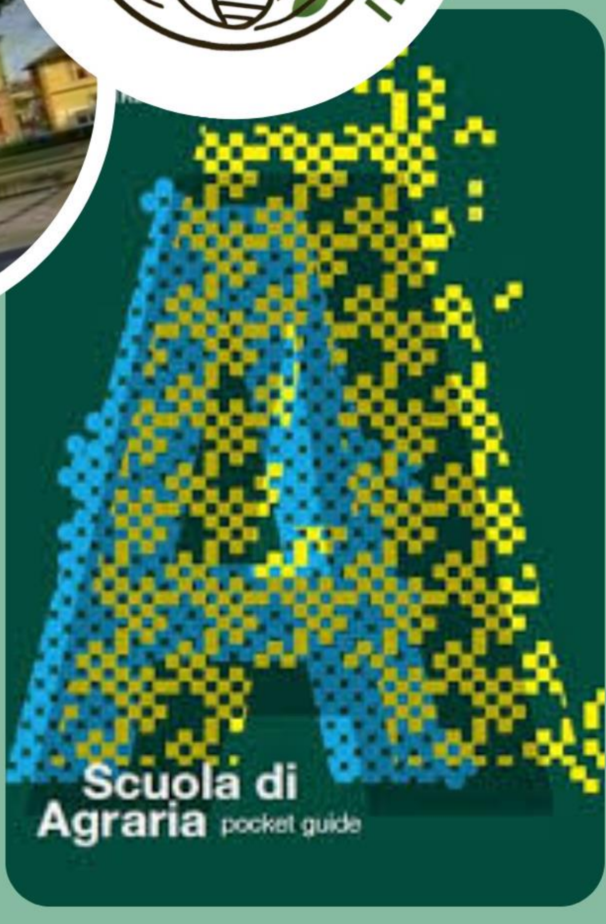
Ph.D. DAY 2024

DOTTORATO IN SCIENZE AGRARIE E AMBIENTALI



Indice

Programma dell’evento

MARTEDÌ 17 DICEMBRE
Aula Magna della Scuola di Agraria

Welcome Meet & Cheers Ph.D. Edition

Programma

14:30 Benvenuto e saluti iniziali

15:00 I dottorandi del XXXVII ciclo presentano le loro attività

17:00 Storie di ex Ph.D. Speaker: Dott. Enrico Tatti

17:30 Tavola Rotonda su Dottorato, Sostenibilità e Ambiente (modera la Dott.ssa Luisa Leolini, RtD dell’Università di Firenze)

17:45 Premiazione del miglior logo rappresentativo del Dottorato in SAA

17:50 Poster session (dottorandi dei cicli XXXVIII, XXXIX, XL) e brindisi finale

L’evento è aperto a tutti coloro (inclusi studenti di corsi di laurea triennale e magistrale, docenti e ricercatori) che desiderano conoscere le tematiche di ricerca del corso di dottorato o cercare un momento di confronto e scambio.

UNIVERSITÀ DEGLI STUDI FIRENZE
DAGRI DIPARTIMENTO DI SCIENZE E TECNOLOGIE AGRARIE, ALIMENTARI, AMBIENTALI E FORESTALI

Presentazioni dei Dottorandi del 37° ciclo

- **Lorenzo Bini:** “Effects of non-conventional substrates and treated wastewaters on plants cultivated in soilless systems and controlled conditions”

- **Paolo Capano:** “Microalgae cultivation in dairy effluents and their utilisation as biostimulants”

- **Matilde Ciani:** “Heavy metal removal and valorization by exopolysaccharide-producing cyanobacteria: a pathway for bioremediation towards circular economy”

- **Dario Gaudioso**: “*Curtobacterium flaccumfaciens* pv. *flaccumfaciens*: an integrated multidisciplinary approach as a model for the control of neglected EU quarantine bacterial plant pathogens”

- **Jacopo Manzini:** “Assessment of ornamental tree species ability to remove atmospheric pollutants and to fight climate change in urban environments”

- **Antonio Pescatore:** “Role of multiple cropping in the conservation of soil fertility and in the reduction of greenhouse gas emissions”

- **Chiara Pastacaldi:** "Integrazione sinergica di strategie e tecnologie ecosostenibili per la difesa innovativa della salute delle piante”

- **Alessandro Puca:** “Around the world in 8 decay agents: Wood degradation processes in Esca Complex of Grapevine”

Moderatori: Matilde Ciani e Antonio Pescatore

Poster dei Dottorandi del 38° ciclo

Welcome meet & Cheers Ph.D. Edition
PhD in Agricultural and Environmental Sciences
17 December 2024 – Aula Magna DAGRI

Role of the exopolysaccharide levan in the life cycle of *Pseudomonas syringae* pv. actinidiae biovar 3, a phytopathogenic member of the bacterial community of *Pseudomonas* sp. associated with kiwifruit

PhD student (XXXVIII cycle): Sara Campigli
Department of Agriculture, Food, Environment and Forestry, University of Florence, P. le delle Cascine 18, 50144 Florence, Italy.
Plant Pathology Section (AGR/12) E-mail: sara.campigli@unifi.it

Background

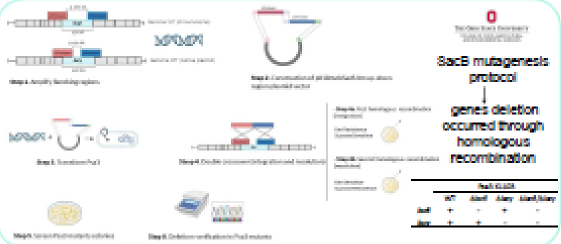
The ability of *Pseudomonas syringae* (Ps) to produce different types of exopolysaccharides (EPSs) is well documented. Some EPSs allow Ps to thrive in different environments, while others, such as levan, a polyfructan polymer synthesized from sucrose by levansucrase enzymes (lsc), are considered to be storage molecules. *Pseudomonas syringae* pv. actindiae biovar 3 (Psa3) possess two functional lsc isoforms: lscβ (chromosome located) and lscγ (plasmid located), which differ in their amino acidic sequence at the putative N-terminus as well as in their biochemical properties .

Aim of the PhD project

To understand: **1)** what are the benefits to Psa3 in maintaining two levansucrase isoforms; **2)** the function of levan during the epiphytic and endophytic phases of Psa3 life cycle on kiwifruit.

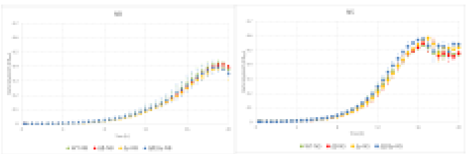
Preliminary results

lsc mutagenesis (Gene Knockout)



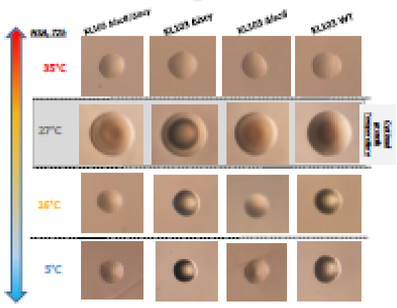
In vitro effects of mutagenesis

- Growth kinetic



lscγ and lscβ do not affect bacterial growth

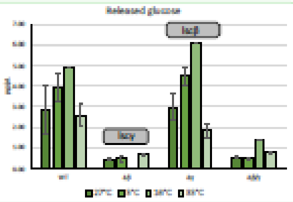
- Morphology of colonies



Only lscβ induces the formation of levaniform colonies

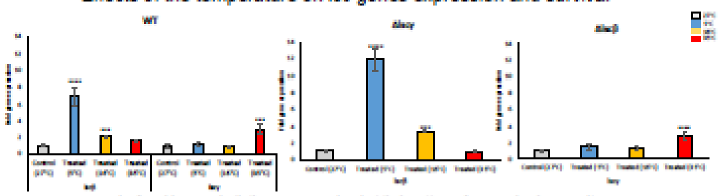
Sucrose hydrolysis activity

Only lscβ activity is detectable in the total cell lysates

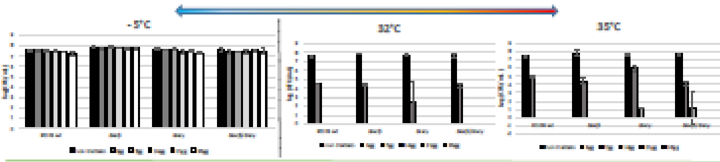


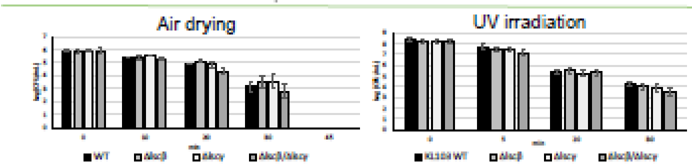
Tollerance to abiotic stresses

Effects of the temperature on *lsc* genes expression and survival



lscβ and lscγ are both thermoresponsive, but their pattern of expression is opposite.





Cell viability decreased in a similar manner in mutants and wild-type strain.

The role of levan in Psa3 infection process

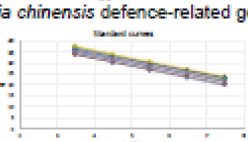
Development of TaqMan qPCR assays for:

- detection of *lsc* mutants

Hypothesis: Levan acts as masking and protecting the bacterium from the recognition and defense mechanisms of the plant host during the early stages of the infectious process

- measuring the expression of *Actinidia chinensis* defence-related genes

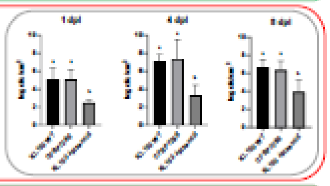
	Gene	Name	Function	Reference
RG	ACT	Actin	Plant cell structure	[illegible]
	PP2A	Protein phosphatase 2A	Plant growth and development	[illegible]
Plant defence-related genes	CAT	Catalase	Antioxidant system	[illegible]
	SOD	Superoxide dismutase		
	LOX	Lipoxygenase [illegible]	[illegible] of oxygenated fatty acids	[illegible]
	SAM	S-adenosylmethionine synthetase	Precursor of ethylene biosynthesis	
	TLP	Thaumatin-like protein	PR protein	
	Pto	Pto-like protein kinase [illegible]	Pathogen recognition	[illegible]



Gene	[illegible]	[illegible]	Linear regression			
ACT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PP2A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CAT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LOX	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SAM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TLP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pto	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

- In progress ➡ Artificial leaf inoculation trials

Colonization of the phylloplane (CFU)
RNA → gene expression analysis
DNA → qPCRs verification



Take-home messages

1) Knowledge of the content of the 74kb plasmid of Psa3 bearing *lscγ*, may provide interesting new clues to understanding the factors involved in the bacterial canker of kiwifruit, as well as the evolution of biovar 3. **2)** Levansucrases may serve different functions in different *P. syringae* genotypes.

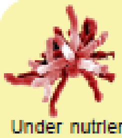
Purple non-sulfur bacteria: ideal microbial cell factories for biotransformation of agro-industrial wastes into high-added value molecules.

L. Bernabò[1], G. Daly[1], V. Galli[1], M. Giovannini[2], F. Decorosi[1], C. Viti[1], M. Fondi[2], A. Adessi[1], L. Granchi[1].
[1] Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence, Italy.
[2] Department of Biology (BIO), University of Florence, Italy.

Problems to be solved

- About 96% of H_2 is synthesized from fossil fuels, emitting 830 million tonnes of CO_2 annually.
- Plastic is made from non-renewable sources and degrades very slowly.
- Microbial bioplastics (e.g., poly-β-hydroxybutyrate) are expensive due to the high costs of synthetic medium for microbial growth.

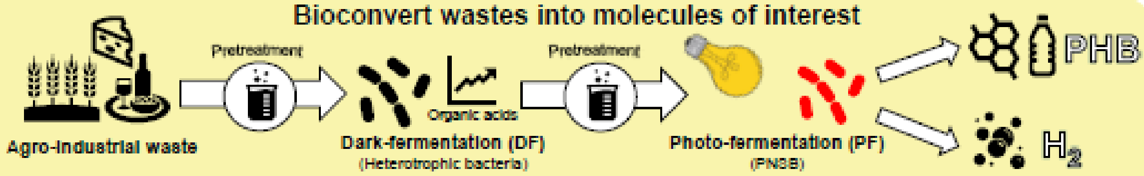
Purple non-sulfur bacteria



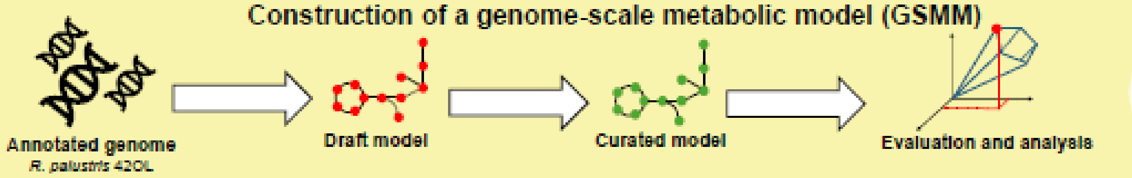
Purple non-sulfur bacteria (PNSB) are extremely versatile Gram-negative microorganisms belonging to the α- and β-proteobacteria classes. They produce Bio-H_2 under light, anaerobic, and nitrogen-limited conditions, offering renewable energy potential.
Under nutrient starvation, PNSB accumulate poly-β-hydroxybutyrate (PHB) intracellularly, a biodegradable plastic.
Agro-industrial residues are low-cost ideal substrates for cultivating purple non-sulfur bacteria to produce Bio-H_2 and PHB.

Objectives of the Ph.D. Program

1. Bioconvert wastes into molecules of interest



2. Construction of a genome-scale metabolic model (GSMM)



Main Results

Photofermentative production of PHB by PNSB using solid olive oil by-products

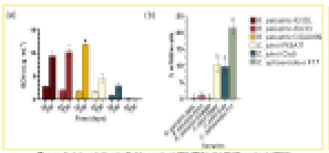


Figure 1. (a) variation in Bchls content (T0-T30). (b) PHB content (T30).

- IPOC is a suitable substrate for PHB production.
- *C. sphaeroides* F17 accumulated 21.48% PHB/cell weight.
- *R. palustris* strains utilized IPOC for cell growth, the others synthesize PHB.

