

PIANO FORMATIVO INDIVIDUALE TRIENNALE

(ai sensi del D.M. 226/2021)

SEZIONE A – DATI ANAGRAFICI DEL DOTTORANDO/A

Nome e COGNOME	ABU KHMAISH MARH M.M.
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Data di inizio dottorato	03/11/2025
Tipologia di borsa	X Borsa di Ateneo <input type="checkbox"/> Borsa PNRR <input type="checkbox"/> Borsa PON <input type="checkbox"/> Borsa esterna <input type="checkbox"/> Senza borsa
Eventuale tematica vincolata	
Tutor	Prof. Leonardo Schena
Co-Tutor (se previsto)	Dr. Marilita Gallo
Ente/Impresa convenzionata (per borse vincolate)	CIHEAM Bari - IAMB

SEZIONE B – PROGETTO DI RICERCA

B.1 – Titolo del progetto di ricerca
Detection and characterization of <i>Colletotrichum</i> species associated with olive anthracnose and development of synthetic microbial communities (SynComs) to control the disease
B.2 – Obiettivi della ricerca (Descrivere gli obiettivi generali e specifici del progetto di ricerca, max 500 parole)
The present project aims to advance current knowledge on the etiology, epidemiology, and biology of olive anthracnose and translate this knowledge into innovative, sustainable control strategies based on synthetic microbial communities (SynComs). This overarching objective will be achieved through the following specific research actions: <ul style="list-style-type: none"> 1. Development of a Loop-mediated Isothermal Amplification (LAMP) assay for the rapid and cumulative detection of <i>Colletotrichum</i> species belonging to the <i>C. acutatum</i> species complex in the olive phyllosphere. 2. Comprehensive characterization of <i>Colletotrichum</i> species associated with olive anthracnose in southern Italy across different tissues and phenological stages. 3. Investigation of microbial interactions in olive drupes during the infection process of <i>Colletotrichum</i> species and identification of key members within the symbiome and the pathobiome. 4. Identification, characterization, and assemblage of putative biocontrol agents to construct synthetic microbial communities (SynComs) for olive anthracnose control. 5. Evaluation of synthetic microbial communities (SynComs) under semi-commercial conditions (greenhouse trials) and commercial field applications.
B.3 – Stato dell'arte e inquadramento teorico (Descrivere il contesto scientifico di riferimento e le principali lacune conoscitive, max 500 parole)
The olive tree (<i>Olea europaea</i> L.) is a crop of major global and Mediterranean importance, both economically and culturally, with over 10.9 million hectares cultivated worldwide and more than 21 million tons produced annually. Among the primary constraints to olive production, fungal diseases

remain particularly impactful, with anthracnose being one of the most destructive, especially in terms of fruit and oil quality.

Olive anthracnose is caused by multiple species of the genus *Colletotrichum*, mainly from the *C. acutatum* species complex. In Italy and other Mediterranean regions, documented shifts in pathogen population structure, notably from *C. godetiae* toward *C. acutatum sensu stricto*, may alter disease dynamics and management efficacy. The disease complexity is further compounded by the ability of *Colletotrichum* spp. to persist in latent, epiphytic, or endophytic forms, making early detection challenging and limiting the efficacy of timely interventions.

Current diagnostic approaches present significant limitations: morphological methods are time-consuming, while PCR-based assays lack scalability for routine field applications. Although loop-mediated isothermal amplification (LAMP) offers rapid and sensitive early detection capabilities, its integration in routine protocols and large-scale field management systems remains underutilized.

While the epidemiology of olive anthracnose has been extensively investigated, disease expression remains highly variable across environments and cultivars, with existing models failing to adequately explain this variability. A major critical knowledge gap concerns the role of the olive-associated microbiome in modulating disease outcomes in relation to the involved *Colletotrichum* species, as most studies focus on the pathogen in isolation, overlooking complex host-pathogen-microbiome interactions. Although several native microorganisms show antagonistic activity against *Colletotrichum* spp., no effective or reliable biocontrol products are currently available for olive anthracnose management. Single-strain biocontrol approaches often show inconsistent field performance, highlighting the need for more robust solutions. Synthetic microbial communities (SynComs) represent a promising but still underexplored strategy to enhance disease suppression in a stable and ecologically grounded manner.

