CIHEAM
BARI

MASTER in

Integrated Pest Management

Academic Year 2026-2027

DESCRIPTION

The Master course aims to train a new generation of motivated students for professional and academic careers that promote integrated pest management (IPM) strategies for the sustainable intensification of tree and vegetable crops across different agroecosystems. The course addresses the management of plant pests and diseases, with a focus on agroecological and food systems. Students acquire knowledge of the ecological and epidemiological traits of pests and pathogens and apply innovative and smart technologies for the diagnosis, monitoring, and management of plant diseases. The course introduces innovative IPM strategies to address pests and diseases affecting major fruit and vegetable crops. In addition, it highlights risks associated with emerging transboundary pests and diseases and analyses quarantine measures to prevent their introduction and establishment.

At the end of the course, students will be able to:

- ✓ Analyse and build agroecosystems for a sustainable management of pests and diseases.
- ✓ Evaluate products for pests and diseases control and their relevant regulations.
- ✓ Develop tools for a rapid and timely identification, diagnosis and monitoring of pathogens and pests.
- ✓ Solve farm-related problems, using biodiversity policy, resistant cultivars, graft combination choices, rational application of pesticides and biological control methods.
- ✓ Plan and implement IPM strategies in different ecosystems.
- ✓ Exploit and apply preventive measures, i.e., plant quarantine measures and certification programmes for the control of important plant pests and diseases.

The program is organized in 7 Units and a Project, awarding a total of 60 credits (see details in the table below).

Units	Credits	Dates
Unit I – Guidelines and Regulations for IPM and Plant Health Systems	4	5-28 Oct 2026
Unit II – Plant Health Management: Ecology and Alternative Control Strategies	8	2-27 Nov 2026
Unit III – Plant Virus Epidemiology, Diagnostics and Management	8	30 Nov 2026 –15 Jan 2027
Unit IV – Integrated Diagnosis and Management of Fungal and Bacterial Diseases	8	18 Jan – 19 Feb 2027
Unit V – Insect and Nematode Pests in Crop Systems: Identification, Forecasting, and Control	8	23 Feb – 19 Mar 2027

Unit VI – Post-Harvest Pest Management, Food Safety and Certification in Crop Supply Chains	4	22 Mar – 16 Apr 2027
Unit VII– Plant Health Surveillance, Biosecurity and Certification Systems	6	19 Apr – 21 May 2027
Project	14	16 Apr – 16 Jun 2027

UNIT I: Guidelines and Regulations for IPM and Plant Health Systems

Global trade associated with the movement of goods and people increases the risk of introducing harmful organisms into new areas. These organisms, whether aliens or not, may become invasive and more harmful in evolutionary adaptation mechanisms in new host plants, in a favourable climate change context, and in the absence of adequate defence strategies.

In this context, a successful IPM strategy is of key importance for the sustainable cultivation of fruit and vegetable cropping, However, the adoption of this approach needs strong and developed institutional and political frameworks and farmers.

This unit will provide basic tools to understand the IPM decision-making process and how to elaborate an IPM program to control economically important pests affecting the main Mediterranean fruit tree and vegetable crops, in accordance with the EU guidelines and regulations, finally learn how to incorporate IPM concepts and methods into a structural pest control business.

AIMS

- Provide basic knowledge on how to design and elaborate an IPM program to control economically important pests.
- Explain agroecosystem functioning by examine the agroecosystems' complexities and challenges.
- Equip students with a comprehensive understanding of IPM principles, regulatory frameworks, and the role of biodiversity and soil health in sustainable agroecosystems.
- Explore the interconnections between plant health, agricultural practices, and regulatory policies across Europe and Africa.

LEARNING OUTCOMES

At the end of this unit, students will be able to:

- ✓ Understand key principles and strategies of IPM.
- ✓ Learn about the EU Plant Health Policy and IPPC standards and compare plant health regulations in Europe and Africa.
- ✓ Evaluate the role of biodiversity in pest suppression and ecosystem resilience.
- ✓ Recognize the importance of soil microbiomes and suppressive soils in plant health.
  Integrate Solutions and propose integrated pest management strategies considering ecological and economic factors.

- ✓ Understand the basic principles and international agreements regulating trade between countries.
- ✓ Identify appropriate IPM strategies for preventing the introduction and spread of harmful and invasive pests in new areas.

