



# Hyperspectral Discrimination of Fusarium Wilt in Tomato Plants Using Machine Learning-Based Approaches

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## Background: Tomato

- Tomato is the most widely grown and consumed vegetable
- Detection of plant diseases is essential application of remote sensing in precision agriculture
- The potential of hyperspectral remote sensing has been well explored for the detection of diseases at the regional level
- Detecting diseases at various levels of severity has not been attempted

## Goal:

- Spectral discrimination of **healthy and Infected** tomato plants at various cases of disease
- Discrimination model development for **Fusarium wilt** discrimination using hyperspectral data



## Diseases Affecting Tomato:



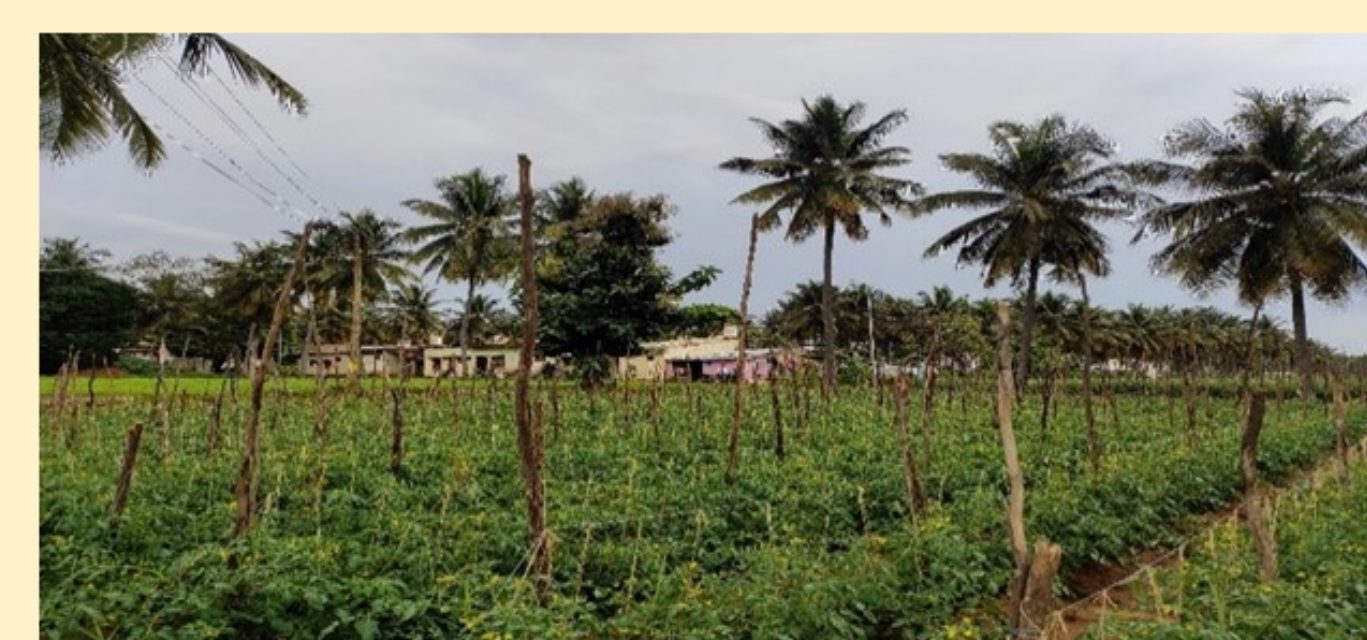
## What is Fusarium wilt?

- Fungal disease caused by *Fusarium oxysporum*
- Symptoms include leaf chlorosis, stunting, and leaf drop
- Transmitted through the contaminated seed, soil, and vascular wounds in plant material



