

Continuing Project

Characterizing abiotic and biotic tree stress using hyperspectral information

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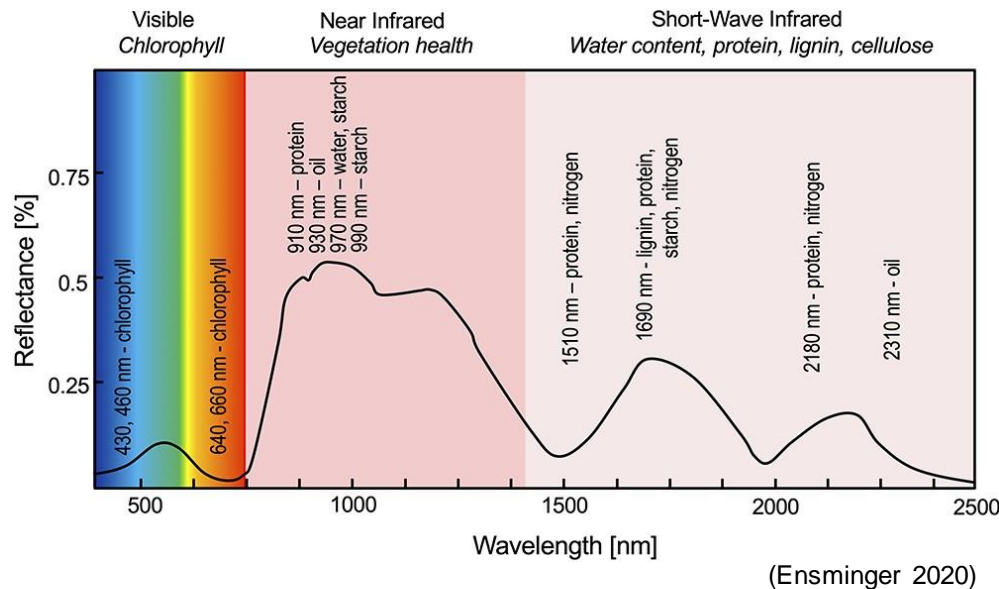


Reflectance spectroscopy

– Forest health management

Justification

- Reflected light from plants can help assess foliar quality.
- Foliar optical properties have been used to investigate finer details from foliage and to detect diverse forest issues at different spatial scales (e.g., drought, air pollution, fire, diseases, invasive species, etc.).



Rapid 'Ohi'a Death, Hawaii (Greg Asner)



Reflectance spectroscopy

– *Tree stress response*

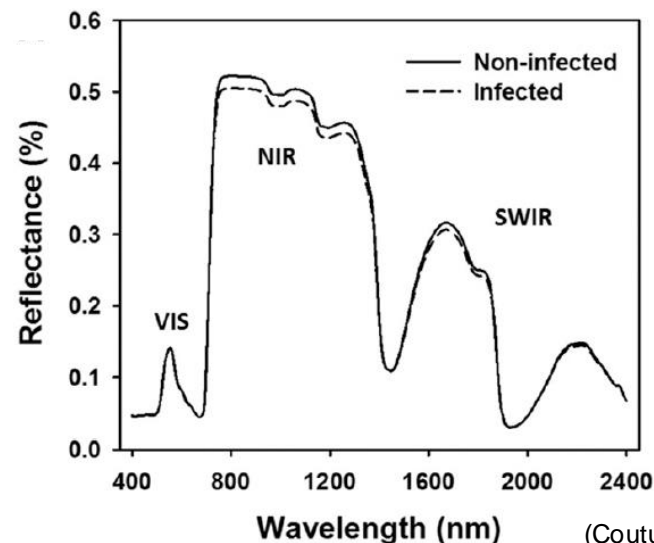
Objectives

Challenges remain to be explored in our understanding of the ability of the hyperspectral approach in identifying multiple stressors and/or diseases.

Research objectives:

Determine the ability of hyperspectral data 1) to estimate plant functional traits in responses to different stress events, alone and in combination and 2) to classify different abiotic and biotic stress events.

