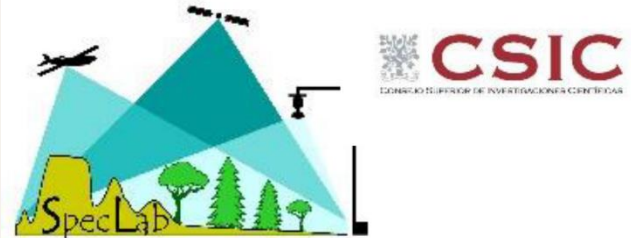




Área de  
Sistemas de Teledetección INTA



Grupo de Espectroscopía de  
Campo y Laboratorio AET



SpecLab CSIC

## Seminario: Protocolos y Librerías espectrales en Espectroscopía de campo: de las buenas prácticas a una mayor utilidad de los datos

Seguimiento de la evolución de la enfermedad “fuego bacteriano” (*Erwinia amylovora*) mediante espectrorradiometría



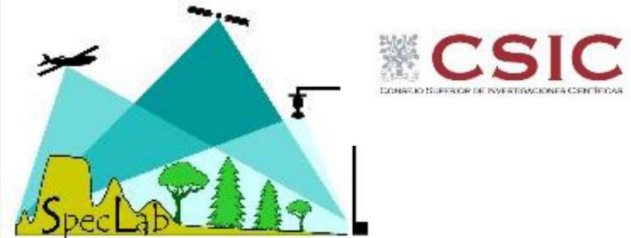
José Ramón Rodríguez Pérez  
7 marzo 2019. (INTA, Madrid)



Área de  
Sistemas de Teledetección INTA



Grupo de Espectroscopía de  
Campo y Laboratorio AET



SpecLab CSIC

## Workshop. Protocols and Spectral Libraries in Field Spectroscopy: good practices & greater utility of data

Monitoring of the evolution of the "fire blight" disease (*Erwinia amylovora*) by spectroradiometry



José Ramón Rodríguez Pérez  
March 7 , 2019. (INTA, Madrid, Spain)

# Contents

**The Disease**

**Symptoms**

**Objective**

**Materials**

**Propocol for field spectroscopy**

**Measurements**

**Results**

**Conclusions**

**References**



## The Disease

**Fire Blight** is the most **destructive bacterial** diseases of pome fruit trees.

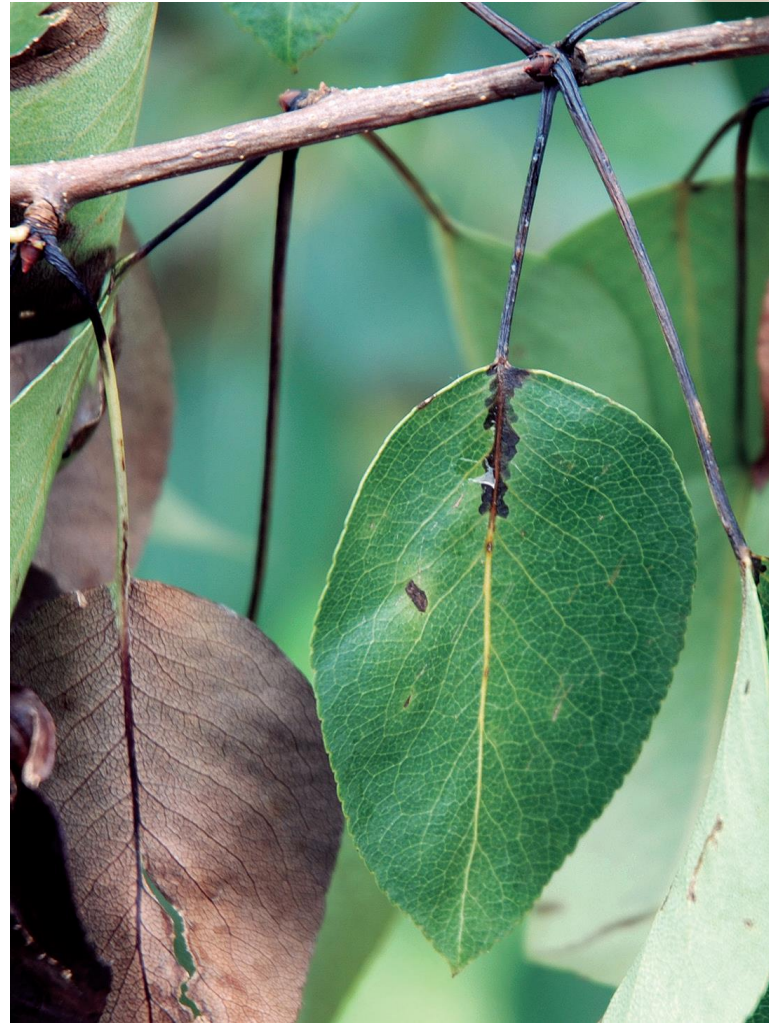
The causal agent: bacterium ***Erwinia amylovora***

This pathogen enters the tree through **openings** (natural or artificial)

It is a **high risk** disease:

- The **damage is very serious** (pear tree can death in a short time)
- The **ease of dispersion**
- There are **not curative treatments**
- Fire Blight is a **quarantine disease**

# Symptoms

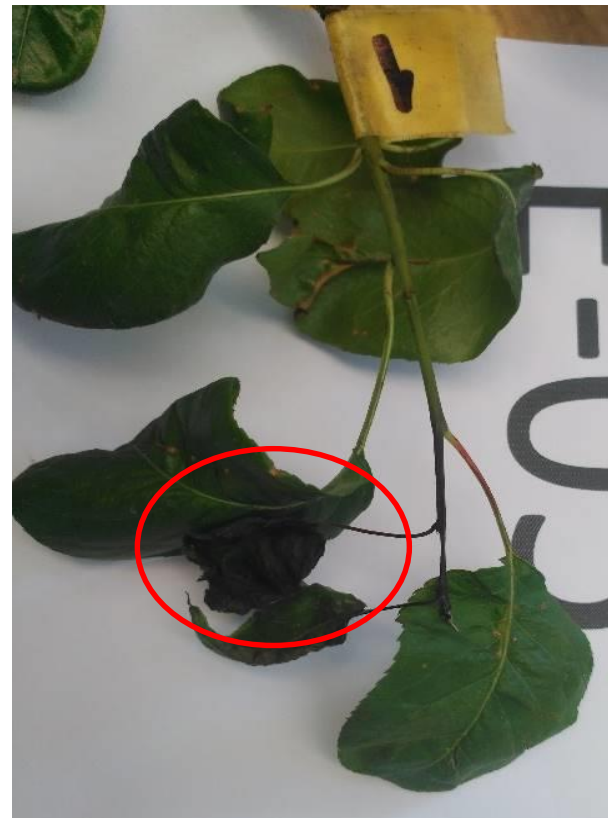


# Symptoms



## Objective

Is it possible to identify the disease **before** the symptoms are presented?



# Material

## The ASD FS4 and contact probe





# Propocol for field spectroscopy

- 1 Plan the field work**
- 2 Turn on the spectrometer**
- 3 Set up the ASD FS4 into the Backpack**
- 4 Attach the pistol grip or the plant probe**
- 5 Switch laptop on**
- 6 Create a path to store the spectral data**
- 7 Start 'High Contrast RS3' instrument software**
- 8 Connect GPS (via Bluetooth) to the laptop**

**9 Spectral measurement setup – saving data**

**10 Adjusting the measurement configuration – fore optics and spectral averaging**

**11 Taking measurements – optimization**

**12 Taking measurements – radiance**

**13 Taking measurements – white reference**

**15 Taking measurements – target**

**16 Taking measurements – repeat white reference**

# Propocol for field spectroscopy

**17 Recording metadata**

**18 Take reference photos**

**19 Moving to the next sample/plot**

**20 Setup for the next sample/plot**

**21 Spectral measurement setup – saving data**

**22 Taking spectral measurements – additional samples/plots**

**23 Returning from spectral sampling**

...

ASD, 1999

Danner et al, 2005

Pfizner et al, 2011

# Propocol for field spectroscopy

## ASD FieldSpec 4: field work metadata

SHEET NO.

<b>Date</b>		<b>Reference Panel</b>	<i>Spectralon 99%</i>	<i>Standard</i>	<i>Reference leaf clip</i>	
<b>Location</b>		<b>Foreoptics (FOV)</b>	<i>NO (25°)</i>	<i>10°</i>	<i>3°</i>	<i>Cosine receptor</i>
<b>Instrument</b>		<b>Mode</b>	<i>Irradiance raw ND</i>	<i>Radiance raw ND</i>	<i>Absolute Reflectance</i>	<i>Relative Reflectance</i>
<b>Operator</b>		<b>Accessory</b>	<i>Pistol grip</i>	<i>Contact probe</i>		
		<b>Light source</b>	<i>sum</i>	<i>Contact probe lamp</i>	<i>Reflectance Lamp (indoor)</i>	

Time	Opt	DC	WR	Filename (Folder)	Description	Sky , comments

SKY: clear; daze; clouds sun not obscured; clouds sun obscured; drizzle (stop measurement j).