UNIT II: – Plant Health Management: Ecology and Alternative Control Strategies

The unit focuses on understanding how plants interact with their environment and how these interactions can be used to manage pests and diseases in a sustainable way. It explores the ecological basis of plant health, examining relationships between crops, pests, beneficial organisms, soil life, and environmental factors such as climate and water. By understanding these interactions, the unit shows how balanced ecosystems can naturally reduce pest outbreaks and disease spread. The unit also emphasizes alternative control strategies that reduce reliance on synthetic pesticides. These include cultural practices like crop rotation and intercropping, biological control using natural enemies and microorganisms, the use of resistant crop varieties, and physical or mechanical methods such as traps and barriers. Botanical and natural products are also considered as safer pest control options. A key aspect is the importance of soil health, highlighting how fertile, biologically active soils contribute to stronger, more resilient plants that are less vulnerable to stress and infection.

Overall, the unit aims to promote sustainable plant protection by applying ecological knowledge and alternative strategies to maintain crop health, reduce environmental impact, and support long-term agricultural productivity.

AIMS

- ❖ Identify and evaluate alternatives to complement or replace conventional pest control, including biological control agents, eco-friendly compounds, host genetic resistance, and targeted resistance inducers.
- ❖ Develop the current knowledge base pertaining to the resistance sources available in host germplasm and to the exploitation of similar mechanisms for their applications in protecting crops.
- ❖ Deliver products that combine high quality and strong marketability with proven safety for consumers.
- ❖ Describe biological control methods, including the use of beneficial insects, microbial agents, and botanical products, and assess their advantages in pest management.
- ❖ Reporting the most updated knowledge and regulations for a sustainable use of conventional pesticides.

LEARNING OUTCOMES

At the end of this unit, students will be able to:

- ✓ Explain crop rotation and soil management practices and evaluate their role in improving soil fertility, reducing pests, and supporting sustainable agriculture.
- ✓ Describe biological control methods, including the use of beneficial insects, microbial agents, and botanical products, and assess their advantages in pest management.

- ✓ Understand and apply the concept of host resistance, identifying how resistant crop varieties can be used to reduce the impact of pests and diseases.
- ✓ Demonstrate knowledge of the rational use of pesticides, including correct selection, timing, and application, while minimizing environmental and health risks.
- ✓ Integrate different plant protection strategies to support effective and sustainable crop management.
- ✓ Implement the acquired theoretical knowledge into every-day practice with the aid of site/field visits and laboratory activities, as well as the elaboration of projects to address relevant issues to country of origin.

UNIT III: PLANT VIRUS EPIDEMIOLOGY, DIAGNOSTICS AND MANAGEMENT

Pathogens are responsible for direct yield losses ranging between 20 and 40% of the global agricultural productivity, whereas their indirect negative impact on consumers, public health, societies, environments, and farmers is much higher. A deep knowledge of the nature of plant pathogens, *i.e.*, viruses and viruses-like agents, together with efficient systems for their diagnoses, identification and control would save and above all avoid many losses at all levels of an agricultural supply chain. This unit will provide valuable information on the awareness of harmful pathogens and on the numerous key factors capable of offering the right methodologies to be followed for the identification, characterization, and management of such pathologies, using both conventional and advanced approaches. The strengthening of preventive control strategies, i.e., the application of good agriculture practices, and the use of healthy certified plant propagating material, would greatly contribute to limiting the occurrence of plant pathogens/pests and possible pandemics, whilst increasing the security level of regions. At the end of this unit, the students will also know the use of bioinformatics tools applied in the analysis of data on pathogens, being the new trend of modern research on data mining of pathogens in agriculture.

AIMS

- ❖ Provide in-depth knowledge on viral and viral-like diseases affecting the main fruit tree and vegetable crops.
- ❖ Acquire fundamental knowledge on the morphology, ecology, and epidemiology of plant pathogens, to propose adequate and sustainable control management.
- ❖ Get acquainted to the taxonomy normally associated with the classification and characterization of species and strains of pathogens.
- ❖ Understand the interaction existing between the host-pathogen-environment, for a better control strategy.
- ❖ Apply conventional and highly advanced technologies for pathogens' detection, identification, and characterization.
- ❖ Perceive the use of biotechnological approaches for creating resistance to plant pathogens and diseases.

- ❖ Learn how bioinformatics could support the research to understand some mystified infectious mechanisms induced by infection of pathogens.

LEARNING OUTCOMES

At the end of this unit, students will be able to:

- ✓ Identify diseases' aetiologies and distinguish between disorders induced by biotic and abiotic factors.
- ✓ Propose the best strategies for detecting and controlling relevant pathogens and diseases.
- ✓ Apply different diagnostic techniques, at biological, serological, or molecular levels.
- ✓ Put in practice the acquired knowledge during field visits, laboratory activities, and analysis of specific case studies.
- ✓ Perceive new horizons of biotechnology in phytopathology.