Fermented bread waste for PHB production by PNSB

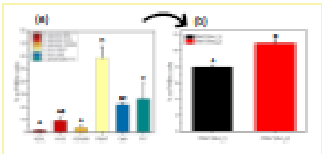
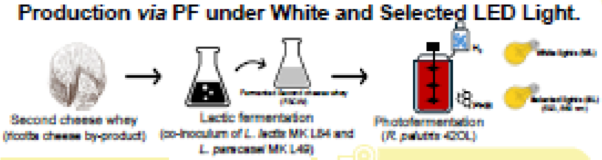


Figure 2. (a) PHB content (T16) in different PNSB strains. (b) PHB content (T16) in *C. johrii* PISA7 grown on 5L Bioreactor.

- FBB is a suitable substrate for PHB production.
- *C. johrii* PISA7 had the highest PHB content (58.46% w PHB/w cells) and was chosen for scale-up.
- In the 5L-bioreactor, PISA7 produced a maximum PHB content of 10.92% w PHB/w cells in Run_2.

Utilization of Second Cheese Whey for H_2 and PHB Production *via* PF under White and Selected LED Light.



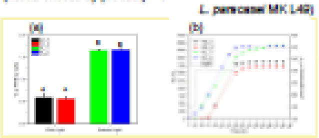
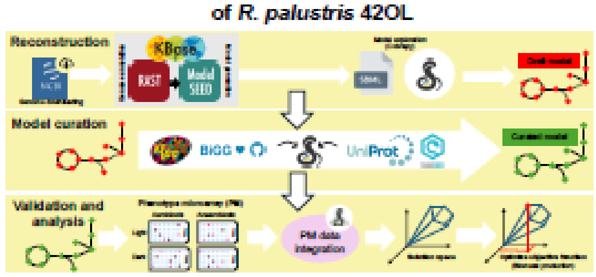


Figure 3. (a) PHB content (T16) and (b) time course of H_2 production under different lighting conditions.

- FSCW is a suitable substrate for H_2 and PHB production.
- Selected Lights boosted Bio-H_2 and PHB production.
- *R. palustris* 42OL produces less PHB than other PNSB grown on agro-industrial waste.

Construction of the genome-scale metabolic model of *R. palustris* 42OL



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Ph.D. Day
December 17, 2024.
Aula Magna, Facoltà di Agraria.
Piazzale delle Cascine 18, 50144.
Florence, Italy.

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Crop productivity and sustainability of Agro-Voltaic systems in response to climate change
XXXVIII PhD Cycle

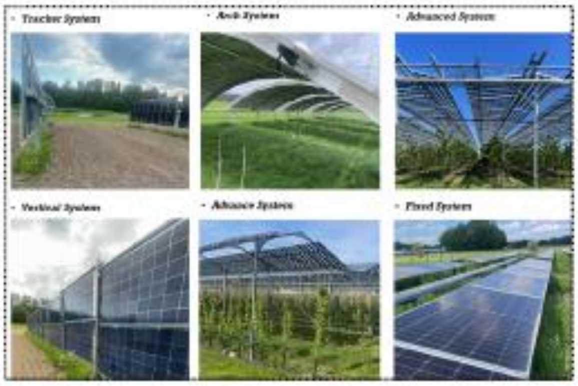
PhD student: Michele Moretta
Tutor: Prof. Marco Bindi

AIM AND SCOPE

Identify agronomic practices to integrate and optimise crop and energy production under current and future climate conditions.

- Monitoring tools
- Morphological Evaluation
- Modeling Approach

Provide a Decision Support System model capable of giving agronomic indications and to be used in the design phase of AV



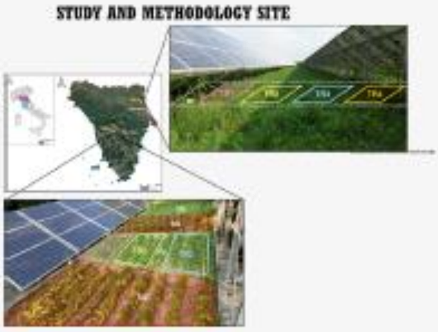
MONITORING TOOLS

TOWARDS CROP MONITORING IN AGRO-PHOTOVOLTAIC SYSTEMS: AN IMAGE-BASED DATA ASSIMILATION APPROACH FOR FPAR-DERIVED BIOMASS ESTIMATION

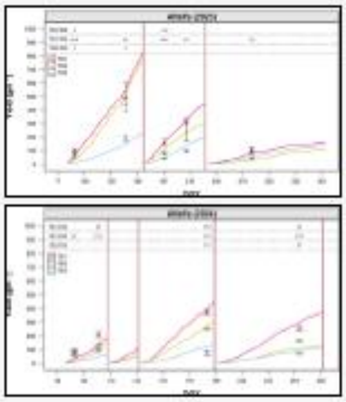
AIM: Propose a monitoring method using time-lapse 2D images and 3D LiDAR for fisiological parameters estimation.

- Grassland and Dwarf Bean — 2023/24
- GrassClover — 2024
- Potatoes/Corn — 2024

STUDY AND METHODOLOGY SITE



RESULTS



MODELLING APPROACH

ANALYSIS OF THE INFLUENCE OF SHADING ON THE PHENOTYPIC TRAITS OF ALFALFA IN 2 DIFFERENT AGROVOLTAIC SYSTEMS USING A MODELLING APPROACH DEVELOPED IN GROIMP

AIM:

1. Analysing the effect of shading on alphalfa in different AV system
2. Parameterisation of a growth and radiation model for alfalfa
3. Evaluation of key phenotypic traits related to growth and production

ALFALFA GROWTHMODEL

MORPHOLOGICAL EVALUATION

AIM:

Analyze morphological traits of horticultural crops under different types of shading conditions.

PHENOTYPING PLATFORM

DECISION SUPPORT SYSTEM

- THE DSS WILL HELP MAKE INFORMED DECISIONS ON CULTIVATION PRACTICES AND OPTIMAL CONFIGURATIONS IN SCENARIOS OF CLIMATE CHANGE.
- THE DATA COLLECTED AND THE ANALYSES WILL PROVIDE USEFUL AGRONOMIC INDICATIONS FOR THE DESIGN AND MANAGEMENT OF AV SYSTEMS.
- POTENTIAL USE FOR PLANNING NEW AV INSTALLATIONS AND COULD BE USED AS A TOOL TO ASSESS THE FEASIBILITY OF ACCESSING FUNDING BY DETERMINING THE % LOSS IN PRODUCTIVITY.

Study of Circular Agroecology Practices at Farm and Territory Level for the Valorization of Organic Residues

Candidate: Dr. Francesco Serafini

Supervisor: Prof. Gaio Cesare Pacini,
Co-supervisor: Dr. Ottorino-Luca Pantani

PhD Program in Agricultural and Environmental Sciences,
University of Florence, Italy

Framework

Background:
The soil organic matter(SOM) significantly decreased during the last decades, thus also decreasing the biodiversity, the stability, and the productivity of agricultural systems.
Composted organic residues, from different sources, can be used to buffer the loss of SOM.

Indicators:
Measurement of **chemical, physical** and **biological parameters** linked to **soil fertility**.
Evaluation of crops' **phenological phases.**
Integration of chemical, physical and biological parameters of fertility with crop productivity.

Main goal:
Evaluate the impact of organic amendments from different sources on soil fertility and crop productivity.

Compost piles for INDIGenous Microorganisms, PRUNing and COMMercial treatments.

Materials and Methods

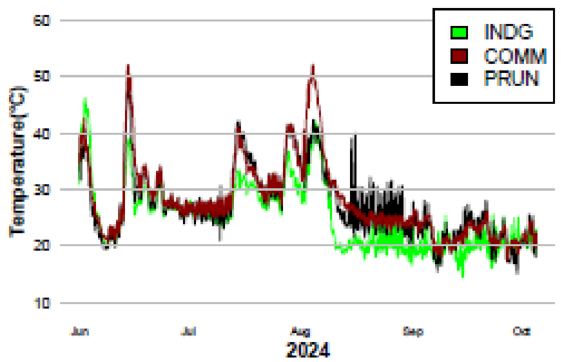
Field Experiment:
Location: Montepaldi Long Term Experiment (MoLTE), San Casciano Val di Pesa (FI), (43°39'49.3"N 11°08'21.6"E).
Crops: *Triticum dicoccum* var. dicoccum, *Triticum aestivum* var. Andriolo, Inalettabile, Gentil Rosso.
Composted OM: 5 treatments at **2 t/ha**
CTRL: Absent, from vine **PRUNing**, with **COMM**ercial composting accelerator, with **INDIG**enous Microorganisms, coffee residues **VERM**icomposted.
The field experiment follows a completely randomized block design with three replications. The experimental design is repeated in two separate field.

Pot Experiment:
Same materials applied at **2, 8, 16, 32 t/ha.**
Each compost at every dose is repeated across 8 completely randomized blocks.

Preliminary results

Compost Piles Temperature

Higher peaks observed in INDG piles during the initial phase. In the later stages, COMM and PRUN piles exhibited higher temperatures.



Temperature profiles(°C) of compost piles over time during the composting process.

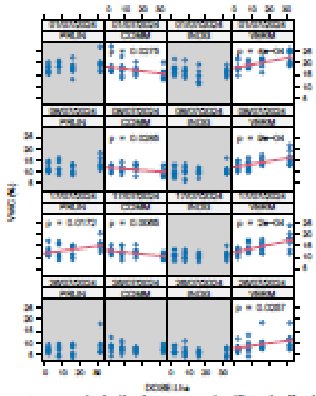
Field Experiment

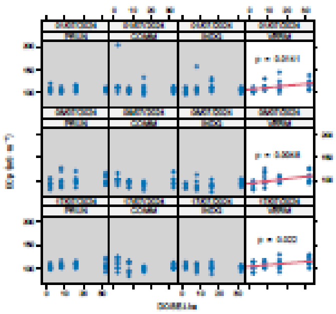
No statistically significant differences were observed among treatments for the analyzed indicators after the first growing season.

Pot Experiment

Soil Moisture: The VERM treatment showed a statistically significant higher soil moisture (VWC) content compared to **CTRL**, and a direct relationship with its amount.

Pore Water Conductivity: The VERM treatment also exhibited a statistically significant increase in pore water conductivity, directly correlated with the increase in treatment dose.





The gray panels indicate a non significant effect of the compost ($p > 0.05$) when compared with **CTRL**, while red lines indicate a significant relationship between applied compost amount and soil moisture (VWC, %)

Conclusions and Perspectives

Conclusions:
Although only one of the two planned agricultural seasons has been completed, we can already observe that the effect of these types of amendments on soil fertility is closely linked to the application dose.

Next Steps:
Repeat the field experiment in the second agricultural season on ancient soft wheat.
For the pot experiment, conduct it again on lettuce, integrating indicators related to crop physiology.

Interactive effects of global warming and management on plant biodiversity and microclimate of Mediterranean forests

PhD student: Dott. Ilaria Santi
Tutor: Prof. Federico Selvi

Introduction & aim

Forests play a crucial role in mitigating the effects of climate change. Tree canopies can limit temperature extremes at the ground level, and therefore, especially in Mediterranean areas, forests can counteract the thermophilization of understory vegetation caused by climate change, creating microclimatic refuges for cool-adapted species. However, microclimate buffering depends on forest structure and density, which are determined by the type of silvicultural management.

PhD aims

The study of the interaction between climate change and silvicultural management on diversity (taxonomic, functional and phylogenetic) and ecology of the understorey vegetation, due to its key role in temperate forest ecosystems.

Material and methods

The research is carried out through the following work packages (WP).

WP1. Impact of coppicing on microclimate and understorey vegetation diversity in an ancient Mediterranean oak forest.

Study area: Bosco ai Frati (FI).

Understory surveys were conducted in 24 quadrats (5x5m).

An air temperature data logger was installed at the center of each plot.

WP2. Intraspecific leaf trait variation in understorey species under different management strategies.

Study areas: Bosco ai Frati (FI) and Anatrice (GR).

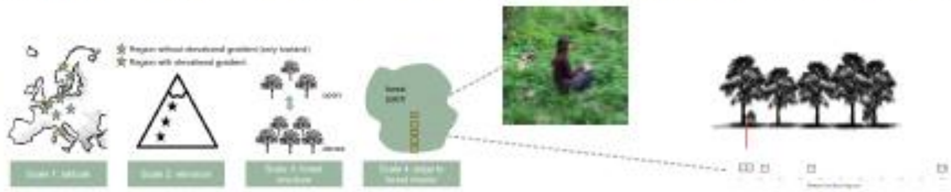
Three plots were placed in the **coppiced** part of the woodlands and three plots in the **high forest**.

Ten species were selected for the study.

Twenty leaves per species were scanned, weighted, and sent to the lab for chemical analysis

WP3. Short-term effects of drought and heat events on forest understoreys: evidence from a five years resurvey (2018-2023) across European forests along edge-to-core gradients.
*Data analysis is ongoing

The third study aims to analyze the **effects of extreme climate events** (heatwaves and droughts) that occurred over the past five years **on plant diversity and composition, forest structure, and microclimate.** To this end, we compared the data obtained from the same sample areas in a 2018 study (Govaert et al., 2018) with those conducted in spring 2023.