University of Edinburgh (Natural Environment Research Council (NERC), Field Spectroscopy Facility (FSF))  
<http://fsf.nerc.ac.uk/resources/logsheets/>

# Measurements

10 trees

3 stems per tree

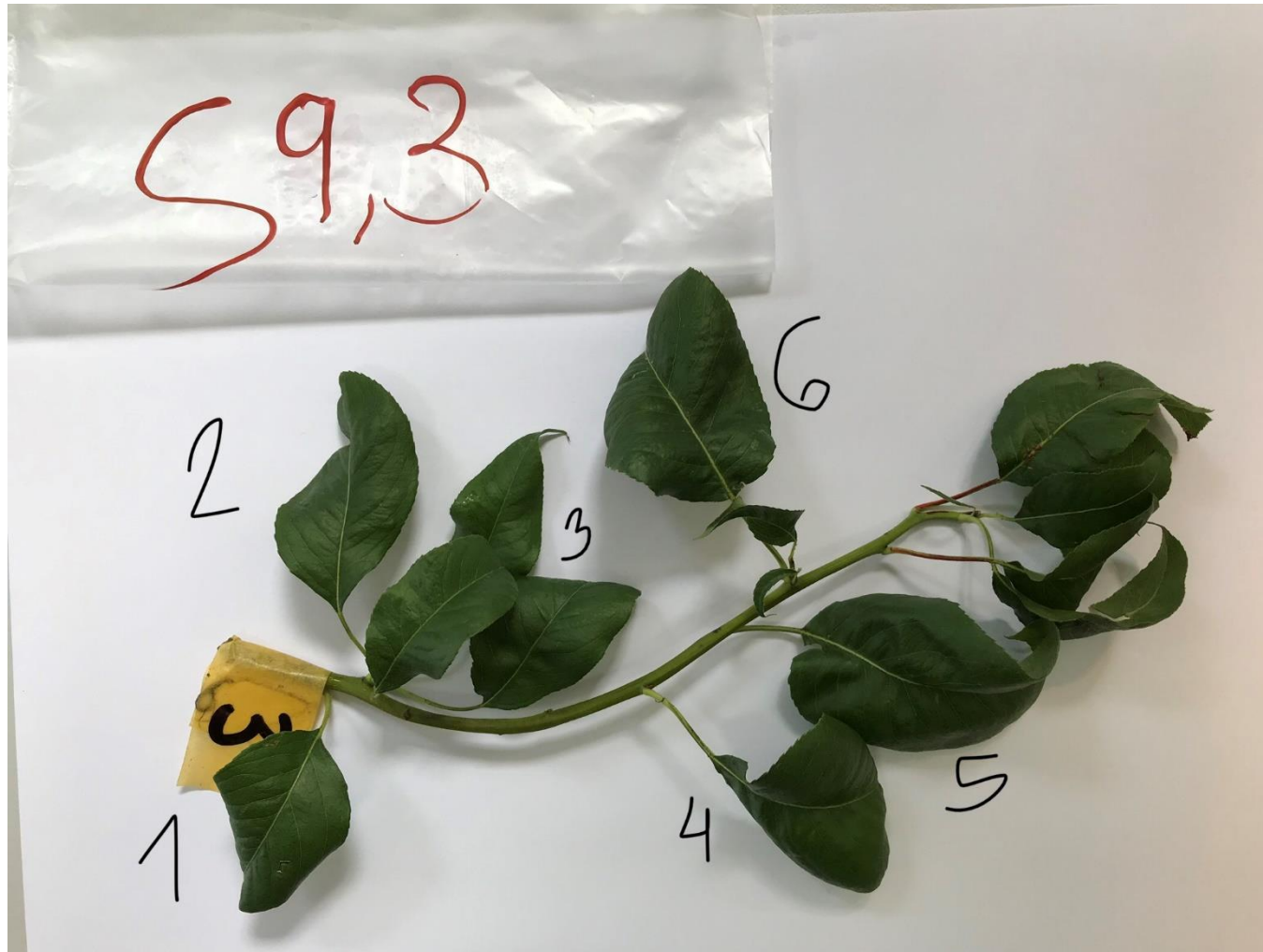
2 leaves per stem

Upper and back sides of leaves

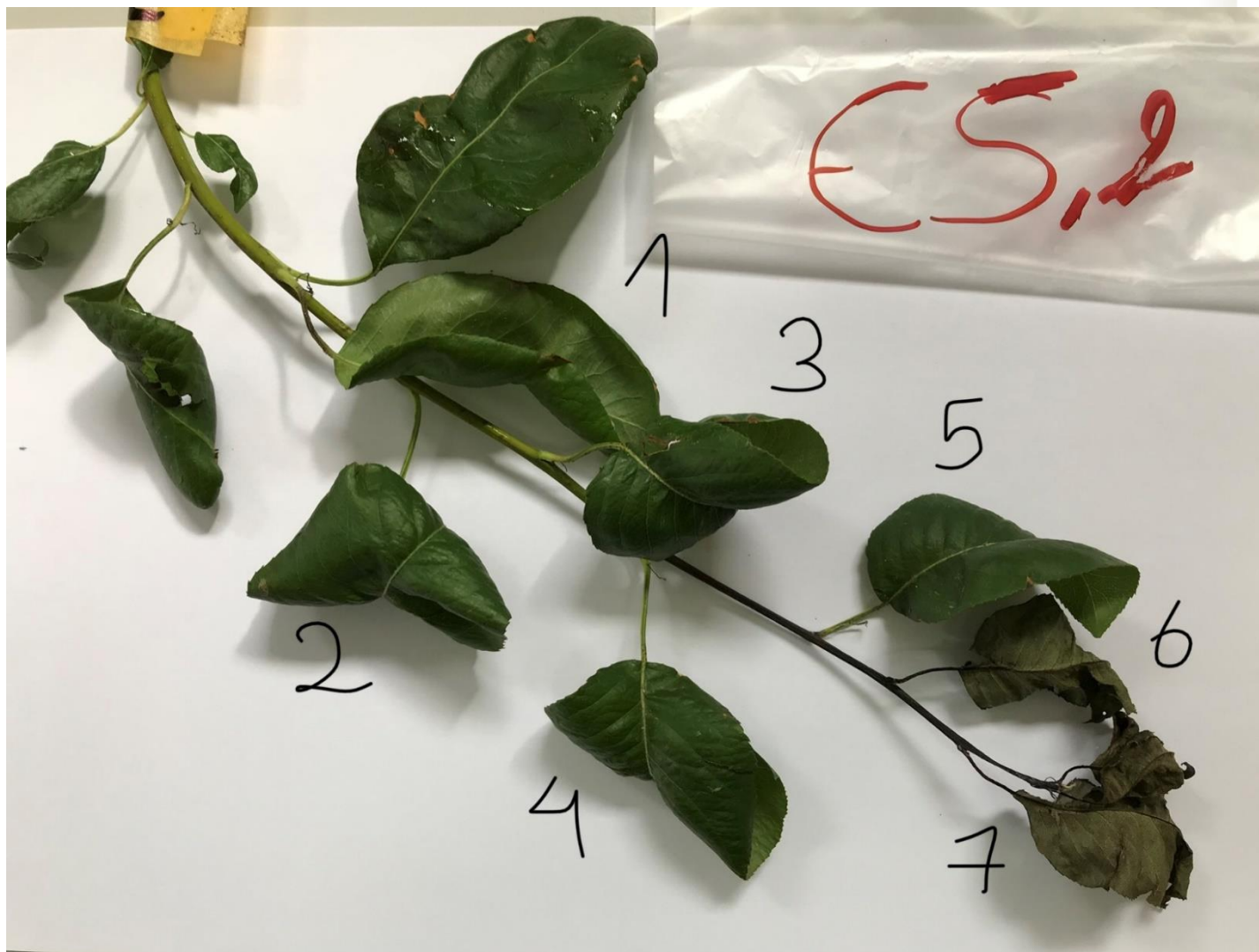
13	14	16	17	20
09/07/2018	10/07/2018	12/07/2018	13/07/2018	16/07/2018
NO	NO	NO	NO	NO
NO	NO	NO	NO	NO
NO	PREVIOUS	PETIOLE	BLADE	BLADE
NO	PREVIOUS	PETIOLE	PETIOLE	PETIOLE
NO	PREVIOUS	PETIOLE	PETIOLE	BLADE
NO	NO	PREVIOUS	PETIOLE	PETIOLE
NO	NO	NO	NO	NO
NO	NO	NO	NO	NO
PREVIOUS	PETIOLE	BLADE	BLADE	BLADE
NO	PREVIOUS	PETIOLE	PETIOLE	PETIOLE
PREVIOUS	PETIOLE	BLADE	BLADE	BLADE
NO	PREVIOUS	PETIOLE	BLADE	BLADE
NO	NO	NO	NO	NO
NO	NO	NO	NO	NO

Tree	Stem	Day Leaf	1	2	3	6	7	8	10	13	14	16	17	20	21	22	27	29
			27/06/2018	28/06/2018	29/06/2018	02/07/2018	03/07/2018	04/07/2018	06/07/2018	09/07/2018	10/07/2018	12/07/2018	13/07/2018	16/07/2018	17/07/2018	18/07/2018	23/07/2018	25/07/2018
1	1	1	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
		2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2	1	NO	NO	NO	NO	NO	NO	NO	NO	NO	PREVIOUS	PETIOLE	BLADE	BLADE	BLADE	BLADE	BLADE
		2	NO	NO	NO	NO	NO	NO	NO	NO	NO	PREVIOUS	PETIOLE	PETIOLE	PETIOLE	PETIOLE	BLADE	BLADE
	3	1	NO	NO	NO	NO	NO	NO	NO	NO	NO	PREVIOUS	PETIOLE	PETIOLE	BLADE	BLADE	BLADE	BLADE
		2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	PREVIOUS	PETIOLE	PETIOLE	PETIOLE	BLADE	BLADE
2	1	1	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
		2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2	1	NO	NO	NO	NO	NO	NO	NO	NO	PREVIOUS	PETIOLE	BLADE	BLADE	BLADE	BLADE	BLADE	BLADE
		2	NO	NO	NO	NO	NO	NO	NO	NO	NO	PREVIOUS	PETIOLE	PETIOLE	PETIOLE	BLADE	BLADE	
	3	1	NO	NO	NO	NO	NO	NO	NO	NO	PREVIOUS	PETIOLE	BLADE	BLADE	BLADE	BLADE	BLADE	BLADE
		2	NO	NO	NO	NO	NO	NO	NO	NO	NO	PREVIOUS	PETIOLE	BLADE	BLADE	BLADE	BLADE	BLADE
3	1	1	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
		2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2	1	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
		2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	3	1	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
		2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4	1	1	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
		2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	2	1	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	PREVIOUS	PETIOLE	PETIOLE	BLADE	BLADE	BLADE
		2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	PREVIOUS	PETIOLE	BLADE	BLADE	BLADE

