

AGRICULTURAL UNIVERSITY OF ATHENS
Department of Crop Science, Laboratory of Plant Pathology

**Integrated pest management
smart technologies to precisely detect
and control plant diseases**

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Integrated management systems of prognosis and diagnosis of plant diseases and mycotoxins

What is IPM?

Integrated Pest Management is a science-based approach that combines a variety of techniques. By studying their life cycles and how pests interact with the environment, IPM professionals can manage pests with the most current methods to improve management, lower costs, and reduce risks to people and the environment.

IPM tools include:

- Alter surroundings
- Add beneficial insects/organisms
- Grow plants that resist pests
- Disrupt development of pest
- Prevention of pest problem developing
- Disrupt insect behaviors
- Use pesticides

3 PREVENT

Some pest problems can be prevented by using resistant plants, planting early, rotating crops, using barriers against climbing pests, sanitation, and sealing cracks in buildings.

4 ACTION

IPM uses multiple tools to reduce pests below an economically damaging level. A careful selection of preventive and curative treatments will reduce reliance on any one tactic and increase likelihood of success.

5 MONITOR

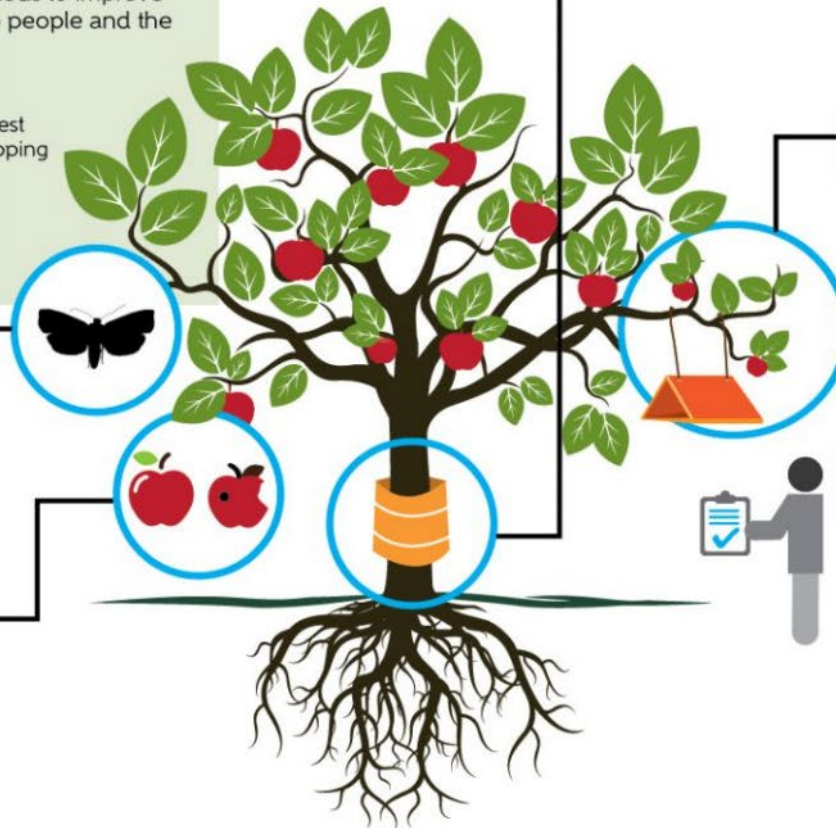
Continue to monitor the pest population. If it remains low or decreases, further treatments may not be necessary, but if it increases and exceeds the action threshold, another IPM tool should be used.

1 IDENTIFY/MONITOR

Determine the causal agent and its abundance (contact your local extension agent for help).

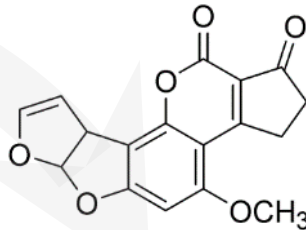
2 EVALUATE

The results from monitoring will help to answer the questions: Is the pest causing damage? Do we need to act? As pest numbers increase toward the economic threshold further treatments may be necessary.

