based visual assessment of disease severity and UAS flight dates:



Sample CLS severity progression for each flight year

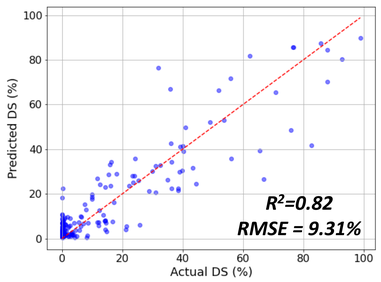


Methodology



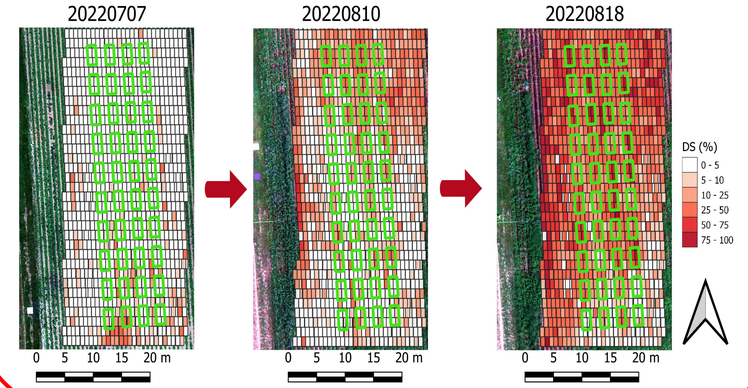
Model Performance

- Random forest regressor had the best performance
- Two features used: Renormalized Difference Vegetation Index (RDVI) skewness and coefficient of variation of texture homogeneity of near-infrared band.



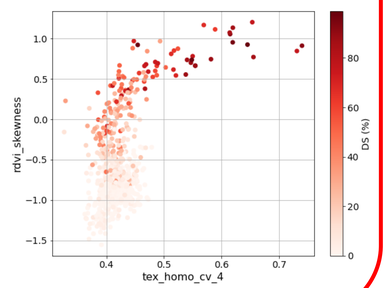
CLS Maps

A heat map of estimated DS across the field at three different dates. These maps provide critical insights for growers to make actionable decisions.



Discussions

- Skewness in the RDVI feature map effectively differentiates DS at low to moderate levels.
- RDVI skewness reaches a saturation point at higher DS values, limiting its differentiation capability.
- The coefficient of variation within the texture homogeneity map of the near-infrared (NIR) band is effective at discriminating DS levels >50%.



Acknowledgments

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