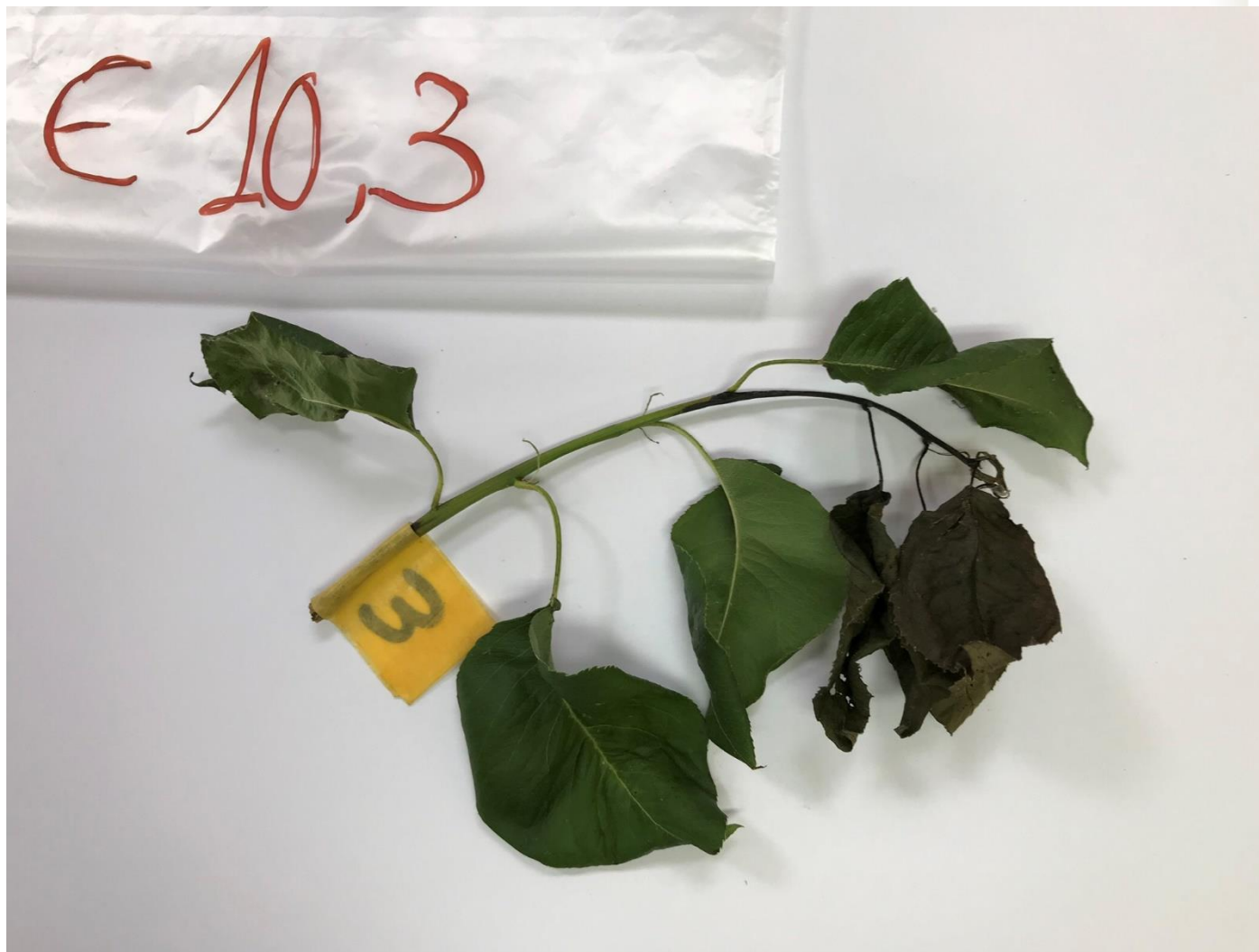
# Measurements



# Measurements

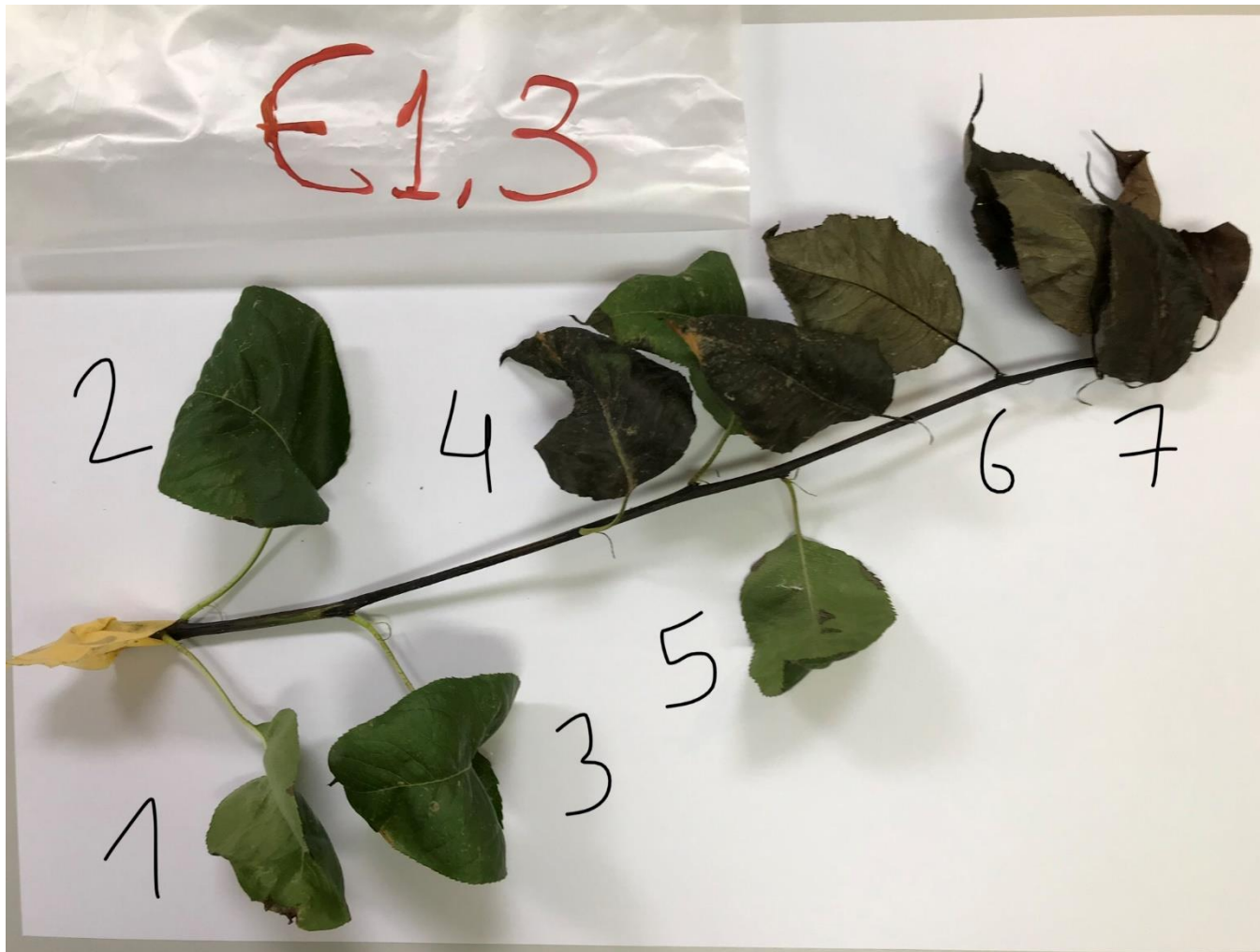


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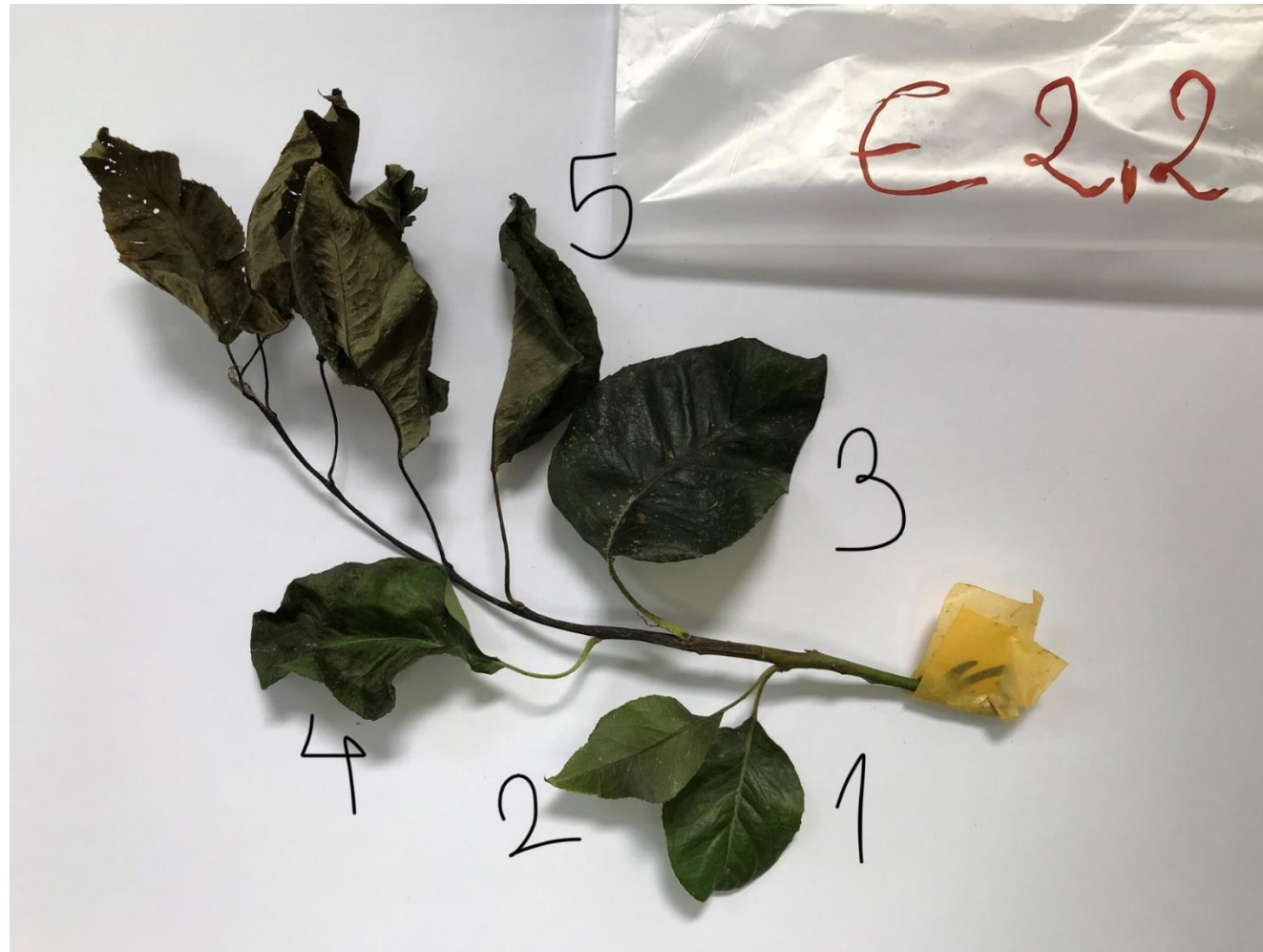