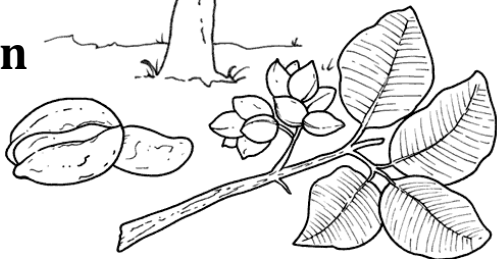


AFLA-pistachio: From the infection cycle to the relational diagram

Growth

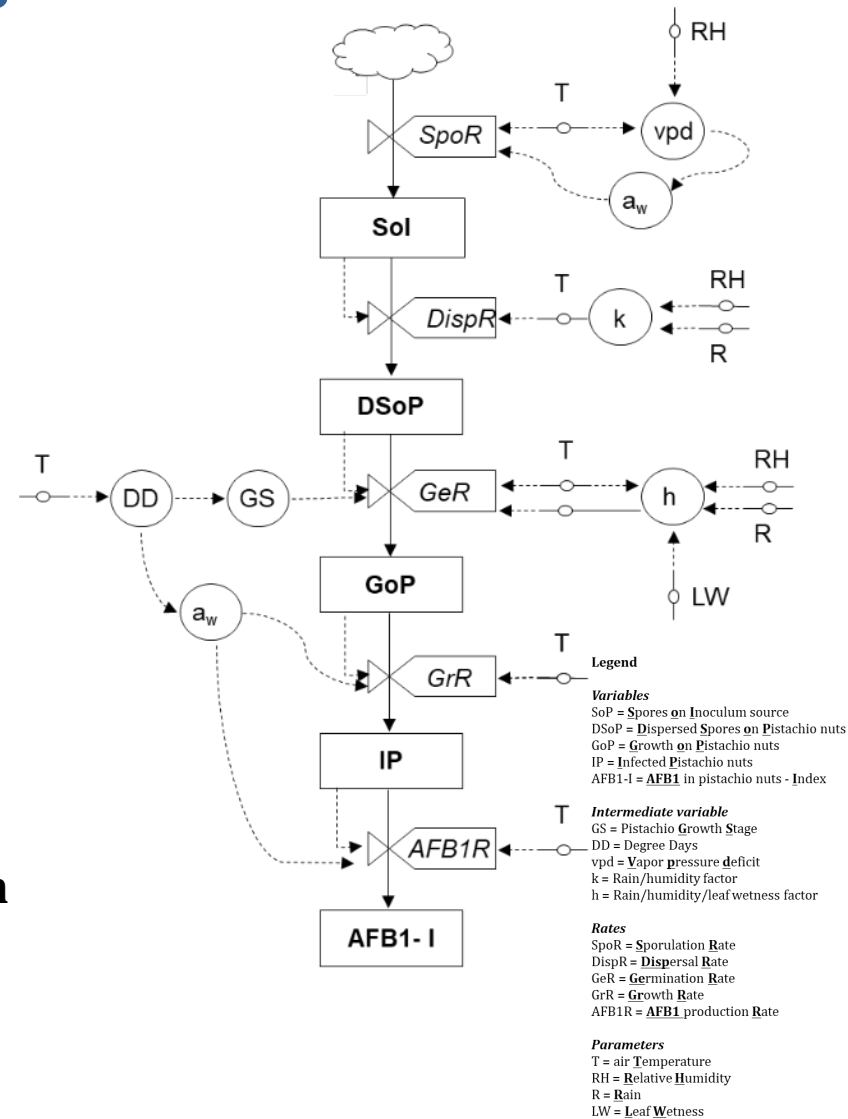


Germination



Sporulation

Dispersal



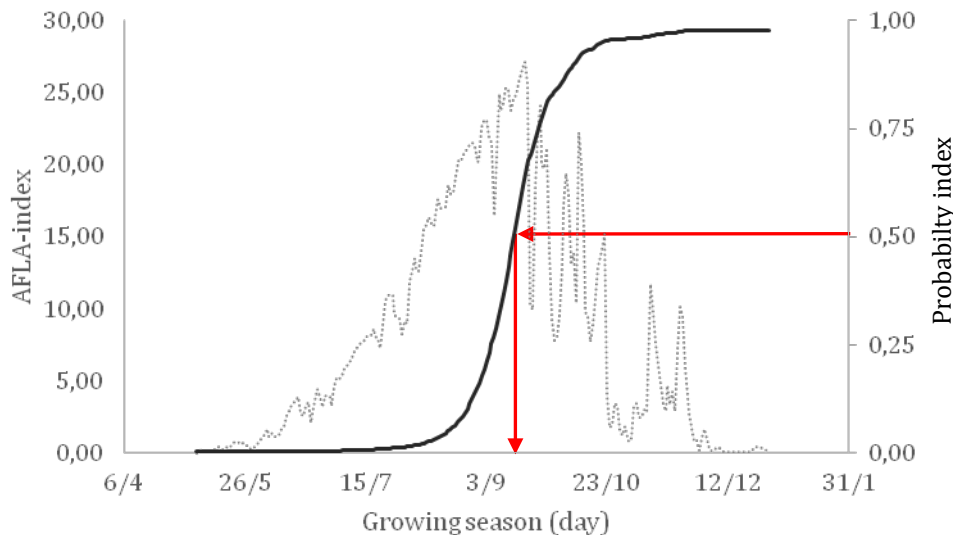
AFLA-pistachio: probability risk

Binary logistic approach

Output of logistic equation 0-1

0.5 indicates that a probability index begins to accumulate

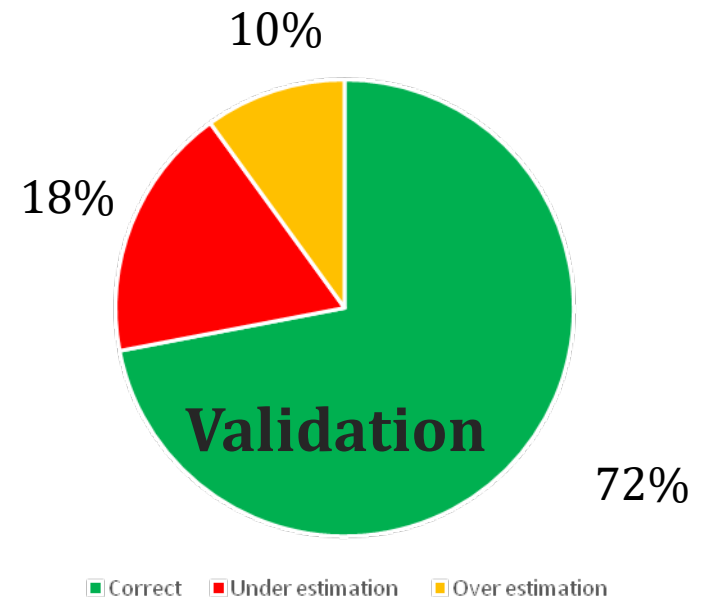
$$P = \frac{1}{1 + \exp^{-(C+B_1X_1+B_2X_2+\dots+B_pX_p)}}$$



		Variabili nell'equazione					
		B	S.E.	Wald	gl	Sign.	Exp(B)
Fase 1 ^a	Index	0.005	0.003	4.064	1	0.044	1.005
	Costante	-5.942	2.709	4.813	1	0.028	0.003



Field contamination data 2014+2015



Article

AFLA-PISTACHIO: Development of a Mechanistic Model to Predict the Aflatoxin Contamination of Pistachio Nuts

Michail D. Kaminiaris ^{1,†}, Marco Camardo Leggieri ^{2,†}, Dimitrios I. Tsitsigiannis ¹ and Paola Battilani ^{2,*}

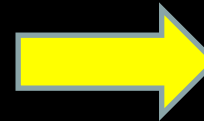
¹ Laboratory of Plant Pathology, Department of Crop Science, School of Plant Sciences, Agricultural University of Athens, Iera Odos 75, 11855 Athens, Greece; mikekaminaris@gmail.com (M.D.K.); dimtsi@aua.gr (D.I.T.)

² Department of Sustainable Crop Production (DI.PRO.VE.S.), Università Cattolica del Sacro Cuore, Via Emilia Parmense 84, 29122 Piacenza, Italy; marco.camardoleggieri@unicatt.it

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† M.D.K. and M.C.L. contributed equally in experimental and writing of this paper.