The sampling sites are located in forests subject to different silvicultural management (not thinned, thinned 5-10 years ago, and recently thinned), along a macroclimatic gradient from Italy to Norway. In each of the 45 selected forests, five plots (3x3 m) were installed at increasing distances from the forest edge (n=225). Additionally, an altitudinal gradient was included in Italy, Belgium, and Norway. **In each plot, species were identified, and their abundances were assessed.**

WP4. Effects of climate warming on functionality of the forest specialist grass *Milium effusum*.
*Data sampling and analysis ongoing

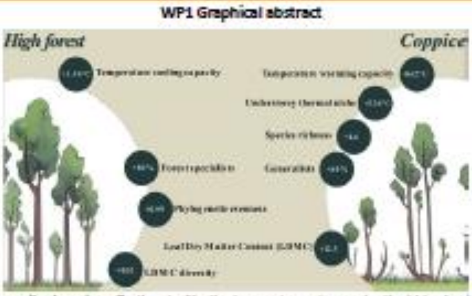
Main purpose: the experimental analysis of the **effects of global warming on the phenology, functional traits and performance of the forest specialist grass *Milium effusum* (Poaceae).**

We will analyse, through a multivariate approach, the interactive effects of climate warming, silvicultural management and distance to the edge on:
- ✓ **germination percentage**
- ✓ **mortality**
- ✓ **biomass**
- ✓ **functional leaf traits**
- ✓ **fluorescence indices**
- ✓ **chlorophyll content**

Experiment design: I collected the seeds of *Milium effusum* in high-altitude forests in Italy and Germany, respectively in Vallombrosa (Italy) and Monschau (Germany). I installed fenced boxes **at lower altitudes to simulate the temperature increase that is expected for the next decades, in thinned and non-thinned forests, inside the forest and near the forest edges (see Fig.).**

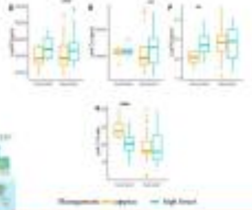
Results

WP1 Graphical abstract



Coppice woodlands are less effective at mitigating temperature extremes, hosting higher levels of taxonomic diversity but lower phylogenetic and functional diversity (Santi et al., 2024, doi:https://doi.org/10.1016/j.scitotenv.2024.170531)

WP2 –Key results SUBMITTED TO FOREST ECOLOGY AND MANAGEMENT



- ✓ Leaf area and specific leaf area were reduced but leaf dry matter content enhanced by coppicing.
- ✓ Leaf nutrient contents were lower compared to high forest.
- ✓ Lower competitive ability and higher stress tolerance occurred in coppice stands.
- ✓ **Close-to-nature management is advocated to support understory species and functions**

Finanziato dall'Unione europea NextGenerationEU | Ministero dell'Università e della Ricerca | Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA | UNIVERSITÀ DEGLI STUDI FIRENZE

Biotechnological procedures and "green extraction" strategies for the sustainable conversion of by-products, residues and wastes from agroforestry and agrifood sector into renewable resources to support innovative agriculture and plant-protection (Btech&green)

PhD student
Cosimo Beltrami

Supervisor
Prof. Stefania Tegli

PhD Day
Scienze Agrarie e Ambientali
17 dicembre 2024

My project
Valorisation of agro-waste to obtain **biostimulants or plant defence inducers**

Waste and residues from the Tuscan Apennine area

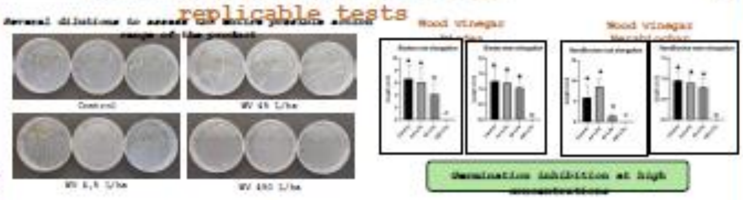
How to start?

WOOD VINEGAR: *Pyrolysis process by-product*

Already marketed as a bio-stimulant and defence inducer, starting from **chestnut** waste → ***To replace traditional fertilisers, pesticides and herbicide***

Commercial products to set up replicable tests

Germination tests/ Fitotoxicity effect

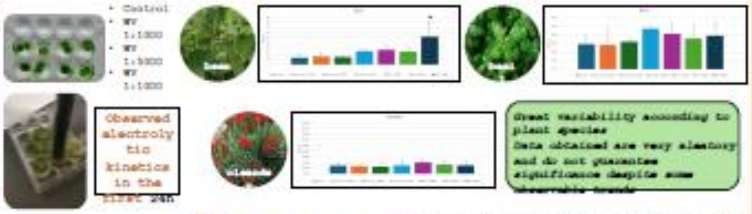


Germination inhibition at high concentrations

Antimicrobial activity

All products antimicrobial activity only with such as and not with all tested species

Electrolyte release

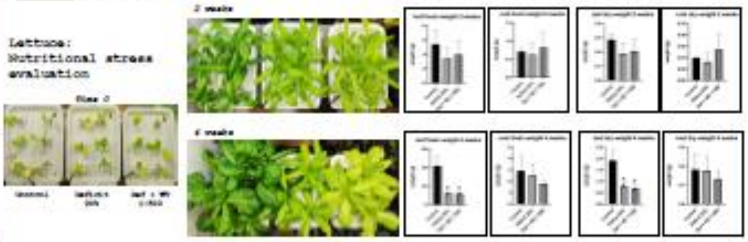


Observed electrolytic kinetics in the first 24h

Great variability according to plant species
Data obtained are very aleatory and do not guarantee significance despite some observable trends

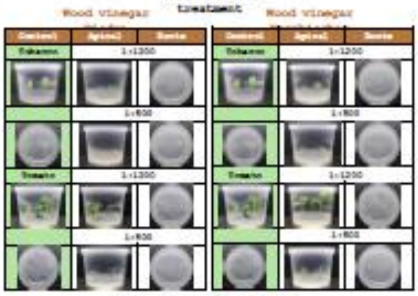
Hydroponics system

Lettuce: Nutritional stress evaluation



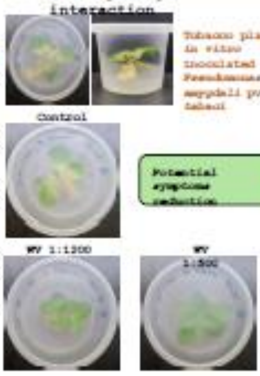
In vitro plants

Morphological characteristics after 3 weeks treatment



Growth inhibition at high concentrations (1:600), species-specific effect

Plant-pathogen interaction



Tobacco plants in vitro inoculated with *Pseudomonas amygdali* pv. *tabaci*

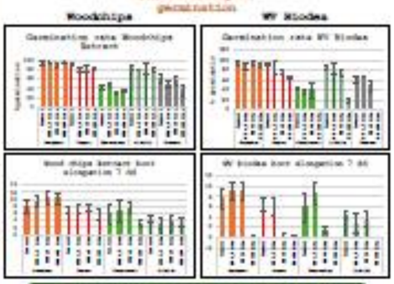
Potential symptoms reduction

Innovative «green extraction»

Infusion of chestnut wood chips

for the extraction of chestnut metabolites, especially tannins

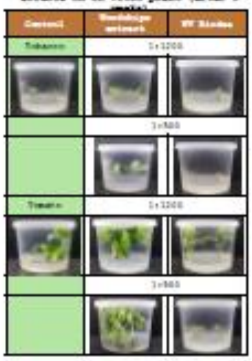
Phitotoxicity on germination



No inhibition even at high concentration

Antibacterial activity: almost zero even at such as

Effects on in vitro plant (after 3 weeks)



In field preliminary trials

Oleander plants treated and challenged by *Pseudomonas savastanoi* pv. *nerii* Psn23 strain

Starting date: 10/05/24
Bacterial Inoculum: 16/05/24
Treatments: 1 treatment/2 weeks
Ending date: 27/06/24

Tested wood chip extract and wood vinegar at different concentrations as plant defence inducers

Results not available, analysis in progress

Monitoring Biodiversity in *Fagus sylvatica* L. Stands: Genetic and Forest Indicators Development

PA127

Ferrante R.[1,2], Vettori C.[1,3], Garosi C.[1], Travaglini D.[1], Parisi F. [1,2], Bajc M.[4], Kraigher H.[4], Mrak T.[4], Nataša S.[4], Westergren M.[4], Dovč N.[4], Damjanić R.[4], Rantaša B.[4], Sever K.[5], Breznikar A.[5], Lanšćak M.[6], Ivanković M.[6], Vujnović Z.[6], Bogunović S.[6], Gavranović Markić A. [6], Paffetti D.[1,2]

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INTRODUCTION

Biodiversity is crucial for forest ecosystem preservation, contributing to productivity and ecosystem functioning. **Human activities** and **climate change** are causing a substantial **loss of biodiversity** at ecological, species, and genetic levels. **Ecologically sustainable forestry** prioritizes **biodiversity conservation**, essential for maintaining healthy forest ecosystems and supporting life on Earth. The **utilization of indicators is pivotal** in monitoring and describing biodiversity across all levels.

OBJECTIVE

Developing and implementing biodiversity indicators enables the **monitoring** of **genetic diversity in forest ecosystems**, facilitating the evaluation of **silvicultural practices** and their impacts on biodiversity in beech stands.

METHODOLOGY

DATA ANALYSIS

Data collections from 12 stands of *Fagus sylvatica* L. located in Croatia, Italy, and Slovenia.

- Genetic data (SSRs)
- Forest structure data
- Deadwood data
- Soil data
- Microhabitat data

CALCULATION OF VERIFICATORS

GENETIC INDICATOR
- N° of alleles
- N° observed alleles
- Effective n° of alleles
- Allelic richness
- N° of rare alleles
- Observed heterozygosity
- Expected heterozygosity
- F-statistic

FOREST STRUCTURE INDICATOR
- Stand density
- Basal area
- Coefficient DBH variation
- Standard deviation of height
- Coefficient heigh variation

DEADWOOD INDICATOR
- Standing dead trees
- Snags
- Stumps

SOIL DIVERSITY INDICATOR
- Richness index
- Shannon's index
- Evenness index

MICROHABITAT INDICATOR
- 7 forms
- 15 groups
- 47 types

RESULTS

GENETIC INDICATOR

Table 1. Genetic diversity for Baldo's forest site based on 16 SSR data

Site	Site name	Country	Silviculture system	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Site 02	Baldo's forest	Italy	Individual tree selective thinning	8.8	4.20	6.68	3.28	0.72	0.72	0.01

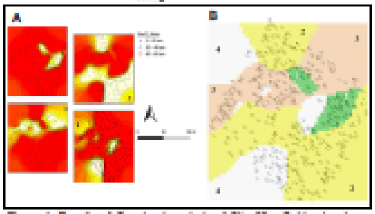

Figure 1. Results of Geneland analysis of Site 02 – Baldo showing the spatial organization into four clusters (B) and maps of posterior probabilities for each cluster (A).

SOIL DIVERSITY INDICATOR

Table 2. Index calculated to quantify biodiversity in soil

Site ID	Site name	Country	Silviculture system	Groups	Richness (mean ± S.D.)	Evenness (mean ± S.D.)	Shannon (mean ± S.D.)
Site 02	Baldo's forest	Italy	Individual tree selective thinning	Bacteria diversity	[illegible]	[illegible]	[illegible]
				Archaea diversity	[illegible]	[illegible]	[illegible]
				[illegible] diversity	[illegible]	[illegible]	[illegible]
				Fungi diversity	[illegible]	[illegible]	[illegible]

- Unmanaged forests demonstrated a more rich and intricate biodiversity
- Forest managed with individual tree selective thinning exhibited biodiversity levels comparable to those of old-growth forests
- Spatial genetic distribution analysis of Baldo's forest revealed a genetic structure complexity similar to that of unmanaged forests

MICROHABITAT INDICATOR

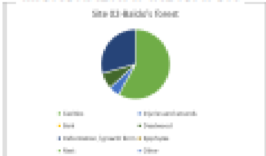

Figure 2. Frequency of microhabitats reclassified to form level

FOREST STRUCTURE INDICATOR

Table 3. Stand structure verificators calculated to develop forest indicator for Baldo's forest site.

Site ID	Site name	Country	Forest structure	Silviculture system	Stand density (n trees/ha)	Basal area (m²/ha)	Coefficient of variation of DBH (%)	Standard deviation of height (m)	Coefficient of variation of height (%)
Site 02	Baldo's forest	Italy	Uneven-aged	Individual tree selective thinning	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

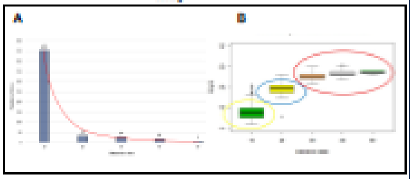

Figure 3 . *Fagus sylvatica* individuals within Site 02 – Baldo's forest. (A) Distribution of individuals according to diametric classes. (B) Boxplot of the variation in height for each diametric class analysed.

DEADWOOD INDICATOR

Table 4 Deadwood verificators calculated to develop deadwood indicator for Baldo's forest site.

Site ID	Site name	Country	Silviculture system	Standing dead trees (including snags) (m³/ha)	Downed dead trees (m³/ha)	Other lying dead wood pieces (m³/ha)	Stumps (m³/ha)	Total (m³/ha)
Site 02	Baldo's forest	Italy	Individual tree selective thinning	0.8	0	0	5.6	6.4

CONCLUSION

- The management approach involving single-tree cutting could be effective in both conserving and enhancing biodiversity.
- This management approach enhances forest complexity, fostering a multi-layered structure that facilitates pollen dispersal and high gene flow, thereby promoting genetic diversity and increasing the likelihood of new allelic variants crucial for climate change adaptation.
- The gathered data will be utilized to create a comprehensive index correlating forest and genetic indicators. This results will be used as an input of the predictive model for adaptive management under climate change.

Funder: Project funded under the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.4 - Call for tender No. 3138 of 16 December 2021, rectified by Decree n.3175 of 18 December 2021 of Italian Ministry of University and Research funded by the European Union – NextGenerationEU. Award Number: Project code CN_00000033, Concession Decree No. 1034 of 17 June 2022 adopted by the Italian Ministry of University and Research, CUP B83C22002910001, Project title "National Biodiversity Future Center - NBFC".

Forum Nazionale della Biodiversità

Convegno Scientifico
20 21 maggio 2024
Università degli Studi di Palermo

Poster dei Dottorandi del 39° ciclo

Hydrogen production in bio-electrochemical systems with purple non-sulfur bacteria

Chiara Capelli

INTRODUCTION

Breweries produce large volumes of brewery waste (BW), including spent grains, hops, yeast and wastewater. This waste, characterised by high chemical oxygen demand (COD), poses environmental risks but can be reused to support circular economy practices (Olajire, 2020). Emerging technologies, such as dark fermentation (DF) and bio-electrochemical systems (BES), show promise for converting BW into valuable products such as hydrogen (H_2). BES, which use microorganisms to transfer electrons between electrodes, can reduce the energy required for H_2 production and treat organic waste (Daghio et al., 2017). In addition, purple non-sulfur bacteria (PNSB) have been investigated for their ability to produce H_2 and fix CO_2 in these systems (Vasiliadou et al., 2018). The integration of DF with BES and PNSB could enable sustainable waste management, reduce environmental impact and generate renewable energy, positioning BW as a resource rather than a liability (Grattieri, 2020).