Key gaps therefore include: (i) insufficient integration of early diagnostics into management strategies, (ii) limited understanding of microbiome–pathogen–host interactions, and (iii) lack of robust, microbiome-informed control solutions for sustainable olive anthracnose management.

B.4 – Metodologia e approccio

(Descrivere la metodologia di ricerca, max 400 parole)

This project aims to develop early diagnostic tools and sustainable biological control strategies to manage olive anthracnose caused by species within the *Colletotrichum acutatum* species complex. The work is organized into five interconnected work packages (WPs).

WP1 focuses on developing a loop-mediated isothermal amplification (LAMP) assay for the rapid and cumulative detection of *Colletotrichum* species in the olive phyllosphere. Primers targeting conserved genomic regions (e.g., TUB2) will be designed from GenBank sequences and optimized for specificity and sensitivity. The assay will be adapted for on-site use, enabling direct detection from crude plant extracts without DNA purification.

WP2 aims to characterize the diversity and dynamics of *Colletotrichum* species across tissues and phenological stages in Southern Italy. Flowers, leaves, fruitlets, and symptomatic and asymptomatic fruits will be sampled throughout the crop cycle. DNA will be extracted, and the ITS region amplified and sequenced using nanopore technology to quantify the relative abundance of different *Colletotrichum* species.

WP3 investigates microbial interactions during latent and active infections. Olive tissues will be artificially inoculated with selected *Colletotrichum* species at different developmental stages. Amplicon metagenomics (ITS and 16S sequencing) will be used to monitor shifts in fungal and bacterial communities, identifying key members of the pathobiome and symbiome. Selected bacterial isolates will be cultured, identified, and tested *in vivo* assays to validate their roles in either promoting or suppressing the disease.

WP4 focuses on isolating, characterizing, and assembling biocontrol microorganisms into synthetic microbial communities (SynComs). Candidate antagonists will be isolated from wild and cultivated olive phyllospheres, screened for antifungal activity, tested for compatibility, and genomically characterized. Based on efficacy, ecological function, and compatibility, 4–5 SynComs will be constructed.

WP5 evaluates SynCom performance under progressively realistic conditions. Initial tests will be conducted on detached fruits, followed by greenhouse trials under semi-controlled conditions. The most effective SynComs will be tested in a commercial orchard, pending authorization, using bloom and pre-ripening applications to assess their capacity to reduce disease incidence and fruit losses.

B.5 – Risultati attesi e impatto

(Descrivere i risultati attesi e le potenziali ricadute, max 300 parole)

Olive anthracnose is a complex, environmentally sensitive disease driven not only by *Colletotrichum* spp. but also by their interactions with the host and the surrounding microbial community. The latent infection cycle of the pathogen, combined with strong climatic and ecological influences, limits the effectiveness of conventional control strategies. This project addresses these limitations through an integrated diagnostic, ecological, and applied approach, since it will:

1. Develop a rapid, sensitive, and cost-effective new tool for the on-site detection of *Colletotrichum acutatum* s.l. in olive orchards. The method will be valuable in advancing current epidemiological knowledge of the disease and will prompt the implementation of more effective management strategies.
2. Investigate *Colletotrichum* species associated with olive anthracnose in southern Italy. The shift from one population to another can be driven by various factors, with climate change playing a pivotal role. Identifying the predominant species in each geographic area is fundamental for effective disease management, as species may significantly differ in terms of pathogenicity, sporulation capacity, optimal temperatures, and the capability of infecting different olive organs. Furthermore, the early monitoring of new putative species may be strategic in a scenario of climate change.
3. Advance current understanding of the infection process of *Colletotrichum* species on olive drupes during both latent and active phases. Particular emphasis will be placed on the role of associated microorganisms that interact with the host and the pathogen, potentially contributing to disease development (pathobiome) or, in contrast, inhibiting pathogen development.
4. Create a collection of selected and well-characterized microorganisms effective in controlling olive anthracnose.
5. Formulate synthetic consortia of microorganisms (SynComs) specifically tailored to be used in biological control strategies against olive anthracnose.