Stress-induced changes
in leaf reflectance



Hyperspectral phenotyping

– Identification of stress

Methods



Controlled environment

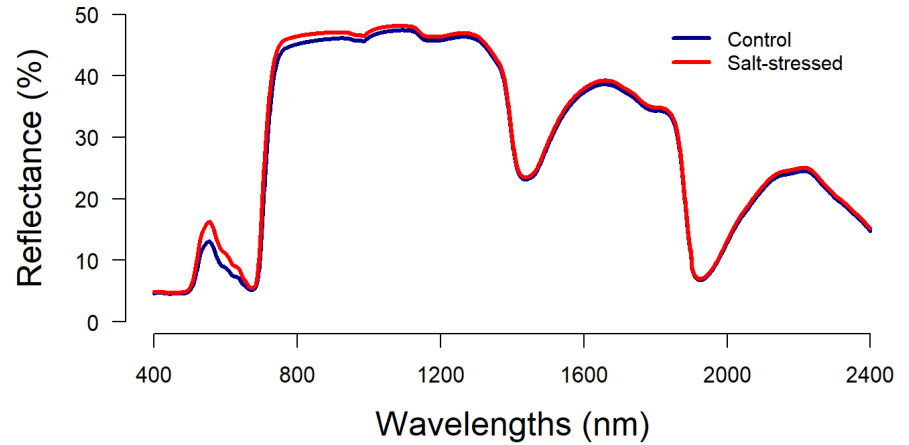
Fungal infection +
Soil quality

Nutrient deficiency
+ Drought

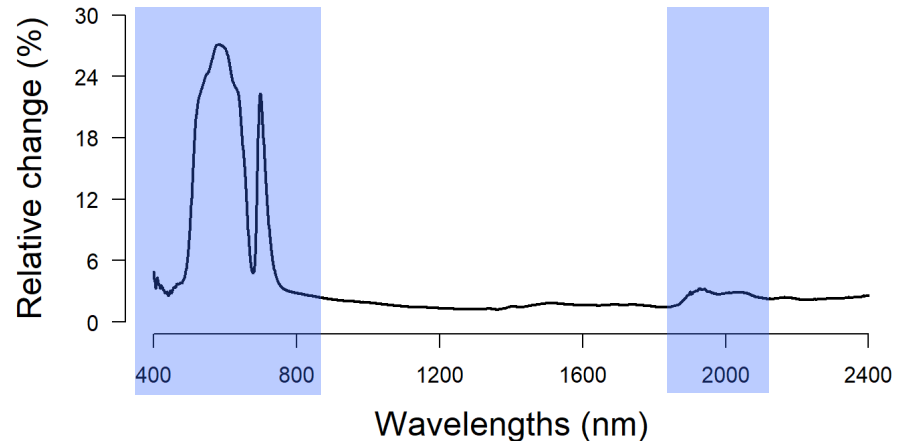
Fungal infection +
Drought

Nutrient deficiency
+ Salt
deposition

Classifying stress using partial least squares-discriminant analysis

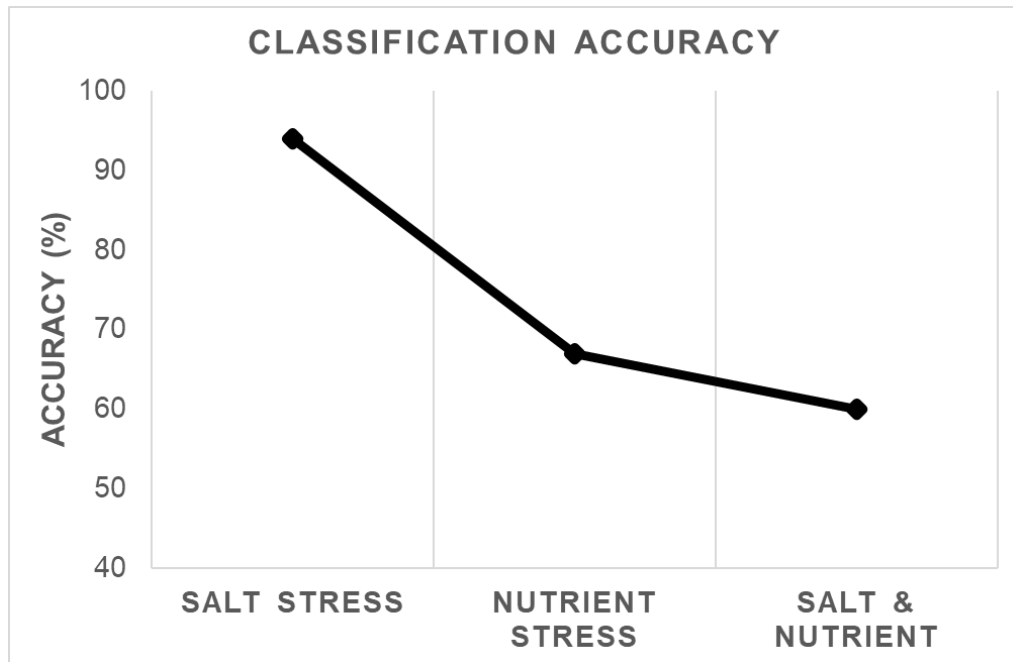