# Measurements



# Measurements



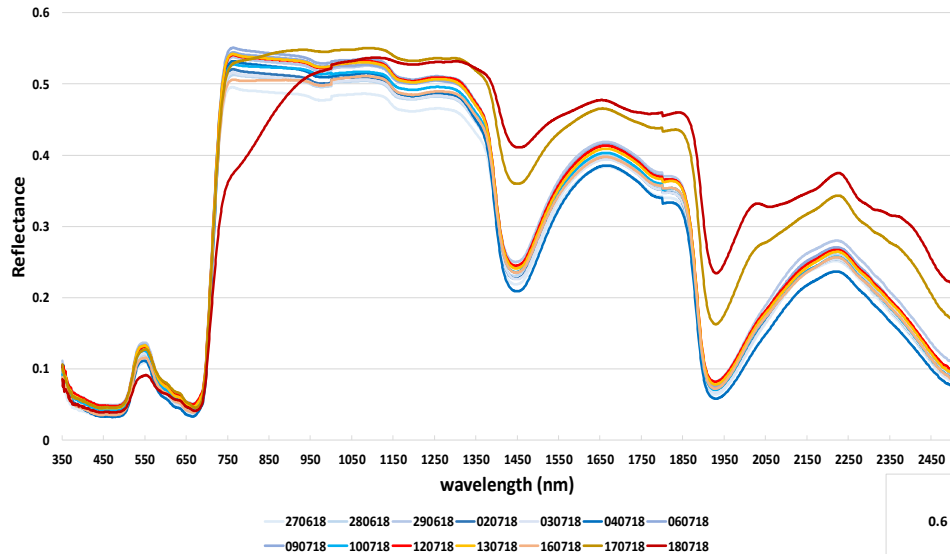
# Measurements



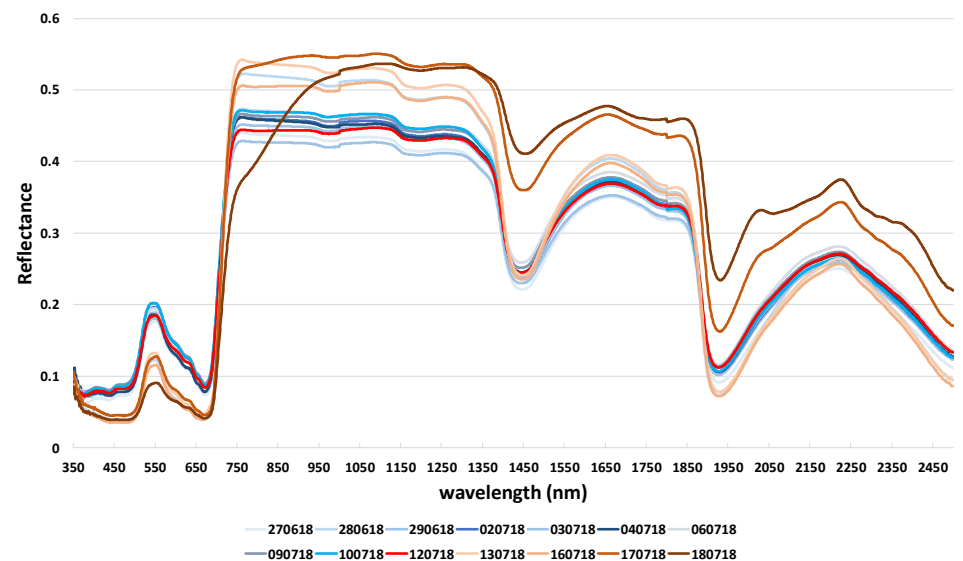
# Results



Tree 1. Stem 2. Leaf 1. Upper side

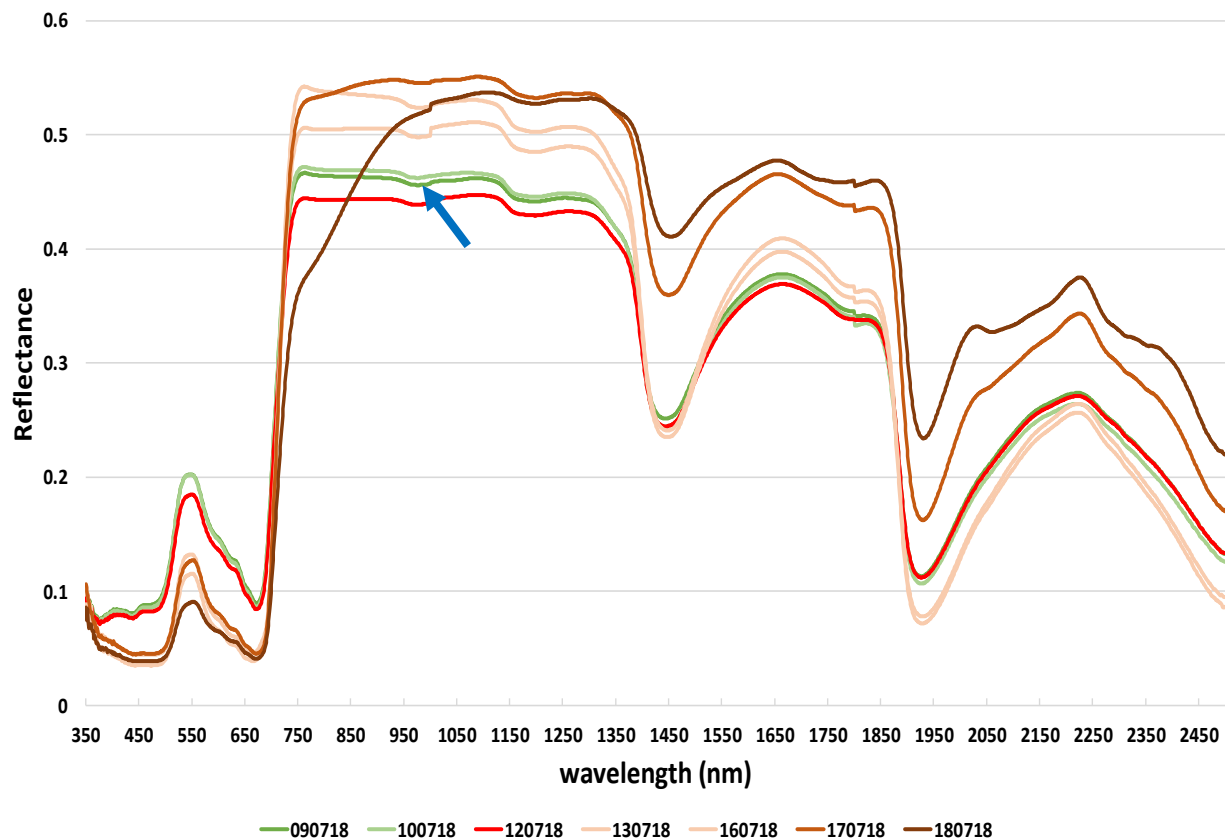


Tree 1. Stem 2. Leaf 1. Back side