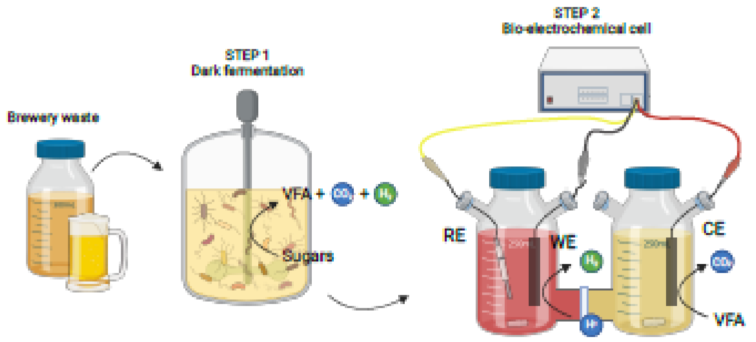

Fig 1. Overall scheme of the process. BW will be first fermented to produce H_2 and to obtain volatile fatty acids (VFAs) (Step1) that can be easily oxidized at the anode of a BES (Step2). The electrons derived from the anodic oxidation will be used for H_2 production at a photocathode inoculated with PNSB (Step2).

METHODS

BWs were fermented at 37°C for two weeks at various dilutions (undiluted, 1:2, 1:4 and 1:8). Centrifugation was also performed to reduce the presence of yeasts (BW4c). Bio-electrochemical analyses focused on cathodic reactions using H-type cells. The anodic chamber acted as the counter electrode (CE), the cathodic chamber as the working electrode (WE), vs. Ag/AgCl reference electrode (RE). Chronoamperometric tests were performed at cathode potentials ranging from -300mV to -600mV vs. Ag/AgCl, with the cathodic chamber inoculated with *R. palustris* 42OL. The anolyte was a mineral medium. H_2 production was quantified using a water displacement method isolating CO_2 via NaOH neutralisation.

RESULTS

For DF, the best results were obtained with BW3, the spent yeast of a Golden Ale beer ("Birrificio Oltrarno" brewery):

- Carbohydrate concentration decreased by 31.8%
- The VFAs production was: 2.14 g/L of acetic acid, 7.54 g/L of propionic acid, and 0.89 g/L of lactic acid;
- Production of 596.5 mL H_2/L of solution.

For BES:

- PNSB grew more at the potential -500mV vs. Ag/AgCl (OD_{660}=1.2±0.005, compared to OD_{660}=0.86±0.005 of the control);
- The greatest H_2 production was obtained at -300mV vs. Ag/AgCl (499.1 mL H_2/mL of solution compared to 63.5 mL H_2/mL of solution of the control).

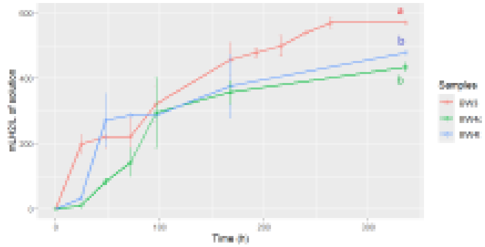

Fig. 3. H_2 production during 2 weeks of dark fermentation

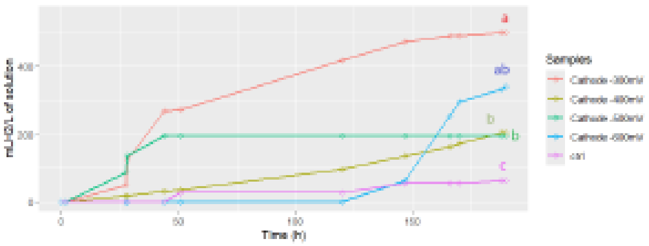

Fig. 2. Cathodic H_2 production in BES

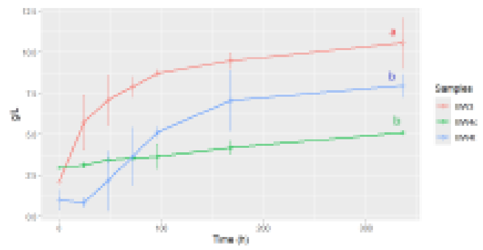

Fig. 4. VFAs production during 2 weeks of dark fermentation

CONCLUSIONS AND FUTURE PERSPECTIVES

The results obtained indicate the feasibility of the project. However, further analyses are still needed to define the best experimental conditions to improve H_2 and VFA production. The next steps of the project will be:

- Evaluate the addition of biochar particles as a strategy to improve DF efficiency;
- Characterise the microbial communities involved in DF;
- Continue testing different conditions in BES (e.g. single chamber, mixed culture).
- Perform a transcriptomic analysis to identify which genes are overexpressed or underexpressed during cathodic H_2 production by *R. palustris*.

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Dottorato in Scienze Agrarie e Ambientali XXXIX CICLO

Effetti dello stress idrico sui parametri agronomici, morfologici e fisiologici di ibridi di mais con diversa tolleranza alla siccità

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Dipartimento di Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI), Piazzale delle Cascine, 18 - 50144 Firenze

Introduzione

Il mais (*Zea mays* L.) è una coltura di grande importanza essendo la prima al mondo per produzioni. Inoltre, è una coltura estremamente polivalente, essendo impiegata per l'alimentazione umana, come mangime, nell'industria dell'amido, biocarburanti e biogas. D'altra parte, è una coltura con un'elevata richiesta di input, principalmente di acqua.

Il cambiamento climatico sta causando problemi alla coltivazione del mais, anche nelle aree tradizionalmente vocate, a causa della diminuzione delle piogge, in particolare durante il periodo di fioritura e di sviluppo delle spighe, fasi critiche per il mais.

Negli ultimi anni, si sta diffondendo l'utilizzo di ibridi maggiormente tolleranti alla siccità che potrebbero consentire la coltivazione del mais anche in condizioni di limitata disponibilità idrica.

Obiettivi

- Valutare il grado di resistenza allo stress idrico degli ibridi tolleranti alla siccità.
- Identificare i tratti e le strategie che attuano gli ibridi commercializzati come tolleranti alla siccità rispetto agli ibridi convenzionali.
- Determinare la produttività e l'efficienza d'uso dell'acqua dei diversi ibridi in condizioni di stress idrico.

Metodi

La prova è stata condotta presso l'Azienda sperimentale del CREA a Fagna, Scarperia (FI). Sono stati registrati i principali parametri meteorologici per il calcolo dell'evapotraspirazione potenziale (ET_0) e del fabbisogno irriguo.

Due ibridi di mais (FAO 400) con diversa tolleranza alla siccità, P0362 (convenzionale) e P0217 (tollerante), sono stati coltivati con irrigazione piena (full, 100% ET_c), irrigazione deficitaria (deficit, 50% ET_c) e in asciutta (rainfed); ogni combinazione ibrido-trattamento è stata replicata 3 volte, per un totale di 18 parcelle. L'irrigazione è stata distribuita con un impianto a goccia. Durante il ciclo colturale sono stati fatti 10 campionamenti per il monitoraggio delle risposte morfologiche e fisiologiche al deficit idrico. È stato valutato l'accrescimento delle piante misurando le altezze, la copertura vegetale (%) e l'indice di area fogliare. Sono state prese impronte fogliari per le analisi stomatiche. È stata valutata la resa in granella e biomassa, la produttività dell'acqua e misurati diversi parametri relativi alle caratteristiche della granella.

Risultati

- L'ibrido tollerante alla siccità (DT) ha raggiunto altezze superiori in tutti e tre i trattamenti (Fig. 1a). Ha, inoltre, mantenuto valori di indice di clorofilla (SPAD) (Fig. 1c) e di indice di vegetazione NDVI (Fig. 1d) superiori all'ibrido convenzionale (Non-DT).
- Non ci sono state differenze significativa di copertura vegetale tra i due ibridi nei diversi trattamenti, tuttavia gli ibridi coltivati senza irrigazione avevano una minore copertura vegetale (Fig. 1b).
- I valori maggiori del contenuto relativo di acqua fogliare (RWC) sono stati osservati nel trattamento di full (~82%), mentre i valori inferiori sono stati riscontrati per l'ibrido convenzionale in rainfed (60%) (Fig. 2a).
- L'ibrido tollerante ha mantenuto uno stato di idratazione superiore sia in deficit che in rainfed. Inoltre, sembra avere una maggiore plasticità fogliare rispetto all'ibrido convenzionale ispessendo i tessuti in condizioni di forte deficit idrico (Fig. 2b).
- La produttività dell'acqua di irrigazione è stata maggiore per l'ibrido tollerante in deficit.

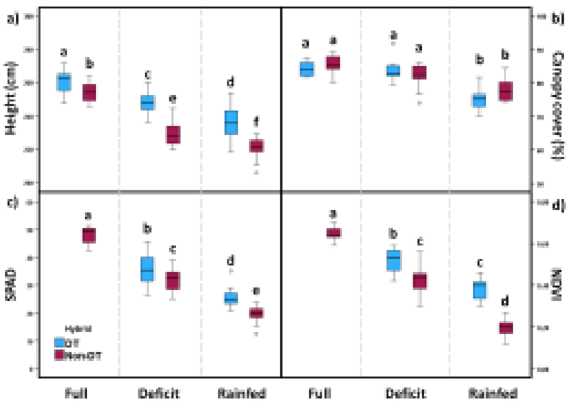


Figura 1

- Nei diversi trattamenti irrigui non ci sono state differenze significative di resa in granella e biomassa tra i due ibridi (Tab. 1). L'ibrido tollerante in deficit ha avuto un indice di raccolto paragonabile all'ibrido convenzionale in full. Il peso di 1000 semi diminuisce significativamente da full a deficit e da deficit a rainfed e l'ibrido tollerante ha un peso superiore rispetto al convenzionale.

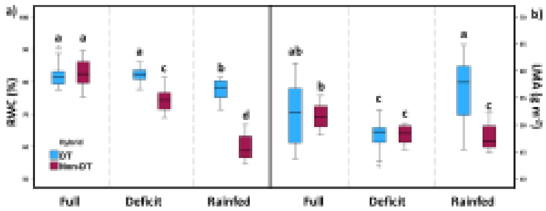


Figura 2

Tabella 1

Hybrid	Water regime	Grain yield (Mg ha⁻¹)	Total aboveground biomass (Mg ha⁻¹)	Harvest index	1000 kernel weight (g)	Water productivity (Kg m⁻³)	Crop water productivity (Kg m⁻³)	Irrigation water productivity (Kg m⁻³)
Non-DT	I_{100}	10.33a	21.12a	0.49a	314.3a	2.2a	4.5a	8.4b
	I_{50}	4.57b	12.35b	0.31b	253.1c	1.4ab	3.6ab	10.3ab
	I_0	1.94c	7.94c	0.24c	208.9e	0.9bc	3.7ab	
DT	I_{50}	6.49b	14.46b	0.43a	282.4b	1.9a	4.3a	12.0a
	I_0	1.37c	8.12c	0.13c	216.9d	0.6c	3.8a	

Conclusioni

L'ibrido tollerante ha mostrato migliori performance per quanto riguarda i parametri fisiologici e vegetativi rispetto all'ibrido convenzionale.

L'ibrido tollerante può conservare più acqua nei tessuti fogliari in condizioni di stress idrico.

Entrambi gli ibridi, nel trattamento rainfed, hanno avuto rese in granella molto basse evidenziando la grande importanza dell'irrigazione per il mais.

I risultati ottenuti, suggeriscono che l'ibrido tollerante può rappresentare una valida soluzione per ottenere rese soddisfacenti con ridotti apporti irrigui. Ulteriori prove, testando diverse classi di mais, saranno necessarie per stabilire l'effettivo vantaggio di questi nuovi ibridi.

Integration of multisensor remote sensing data and modeling tools for the monitoring and characterization of agro-silvo-pastoral systems

XXXIX PhD Cycle

Candidate: ***Luca de Guttry***

Tutor: ***Prof. Camilla Dibari***
Co-tutor: ***Prof. Giovanni Argenti***

Context

Extensive agro-silvo-pastoral systems contribute to multiple functions and ecosystem services (e.g., biodiversity, cultural and aesthetic values, carbon stock…).
However, **often located in marginal areas** (operational difficulties, high costs…), **these systems are facing the consequences of land abandonment**, together with **the negative influence of climate** and **land use change**

AIM

Assess the use of **Optical and SAR remote sensing** and **modeling** tools to develop new methodologies and approaches **for the study of extensive agro-silvo-pastoral systems and the optimization of their management.**

Crop modeling + RS
Agro-silvo-pastoral systems productivity and management

Image classification
Agro-silvo-pastoral systems monitoring and characterization

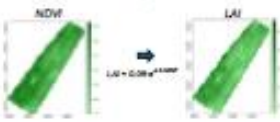
Field data collection (2024) – Borgo San Lorenzo (FI, ca. 200 m a.s.l.)