UNIT IV: Integrated Diagnosis and Management of Fungal and Bacterial Diseases

This unit provides in-depth knowledge of the most important fungal and bacterial diseases, together with the disorders induced by abiotic factors, which compromise the quality and quantity of Mediterranean fruit and vegetable production. Knowing how to identify and characterize the various species, strains and isolates of adverse pathogens offers a large benefit in the control, management and prevention pathogens affecting fruit tree and vegetable crops. This unit also provides biological, epidemiological, and ecological key elements necessary for analysing the pathogens\diseases relevance, distribution, and impact on farming systems. This knowledge will help set out rapid IPM interventions and strategies able to prevent crop and product losses, always ensuring the human and environmental health. Another thread if this unit is the forecasting and modelling systems able to identify the natural elements that can favourable the onset of diseases induced by biotic and abiotic factors in different environmental ecosystems. This prediction may involve phytosanitary intervention suitable to block the onset of diseases or risk factors.

AIMS

- ❖ Discriminate between groups of pathogens according to their biological, morphological, and physiological characteristics, with brief hints to their taxonomy.
- ❖ Identify the epidemiological mechanisms of disease and study the interaction between host-pathogen-environment.
- ❖ Develop specific IPM, tailored to the type of host-pathogen-environment context.
- ❖ Use the forecasting modelling for prediction the spread of infection, and the key elements for Decision Support System
- ❖ Have an idea of the disorder caused by the abiotic factors.

LEARNING OUTCOMES

At the end of this unit, students will be able to:

- ✓ Identify the disease aetiology and discriminate between biotic and/or abiotic disorders\symptoms.
- ✓ Understand pathogens cycles, symptoms expression in infected plants and how to intervene for their control.
- ✓ Identify strategies for detecting and controlling relevant bacteria and fungi.
- ✓ Implement effective, safe, and secure strategies for controlling a disease by use different sustainable approaches.

UNIT V: Insect and Nematode Pests in Crop Systems: Identification, Forecasting, and Control

Insects and nematodes are among the most important pests in agriculture, as they can seriously compromise food security and induce serious economic and environmental consequences for many crops and territories, as well as social destabilisation. Pests are responsible for direct yield losses estimated at around 20% of global agricultural productivity, although their indirect negative effects on consumers, public health, society, and the environment are much higher.

The correct and rapid identification of the pests responsible for crop damage based on their morphological characteristics or the symptoms they induce in host plants is a prerequisite for setting up an appropriate control strategy.

The need to significantly reduce the use of pesticides in agriculture to safeguard the environment and public health requires increasingly aware and rational methodological approaches to pest control. The realisation of predictive models of insect infestation successfully fulfils this need.

Insect and nematode infestations are significantly favoured by ecological conditions, but also by incorrect human behaviour.

AIMS

- ❖ Present a range of typical plant symptoms caused by different groups of insects or nematodes.
- ❖ Provide the basic elements to recognize the main groups of pests according to morphological and physiological characteristics, with brief hints to their taxonomy.
- ❖ Describe the main epidemiology mechanisms of plant pests and the relationship between host-pathogen-environment
- ❖ Provide basic information for the realisation of forecasting models of pest spreading in the territory.

LEARNING OUTCOMES

At the end of this course students manage to:

- ✓ Identify on a morpho-physiological basis the main groups of insects and nematodes of agricultural interest.

- ✓ Understand the cycle of the symptomatologic manifestation induced by the insect/nematode disorder and understand how to intervene for its control.
- ✓ Identify the best strategy for detecting and controlling relevant nematodes and insects.
- ✓ Implement in practise the acquired knowledge during field visits, laboratory activities, and analysis of specific case studies.

UNIT VI: Post-Harvest Pest Management, Food Safety and Certification in Crop Supply Chains

Nowadays, one of the main global challenges is to ensure food security for a world growing population whilst ensuring long-term sustainable development. According to the FAO, food production will need to grow by 70% to feed world population which will reach 9 billion by 2050. Therefore, there is a need for an integrated and innovative approach to the global effort of ensuring sustainable food production and consumption. In this context, a wide variety of post-harvest diseases severely affect fruit and vegetable crops, mainly in developing countries, reducing the quantity and the nutritional quality of food due to contamination by toxic compounds (pesticide residues and mycotoxins). As such, an effective prevention and control strategies are needed to apply throughout the production chain. This unit will provide knowledge on the post-harvest life of products, both in the field and after harvest, products that can be contaminated by toxic secondary metabolites of fungi and toxins. In addition, this unit will also provide information on to increase knowledge on the sustainable use of conventional means and the possibility of integration with safe alternatives such as biocontrol agents, generally recognized safe compounds (GRAS), genetic resistance to reduce contamination of fruits and vegetables.