Identifying stress diagnostic spectral regions using RELEF-F algorithm



Hyperspectral phenotyping – Salt and Nutrient stress

Major Findings



Salt stress condition was most accurately classified from spectra (94%), and modest classification outputs were found for nutrient (67%) and bifactorial conditions (60%).



Classification **Salt & Nutrient stress**

Validation Accuracy: 0.60 (100 iterations)

		Observed			
		1	2	3	4
Predicted	1	40	4	0	0
	2	3	40	0	0
	3	0	0	33	4
	4	1	0	3	32

		Observed			
		1	2	3	4
Predicted	1	8	2	1	0
	2	2	8	0	1
	3	0	0	4	5
	4	0	0	4	2

Major Findings

- 1: Control
- 2: Nutrient stress
- 3: Salt stress
- 4: Salt stress & Nutrient stress

Calibration
Accuracy: 0.91

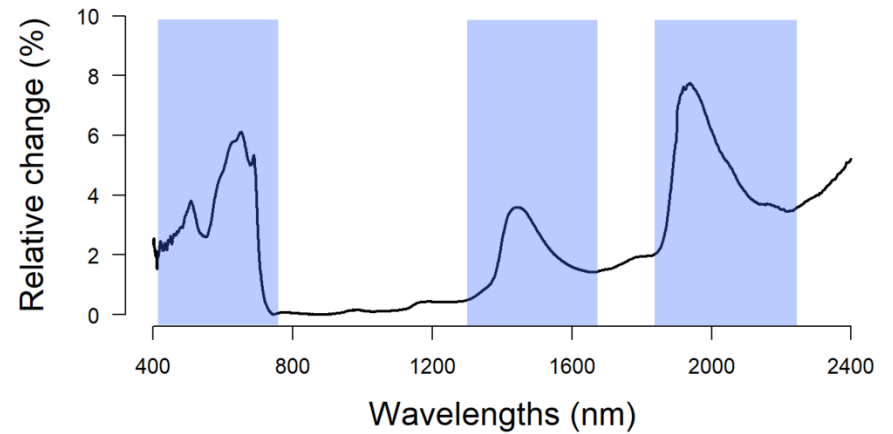
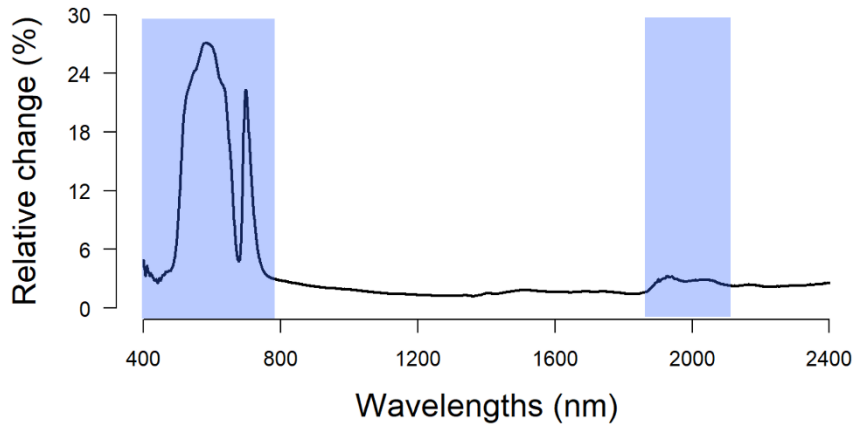
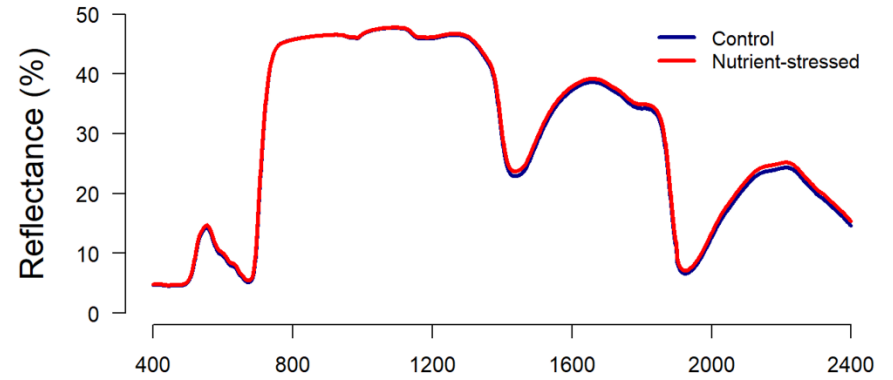
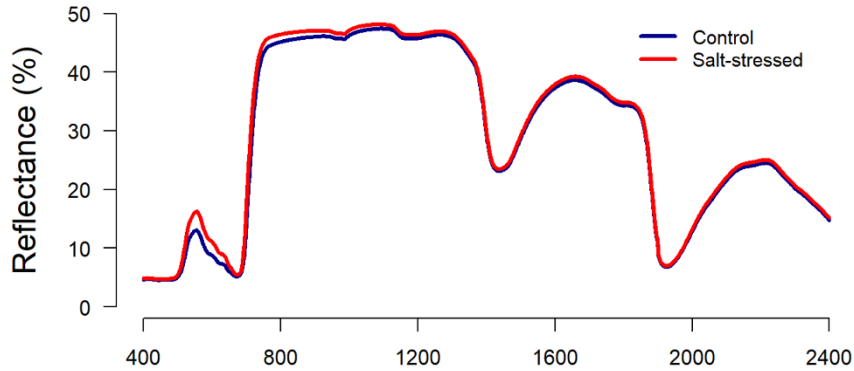
Validation
Accuracy: 0.60