- Grass height
- LAI
- Proximal NDVI
- AGB
- Simplified botanical composition
- Forage quality

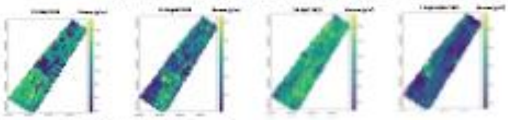
First results – Borgo San Lorenzo (FI) (data 2020-2022)

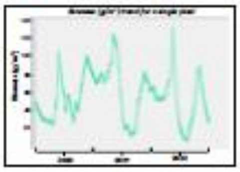
Study area

Remotely sensed LAI



Spatialized biomass simulations
Vistock model (Bellini et al., 2023; Leolini et al., (under review))



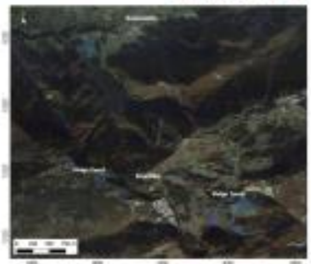


r = 0.43
RMSE = 50 g/m²

Next steps:

- 2[nd] round of field sampling (2025)
- Spatialized Vistock model + SAR
- Test with field-collected data (2024-2025)

Field data collection (2023 + 2024) – Friuli-Venezia-Giulia (Mount Zoncolan, ca. 1700 m a.s.l)



- Grass height
- LAI
- Proximal NDVI
- AGB
- Species-level botanical composition
- Forage quality

3 drone flights in 2024 (multispectral camera)

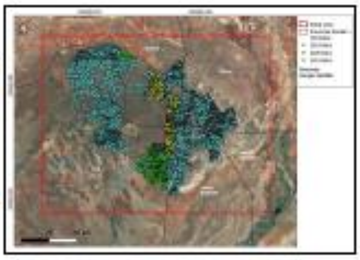
Next steps:

- Pastures' classification using RS (SAR + Optical) and drone imagery
- 3[rd] round of field sampling (2025)

Additional case study:
Somalia's rangelands: a multisensor and machine learning approach to monitor illegal charcoal production sites

Context: *Forest and habitat degradation* ➡ *Negative impacts on local silvo-pastoral activities*

Study area:



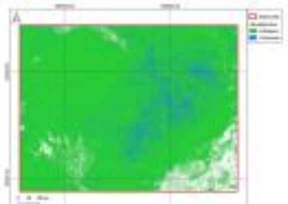
Results: SVC classification of charcoal kilns presence-absence

Training set

R²	Standard deviation
[illegible]	[illegible]

Test set

R²	Overall Accuracy	Precision	Recall (sensitivity)	Specificity	Cohen's K
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



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Bellini, E., Moriondo, M., Dibari, C., Bindi, M., Staglianò, N., Cremonese, E., Filippa, G., Galvagno, M., & Argenti, G. (2023). VISTOCK: A simplified model for simulating grassland systems. *European Journal of Agronomy*, 142(November 2022). https://doi.org/10.1016/j.eja.2022.126647

Strategie agronomiche di adattamento al cambiamento climatico per il risparmio idrico e la tolleranza alla siccità

Pastacaldi, G., Mancini, M., Ghinassi, G., Verdi, L., Orlandini, S., Dalla Marta, A.

Dipartimento di Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI), Università degli Studi di Firenze, Firenze, Italia

Introduzione

Il progetto si colloca nel contesto della diminuzione delle risorse idriche e dell'aumento della frequenza di siccità e ondate di calore. Queste condizioni incidono drammaticamente sulle rese delle colture, in particolare nel periodo tardo-primaverile ed estivo, caratterizzato da temperature più elevate, precipitazioni ridotte e una maggiore frequenza e durata di tali eventi a causa del riscaldamento globale. Pertanto, risulta urgente migliorare l'efficienza dell'uso dell'acqua, implementare strategie agronomiche per conservare l'acqua e migliorare la resilienza delle colture alle condizioni di siccità.

Prova 1

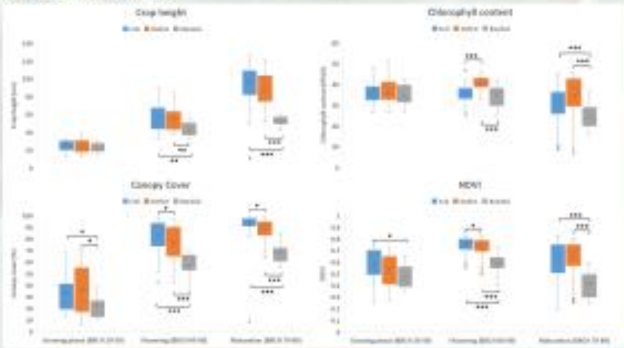
Obiettivi

1) Stimare il fabbisogno idrico della soia;
2) Stimarne e validarne lo stato idrico comparando i dati raccolti *in situ* con dati e remote sensing;
3) Esaminare gli effetti di diversi regimi irrigui sulla produttività, l'efficienza di uso dell'acqua e le caratteristiche qualitative dei semi.

Materiali e metodi

La soia (*Glycine max* (L.) Merr.) è la quarta coltura più coltivata al mondo (FAOSTAT, 2023), la cui produttività dipende strettamente dalla disponibilità di risorse idriche.

Nel campo sperimentale nei pressi di «Le Chianacce» (Foiano della Chiana, Arezzo) la soia è stata sottoposta a tre trattamenti irrigui: irrigazione piena (Full, 100% evapotraspirazione colturale, ET_c), deficitaria in base alla fase fenologica (Regulated deficit, 70% ET_c in accrescimento, 100% ET_c fioritura, 70% ET_c maturazione) e asciutta (Rainfed). L'irrigazione è stata effettuata con irrigatore a barra semovente. Quattro gruppi di sensori hanno monitorato l'umidità del suolo a diverse profondità (20, 40 e 60 cm) e il potenziale matriciale (40 cm). Sono stati inoltre monitorati i parametri meteorologici principali, tra cui l'evapotraspirazione di riferimento (ET_0) per la stima del fabbisogno irriguo. Rilievi fenologici, altezza della pianta (crop height), indice di clorofilla (chlorophyll index), copertura fogliare (canopy cover) e NDVI (Normalized Difference Vegetation Index) sono stati svolti durante tutto il ciclo colturale. Sono stati infine misurati la produttività in termini di resa e biomassa, e la qualità della granella.



	Yield (t/ha)	Total above ground biomass (t/ha)	Harvest index	Water productivity (kg/m³)	Irrigation water productivity (kg/m³)
Full	2.70	7.75	0.35	5.70	10.43
Deficit	3.07	7.92	0.39	8.00	17.91
Rainfed	1.27	3.88	0.33	5.98	

Risultati preliminari

Le differenze tra irrigazione piena e deficitaria di altezza delle piante, indice di clorofilla, copertura fogliare e NDVI non risultano statisticamente significative in fase di accrescimento. Si notano differenze significative in fioritura sull'indice di clorofilla ($p<0.001$), copertura fogliare ($p<0.05$) e NDVI ($p<0.05$). In fase di maturazione vi è significatività solo sulla copertura fogliare ($p<0.05$). Per quanto riguarda i dati di produttività, l'irrigazione deficitaria mostra risultati superiori all'irrigazione piena per tutti i parametri studiati, ovvero resa in granella, produzione di biomassa, indice di raccolta, produttività dell'acqua e produttività del volume irriguo.

Prova 2

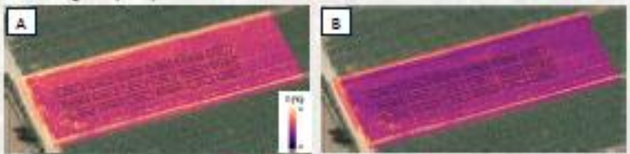
Obiettivi

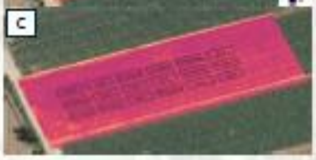
1) Indagare l'efficacia dei biostimolanti e prodotti di selezione sul sorgo come strategie di mitigazione in condizioni di ondate di calore e siccità;
2) Valutare l'effetto di questi prodotti sulla produttività del sorgo, in particolare in termini di resa e biomassa, nonché di qualità della granella.

Materiali e metodi

Il sorgo, al contrario della soia, è considerato una pianta tollerante alla siccità, ma la sua produttività e le sue proprietà nutrizionali, già elevate, potrebbero essere migliorate attraverso l'uso di prodotti in grado di ridurre lo stress causato da ondate di calore.

La prova è stata effettuata alla Tenuta di Cesa (Terre regionali Toscana, Marciano della Chiana, Arezzo). Il sorgo è stato trattato con sei prodotti: uno schermante (caolino); due biostimolanti estratti da alghe (*Eck. maxima* e *Asc. nodosum*, rispettivamente); un biostimolante composto da silicio e glicinbetaina; un biostimolante a base di calcio; e il controllo. Sono state effettuate due applicazioni durante le fasi di formazione dei chicchi e di maturazione, prima e dopo un'ondata di calore. Il prodotto schermante, riducendo l'assorbimento di raggi ultravioletti e infrarossi, impedisce l'accumulo di calore nelle foglie e attenua gli effetti dello stress termico e da irraggiamento. I biostimolanti stimolano la biosintesi di ormoni vegetali e osmoliti, ripristinano l'equilibrio energetico ostacolato da una disponibilità idrica insufficiente per il normale funzionamento degli stomi, contrastano la produzione di specie reattive dell'ossigeno (ROS).





Il campo è stato monitorato con una camera multispettrale e termica, la MicaSense Altum PT (AgEagle Aerial Systems Inc., Wichita, Kansas, USA).
In Figura A, B e C le immagini termiche.

	Yield (t/ha)	Total above ground biomass (t/ha)	Harvest index	500 kernel weight (g)
Siglycinbetaine	0.96	8.35	0.12	10.44
Calcium	1.48	9.20	0.16	11.00
Kaolin	2.04	8.20	0.25	11.74
Eck. maxima	1.47	8.73	0.17	9.66
Asc. nodosum	2.08	8.39	0.25	11.72
Untreated	1.06	8.99	0.12	9.24

Risultati preliminari

Le parcelle trattate con *Asc. nodosum* mostrano valori superiori sia di resa che di indice di raccolta rispetto agli altri trattamenti. Al contrario, le parcelle trattate con silicio e glicinbetaina mostrano i valori più bassi per tutti i parametri, paragonabili al controllo (non trattato) per quanto riguarda resa e indice di raccolta.

Osservando le immagini termiche del campo, si evince una leggera variabilità nella distribuzione spaziale delle temperature. Tuttavia, le immagini termiche e multispettrali dovranno essere ulteriormente e approfonditamente analizzate.

Optimization of plant-soil feedback under legume-cereal intercropping systems: Understanding the interplay between aboveground plant communities and belowground microbial communities under legume-cereal intercropping

PhD candidate: ***Riccardo Picone****

Supervisors: Dr. ***Shamina Imran Pathan***[a], Prof. *Giacomo Pietramellara*[a], Prof. *Georg Guggenberger*[b], Dr. *Norman Gentsch*[b]

[a]Università degli Studi di Firenze; [b]Leibniz Universität Hannover

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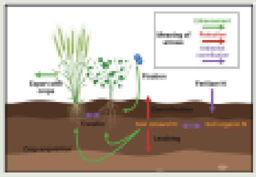
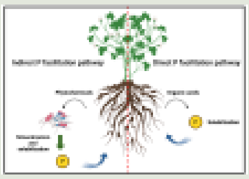
Background

- **Enhancing crop yield intensity** while promoting **soil multifunctionality** is essential for achieving **world food security** with minimal negative environmental impacts
- **Legume-cereal intercropping**, guided by the principles of **complementarity** and **facilitation**, can lead to increased **resource use efficiency** and **higher crop yields**

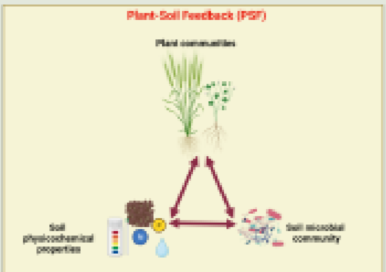
Knowledge gaps

LEGUMINOSE
the way to a green transition





Hypotheses

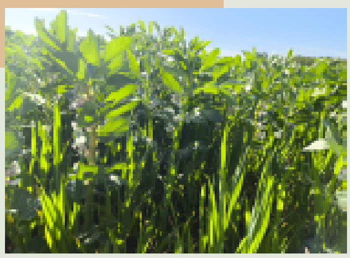


- **Wheat-faba bean intercropping** can cause an **increase** in **soil** and **root microbial communities'** α-diversity and functionality related to **nutrients** and **C cycling**, thus promoting **C and N retention in soil** and **nutrient use by plants (H1)**
- These changes might result in the **enhancement of plant performance** compared to sole cropping due to the **reduction of nutrient losses** and the improved **nutrient use efficiency** of plants (**H2**)

Materials and methods

Plant performance

- **Crop yield and quality**
- Plant biomass **C** and **Total N** and their **δ13C and δ15N**
- Land Equivalent Ratio
- **N use efficiency**



Soil physicochemical properties

- **Plant nutrients' availability** (NH4+, NO3-, plant-available P, K, and micronutrients)
- **Soil Organic C** (SOC) and **Total N** (TN) stocks and their **δ13C and δ15N**
- **Greenhouse Gases Emissions** (GHG) and **Net Ecosystem Production** (NEP)

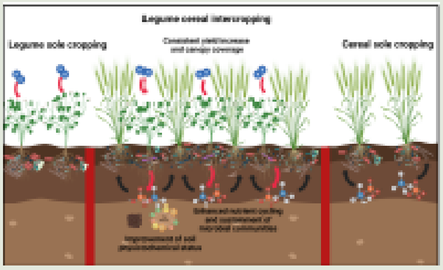
Microbial biochemical properties

- **Microbial biomass C and N abundance**
- **Enzyme functional potential** related to nutrients and C cycles
- **C Use Efficiency** (CUE)

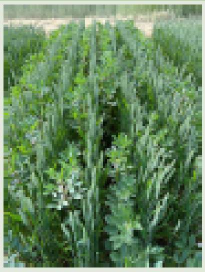
Soil and root microbiome functional and structural potential

- **Soil and root bacterial and fungal communities' potential taxonomic composition, structure, biodiversity** and **connectivity**
- **Abundance** of **microbial phylogenetic and functional markers** (N, P and C cycling)
- Soil **multifunctionality**

Expected results



- **Improved crop performance**
- **Enhanced nutrient and C status** in soil
- **Higher microbial functional potential and biodiversity**
- **Reduced losses in GHG**
- **Increased soil-plant-microbiome ecosystem multifucntionality**



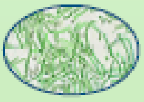
All images were created in Biorender

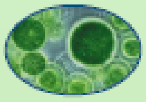
Scienze Agrarie e Ambientali PhD Day
Firenze, 17.12.2024

