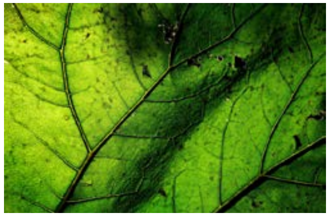


Progress Report

Characterizing abiotic and biotic tree stress using hyperspectral information

CAFS 20.80

John Couture, Sylvia Park, Melba Crawford, Matthew Ginzel,
Brady Hardiman, Douglass Jacobs (Purdue University)
Aaron Weiskittel, Parinaz Rahimzadeh, Peter Nelson (University of Maine) Cristian Montes, Caterina Villari, Kamal Ghandi (University of Georgia)

Sylvia Park (Purdue University)

Project Overview

Monitoring forest health is challenging because of the spatial scale (both horizontal and vertical) of forests

Remote sensing approaches to monitor natural and managed forest systems have the potential to resolve logistical challenges with integrating precision agricultural into forest management

Questions remain about relating information available from remote sensing into forest management

Project 1: Quantifying tree foliar chemical and physiological responses to abiotic and biotic stress using hyperspectral data

Two specific objectives:

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

2. Determine the ability of hyperspectral data to classify different abiotic and biotic stress events.

Project 1: Quantifying tree foliar chemical and physiological responses to abiotic and biotic stress using hyperspectral data

Four stress combinations

- Fungal infection + Soil quality
- Nutrient deficiency + Drought
- Fungal infection + Drought
- Nutrient deficiency + Salt deposition

Detection of tree stress responses

Leaf functional traits

1) Gas exchange related traits
2) Water related traits
3) Chemical traits

using different analytical procedures and leaf spectral collections.






Project 1: Quantifying tree foliar chemical and physiological responses to abiotic and biotic stress using hyperspectral data

Abiotic and biotic stressors

Instrumental & chemical analyses

Ex)
Li-6400
Pressure chamber
HPLC

Foliar stress responses

Trait-based approach
Gas-exchange
Water
Chemical

Leaf spectral collection

Spectroradiometer

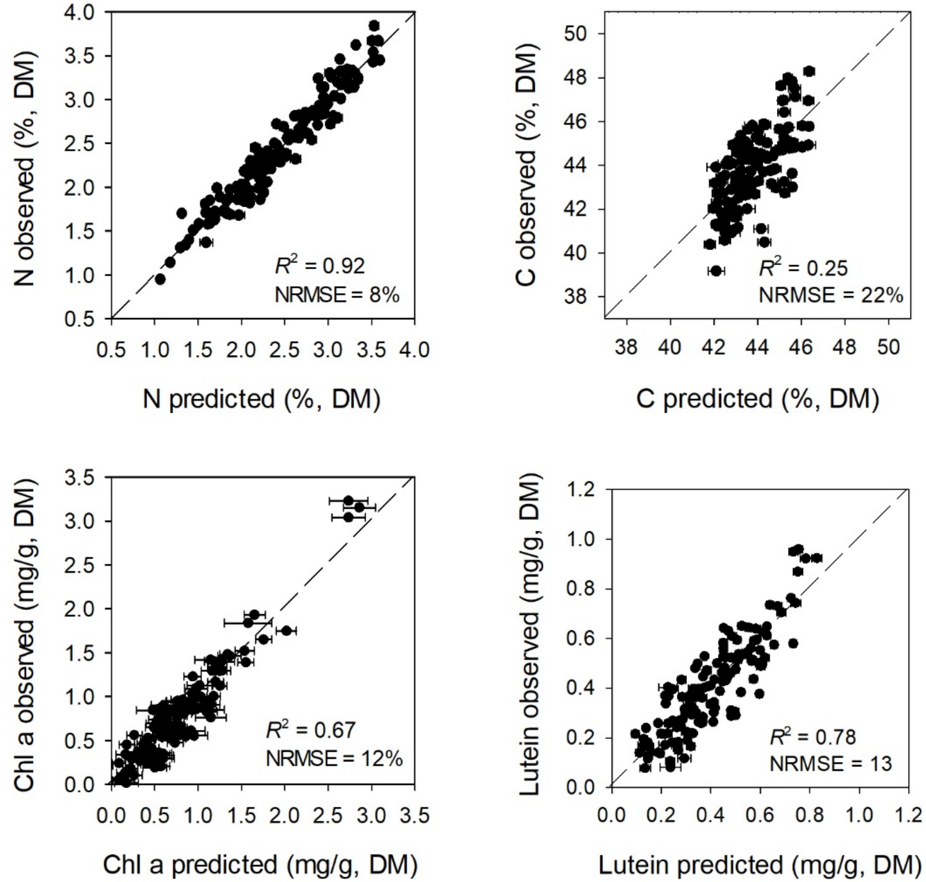
- 29 foliar biochemical traits were analyzed using high-performance liquid chromatography (HPLC) for trait retrievals.

Functional characterization	Traits	Details
Primary	Foliar nutrients	Carbon, nitrogen
	Pigments	Neoxanthin, violaxanthin, lutein, zeaxanthin, chlorophyll b, chlorophyll a, β-carotene
	Sugars	Sucrose, glucose, fructose
Secondary	Phenolic compounds	11 Phenolic acids, 5 flavonoids, juglone

Phenolic acids (gallic, vanillic, chlorogenic, caffeic, syringic, p-coumaric, ferulic, sinapic, salicylic, ellagic and trans-cinnamic acids),
Flavonoids (catechin hydrate, epicatechin, rutin, myricetin and quercetin)
Juglone