# Results

Tree 1. Stem 2. Leaf 1. Back side

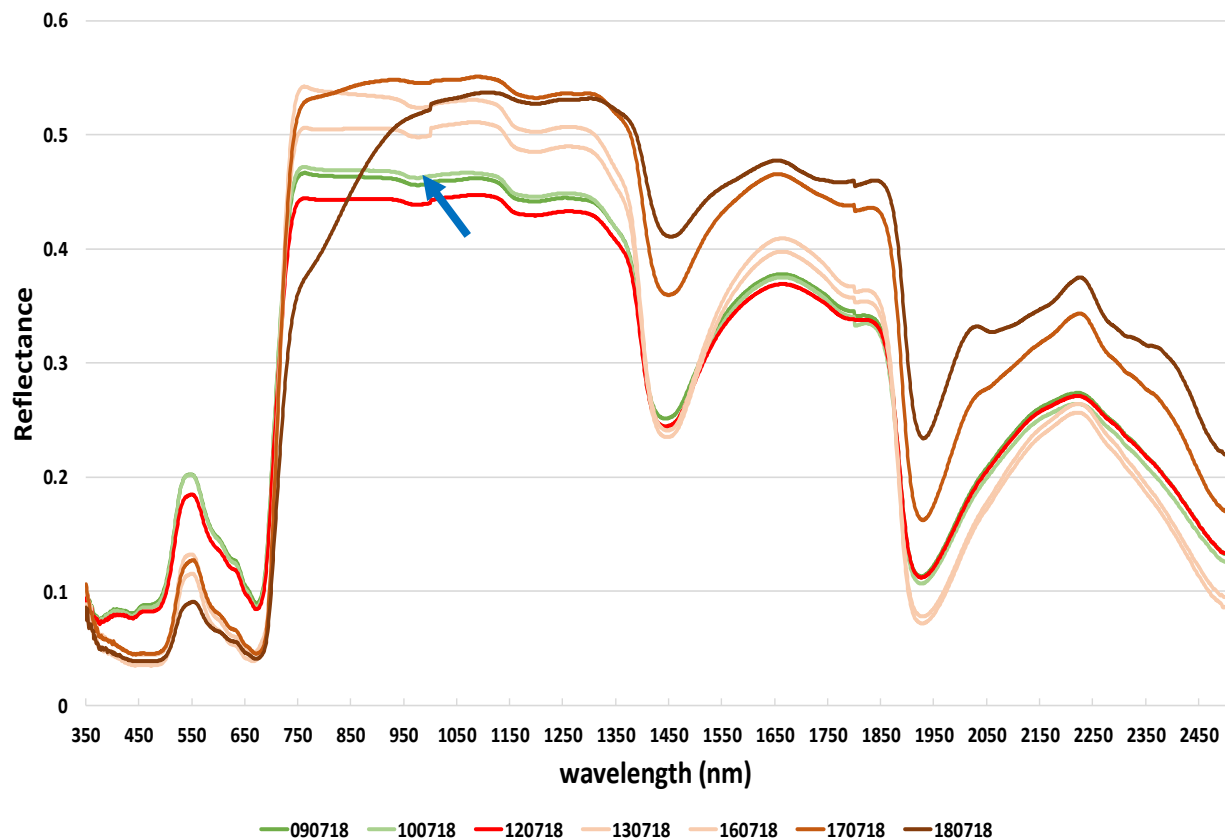


090718



# Results

Tree 1. Stem 2. Leaf 1. Back side

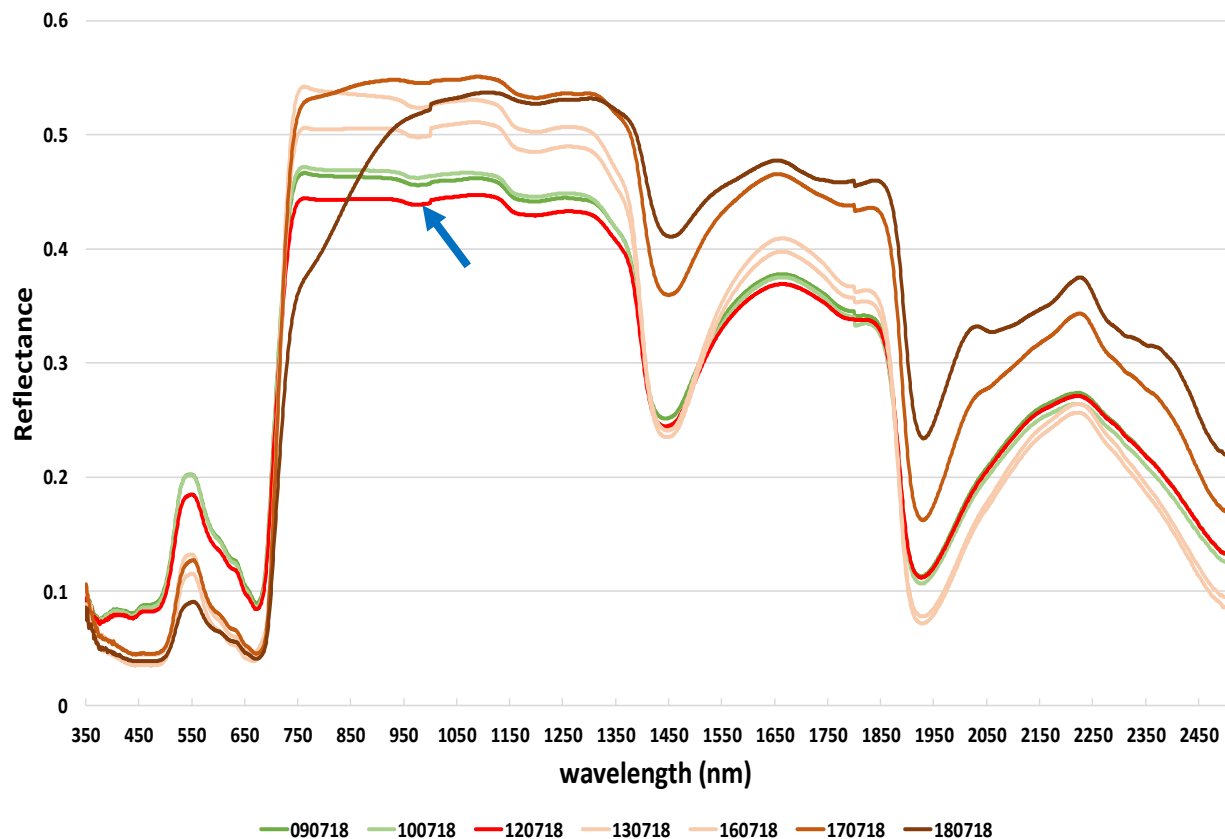


100718



# Results

Tree 1. Stem 2. Leaf 1. Back side

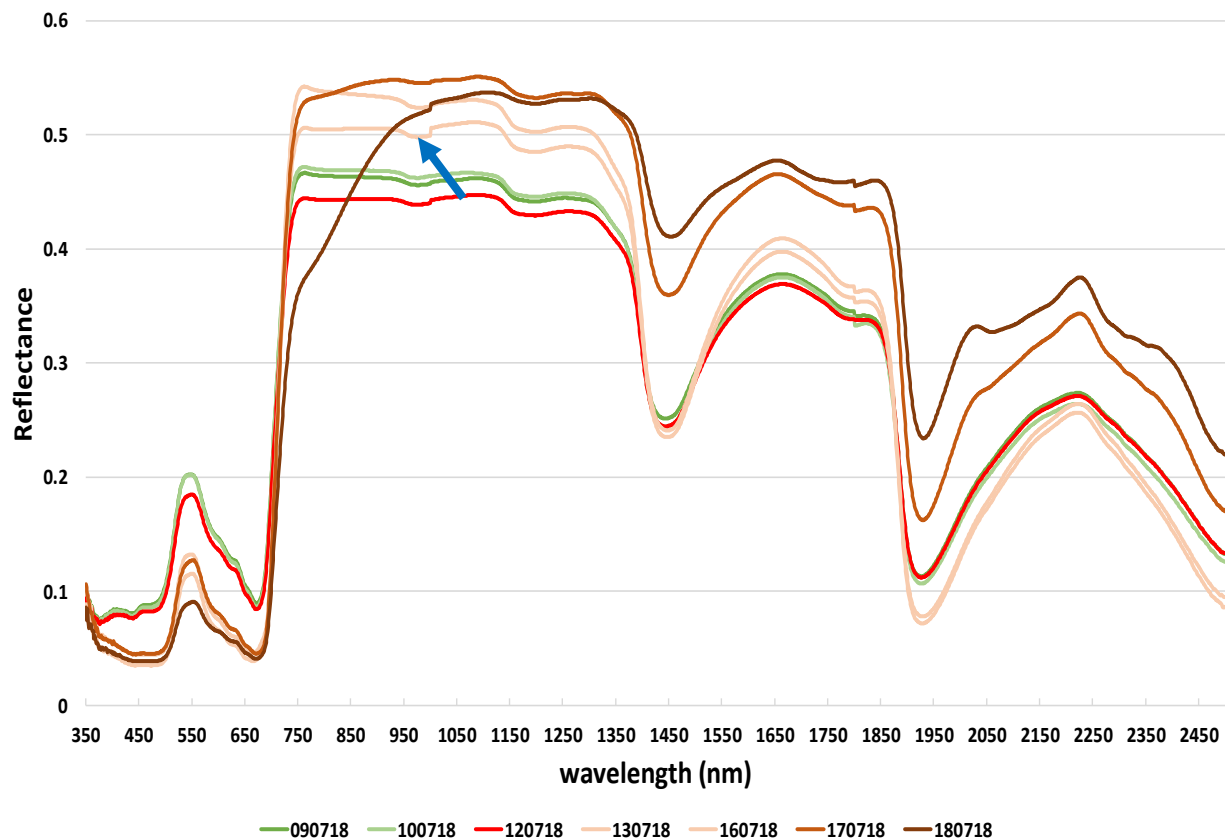


120718