Smart systems for plant disease diagnosis

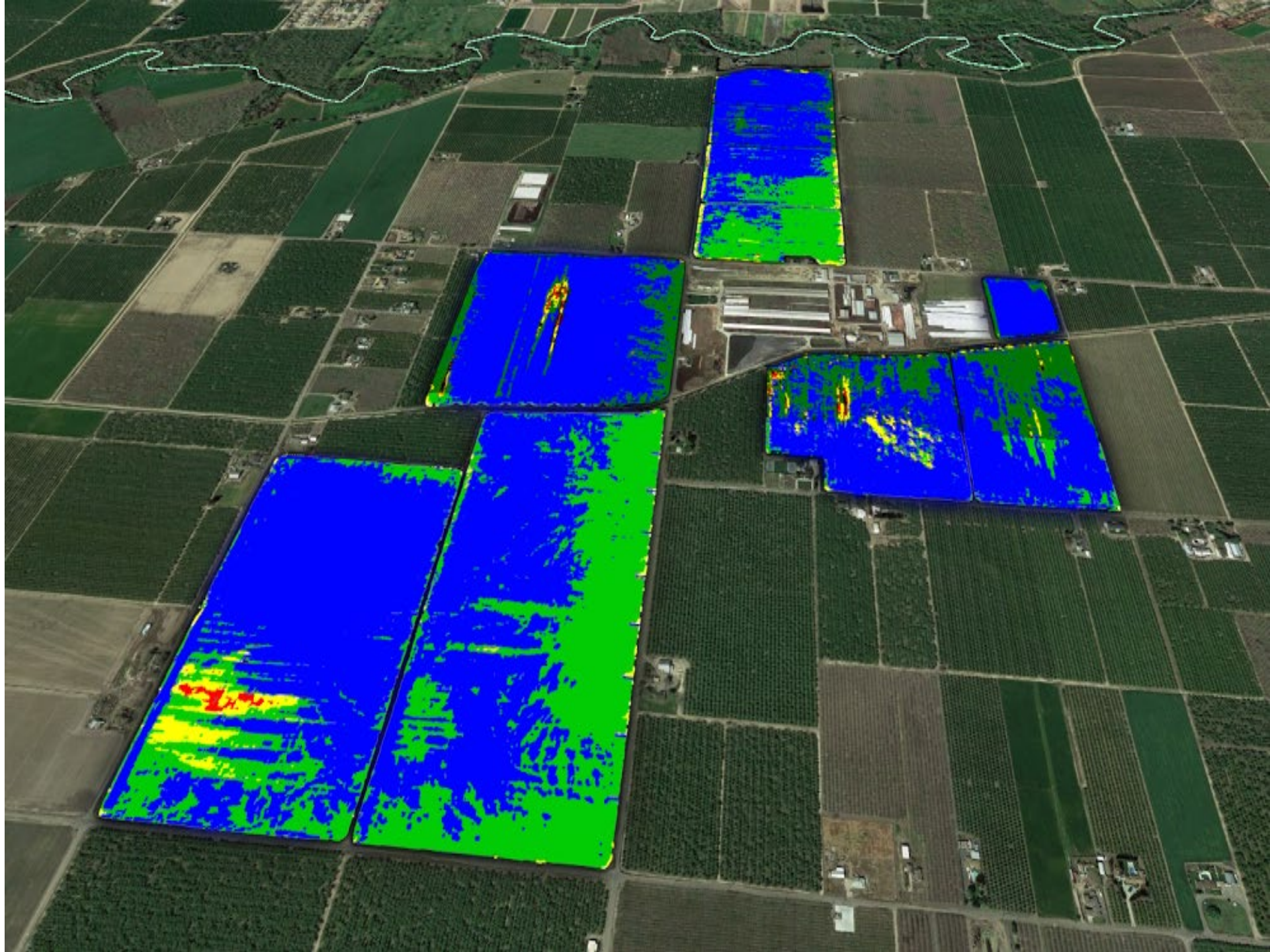




AI Helping Farmers Detect Plant Diseases

Source: Google AI





Optical sensors for the detection of plant diseases

RGB



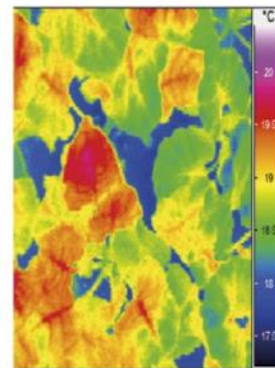
Multispectral



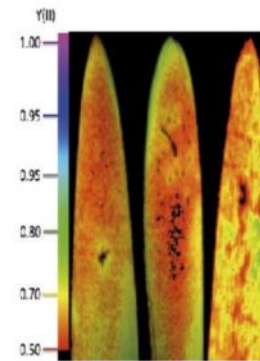
Hyperspectral



Thermal

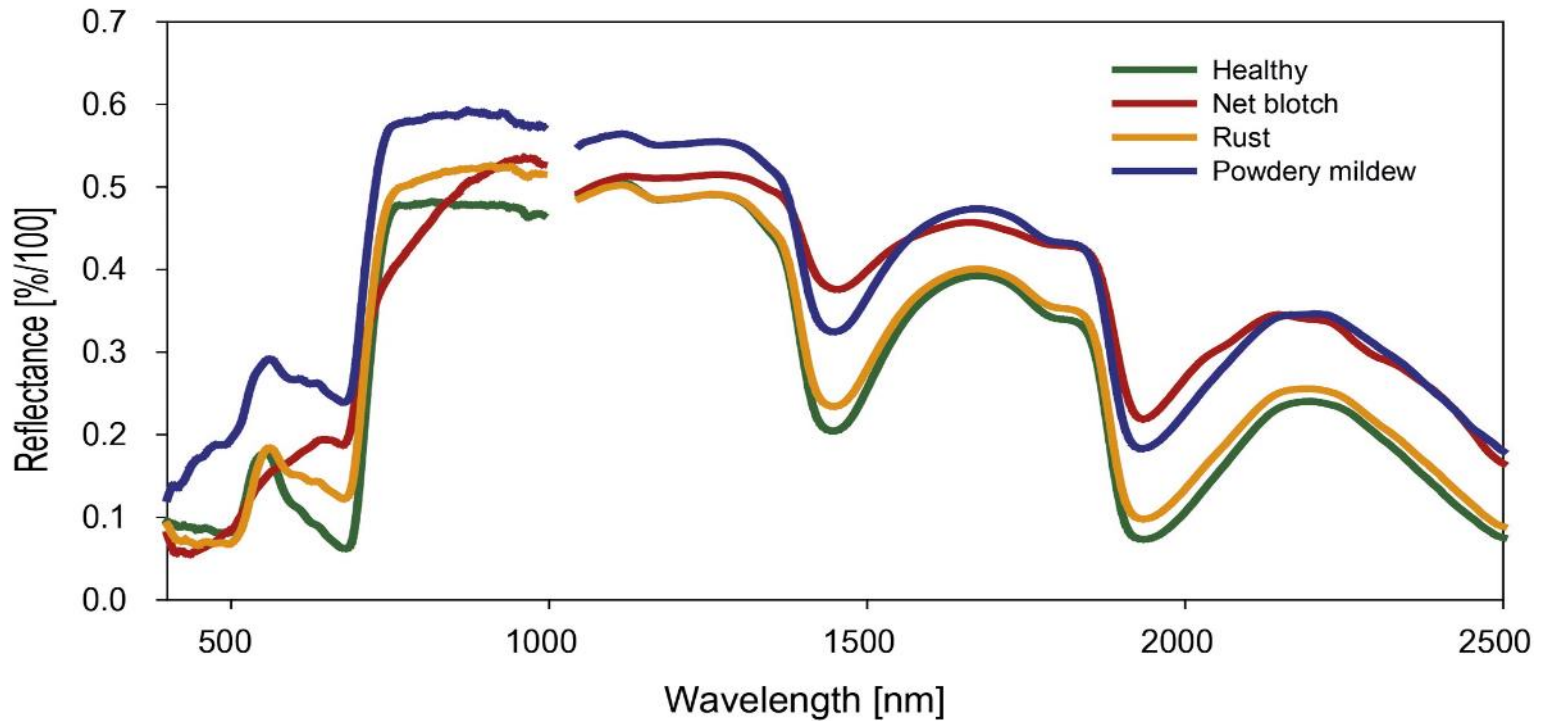
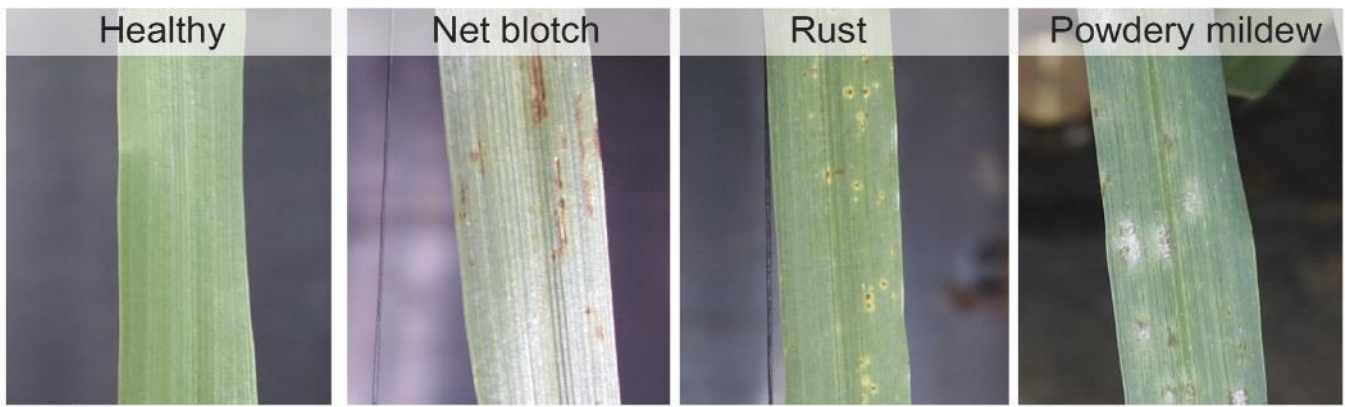


Chlorophyll-
Fluorescence

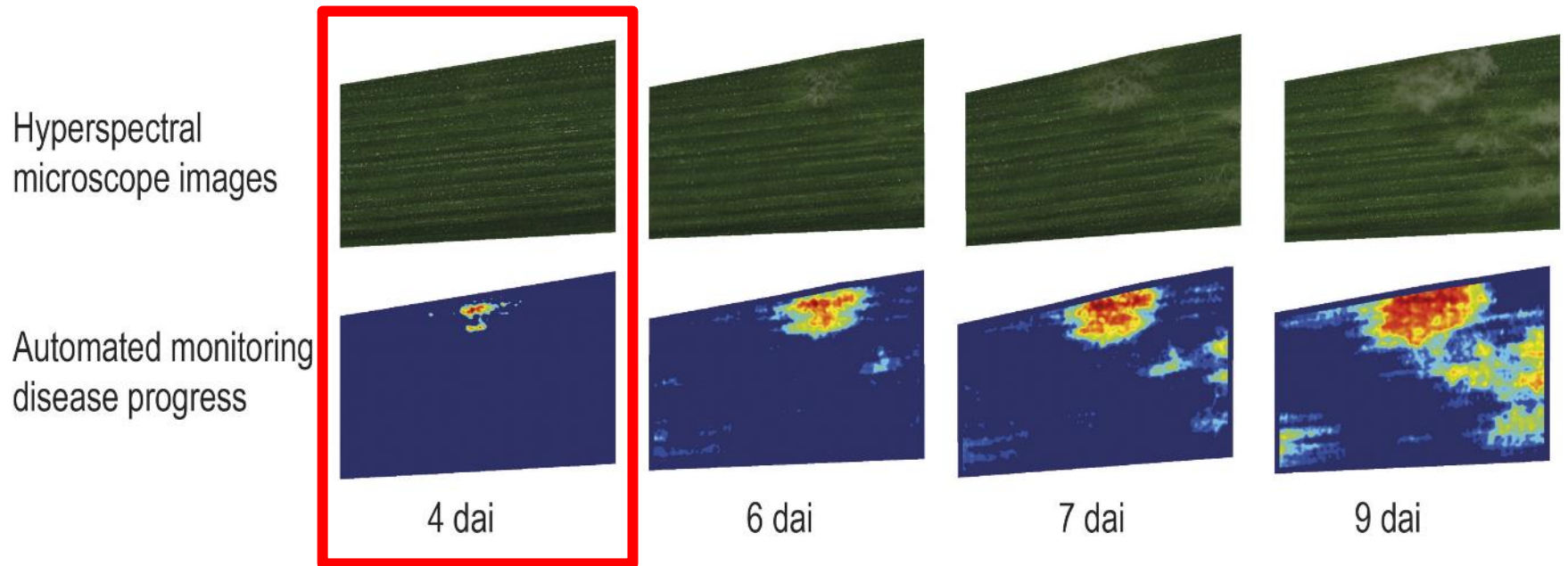


3D-Sensors





Characteristic spectral signatures of barley leaves diseased with net blotch, rust, and powdery mildew, respectively



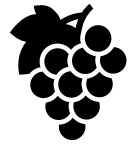
Powdery mildew progress on a susceptible barley genotype cv. Ingrid assessed by a hyperspectral microscope (Kuska et al. 2015). Using this small-scale approach, the phenotyping and differentiation of different genotypes is possible