## Data:

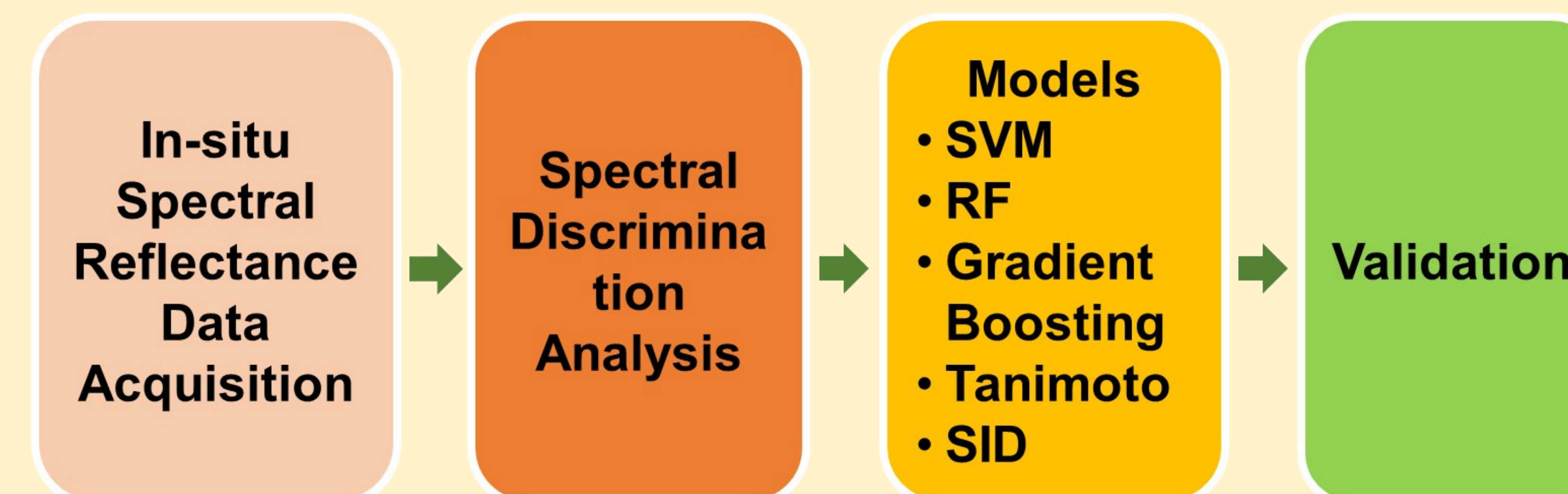
- Tumkur region, Karnataka, India
- In-situ spectral reflectance measurements spectral range- 450-2500nm
- ASD spectroradiometer (HR-1024i, Maker: SVC, USA)



Class	State
HP	Healthy Plant
FW_1	Affected /Not visible
FW_2	Affected (inspection)

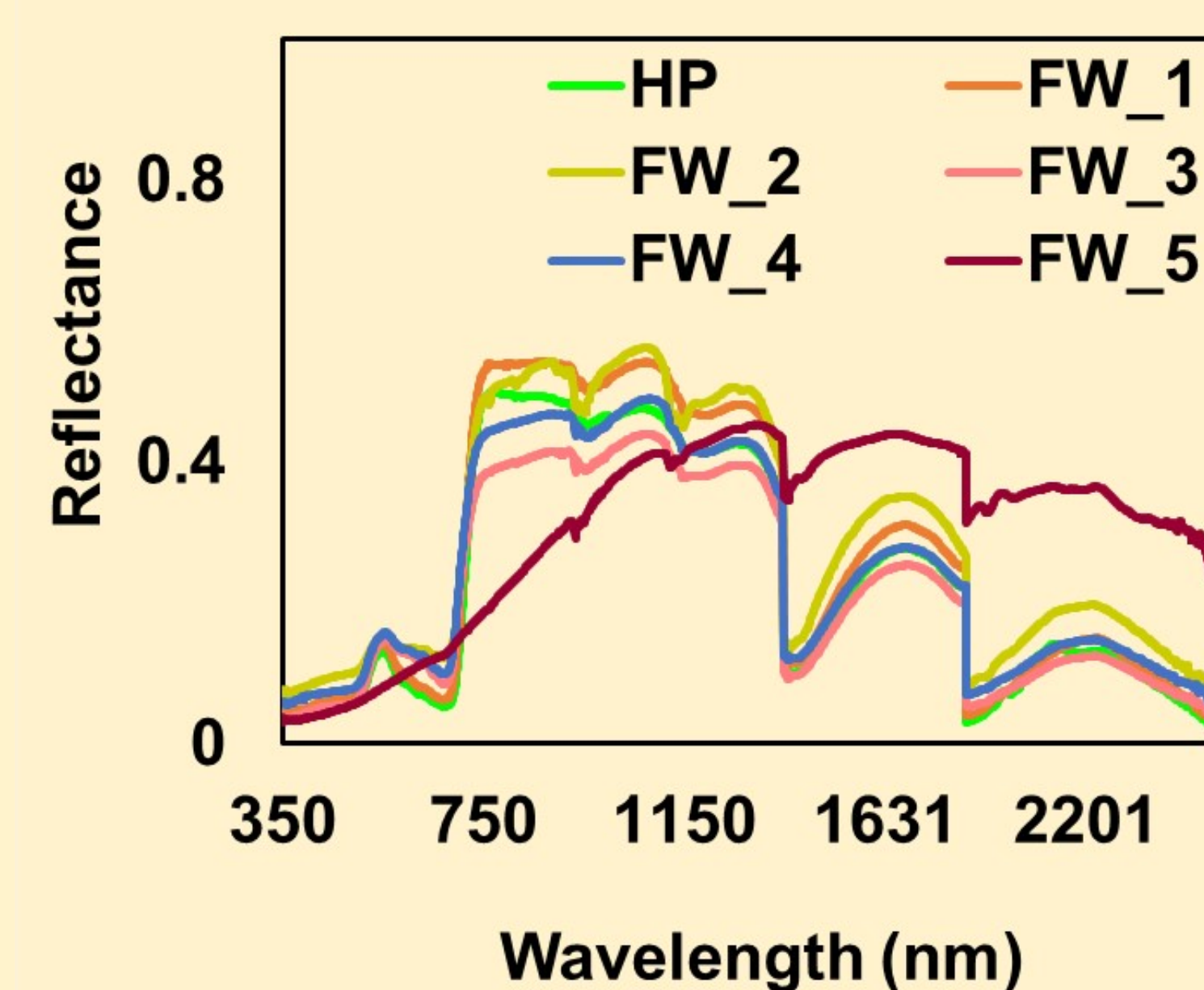
Class	State
FW_3	Visible symptoms
FW_4	Extensive spread
FW_5	Fully wilted