# Results

Tree 1. Stem 2. Leaf 1. Back side



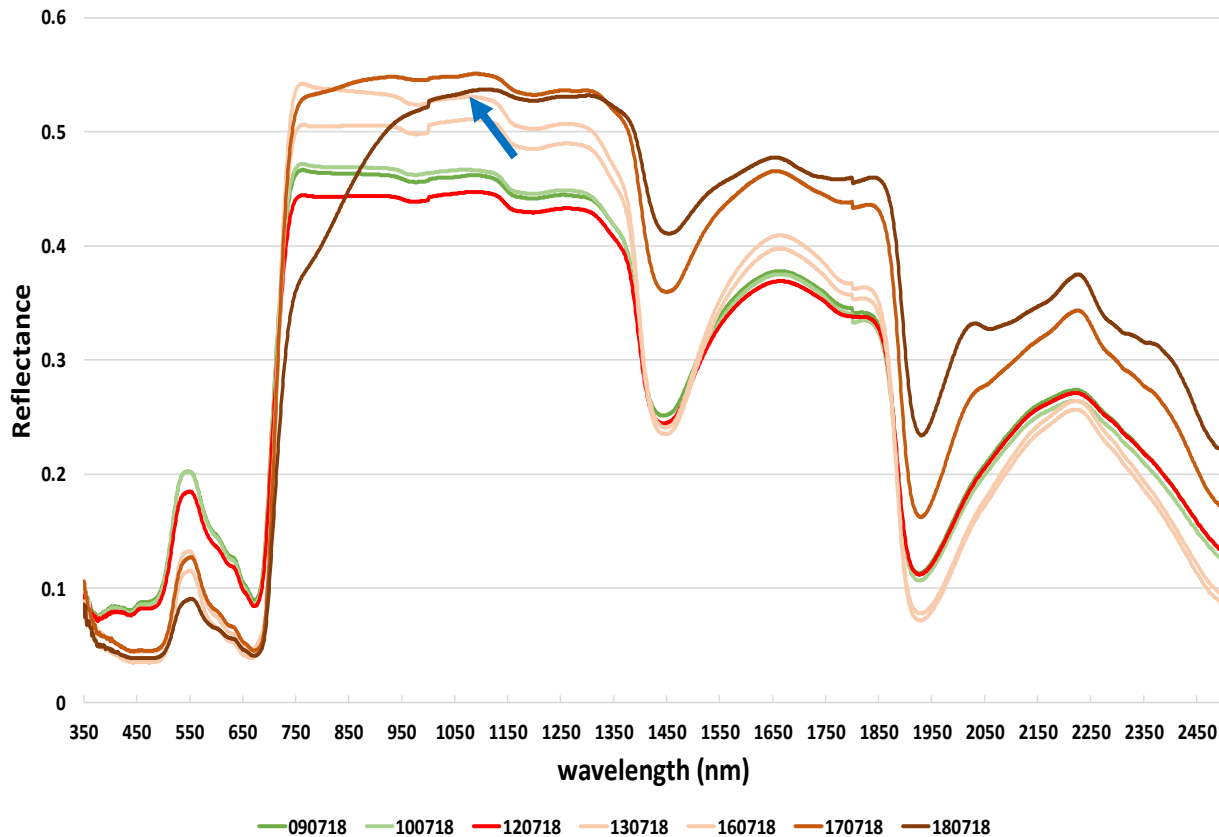
130718





# Results

Tree 1. Stem 2. Leaf 1. Back side

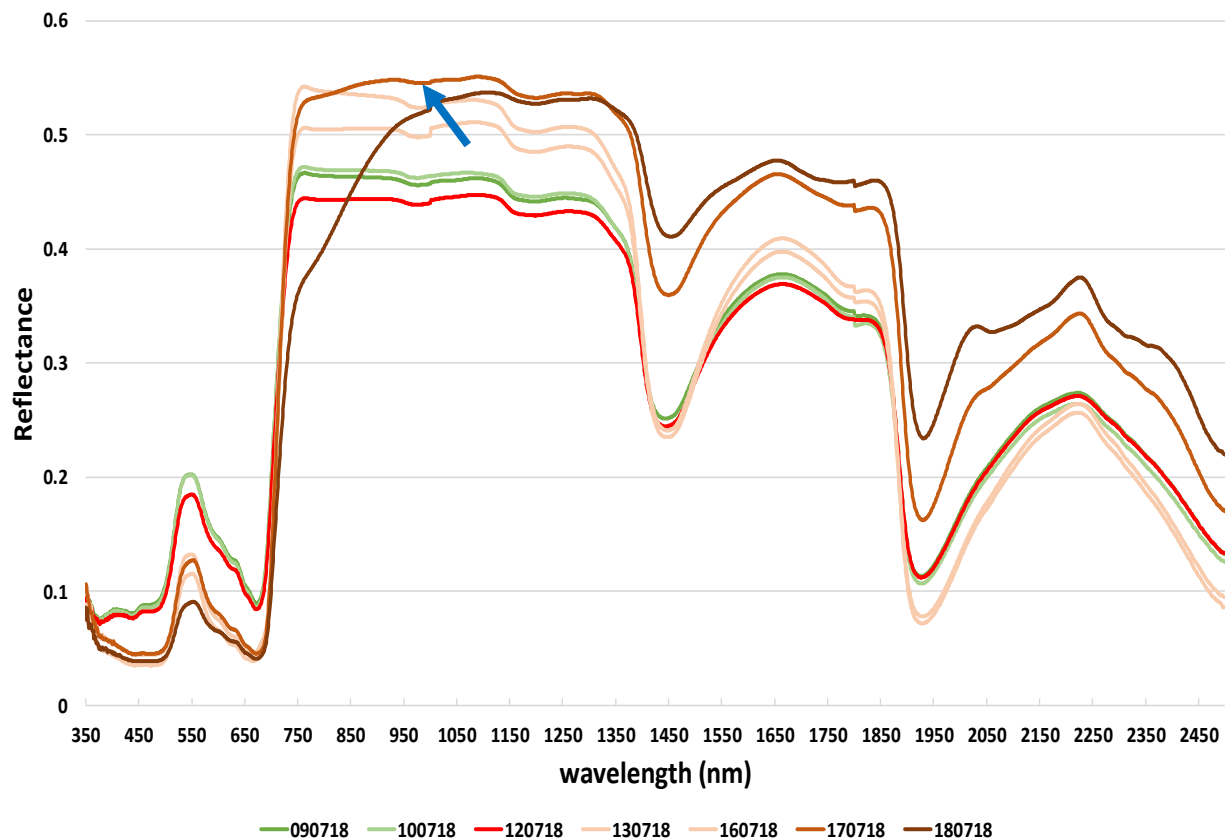


160718



# Results

Tree 1. Stem 2. Leaf 1. Back side

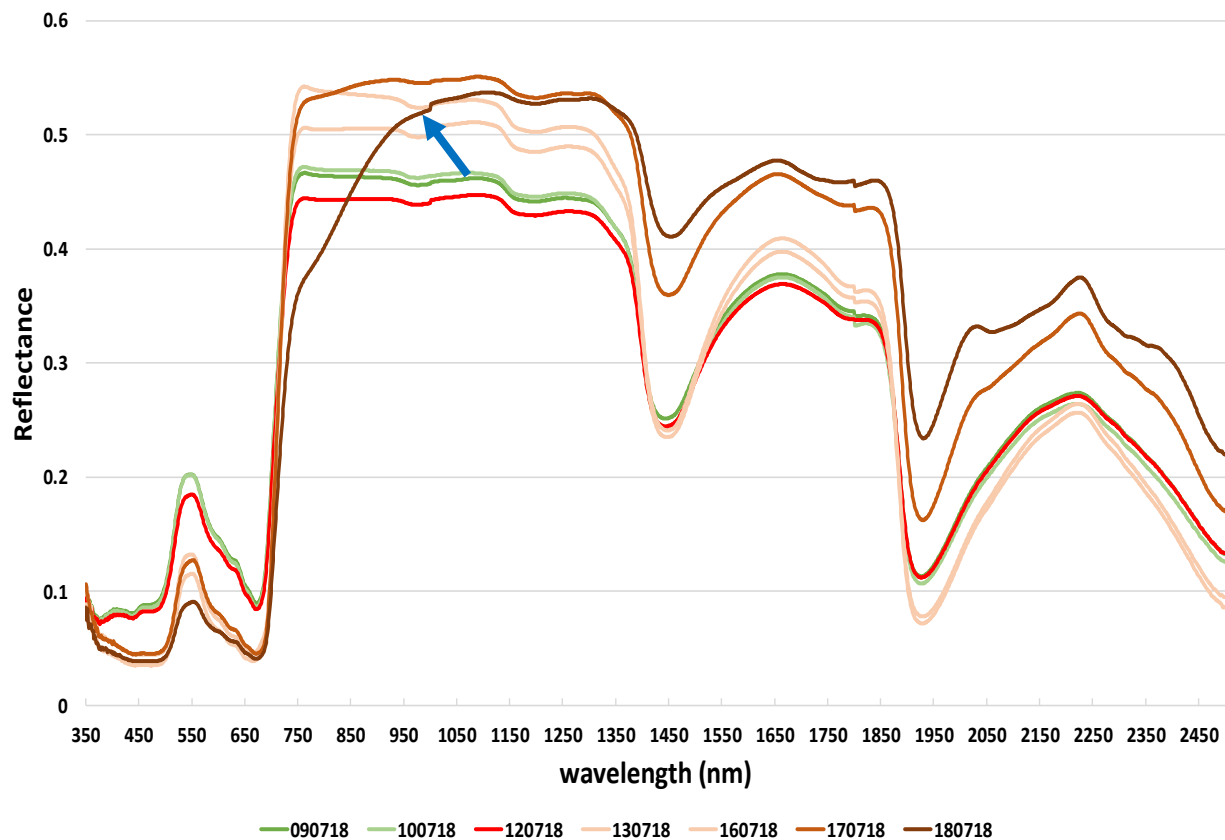