Multispectral images



Infected with *Fusarium graminearum*

Downy mildew in grapes

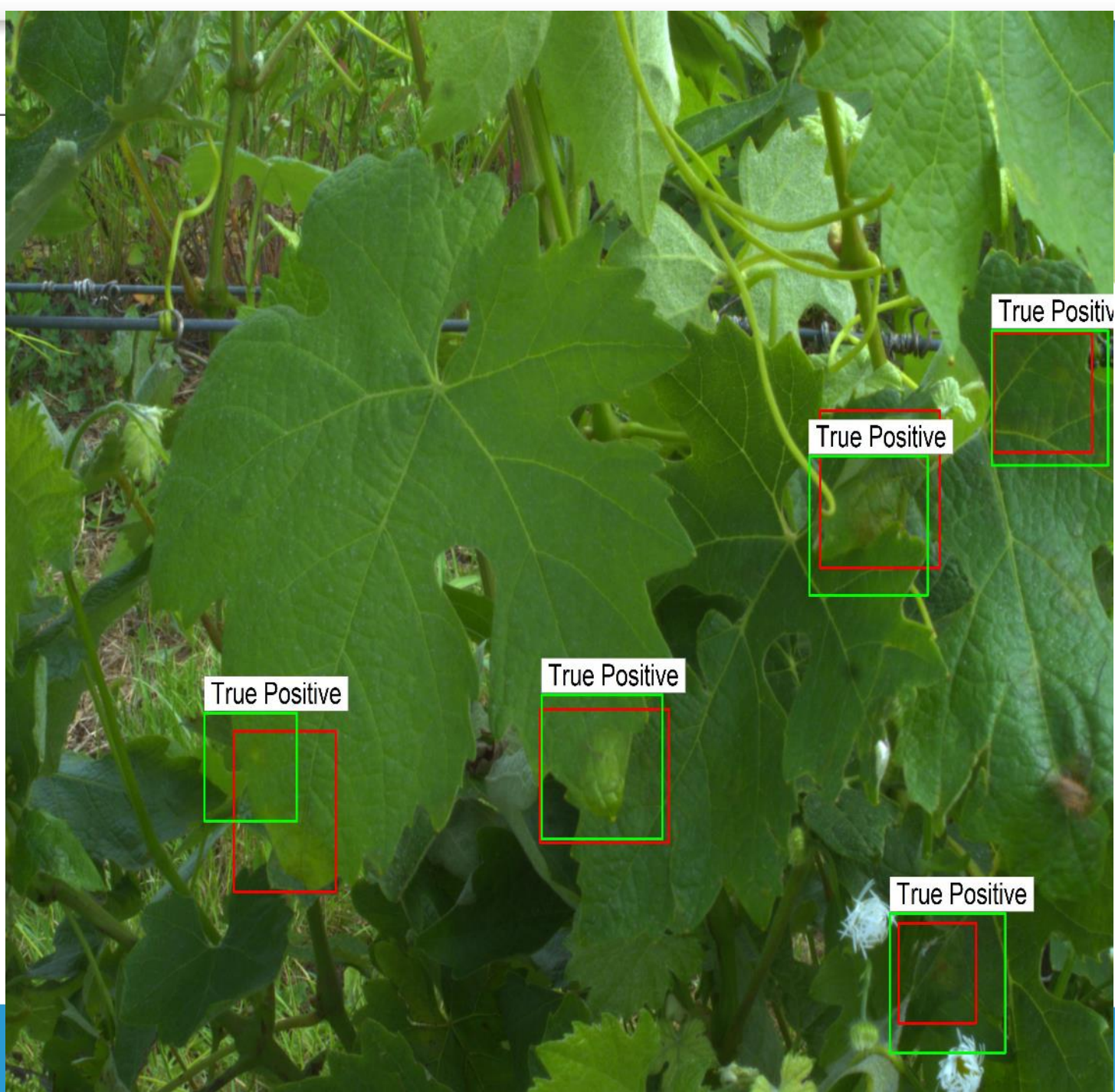


Disease detection

Correct detections

 Ground truth

 Detection



Sour rot of grapes





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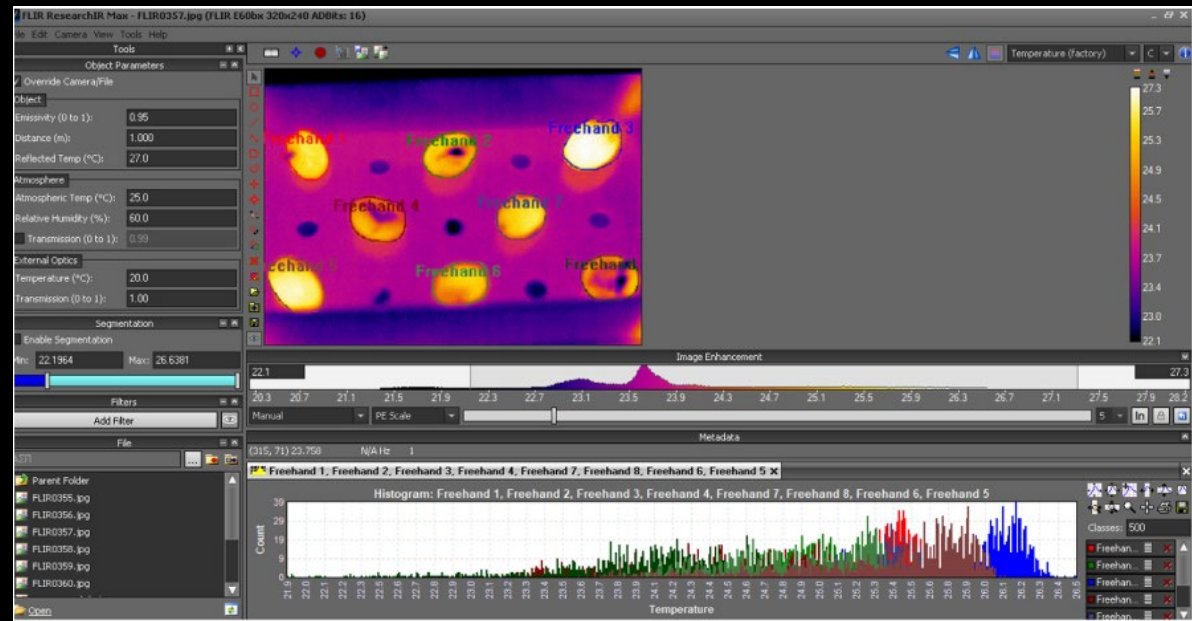


Development of thermography methodology for early diagnosis of fungal infection in table grapes: The case of *Aspergillus carbonarius*

N. Mastrodimos^a, D. Lentzou^b, Ch. Templalexis^b, D.I. Tsitsigiannis^a, G. Xanthopoulos^{b,*}

^a Department of Crop Science, Agricultural University of Athens, 75 Iera Odos Str., 11855 Athens, Greece

^b Department of Natural Resources Management and Agricultural Engineering, Agricultural University of Athens, 75 Iera Odos Str., 11855 Athens, Greece

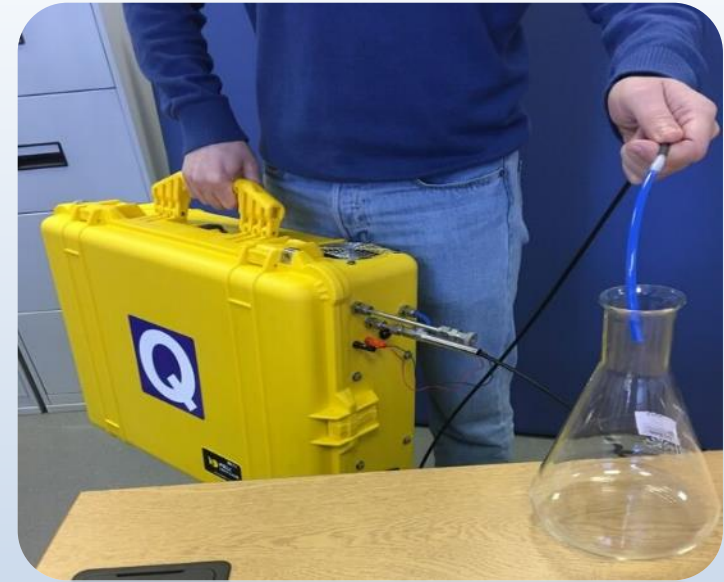


scientific reports

OPEN Analysis of volatile emissions from grape berries infected with *Aspergillus carbonarius* using hyphenated and portable mass spectrometry

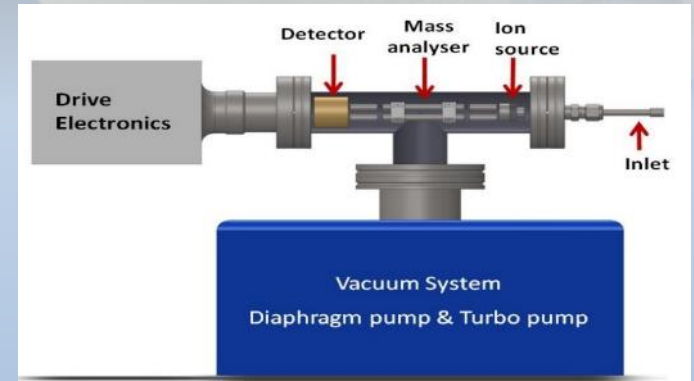
Konstantinos Giannoukos¹, Stamatios Giannoukos², Christina Lagogianni³, Dimitrios I. Tsitsigiannis³ & Stephen Taylor^{1,4}

Check for updates



The main parts of the **OchraSensor** will be:

- a) **Sampling probes** (a membrane inlet and a capillary column) that allow to the sample molecules to enter into the MS for analysis,
- b) the **MS** (consisting of an ion source, mass analyzer and a detector-multiplier),
- c) the **vacuum system**







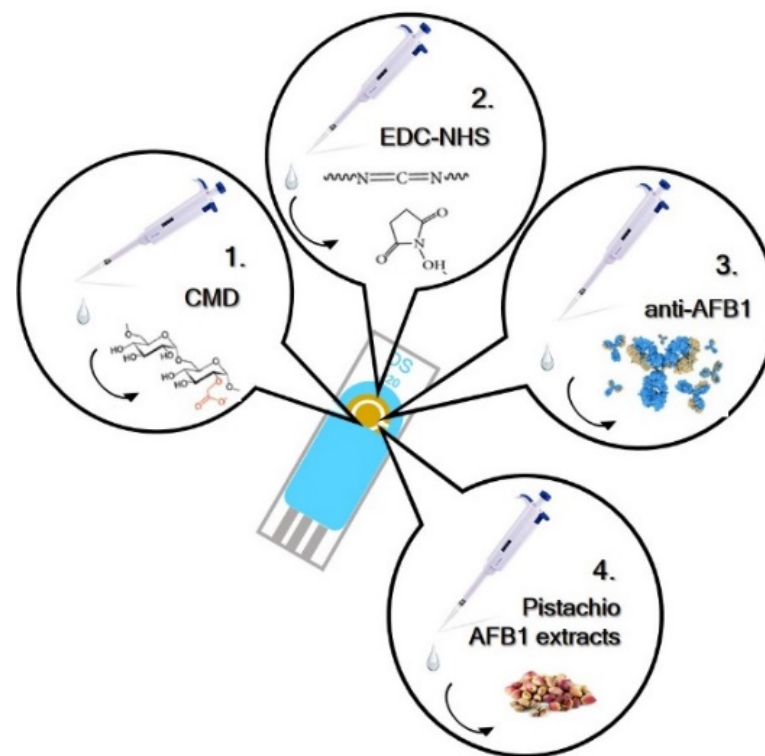
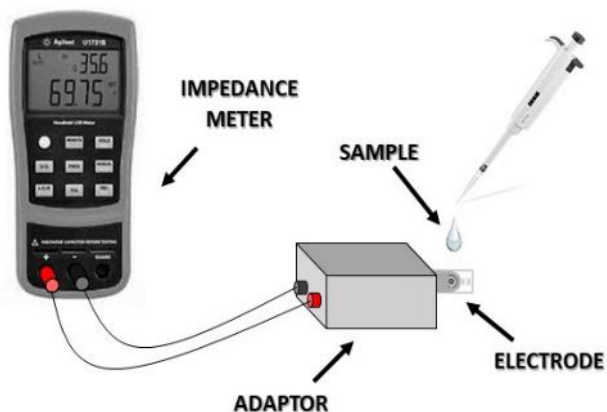
Schematic diagram of a mass spectrometer.



Article

An Impedance Based Electrochemical Immunosensor for Aflatoxin B₁ Monitoring in Pistachio Matrices

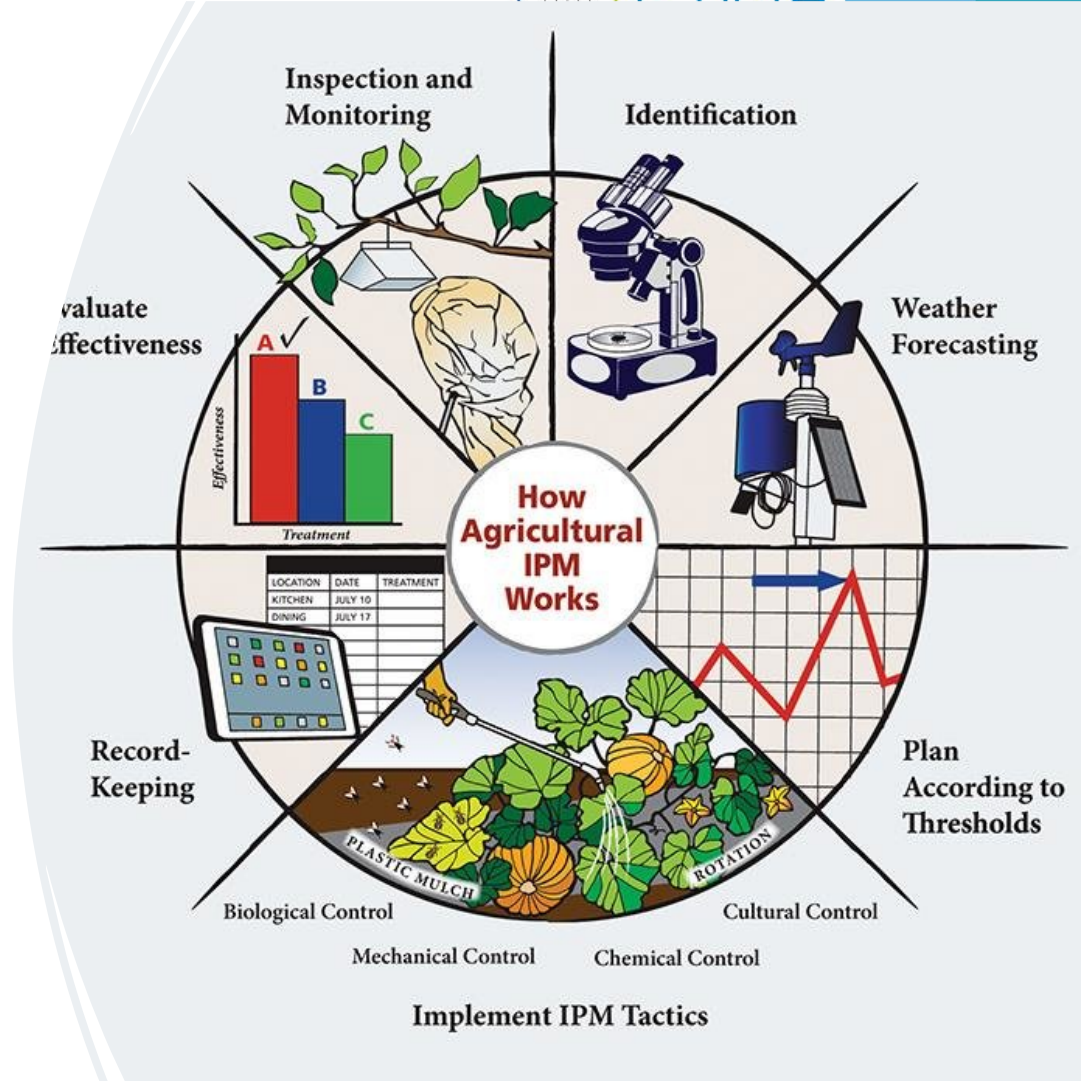
Michail D. Kaminiaris ¹, Sophie Mavrikou ^{2,*}, Maria Georgiadou ³, Georgia Paivana ^{2,*},
Dimitrios I. Tsitsigiannis ¹ and Spyridon Kintzios ²