## Methodology:



## Results:

- Results indicate the possibility of discriminating the healthy tomato plants vs. infected plants at various levels
- The discrimination is not stable across different levels
- Discrimination is substantially influenced by the method used
- However, when considering the high levels of infection severity, the discrimination is stable and different methods show similar results
- This study has established the existence of spectral features of disease for Fusarium wilt in tomatoes



Random Forest				
classes	precision	recall	f1-score	support
HP	0.94	0.67	0.78	45
FW_1	0.77	0.83	0.8	52
FW_2	0.78	0.78	0.78	41
FW_3	0.75	0.71	0.73	34
FW_4	0.92	0.88	0.9	26
FW_5	0.91	1	0.95	118
accuracy			0.85	316

Tanimoto	FW_1	FW_2	FW_3	FW_4	FW_5	HP
FW_1	1	0.985	0.988	0.960	0.859	0.943
FW_2		1	0.992	0.932	0.885	0.978
FW_3			1	0.967	0.914	0.948
FW_4				1	0.906	0.853
FW_5					1	0.831
SID	FW_1	FW_2	FW_3	FW_4	FW_5	HP
FW_1	0	0.001	0.012	0.055	0.179	0.014
FW_2		0	0.011	0.055	0.183	0.017
FW_3			0	0.017	0.114	0.052
FW_4				0	0.052	0.123
FW_5					0	0.283

Method	Accuracy score
LDA	0.79
Tanimoto	0.86
SID	0.183
ML	0.85

## Conclusion:

- Disease is discriminated against; however, it is also influenced by the severity and methods used
- Evaluation suggests identifying an appropriate method with a level of disease severity for remote sensing as a tool for disease detection

## Future:

- Assessment of the disease within the features and discrimination at plant and canopy scale using airborne or satellite imagery

## References:

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- [2] J. Lu, R. Ehsani, Y. Shi, A. I. de Castro, and S. Wang, "Detection of multi-tomato leaf diseases ( late blight , target and bacterial spots ) in different stages by using a spectral-based sensor," *Scientific Reports*, vol. 8, no. 1, pp. 1–11, Feb. 2018, doi: 10.1038/s41598-018-21191-6.
- [3] Y. Cen, Y. Huang, S. Hu, L. Zhang, and J. Zhang, "Early Detection of Bacterial Wilt in Tomato with Portable Hyperspectral Spectrometer," *Remote Sensing*, vol. 14, no. 12, p. 2882, Jun. 2022, doi: 10.3390/rs14122882.