170718



# Results

Tree 1. Stem 2. Leaf 1. Back side

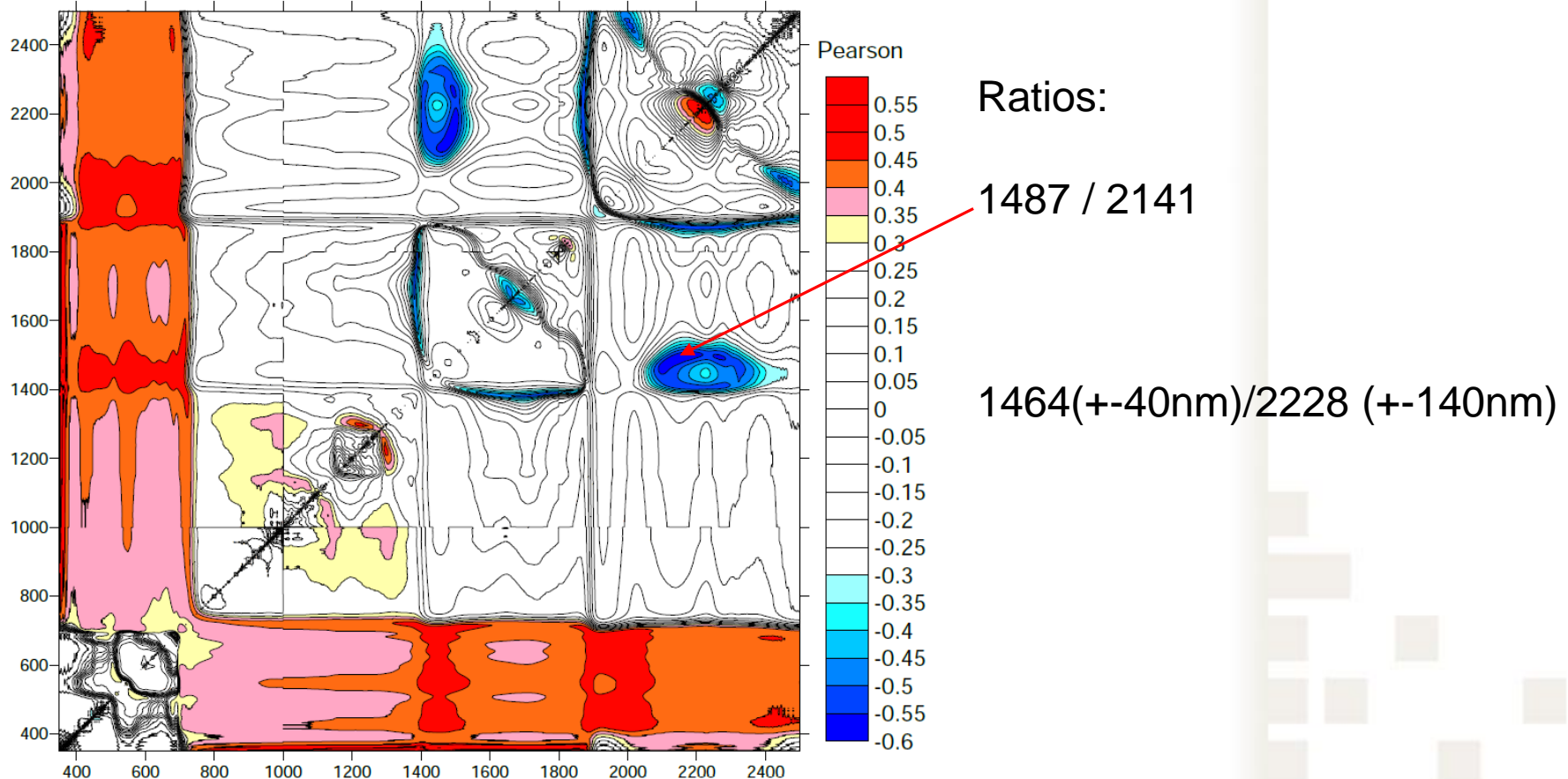


180718

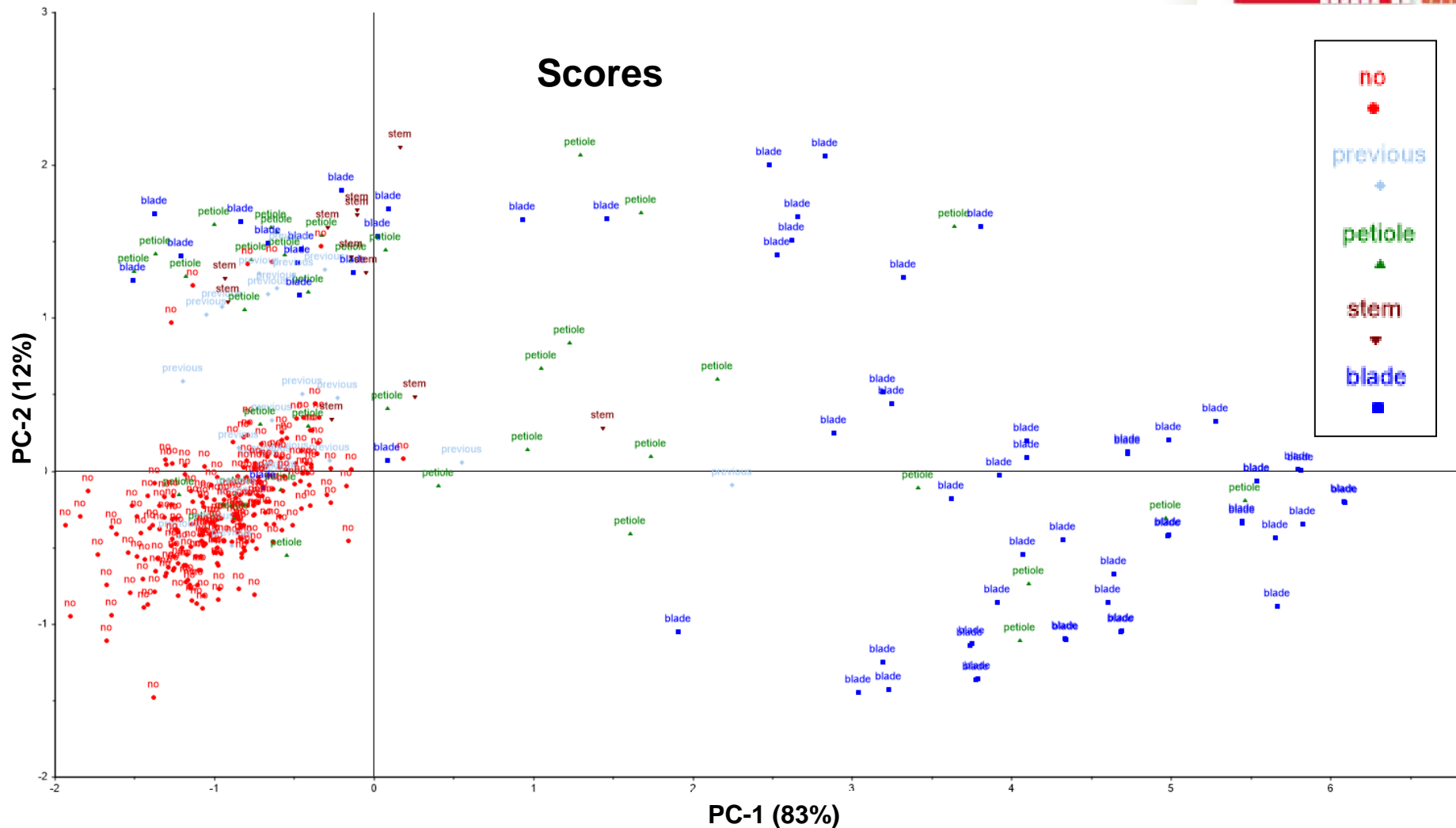


# Results

Correlation between the days remaining for the appearance of symptoms and the ratios between wavelengths