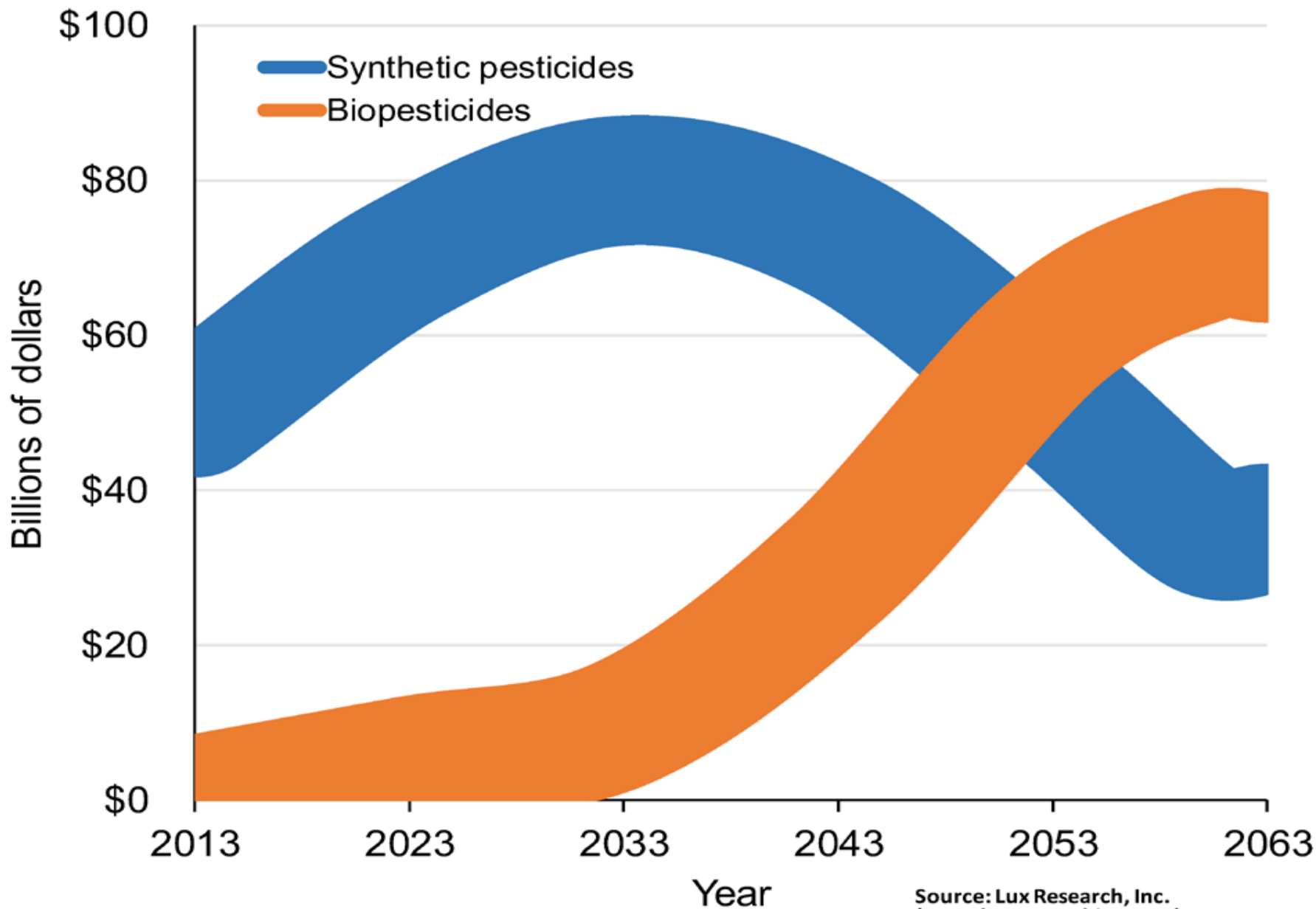


Detection of AFB₁

Integrated Pest Management

- Environmental factors
 - Climate change
- Agronomic practices
- Epidemiology/Prediction models
- **Chemical control**
- **Biological control**
- **Host plant resistance**





* Definition of biopesticide : US EPA definition ¹¹⁴⁾ (Biochemical pesticides + Microbial pesticides + Plant-Incorporated-Protectants :PIPs) + Predatory insects

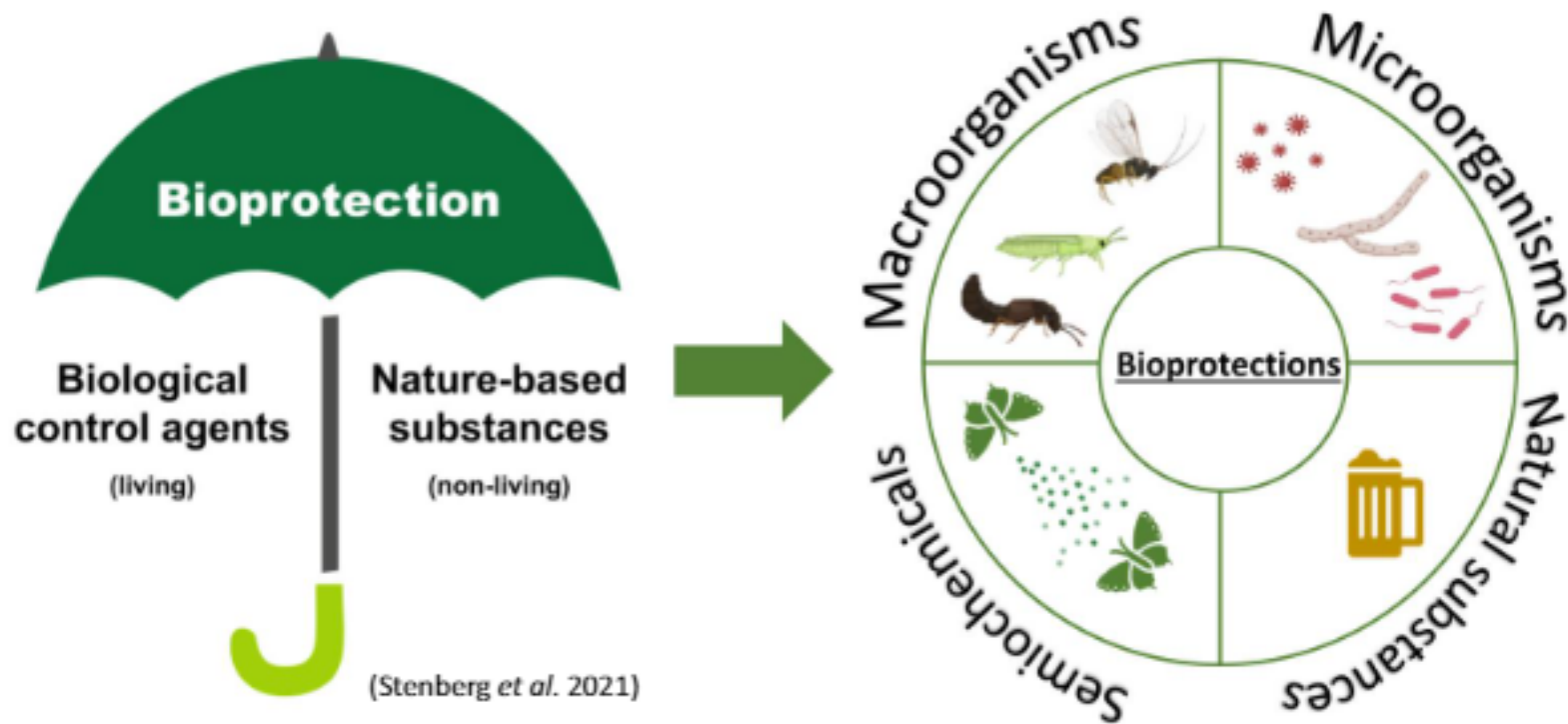
Mode of action of biological control agents and biostimulants



Alternative Pest Management Strategies

Directive 2009/128/EC (European Parliament, 2009)

A framework for an integrated pest management (IPM)

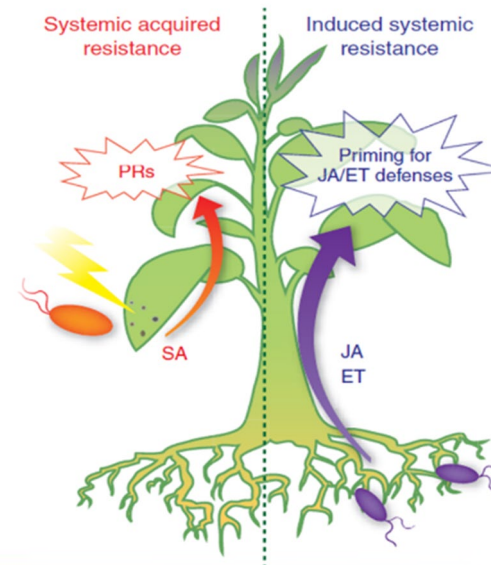
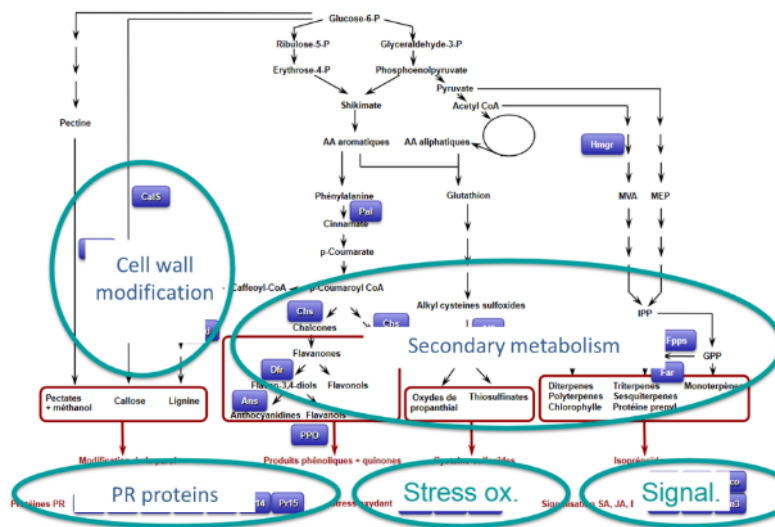


Mode of action of bioPPPs/PRIs



The most promising bio-PPPs were tested for their ability to activate the plant defence mechanisms.

qPFD analysis → provides information about the defense status of the plant (**expression of 28 targeted genes**) and allows screening of PPPs able to elicit these genes



- **Dosage, formulation and timing of the applications of bio- and synthetic PPPs**
- **IPM strategy**
 - optimal use of PPPs
 - choice of best combination between plant variety and active substance
 - dosage rate
 - number of applications
 - optimum application timing and frequency
 - minimize residue risks