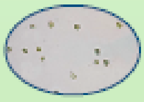
Microalgal cultures for obtaining raw materials for biosustainable industrial and food applications

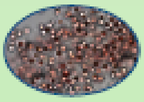
PhD Student: Lorenzo Reali

Supervisor: Prof. Liliana Rodolfi
Co-Supervisor: Prof. Natascia Biondi


Cyanobacteria


Green algae


Haptophyte


Red algae


Diatoms

What are we working with

Oxygenic photosynthetic microorganism able to fix CO_2 using visible light

Aim of the project

- Find a promising polysaccharide producing strain
- Testing polymer for application in nutraceutical, cosmetics or biomaterial sectors
- CO_2 fixation + Energy consumption reduction= Environmentally and economically sustainable production

What are we looking for

Polysaccharides

Starch
- Glucose monomer chain with α-glycosidic bonds
- Intracellular storage polymer
- Mostly found in **green algae**

Β-glucans
- Glucose monomer chain with β-glycosidic bonds
- Intracellular storage polymer
- Mostly found in **diatoms**

Exopolysaccharides
- Long chain with different monomers
- Released in the medium or cell-bound
- Mostly produced by **red algae** and **cyanobacteria**

What are the phases of the project

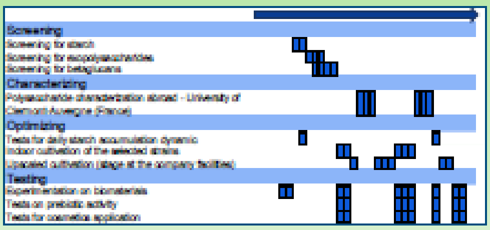
Screening
- Investigation of different strains for each molecules

Characterizing
- Characterization of obtained polymers to identify those with potential application value

Optimizing
- Improving production of the selected polysaccharides and feasibility of larger volume culture

Testing
- Test polysaccharides obtained for industrial application

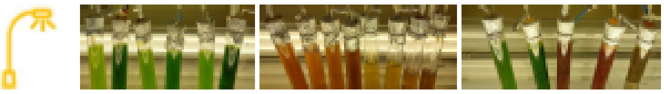
Timeline



What has been done so far

Screening

Starch | Β-glucans | Exopolysaccharides



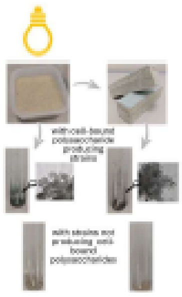
Tested strains: Starch 10; Β-glucans 7; Exopolysaccharides 10

- 500 mL bubble tubes with air:CO_2 mixture
- Continuous light 160 μmol photon m^{-2} s^{-1}, 27 °C temperature
- Cultivation in replete (all) and nitrogen and phosphorous-depleted media (starch and beta-glucans trials)

Optimizing

- Starch accumulation dynamic investigation in two selected strains
- Cultivation outdoors during July
- 7 L bubble tubes with controlled temperature (27°C) and pH (7,8)
- Cultivation in replete and nitrogen and phosphorous-depleted media

Testing



- Novel biomaterial obtained from marble extraction leftovers, microalgal biomass enriched with calcium and bicarbonate, and pectin as binding agent
- Evaluation of polysaccharide role on microalgae viability in the material

Acknowledgments: Part of the research was carried out at Centro di Competenza Valore, Florence, Italy (Regione Toscana, Par-FAS 2007-2013 Projects).

4.23

Integrating phenotypic, genotypic, and environmental data for predictive modeling in **durum wheat** (*Triticum durum* Desf.) cultivation using **Artificial Intelligence**

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2- Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence. Via Maragliano, 77 - 50144 Florence, Italy
*Corresponding author: walter.vieri@unifi.it

Figure 1. Experimental wheat fields

Background

The Mediterranean region is experiencing rising temperatures and decreasing water availability, which could significantly impact durum wheat cultivation. Nowadays, the need for a comprehensive understanding of **how durum wheat yield and protein quality change under different environmental conditions** is increasingly urgent, aiming to optimize **agronomic practices** and **mitigate potential losses**.

Data? No. BIG DATA for AI

- **Phenotypic data:** Dataset from CREA (Rome) was used, featuring 200 durum wheat varieties, **14** measured **traits**, collected over 24 years (1998/2022) in **119 fields** across the whole Italian territory **(Fig.1)**
- **Genomic data: 91 varieties** with **25,636 SNPs** obtained from online the T3/Wheat database.
- **Historical climate series** for each locality include data on solar radiation, growing degree gays (GDD), precipitation, moisture, soil water, wind and temperature, obtained from the ERA5 database.
- **Machine learning** algorithms: Random Forest, Linear Regression, and Gradient Boosting.

Goals

- Develop a **predictive model** for durum wheat yield and protein content based on phenotypic, genetic, and climatic data.
- Identify **optimal locations** for cultivating different varieties of durum wheat.
- Identify **key genetic polymorphism** to create genotypes suited to specific climates and agronomic needs like yield or protein content.

SNP Analysis in Durum Wheat: Yield and Protein Trade-Offs

In preliminary analyses, we used genomic data and two phenotypic traits: yield and protein percentages. Currently, climatic data are not included in the analysis. Based on initial analyses, durum wheat varieties cluster in **two main groups according to SNPs presence or absence (Fig. 2)**.

We compared average yield and protein percentages across varieties without considering location or year, finding that **Casteldoux** and **Anvergur** (highlighted in green) had **highest yields** and fell within the same cluster. The SNPs most correlated with yield and protein content are detailed in **Figure 3**. Notably, SNPs associated with **higher yield showed a negative correlation with protein percentage**, while those linked to **higher protein content exhibited a negative correlation with yield.**

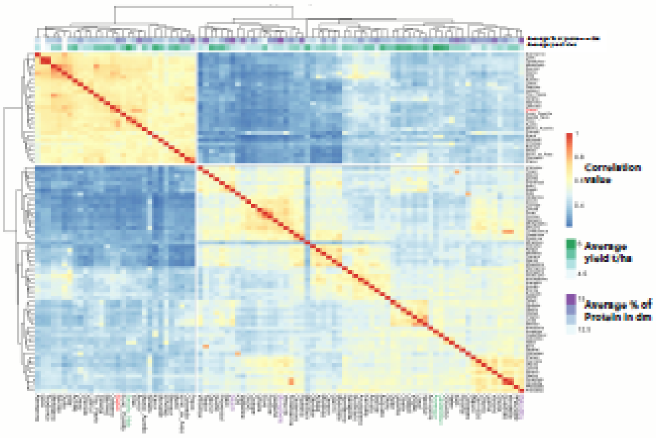

Figure 2. Correlation between varieties based on SNP presence/absence. Yield and protein content (yearly fields average values are shown at the top of the figure. Varieties with the highest yield and highest protein content values are written in green and purple, respectively. Svevo is written in red.

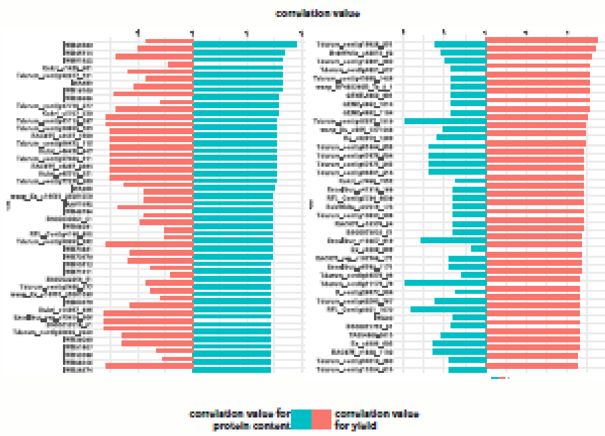

Figure 3. SNP's most correlated with yield (A) and protein content (B). Red bars indicates correlationvalue with yield (t/ha), while light blue ones show correlation with protein content (%dm).

Evaluating Machine Learning Models for SNP-Based Yield Prediction

Genomic data **modeling** was conducted to predict yield based on SNPs without climatic data. **Figure 4** shows prediction errors for three **machine learning** algorithms: Random Forest, Linear Regression, and Gradient Boosting.
Linear Regression performs best in terms of error and data explanation, closely followed by **Gradient Boosting**. Random Forest is the least effective model of the three.

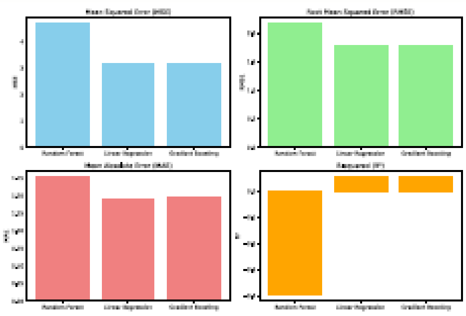

Figure 4. This figure displays prediction errors for three machine learning algorithms Random Forest, Linear Regression, and Gradient Boosting used to model genomic data for yield prediction based on variety and SNP presence.

Summary and Prospects

- The prediction error values indicate that the **models require further improvement.**
- Incorporating historical climate data will enhance our ability to identify the **best varieties** for specific **climatic conditions** and **predict their performance in diverse environments.**
- This comprehensive approach will significantly improve our ability to **select optimal varieties and forecast yields in varying climatic contexts.**

Poster dei Dottorandi del 40° ciclo

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PhD in Agricultural and Environmental Sciences XL Cycle – Year 1

Research project

Impact of advanced agri-voltaic systems designed according to the principles of agroecology on water, energy and food balance: assessment at farm and landscape level

1. Problem statement

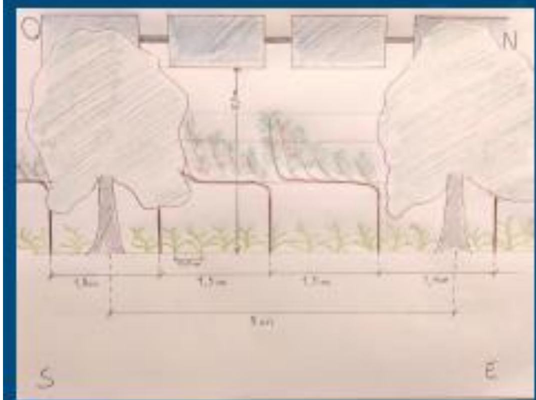
How to redesign agroecosystems to address water, energy and food crisis

2. Project Idea

Global energy demand is expected to increase, but a 1.2% annual decline in primary energy demand could occur starting in 2030 due to electrification and improved process efficiency (IEA, 2023). Renewable energy, especially solar, will play a key role in this shift. However, large-scale solar power generation requires significant land, which competes with agricultural use. Agrivoltaic (AV) systems, which combine farming with electricity generation, can reduce land use conflicts and provide economic, social, and environmental benefits (Campana et al., 2021; Mamun et al., 2022).

3. Project description

The project focuses on developing an advanced agrivoltaic system in agroforestry context combining agroecology principles (Gliessman, 2015) and renewable energy. The system will be co-designed by the Department of Agricultural, Food, Environmental, and Forestry Sciences and Technologies (DAGRI) in collaboration with the Department of Industrial Engineering (DIEF) of the University of Florence and it will integrate photovoltaic panels, trees, and herbaceous crops into a three-tier agroforestry model. The project aims to assess the agrivoltaic system's impact on crop yields, water balance, soil fertility, microclimate, ecosystem services, and solar energy use efficiency. The evaluation will account on model-based analysis and filed experiment in different pedo-climatic scenarios in Italy.



4. Research activities

a) design and simulation of the agrivoltaics system in collaboration with DIEF-UNIFI;

b) Model-based analysis to evaluate the impact of the agrivoltaic system on water, food and energy balance in different pedo-climatic scenarios;

c) Simulation of the application of water harvest technique to the agrivoltaic system;

d) Field-data collection in different pedo-climatic scenarios: fertility, agro-biodiversity, ecosystem services, microclimate

e) Data processing through linear models and multivariate analysis

f) Application of multi-objective optimization techniques to the agrivoltaics system at farm and landscape level in collaboration with the University of Wageningen (NL).

5. Expected results

This project aims to provide scientific data on the use of agrivoltaics in agroforestry. Nevertheless, the proposed agrivoltaics model will supply an alternative to current land use. The study will provide results on the impact of complex agrivoltaic system on water, food and energy balance as well as on the landscape, offering valuable insights for future research on agricultural system re-design to face water, food and energy crisis.

6. References

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Bioactive compounds from pruning waste

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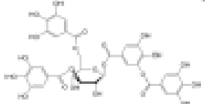
2 National Reaserch Council of Italy (CNR), Institute for Sustainable Plant Protection (IPSP), Florence;
3 Laboratory of Chemistry of Natural Molecules, Gembloux Agro-Bio Tech, University of Liège, Belgium.

Introduction



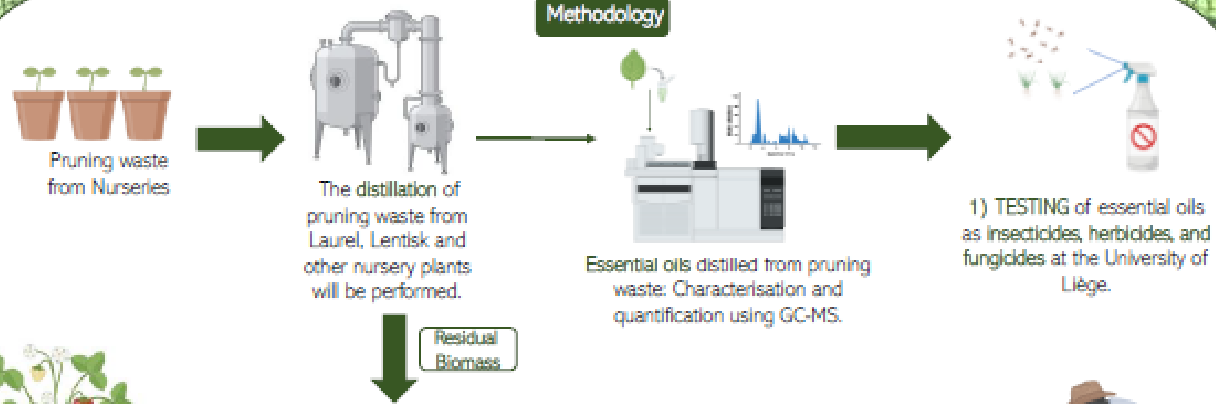
Nursery companies are currently facing several management challenges to ensure good production. These challenges include insect and phytopathogen attacks, maintaining plant health with reduced use of chemicals and proper disposal of pruning waste. One potential solution is the recovery and reuse of pruning waste. Pruning waste is rich in bioactive substances that can be utilized in nurseries.