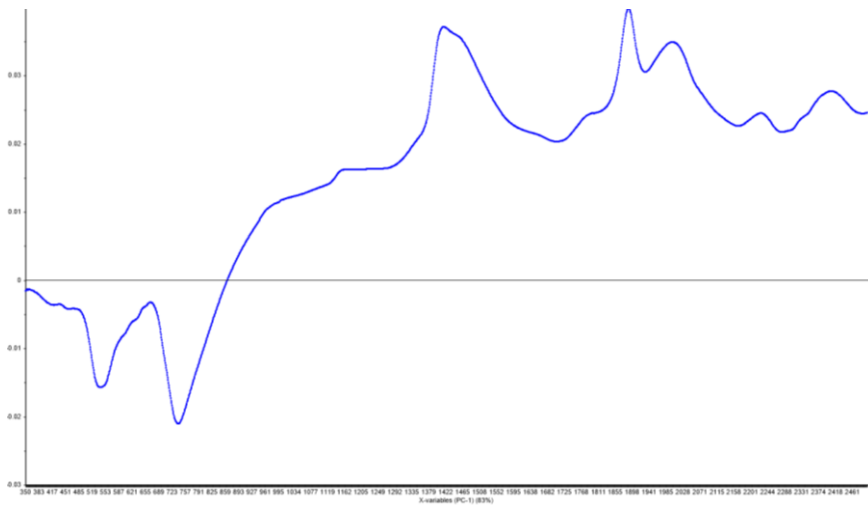


# Results



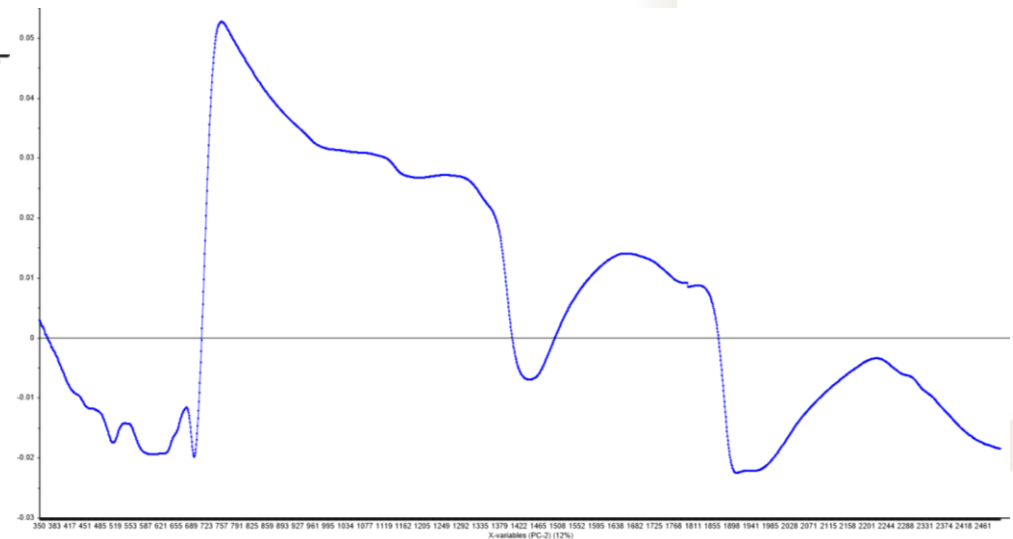
# Results

## Loadings

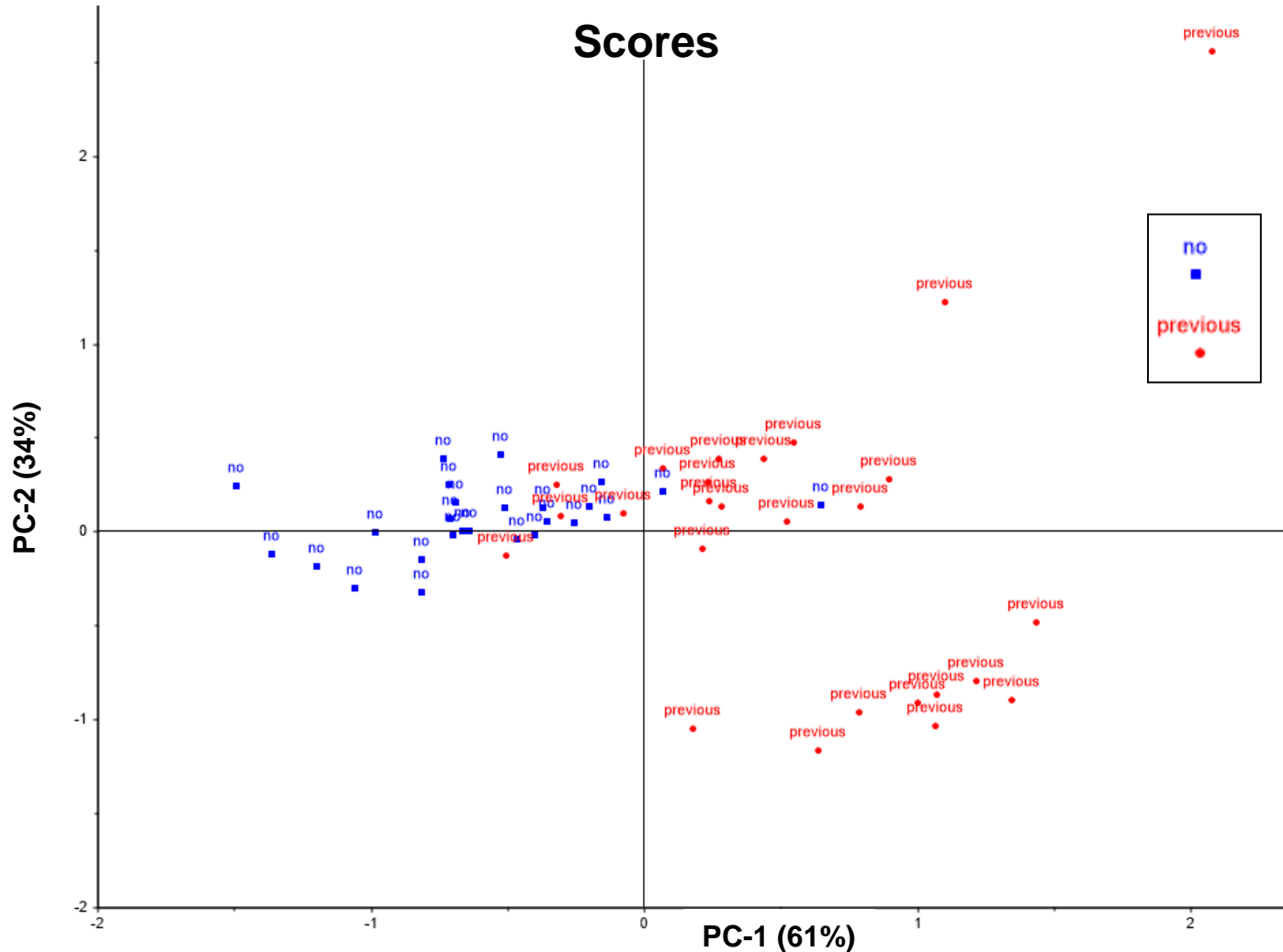


Loadings PC1:  
1400nm  
2000nm

Loadings PC2:  
760nm

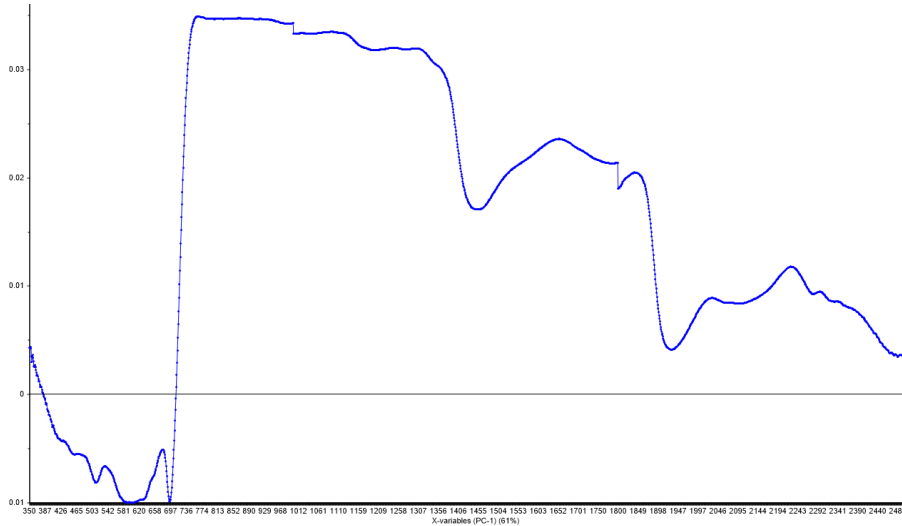


# Results



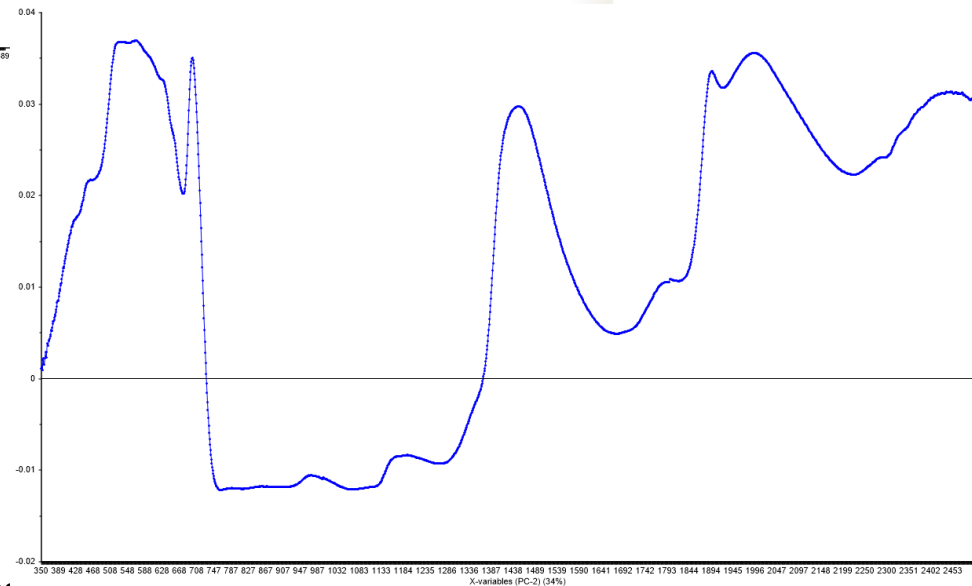
# Results

## Loadings



Loadings PC1:  
760 – 1130 nm

Loadings PC2:  
530-550 nm  
1430 nm  
2000 nm





## Conclusions

Fire Blight has an **erratic** behavior ...

It can be **predicted before** the symptoms appear

It is very important to choose the **leaf position**

Wavelengths: 750 – 1100nm; 1400; 1900

## Acknowledgment

Enoc Sanz, Pablo Fernandez, Pablo Carballo,

Eva M<sup>a</sup> Gómez-Bernardo, Alicia Lorenzana

Pablo Linares, Victoriano Marcelo

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Metadata: University of Edinburgh (Natural Environment Research Council (NERC), Field Spectroscopy Facility (FSF)) <http://fsf.nerc.ac.uk/resources/logsheets/> (accessed on 20190306)

Guidelines: University of Edinburgh (Natural Environment Research Council (NERC), Field Spectroscopy Facility (FSF)) <http://fsf.nerc.ac.uk/resources/guides/> (accessed on 20190306)



**Thank you very much  
for your time**

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