SEZIONE C – PIANO DELLE ATTIVITÀ FORMATIVE

CFU previsti per il I anno: 60. L'attribuzione dei CFU segue i criteri approvati dal Collegio dei docenti nell'adunanza n. 4 del 16.12.2025.

I ANNO

Attività formative/didattiche: CORSI (I Anno)

Denominazione corso	Docente/Sede/Ente erogatore	Durata	CFU
Statistica descrittiva e statistica inferenziale per la validazione di dati sperimentali in campo agro-forestale	Dottorato SAAF Pasquale Marziliano Orlando Campolo	20	5
Sicurezza nelle strutture di ricerca	Dottorato SAAF Simone Santacaterina	10	2,5
Valutazione della sostenibilità delle sperimentazioni e delle innovazioni per la validazione dei percorsi di ricerca	Dottorato SAAF Giacomo Falcone	10	2,5

Denominazione corso	Docente/Sede/Ente erogatore	Durata	CFU
Utilizzo delle principali banche dati e fonti statistiche in ambito agroalimentare e forestale	Dottorato SAAF Nathalie Iofrida	10	2,5
La ricerca bibliografica nel settore delle Scienze Agrarie, Alimentari e Forestali	Dottorato SAAF Angelo Giuffrè	5	1,25
Presentazione di dati sperimentali e redazione di articoli scientifici	Dottorato SAAF Meriem Miyassa Aci	5	1,25
Perfezionamento linguistico	Scuola di Dottorato ihBRITISH SCHOOL di Reggio Calabria	40	5
Valorizzazione e disseminazione dei risultati, della proprietà intellettuale e dell'accesso aperto ai dati e ai prodotti della ricerca	Scuola di Dottorato	4	1
Gestione della ricerca e della conoscenza dei sistemi di ricerca europei e internazionali	Scuola di Dottorato	4	1
Genomica Computazionale Applicata al settore Agroforestale e Ambientale	Dottorato SAAF Antonio Mauceri	10	2,5
Il microbioma e la Protezione sostenibile delle Colture in un approccio "One Health"	Dottorato SAAF Meriem Miyassa Aci	10	2,5
Subtotale C.127			

Attività formative/didattiche: SEMINARI/WORKSHOP

Denominazione seminario/workshop	Docente/Sede/Ente erogatore	Durata	CFU
Seminars organized by the SAAF PhD program or external institutions			2
Subtotale C.22			

Attività formative/didattiche: CONVEGNI

Denominazione	Sede	Periodo	Tipo*	CFU
XXXI SIPaV Congress	Udine	September 2026	N	1
Subtotale C.31				

*Tipo: N = rilevanza nazionale; I = Rilevanza internazionale

Attività di ricerca e redazione tesi

Descrizione attività di ricerca previste	CFU
<ul style="list-style-type: none"> Research activities conducted at CIHEAM Bari. Research activities at the UNIRC plant pathology lab. Poster at a national conference. 	30
Subtotale C.430	

TOTALE CFU I ANNO 60/60

II ANNO

Attività formative/didattiche: CORSI

Denominazione corso	Docente/Sede/Ente erogatore	Durata	CFU
Courses organized by the SAAF PhD program or external institutions			4
Subtotale D.14			

Attività formative/didattiche: SEMINARI/WORKSHOP

Denominazione seminario/workshop	Docente/Sede/Ente erogatore	Durata	CFU
Seminars organized by the SAAF PhD program or external institutions			3
Subtotale D.23			

Attività formative/didattiche: CONVEGNI

Denominazione	Sede	Periodo	Tipo*	CFU
18 th International Congress of the Mediterranean Phytopathological Union			I	2
XXXII SIPaV Congress			N	1
Subtotale D.33				