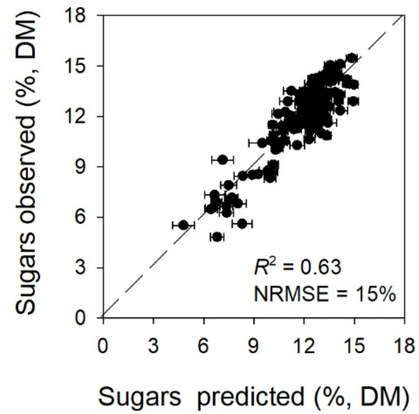
- Trait retrievals

  (Determination of the ability of hyperspectral data to estimate leaf functional traits)

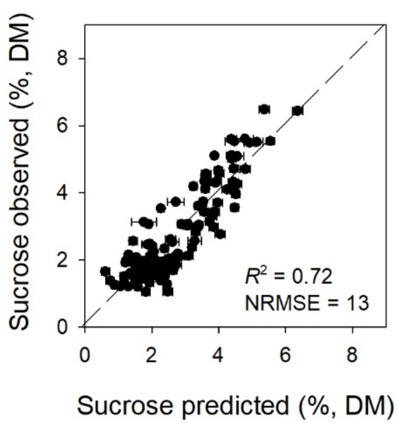


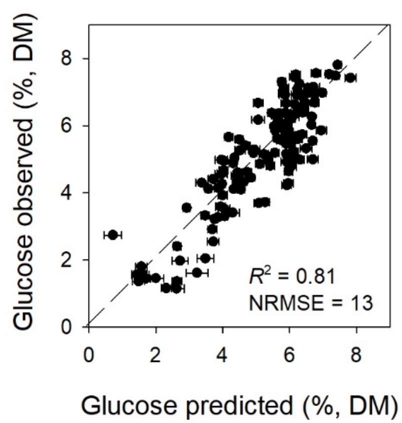
- Trait retrievals

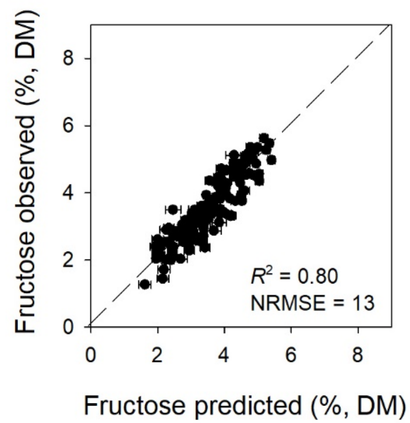
  (Determination of the ability of hyperspectral data to estimate leaf functional traits)



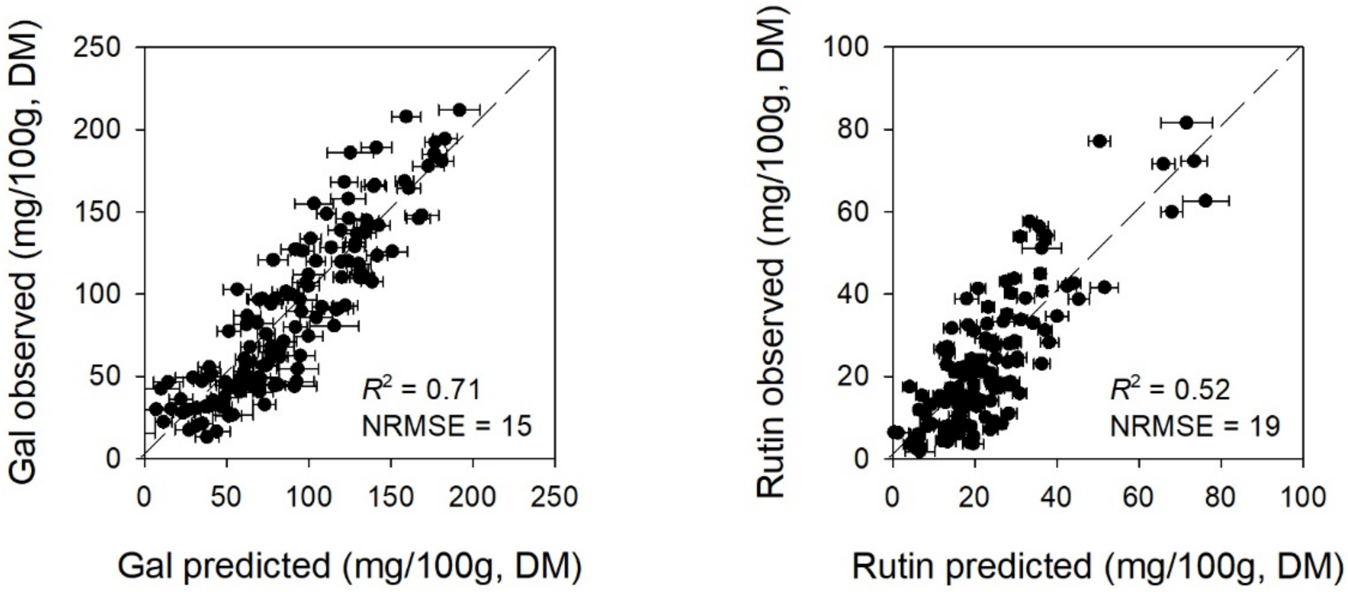
Sugars;
sucrose + glucose + fructose







- Trait retrievals
  (Determination of the ability of hyperspectral data to estimate leaf functional traits)



*Gal: Gallic acid

Future Plans

- Predict other biochemical leaf traits under abiotic and biotic stressors.
  - Leaf starch and condensed tannins
- Determine physiological and chemical differences among stress treatments.
- Prepare a research paper for publication.

Acknowledgements

Funding agency
- National Science Foundation/Center for Advanced Forestry Systems
- Hardwood Tree Improvement & Regeneration Center

Plant-insect chemical ecology lab

Regeneration and Restoration Silviculture Laboratory

Mickelbart lab

Martell Wright center