To recover bioactive compounds from pruning waste, an initial extraction can be performed through steam distillation to obtain essential oils, which can be used in agriculture against weeds as well as fungicides and insecticides. The by-product of the distillation process is residual biomass, which can further be used to produce tannin enriched extracts to be applied as biostimulants and lastly used as soil amendment.

Goals

- Optimizing the extraction of tannins from pruning waste.
- Characterisation and quantification of tannins, along with an evaluation of their potential as biostimulants. This includes measurements of water content and nutrient levels.
- Optimization of the steam distillation process for the production of essential oils, followed by an assessment of their efficacy as herbicides, insecticides, and fungicides.

Methodology



Tannin extraction from residual biomass, characterization and quantification by and HPLC-DAD-Q-TOF.
Testing of Tannin extracts as root biostimulants:
- Test on strawberry plants of the Clery cultivar in pots
- Field Tests

2) TEST concentrations. Preliminary measurements to test the concentration of Tannin extracts from Laurel and Lentisk tannins to find the best dilution.
Measurements: physiological performances and biomass.

3) TESTING Biostimulant activity under water stress. Best concentration of Tannins Lentisk and Laurel tannins on potted strawberry plants.
Measurements: ecophysiological and morphological measurements, destructive sampling (biomass, leaf collection for biochemical analysis), water relations and soil physico-chemical analyses.

4) TESTING biostimulant activity of Laurel and Lentisk tannins under water stress repeated in the field on strawberry plants ('Clery').

Expected Results

- Development of effective methods of distillation of pruning waste for a higher yield of essential oils and identification of the main molecules contained within essential oils.
- Development of effective methods for the extraction of tannins from residual biomass derived from distillation and subsequent identification biochemical characterization.
- Evaluation of the effect of biostimulants on physiological performance and under water stress conditions.
- Evaluation of the effect of biostimulants on fruit production, quality and yield, under both well water and water stress.

Conclusions

The research project proposes an excellent alternative to wasting plant material, a rich source of bioactive compounds, the valorisation of which could solve part of the environmental problems associated with the disposal of waste from nursery activities. At the same time, a value chain could be established that would help to increase the income of nursery companies, thus introducing a circular bio-economy with sustainable development practices.

The Role of Acoustic Vibration to Boost Plant Defense Mechanisms and Stimulate Specific Traits or Compounds of Interest in *Olea europaea*.

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Fig. Graphical abstract of the role of acoustic vibration to boost plant defense mechanisms and stimulate specific traits or compounds of interest in *Olea europaea*.

CONTEXT

Contemporary agriculture faces challenges from climate change and the need for sustainability, directly affecting olive production by threatening crop stability, increasing pathogens, and impacting quality. Adopting advanced technologies, including sound vibrations as a green alternative to chemicals, offers a promising approach to enhancing defense mechanisms and stimulating beneficial traits in *Olea europaea*. This method has proven effective, notably by enhancing structural and phenotypic responses in plants, including increased metabolite synthesis. (Gosh et al. 2017; Jung et al. 2018; Bhandawat and Jayaswall 2022), productive performance (increase in photosynthetic activity), and elicitation of defense mechanisms against biotic (Appel and Croft, 2014; Body et al. 2019) and abiotic agents (Demey et al. 2023; Ali et al. 2024). Acoustic vibrations can disrupt insect and parasite behavior, hindering their feeding and reproduction (Sindhura et al. 2020; Jung et al. 2020; Wassermann et al. 2021).

PROBLEM STATEMENT

Olive production faces challenges from climate change, declining crop stability, and pathogen pressures, demanding sustainable solutions. While acoustic vibrations show potential in enhancing plant traits productivity, and defenses against stressors, their application in *Olea europaea* remains unexplored. This gap underscores the need for innovative, eco-friendly approaches in olive cultivation.

EXPECTED OUTCOMES

Better knowledge of the effect of specific acoustic vibrations in olive trees. Development of a sustainable cultivation technique aimed at controlling growth, vegetative-productive balance, production quality, synthesis of compounds of interest and which stimulates defense against stress agents, while promoting biological containment of pathogens and parasites.

OBJECTIVES

01 Testing acoustic vibration frequencies known to elicit responses in other plants, in order to understand the specific response mechanisms of olive tree.

02 Identifying the most effective frequencies to promote desired physiological responses and to mitigate pathogen pressure in field conditions.

03 Comparing the results obtained in controlled indoor trials with those obtainable in experimental olive orchards outdoors.

04 Developing targeted agricultural practices to promote a more resistant and sustainable olive growing.

05 Implementing an approach to enhance the qualitative and nutraceutical properties of the final product.

06 Creating a tool for plant growth control.

APPLICATIONS

The application of acoustic vibrations in olive cultivation can offer a double advantage: on the one hand, as a useful tool to manage the vegetative and productive activity of the olive tree, control its growth and stimulate the defense against stress agents, favoring the biological containment of pathogens and parasites; on the other hand, improving the nutraceutical quality of the fruits and the oil produced with them.

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DAGRI
DIPARTIMENTO DI SCIENZE E TECNOLOGIE AGRARIE, ALIMENTARI, AMBIENTALI E FORESTALI

DOTTORATO IN SCIENZE AGRARIE E AMBIENTALI
CICLO XL
DOTTORANDA: EMMA BEATRICE CROCE

Exploring *Leonotis leonurus* (L.) R. Br. as alternative to cannabis: a study on the impact of botanical traits, cultivation techniques, and endophytes in modulating the production of psychoactive substances and drugs.

INTRODUCTION

In recent years, the number of websites and forums focused on drug-use experiences has increased. Besides the new psychoactive substances (NPS), several communities have tested new compounds. Many of these are derivatives of common plants whose psychotropic use has not been fully studied. Anyway, a lot of users describe their own experience of consumption in an almost scientific manner. *Leonotis leonurus* (L.) R. Br. is one of the most commonly mentioned plants.

LEONURINE

4-[(diaminomethylene)amino]butyl 4-hydroxy-3,5-dimethoxybenzoate
Chemical Formula: $C_{14}H_{21}N_3O_5$
Exact Mass: 311.15

Leonurine, a guanidinic alkaloid of *L. japonicus*, is supposed to induce many psychoactive effects, even if its presence in *L. leonurus* has yet to be verified.

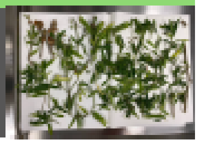
Little or no knowledge is available on how the chemical composition and content of active substances in *L. leonurus* varies depending on genotype, plant part used, geographical origin, growing conditions, and cultivation techniques/methods.

In addition to genetic, botanical, and agronomic factors [3], it is increasingly evident that the microbial community associated with the plant influences its chemical composition drastically. Endophytes contribute to plant growth by facilitating mineral nutrition, modulating secondary metabolism and eliciting stress resistance [4].

THE PLANT

It is a subtropical shrub belonging to the Lamiaceae family also known as "wild dagga" or "wild Cannabis". *Leonotis leonurus* is widely distributed in South Africa, where it is frequently used in ethnopharmacological practices to treat asthma, viral hepatitis, and as a diuretic. Dried leaves and flowers are smoked to relieve epilepsy and as a treatment for partial paralysis [1]. In addition to the traditional uses mentioned above, *L. leonurus* is marketed for its alleged Cannabis-like psychoactive effects [2].

However, little is known about the active substances in the leaves and flowers of *L. leonurus*.



AIMS OF THE STUDY

How different cultivation techniques influence plant growth and the quali-quantitative production of bioactive compounds

The characterization of endophytic fungi and their activity in affecting the quali-quantitative production of bioactive compounds

The chemical characterization of bioactive compounds present in flowers and leaves

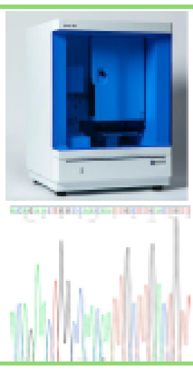
EXPECTED RESULTS

This study will provide new knowledge useful for the potential exploitation of *L. leonurus* as an alternative crop to cannabis and to evaluate the beneficial effects and risks of its use.
The main expected results are:

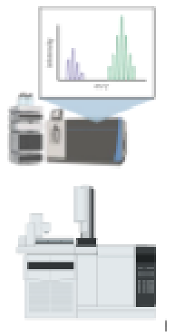
- Assessment of the influence of growing conditions, cultivation techniques, and endophytes on plant growth and metabolism;
- Chemical characterization of the main bioactive substances;
- Publication of results on agronomic experiments, endophytic microbiome, analytical methods and chemical characterization.

METHODS

In order to evaluate the influence of different cultivation techniques on the quantitative and qualitative production of bioactive secondary metabolites, clones of *L. leonurus* will be grown in pots in a growth chamber under different growing conditions, NPK fertilization rates, and irrigation regimes.



The core endophytic fungal community will be characterized at the Plant Pathology and Mycology Lab (DAGRI) in different plant compartments and growing conditions by cultivation-based techniques.



Chemical characterization of bioactive substances will be carried out at FT-LAB, Department of Health Science, University of Florence. Vegetal matrices will be liquid-liquid or solid-phase extracted and then analyzed by gas (GC) and liquid chromatography (LC) coupled to single or tandem mass spectrometry (MS).

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Impact of microplastics in fire-affected forest soils.

Giulia Marmo, SAA PhD student, XL cycle
Dipartimento di Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI) – University of Florence, Italy.

Introduction Microplastics (MPs) are synthetic polymer fragments (ranging from 1 to 5,000 µm) with varying compositions, shapes, and origins. They result either from the breakdown of larger plastic items or from direct environmental emissions (secondary and primary MPs). Due to their small size and ubiquitous distribution, MPs can easily impact ecosystems and the organisms within them. Studies have shown that the abundance of MPs in soils exceeds that in the global oceans; however, our understanding of their effects on soil systems, particularly forest soils, remains incomplete.

Forest soils are the least studied environment regarding microplastic contamination. Moreover, most forest ecosystems, especially in the Mediterranean region, are periodically affected by wildfires, but there is a lack of research on how fire influences MPs in the soil and its overall impact on forest soil ecosystems. Fires can heat plastic particles to temperatures high enough to trigger chemical changes in the polymers. These alterations can lead to a variety of outcomes, such as the breakdown of plastics into smaller fragments, including microplastics and nano-plastics.

Objectives

A Investigate how fire changes MPs in forest soils.

B Investigate how burnt MPs alter physical, chemical and biochemical soil properties.

C Investigate how bMPs influence soil microbiological properties.

D investigate how bMPs affect plant growth in terms of height, biomass, leaf colour and fruiting

Material & Methods

The research will rely on both *in* and *ex-situ* experimentation. After identification of recently burned forest areas and areas in proximity of prescribed fires, we will sample and analyse the soil using a spectroscopy-based imaging methods (FT-IR and Raman spectroscopy) and X-ray microscopy, which are able to recognize the type of polymer with high accuracy and determine particle size and distribution(*Elert et al. 2017*). Physical, chemical and biological properties of the samples collected will be assessed as well. Regarding ex-situ experimentations, columns will be set up to determine the distribution and mobility of burnt and unburnt microplastics. Spectroscopy techniques will be used to assess qualitative changes in bMPs.

Pineta di Tocchi (SI) Tuscan pine forest where the prescribed fires take place

Expected results

Expected results could represent a turning point on the topics due a lack of data and analyses in literature.

A Fires are expected to reduce MPs weight due to thermal degradation. MPs shapes could change with fragmentation and chemical transformations of the polymers.

B It is possible that bMPs negatively affect soil aggregates stability by increasing disintegration due to reduced cohesion between soil particles, resulting in a possible increase of soil bulk density and decrease in porosity. Ks could thus probably decrease. pH could vary unpredictably with the possibility of increases or decreases depending on the type and concentration of burnt MPs. SOM content could decrease due to combustion. Soil enzyme activity could be significantly reduced indicating interference in microbial activity and a potential reduction in soil fertility.

C A decrease in SMB could be expected.

D Plants may show reduced growth in height and biomass, signs of abiotic stress such as leaf discolouration and potential reduction in fruiting.

Bibliography
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DAGRI DIPARTIMENTO DI SCIENZE E TECNOLOGIE AGRARIE, ALIMENTARI, AMBIENTALI E FORESTALI

Ph.D. Day
December 17, 2024.
Aula Magna, Facoltà di Agraria.
Piazzale delle Cascine 18, 50144.
Florence, Italy.

FOOD MICRO TEAM

BIOLOGICAL VALORIZATION OF PLANT-BASED WASTE AND BY-PRODUCTS

V. Russo, V. Galli[2], S. Guerrini[1], A. Adessi[1]

[1] Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence, [2] FoodMicroTeam s.r.l. Firenze (FI).

INTRODUCTION

In Italy, agri-food by-products represent an economic value of **€8.5 billion per year**, but much of this potential is lost as they are treated as waste, leading to high costs and the loss of **bioactive compounds** like fibers, polyphenols, and vitamins (Rana et al., 2021; Bianchi et al., 2020). Recent advances suggest that **microorganisms** can transform these by-products through fermentation, enhancing their nutritional properties and making them suitable for sustainable applications (Silva et al., 2021; Garcia et al., 2020).

OBJECTIVES

The study aims to isolate and characterize **lactic acid bacteria** and **yeasts** from agri-food by-products to identify strains capable of **producing bioactive compounds** like polyphenols and vitamins. These microorganisms will be used to create a **microbial biobank** for applications in the **food** and **cosmetic sectors** (Kumar et al., 2022).

METHODOLOGICAL APPROACH

MICRORGANISM ISOLATION AND CHARACTERIZATION

Spontaneous fermentations will be conducted under controlled conditions (temperature, pH, humidity) with periodic sampling to monitor microbial growth and acidification.