Hyperspectral phenotyping

- Stress diagnostic spectral regions

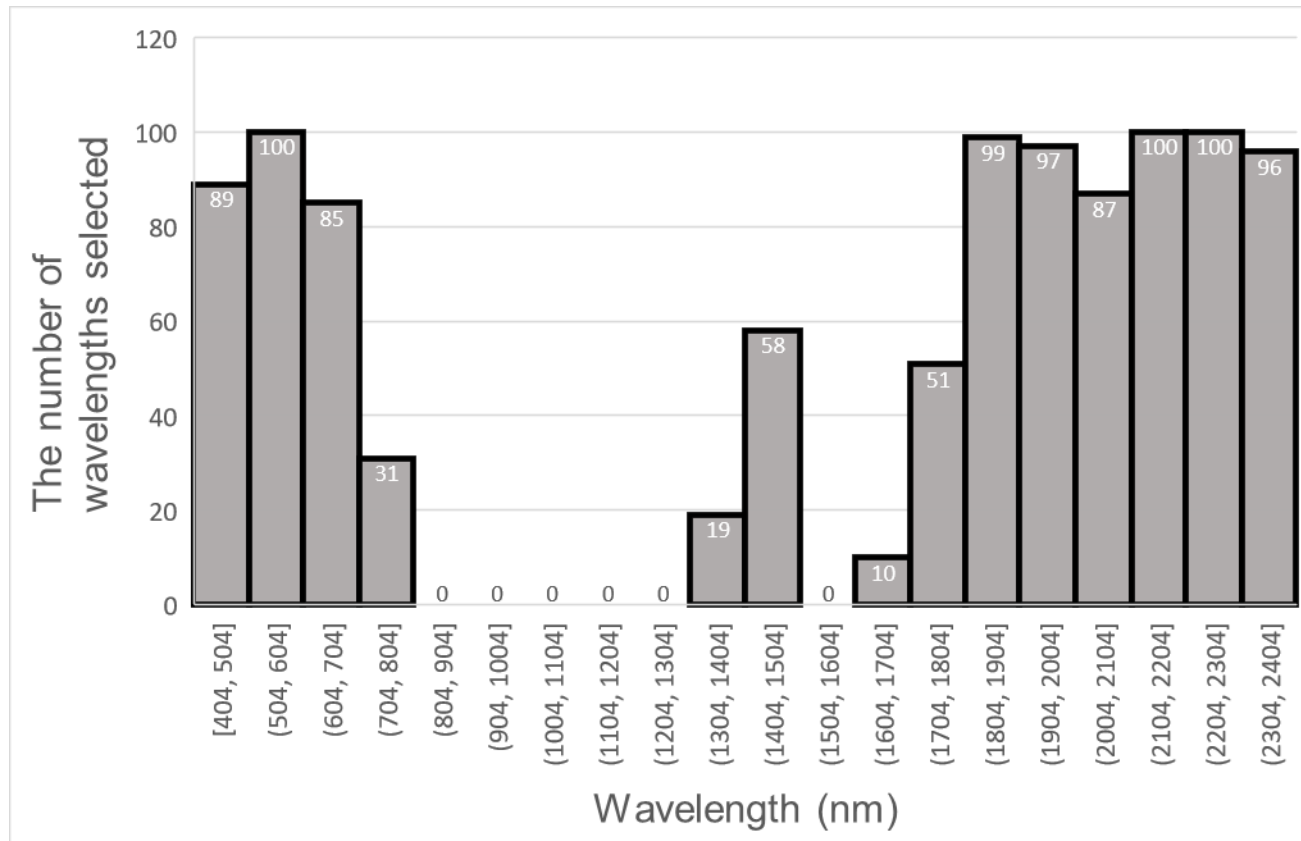
Major Findings



Hyperspectral phenotyping

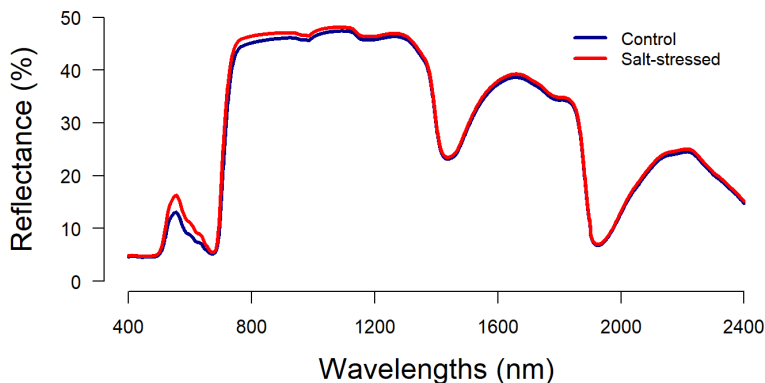
- Selected spectral regions by ReliefF

Major Findings

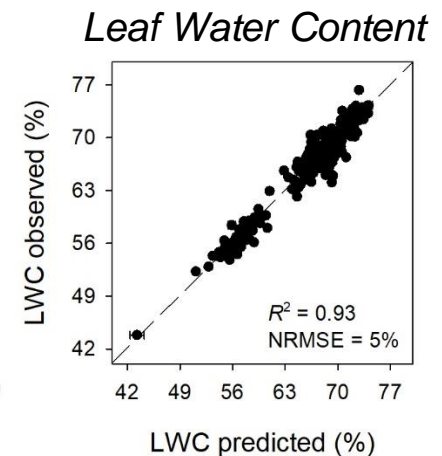
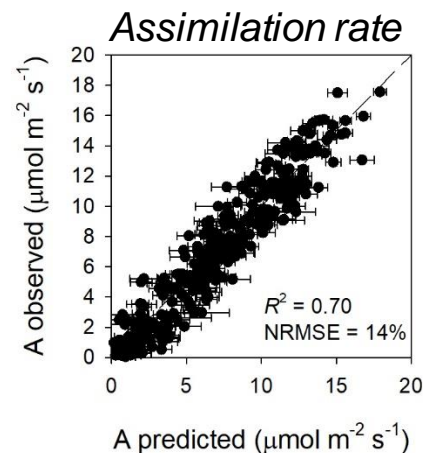


- Relate predictive leaf trait responses to hyperspectral phenotyping outcomes to interpret the classification results.
→ Two approaches, hyperspectral phenotyping and leaf trait predictions, provide multiple layers of stress-specific information.

Hyperspectral phenotyping



Leaf trait predictions





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Mickelbart lab

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