*Tipo: N = rilevanza nazionale; I = Rilevanza internazionale

Attività di ricerca e redazione tesi

Descrizione attività di ricerca previste	CFU
<ul style="list-style-type: none"> • Oral and/or poster presentation at national and/or international congress • Research activities at the UNIRC plant pathology lab • Research activities at an international institution (period abroad) 	50
Subtotale D.450	

TOTALE CFU II ANNO 60/60

III ANNO

Attività formative/didattiche: CORSI

Denominazione corso	Docente/Sede/Ente erogatore	Durata	CFU

Denominazione corso	Docente/Sede/Ente erogatore	Durata	CFU
Subtotale E.1			

Attività formative/didattiche: SEMINARI/WORKSHOP

Denominazione seminario/workshop	Docente/Sede/Ente erogatore	Durata	CFU
Seminars organized by the SAAF PhD program or external institutions			2
Subtotale E.22			

Attività formative/didattiche: CONVEGNI

Denominazione	Sede	Periodo	Tipo*	CFU
13th International Congress of Plant Pathology (ICPP)				2
XXXIII SIPaV Congress				1
Subtotale E.33				

*Tipo: N = rilevanza nazionale; I = Rilevanza internazionale

Attività di ricerca e redazione tesi

Descrizione attività di ricerca previste	CFU
<ul style="list-style-type: none"> • Writing the doctoral thesis • Publication on ISI/Scopus journals (2 as first author and 2 as co-author) • Oral and/or poster presentation at national and/or international congress • Research activities at CIHEAM Bari. • Research activities at the UNIRC plant pathology lab. 	55
Subtotale E.455	

TOTALE CFU III ANNO	60/60
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RIEPILOGO CFU

Tipologia attività	CFU			
	I anno	II anno	III anno	Tot
Attività formative/didattiche: CORSI	27	4	-	31
Attività formative/didattiche: SEMINARI/WORKSHOP	2	3	2	7
Attività formative/didattiche: CONVEGNI	1	3	3	7
Attività di ricerca e redazione tesi	30	50	55	135
TOTALE	60	60	60	180

SEZIONE D – CRONOPROGRAMMA TRIENNALE

Indicare le principali fasi del progetto (X = attività prevista).

Fase/Attività	I ANNO				II ANNO				III ANNO			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
Revisione letteratura	X	X	X	X	X	X				X	X	
Definizione quadro teorico	X	X	X									
Raccolta dati / attività sperimentale		X	X	X	X	X	X	X	X	X		
Analisi dei dati			X	X			X	X		X	X	
Periodo all'estero								X	X			
Periodo presso impresa/ente	X		X			X						
Stesura capitoli tesi				X				X		X	X	X
Revisione e finalizzazione tesi											X	X
Pubblicazioni scientifiche								X	X	X	X	
Partecipazione a convegni				X			X				X	X
Altro: _____												

T1-T4 = Trimestri dell'anno accademico

SEZIONE E – PRODUZIONE SCIENTIFICA PREVISTA

Tipologia prodotto	N. previsto	Anno	CFU
Articoli su riviste con peer review (ISI/Scopus)	4	II and III	80
Contributi in atti di convegno			
Capitoli di libro / monografie			
Brevetti			
Altro: _____			

Nota: Per l'ammissione all'esame finale è richiesta almeno una pubblicazione pertinente alla tematica di ricerca.

SEZIONE F – APPROVAZIONE E FIRME

Data: _____ 23/01/2026 _____

Il/La Dottorando/a

_____ (firma)

Il/La Tutor

_____ (firma)

APPROVAZIONE DEL COLLEGIO DEI DOCENTI

Il Collegio dei Docenti, nella seduta del _____,

APPROVA APPROVA CON MODIFICHE NON APPROVA

il Piano Formativo Individuale Triennale sopra descritto.

Eventuali note/prescrizioni: _____

Il Coordinatore del Dottorato

_____ (firma)