Isolation and preservation:

Microorganisms will be isolated using selective media (MRS for lactic acid bacteria, YPD for yeasts).

Strains will be preserved in glycerol at -80°C for future use.

Characterization and identification:

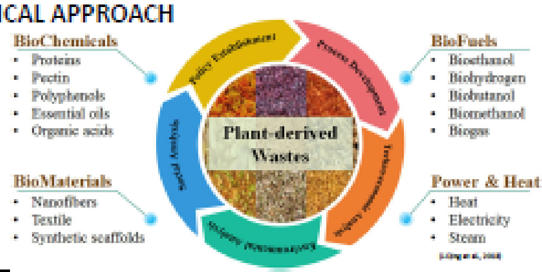
Biochemical tests and morphological analysis will be performed.

Molecular identification methods:

Lactic acid bacteria: PCR-ARDRA (16S rRNA) and sequencing.

Yeasts: PCR-RFLP (rDNA-ITS) and sequencing.

Strain-level differentiation using RAPD-PCR.



SCREENING AND SELECTION

***In vitro* evaluation:**

Resistance to environmental stressors, including pH, salinity, and temperature variations.

Capacity to efficiently ferment plant-derived sugars.

Nutritional and nutraceutical potential:

Production of bioactive metabolites such as lactic acid, polyphenols, vitamins, and gamma-aminobutyric acid (GABA).

Reduction of antinutritional factors like phytates and oxalates.

Selection criteria: Best performing strains.

PLANT BY-PRODUCTS FERMENTATION FOR INGREDIENT PRODUCTION

Strain Testing:

ability to: enhance bioactive compounds, degrade biogenic amines and toxic compounds and improve bioavailability of essential nutrients.

Bioactive compounds:

Polyphenols, vitamins, and GABA, enhancing nutritional and nutraceutical value.

Antinutritional Compounds:

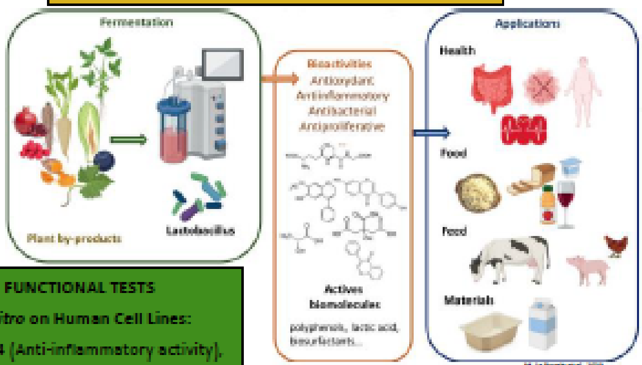
Reduction of phytates and oxalates to improve nutrient bioavailability.

Antioxidant Activity:

Assessed via DPPH radical scavenging test.

Metabolic Profiling:

HPLC for polyphenols and amino acids. GC-MS for aromatic compounds and volatile metabolites.



FUNCTIONAL TESTS

***In Vitro* on Human Cell Lines:**

RAW 264 (Anti-inflammatory activity), Caco-2 (Intestinal permeability and nutrient transport) and HepG2 (Toxicity and metabolic effects)

Biochemical Assays:

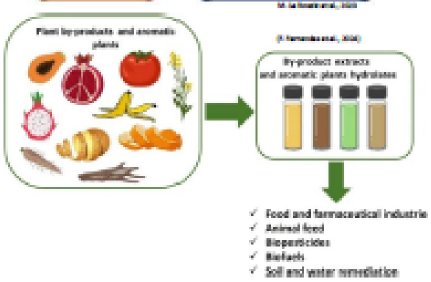
Cell viability , Pro-inflammatory cytokine and intestinal barrier function.

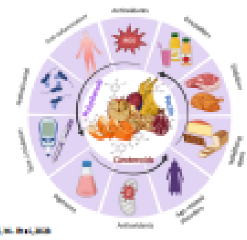
POTENTIAL APPLICATIONS

Food Industry: Incorporation of the fermented ingredients in foods such as bakery products or pasta to enhance nutraceutical and nutritional value.

Cosmetic Sector: Incorporation into formulations for skin protection, with potential anti-aging and antioxidant properties.

Sustainability: Provides a sustainable solution for both industries by utilizing agri-food by-products.





Dottorato cofinanziato da FoodMicroTeam s.r.l. ai sensi del DD.MM. 629-630/2024

PhD day
17th December 2024

Exploiting microalgae CO_2 photo-bioconversion to develop innovative Sustainable Aviation fuel (SAF) in a zero-waste biorefinery approach

PhD student: Daniel Ronca[a], Supervisor: Liliana Rodolfi[a] Co-supervisor: Giacomo Sampietro[a]

[a] *Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence, piazzale delle Cascine 18, 50144 Florence, Italy. E-mail: daniel.ronca@unifi.it*

INTRODUCTION

Cyanobacterium strain *Synechocystis* PCC 6803, model species, metabolically engineered is able to produce ISOPRENE (target compound), a Sustainable Aviation Fuel (SAF) precursor. Rodrigues *et al.*, 2023 have also demonstrated that this cyanobacterium is able to increase isoprene production if exposed to violet light.

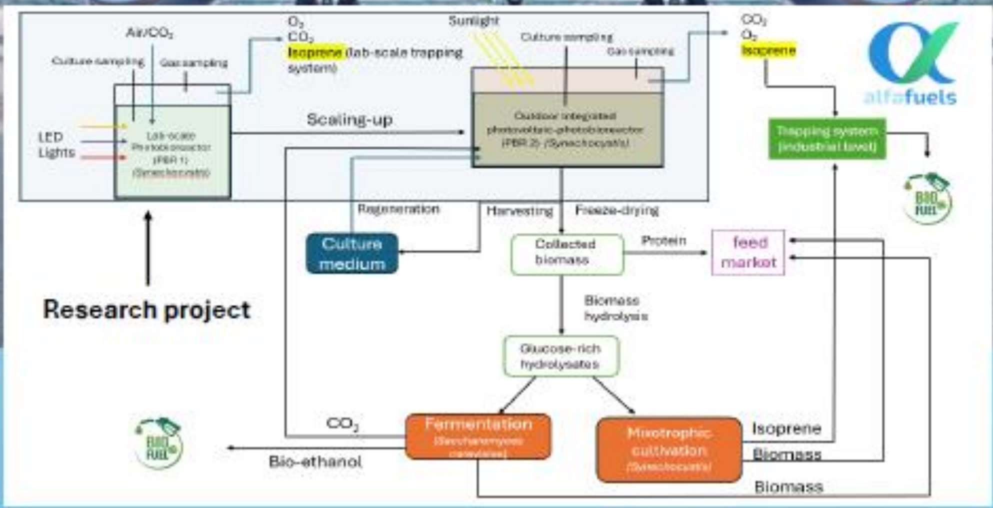

Aoki *et al.*, 2024

Why ISOPRENE as a SAF precursor from photosynthetic microrganisms?

- Microalgae, including cyanobacteria, represent the third generation of biofuels (Lim *et al.*, 2021) as they do not require arable land and exhibit higher growth rates, greater carbon fixation efficiency compared to energy crops and lignocellulosic biomass.
- Isoprene has higher energy density respect to other C-compounds
- Higher drop-in values compared to other Bio-jet fuel precursor
- High vapor pressure that may facilitate its recovery from photobioreactor headspace respect to other high-C compound.

OBJECTIVE

Testing metabolically engineered microalgae to drive CO_2-derived molecules conversion into ISOPRENE defining the factors that affect microalgae growth and production of the compound of interest (temperature, mixing rate, light intensity and spectrum), aiming to demonstrate environmental benefit, economic and technical feasibility of the process with a biorefinery approach in a new designed photobioreactor



Challenges and mitigation plans

1. Some microalgae associated bacteria may metabolize ISOPRENE reducing the whole process yield
2. Some photobioreactors materials may react with isoprene.
3. Isoprene may be toxic, similar to oxygen, to cells at certain concentrations.
4. Try to direct the inorganic carbon (CO_2) flow toward the production of the target compound rather than biomass (Rodrigues et al., 2023)

Acknowledgements

This work will be supported by the AlfaFuels project funded by the European Union under grant agreement N° 101122224.

Funded by the European Union

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Development of a combination of innovative digital technologies aimed at early detection of regulated forest pests: *Cryphonectria parasitica* and *Ceratocystis platani*

Hari Berto[a,b], Giovanni Marino[b], Francesco Pecori[b], Alessia Lucia Pepori[b], Nicola Luchi[b], Francesco Ferrini[a,b] and Alberto Santini[b]

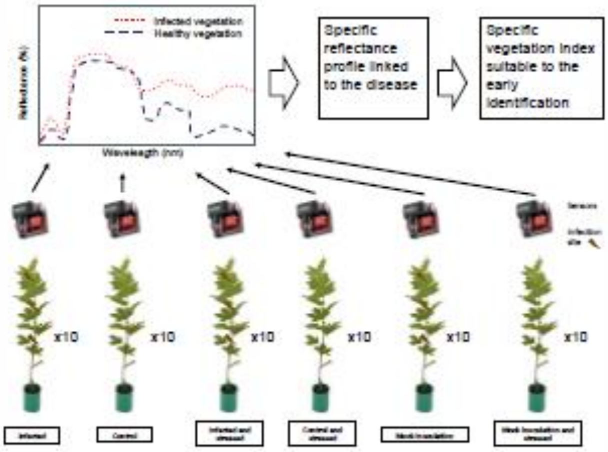
[a] University of Florence, Department of Agriculture, Food, Environment and Forestry (DAGRI), Firenze, Italy
[b] National Research Council, Institute for Sustainable Plant Protection (CNR-IPSP), Sesto Fiorentino, Firenze, Italy

Introduction
This PhD project is within the Horizon project FORSAID', funded by European Union, with the main goal to develop innovative digital technologies aimed at detecting regulated forest pests at an early stage.

Aim 1

Proximal remote sensing of *Platanus* saplings damage in controlled environments and nurseries.

Will be monitored the development of symptoms of *Ceratocystis platani* infection on *Platanus* in a High-Throughput Plant Phenotyping (HTPP) facility. With the analysis of the multispectral images, it will be possible to assess the plants' state of health and find the indices which can supply an early detection of the infection.



Expected result
Specific markers of pathogen infection (*Cx. platani*) based on multispectral/hyperspectral measurements allowing to identify the early stage of infection. Additionally, the study will be able to supply information on the relation between pathogens and host saplings.

Ceratocystis platani infection on plane tree trunk

Ortomosaics of UAV images acquisitions, showing different vegetation index

Aim 2

Aerial remote sensing of tree damage at regional scale

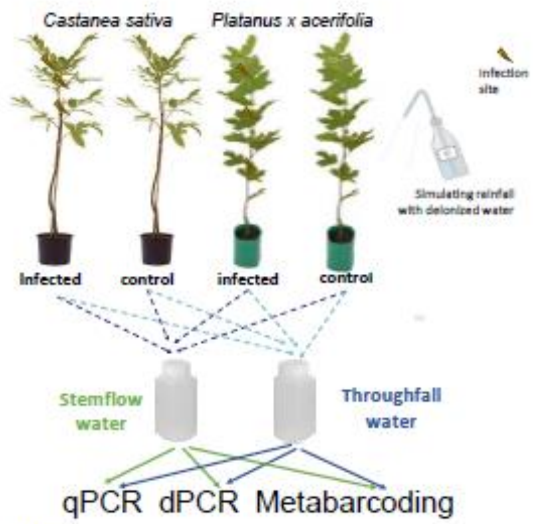
The indices found with the previous study (aim 1), will be employed to early detection of the *Ceratocystis platani* infection in urban area, using unmanned aerial vehicles (UAVs).

Expected result
Infestation severity based on computer vision algorithm at tree level and remote sensing approach to map of urban area. For the pathogen (*Cx. platani*), it will be possible an early detection in areas where symptoms are not present yet and to assess the spread of both diseases without the need of on-site monitoring. Additionally, provide essential information for the adoption of phytosanitary measures to limit their spread and impact, especially in remote areas.

Aim 3

Automated metabarcoding procedures

The purpose is to develop an automatic procedure for processing eDNA (environmental DNA) collected from different matrices (liquid of insects' traps, tree run-off water). From these samples the presence of *Cr. parasitica* and *Cx. platani* DNA will be tested . Using different molecular techniques real time PCR (qPCR), digital PCR (dPCR) and metabarcoding, which will be combined and compared with each other.



Expected result
Protocols to identify *Cr. Parasitica* and *Cx. platani* in insect trap liquid and running water from tree stems based on Digital PCR and metabarcoding applied to environmental DNA. From methods comparison (dPCR and metabarcoding) the advantages and disadvantages of both will be listed. Careful bio-surveillance is essential to reduce the threat arising from the spread of regulated pathogens.

'FORSAID
Forest surveillance with artificial intelligence and digital technologies
HORIZON-CL6-2023-GOVERNANCE-01-16

Corso di Dottorato in Scienze Agrarie e Ambientali (SAA) ciclo XL

PhD Day 17/12/2024

Consiglio Nazionale delle Ricerche | Istituto per la BioEconomia

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"Green production of hydrogen using microalgae/cyanobacteria and valorization of exhausted biomass for food and cosmetic applications"

Balestra Francesco, Faraloni Cecilia, Chini Zittelli Graziella

The project focuses on the use of microalgae and cyanobacteria to develop a circular and sustainable process for hydrogen production and the valorization of exhausted biomass for food and cosmetic applications.

OBJECTIVES:

1. Production of green hydrogen through the anoxygenic photosynthesis of microalgae and cyanobacteria.
2. Valorization of the exhausted biomass to create food and cosmetic products.
3. Promotion of the circular economy.

PROJECT PHASES:

1. Species selection.
2. Cultivation optimization.
3. Hydrogen production and storage.
4. Extraction of bioactive compounds.
5. Product development.
6. Effectiveness and safety testing.

EXPECTED RESULTS:

1. Sustainability: Optimization of a process for green hydrogen production.
2. Innovation: Development of microalgae-based products with benefits for health and the environment.
3. Industrial Collaborations: Encouraging technology transfer to the energy, food, and cosmetic sectors.

Contest miglior logo

Dario Gaudioso:

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