Leaf blight on carrot caused by *Alternaria dauci*

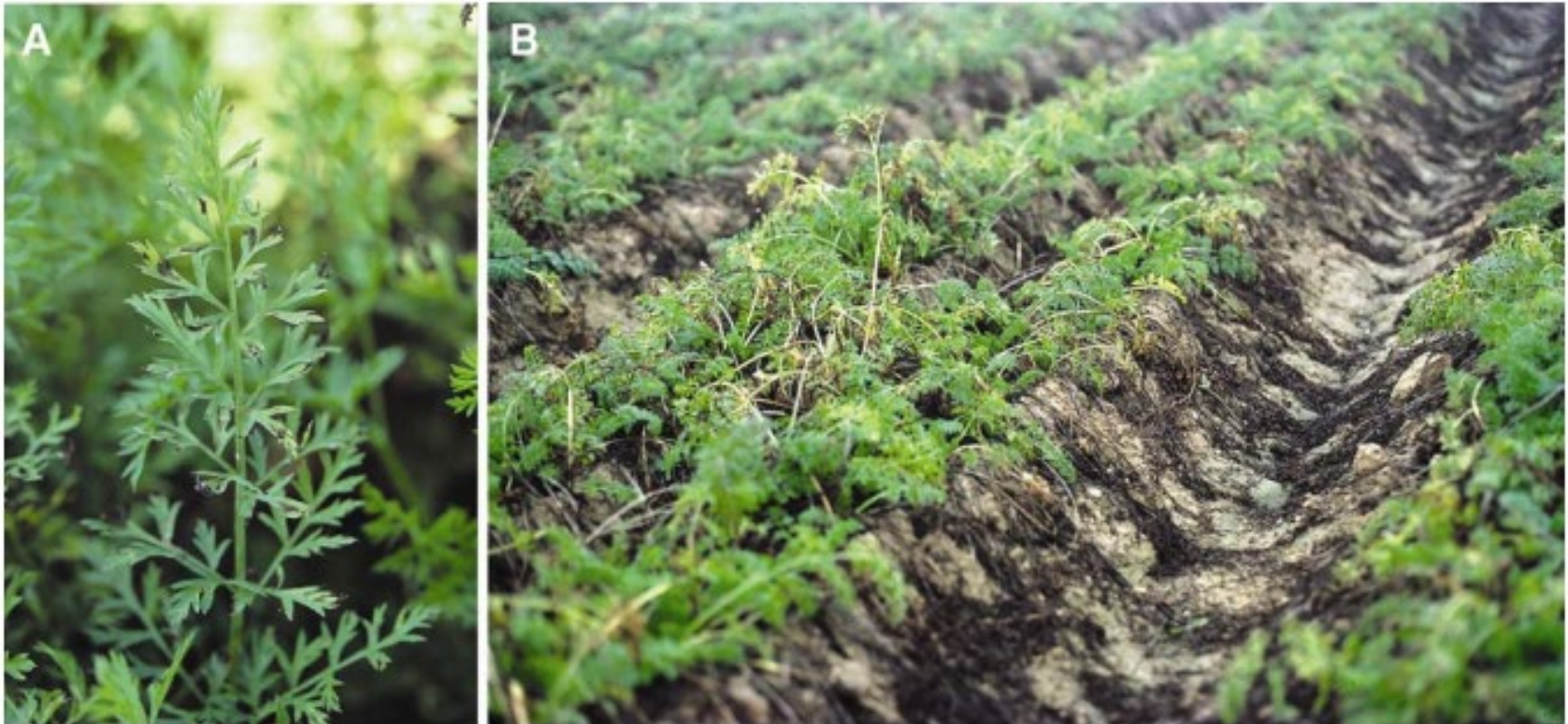
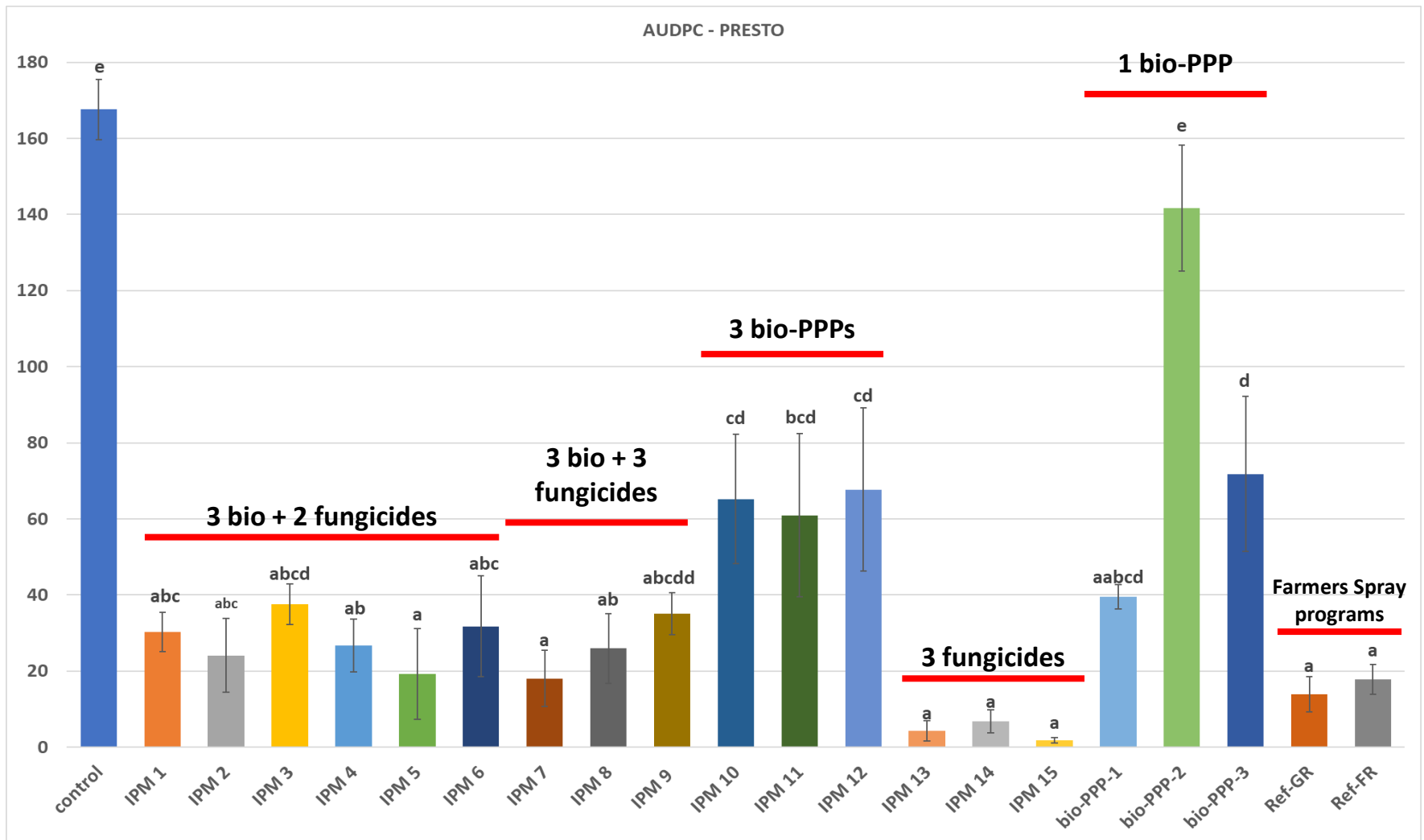


Fig. 3. *Alternaria* leaf blight symptoms: A, on an individual leaf, and B, extensive defoliation in the field (41).