AIMS

- ❖ Develop understanding of how to manage crops after harvest to reduce losses and maintain quality
- ❖ Provide knowledge of pest control methods during storage and transport and introduce principles of food safety and hygiene in supply chains
- ❖ Explain the role of systems like Hazard Analysis and Critical Control Points (HACCP) in preventing contamination
- ❖ Build awareness of certification standards such as Global G.A.P. and ISO
- ❖ Highlight the importance of efficient and traceable supply chains

LEARNING OUTCOMES

At the end of this unit, students will be able to:

- ✓ Identify common post-harvest pests and explain their impact on crop quality and losses
- ✓ Address the basic principles of sustainable use of conventional means of post-harvest control through integration/replacement with biocontrol agents, eco-friendly compounds, and exploitation of host resistance.

- ✓ Evaluate the risks of contamination by toxic compounds such as mycotoxins and possible strategies to preserve food quality and safety through sustainable management throughout the production chain.
- ✓ Analyse crop supply chains to find critical points and risks, and understand how to ensure traceability, quality control, and compliance with standards throughout the system.
- ✓ Apply food safety principles, including Hazard Analysis and Critical Control Points (HACCP), in practical contexts, and identify types of food contamination, explaining effective prevention methods during handling and storage environments.

UNIT VII: Plant Health Surveillance, Biosecurity and Certification Systems

The unit analyses the integrated framework used to protect plant resources, agriculture, and ecosystems from pests and diseases while enabling safe international trade. It covers plant health surveillance as a systematic process of monitoring crops and environments through field inspections, sampling, laboratory diagnostics, and data reporting systems to enable early detection and rapid response to outbreaks. It also explores biosecurity, which involves preventive and control measures such as quarantine regulations, border inspections, on-farm hygiene practices, and risk analysis to minimize the introduction and spread of harmful organisms across regions. In addition, the unit addresses certification systems, which ensure that seeds, plants, and plant products comply with established health and quality standards through phytosanitary certification, traceability mechanisms, and alignment with international frameworks like the International Plant Protection Convention. Together, these components form a coordinated system that supports regulatory compliance, protects biodiversity, ensures food security, and facilitates reliable and safe global trade in plant materials.

AIMS

- ❖ Provide knowledge on the principles and strategies governing the international phytosanitary measures (ISPM) and quarantine systems (QS).
- ❖ Analyse and discuss the current quarantine legislation in the European Union.
- ❖ Emphasise the importance of potential invasive harmful organisms for the Euro-Mediterranean area and plan possible countermeasures.
- ❖ Introduce cartography, Geographic Positioning System and Remote sensing concepts and approaches.
- ❖ Present the newest modern approaches and tools available in the geomatic, geoscientific and informatics fields that can be useful for the early detection, control, and eradication of quarantine pests.
- ❖ Emphasize the importance of phytosanitary monitoring and surveillance
- ❖ Provide concepts on the certification programs to produce healthy plant propagating material as the main pest prevention measure.

LEARNING OUTCOMES

At the end of the Unit, students will:

- ✓ Assess pest threats in a new area through the elaboration of a Pest Risk Analysis (PRA) and propose an appropriate contingency plan.
- ✓ Become knowledgeable about the basic concepts, principles, methods, and practical applications of the Cartography and Geographic Information System (GIS), and fundamental concepts of remote sensing for monitoring phytosanitary surveillance.
- ✓ Apply multidisciplinary approaches for implementing innovative sustainable IPM strategies for fruit tree and vegetable crops.
- ✓ Intersect between scientific, legislative, and phytosanitary service activities for effective control strategies of harmful pests and pathogens.

RESEARCH-BASED PROJECT ACTIVITY

With the academic year ending, students will be asked to carry out at CIHEAM Bari a research-based project activity, dealing with a topic introduced during the units' lectures. The topic can deal with various phytosanitary aspects, i.e., diagnostics, control, monitoring, surveillance and management of plant pests and pathogens. Once the topic is identified, students must conduct small-scale research activity for a period of 4 weeks, assisted by the mentor who proposed the topic. Once the research activity is over, students shall present (PowerPoint slide show) their topic and relative results to an examination board which will assess the scientific content and knowledge acquired by the students during that period.