Carrot field experiments in AUA (Greece)



Evaluation of IPM strategy for *Alternaria* leaf blight in carrots by AUA (Greece)



PRESTO variety

Determination of the best protection route for *Alternaria* leaf blight in carrots



Cultivation week	Product	Dose (L/ha)
11	Synthetic PPP-1	0,5
13	bioPPP1	10,0
15	Synthetic PPP-2	1,0
16	Plant Resistance Inducer (PRI)	6,0
17	bioPPP1 if needed	10,0
Harvest		

Smart spraying systems to control plant diseases



Present situation in Plant Protection

Few bio-PPP available

Poor sprayer adjustment

High number of treatments



High losses of PPP out of target

High cost

High environmental impact

Development and optimization of innovative spraying technologies



Upgrade commercial sprayers by:

- Testing different **nozzle types** and **sprayer settings**
- Adopting **variable rate control** based on **canopy characteristics** and **pathogen dispersal**
- Integrating **smart components** for optimum **localization**, **spraying application** and **crop status perception**



● Carrots



● Vineyards



● Apples

Smart spray systems



Spray when & where needed

Compatible with microorganisms / bio PPPs



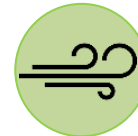
**Reduce PPP use
Lower application rate**

Obtain uniform spray distribution



Reduce losses to the ground

Obtain good & uniform spray coverage



Reduce (potential) spray drift

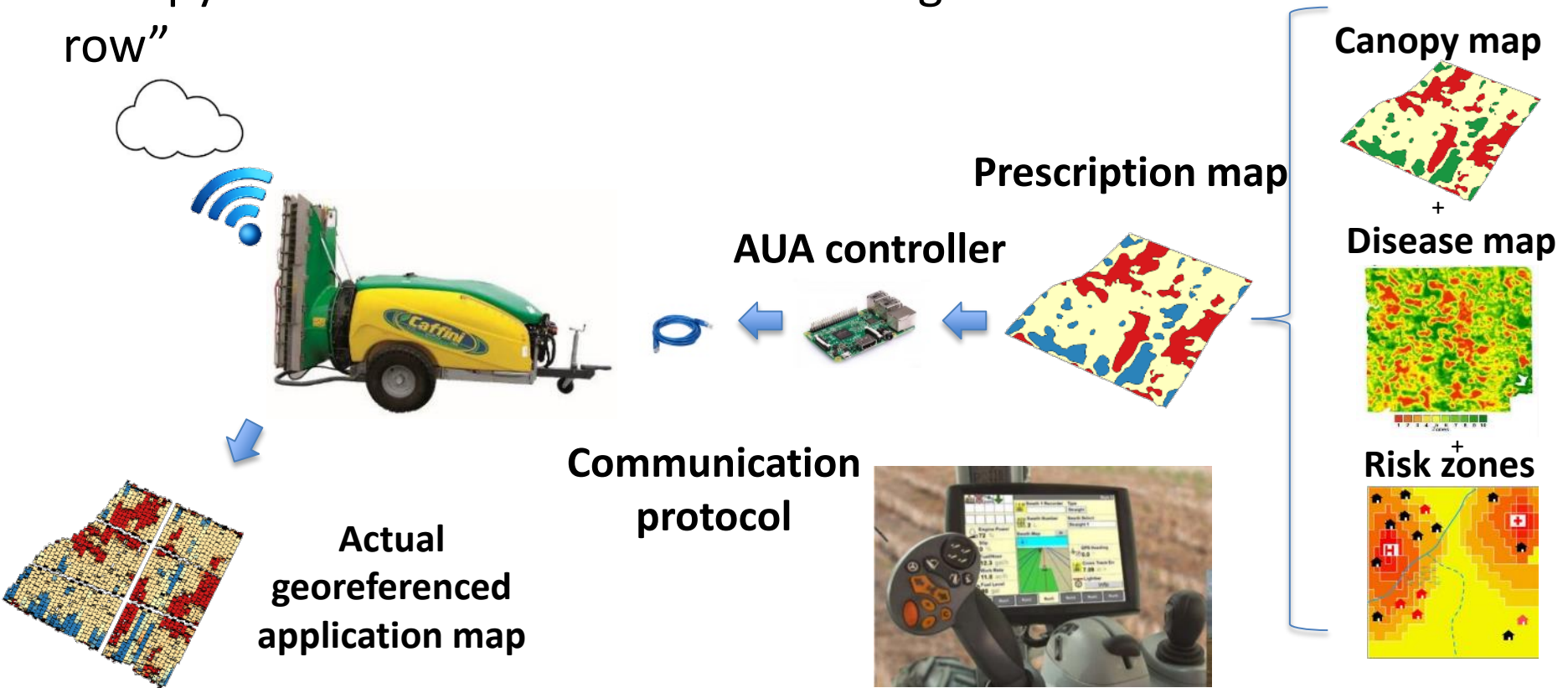
Obtain good spray deposition



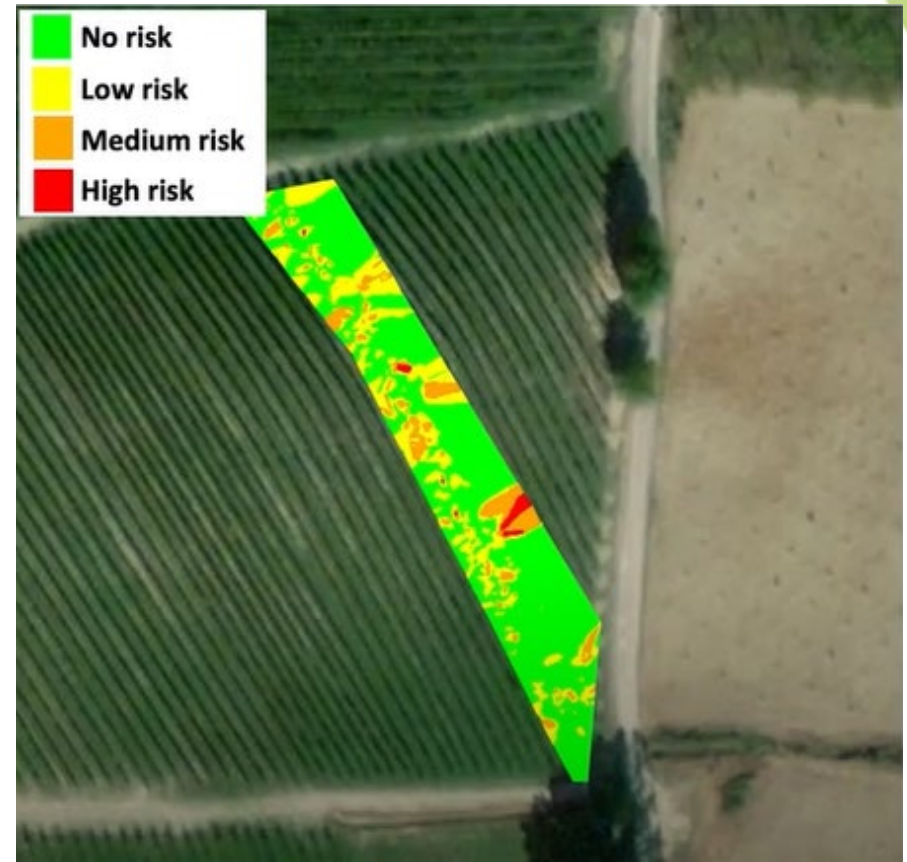
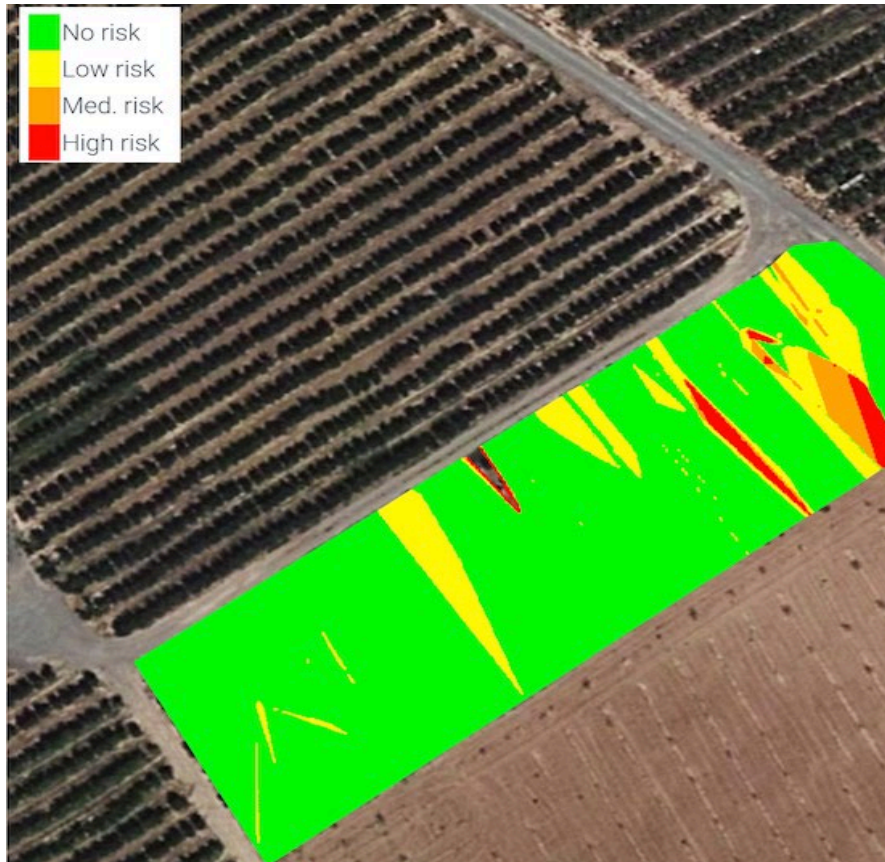
Vineyard sprayer intelligence upgrade



“... able to modify the total amount of liquid and air according to the disease spreading and canopy structure and its variations along the row”



DSS Prescription Maps



DSS: Decision Support Systems

Vineyard sprayer



