IPM MASTER DEGREE

Knowledge and understanding

Graduates in Plant Medicine should have:

• in-depth scientific and technological knowledge to design and manage innovation in the protection of crops and plant products to improve the qualitative, quantitative, hygienic and sanitary aspects of plant products especially through the implementation of IPM;
• in-depth knowledge on plant harmful (pests, pathogens, weeds) and associated organisms, their ecology, disease aetiology and epidemiology, pest bio-ethology;
• in-depth knowledge of non parasitic diseases and their control;
• adequate knowledge to recognize plant diseases, pests, weeds and associated organisms under practical conditions;
• in-depth knowledge of the influence of the agro-ecosystem components and cultural practices on plant pathogens, pests, weeds and associated organisms;
• in-depth knowledge of the technical tools, natural, synthetic and biological Plant Protection Products (PPPs) utilized for the Integrated and Biological protection of plants and their products, and prevention of possible negative-side effects.

Furthermore, graduates must have:

• in-depth knowledge on the methods and technologies for the diagnosis of diseases and the identification of pests, weeds, and associated organisms;
• knowledge of biotechnologies for their application in diagnosis, pathogen and pest characterization, and in plant genetic improvement;
• in-depth knowledge of the methods and technologies for the production, preservation and utilization of sanitarily- and genetically-improved plant propagation materials;
• knowledge of plant physiology apt to understand plant-pathogen, plant-pest and plant-environment interactions;
• knowledge to safeguard genetic resources (biodiversity) and their utilization to improve plant production and resistance to pathogens and pests, utilizing both innovative and traditional technologies;
• knowledge on the causes and prevention of contamination of plant products by mycotoxins and plant protection residues;
• knowledge of the interactions of PPPs with plants and the environment;
• knowledge on the causes and prevention of acquired resistance of target organisms to plant protection products;
• knowledge of the phytosanitary rules and of the problems related to production and selling of plant propagation materials (phytosanitary certification, CAC);
• knowledge of the European and national laws concerning selling and utilization of PPPs, as well as the production and marketing of crop products;
• knowledge on principles of modelling and forecasting methods for pests and diseases;
• knowledge of the aspects and machineries related to PPPs applications;
• knowledge on the quality certification systems which can be applied to crop production.
CORE TOPICS ≥ 80 ECTS

This group of topics should give specific and fundamental skills, and competences addressed to Plant Medicine.

The minimum number of ECTS concerning these topics is mandatory for all the University partners.

The contents of these topics concern Plant Pathology, Entomology and Applied Zoology, Weed Sciences, Genetics in Plant Medicine, Integrated Pest Management, and Phyto sanitary laws.

1. PLANT PATHOLOGY
   1.1- Basic Plant Pathology
   1.2- Phytopatological Mycology
   1.3- Phytopatological Bacteriology
   1.4- Plant Virology
   1.5- Abiotic Diseases
   1.6- Physiopathology and Plant-Pathogen Interactions
   1.7- Diagnosis and Applied Biotechnology
   1.8- Mycotoxins

2. ENTOMOLOGY AND APPLIED ZOOLOGY
   2.1- Basic and Applied Agricultural Zoology
   2.2- Basic Entomology
   2.3- Applied Agricultural Entomology
   2.4- Agricultural Acarology
   2.5- Agricultural Nematology
   2.6- Plant-Pest Interactions
   2.7- Diagnosis and Applied Biotechnology

3. WEED SCIENCES
   3.1- Weed Management and Control

4. GENETICS IN PLANT MEDICINE
   4.1- Plant breeding for Resistance

5. INTEGRATED PEST MANAGEMENT (IPM)
   5.1- Integrated Pest Management, Biological Control and Organic Agriculture
   5.2- Plant Protection Products (PPPs)
   5.3- Environment and Plant Interactions with PPPs
   5.4- Engines for PPPs Applications

6. PHYTOSANITARY LAWS
   6.1- Quarantine and Mandatory Control
   6.2- Phyto sanitary Quality of Plant Propagation Materials
1. PLANT PATHOLOGY

1.1 Contents for Basic Plant Pathology
   1.1.1 - Disease concept
   1.1.2 - Evaluation of diseases and related damages
   1.1.3 - Biotic and abiotic aetiological agents
   1.1.4 - Pathogenetic mechanisms
   1.1.5 - Parasitism, pathogenesis and defense reactions of plants, aggressivity and virulence
   1.1.6 - Plant susceptibility and resistance
   1.1.7 - Systemic acquired resistance (SAR)
   1.1.8 - Variability of pathogens
   1.1.9 - Transmission and spreading of pathogens
   1.1.10 - Disease epidemiology
   1.1.11 - Symptomatology

1.2 Contents for Phytopathological Mycology
   1.2.1 - Taxonomy of phytopathogenic fungi
   1.2.2 - Biological features of phytopathogenic fungi
   1.2.3 - Aetiology, epidemiology (inoculum sources, survival, spreading, inducing environmental conditions), symptoms and damages of the main fungal diseases affecting the main agricultural crops (including ornamentals, greenhouse and soil-less crops, and plant products), and principles of their integrated management

1.3 Contents for Phytopathological Bacteriology
   1.3.1 - Taxonomy of phytopathogenic bacteria
   1.3.2 - Biological features of phytopathogenic bacteria
   1.3.3 - Aetiology, epidemiology (inoculum sources, survival, spreading, inducing environmental conditions), symptoms and damages of the main bacterial diseases affecting the main agricultural crops (including ornamentals, greenhouse and soil-less crops, and plant products), and principles of their integrated management

1.4 Contents for Plant Virology
   1.4.1 - Taxonomy and of plant viruses and virus-like pathogens
   1.4.2 - Features of plant viruses and virus-like pathogens
   1.4.3 - Aetiology, epidemiology (inoculum sources, survival, spreading, inducing environmental conditions), symptoms and damages of virus and virus-like diseases affecting the main agricultural crops (including ornamental, greenhouse and soil-less crops), and principles of their integrated management

1.5 Contents for Abiotic Diseases
   1.5.1 - Diseases caused by abiotic factors (nutritional disorders, environmental stress, air pollution, pesticide toxicity, chimeras)

1.6 Contents for Physiopathology and Plant-Pathogen Interactions
   1.6.1 - Types of plant diseases, their development/cycle, morphological effects on diseased plants
   1.6.2 - Cytological, morphological, biochemical, physiological and genetic alterations induced by pathogens in host plants
   1.6.3 - Effects of pathogens on plant physiological functions (photosynthesis, water and nutrients translocation, respiration, transcription, translation, plant growth, reproduction)
   1.6.4 - Defence mechanisms of plants against diseases
   1.6.5 - Strategies adopted by pathogens to attack plants (enzymes, microbial toxins, exopolysaccharides, growth regulators, plasmids, suppressor of plant defence response)
   1.6.6 - Signal-molecules produced by pathogens and/or host plants during pathogenesis

1.7 Contents for Diagnosis and Applied Biotechnology
   1.7.1 - Monitoring and sampling procedures in plant pathology
   1.7.2 - Diagnosis on the ground of symptoms

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1.7.3 - Traditional diagnostic techniques (sample preparations; isolation from plant organs, seeds, bulbs, tubers and soil; isolation on artificial media, selective and semi-selective media; pathogenicity assay; plant pathogen identification on the ground of morphological features)

1.7.4 - Biological, biochemical, serological and molecular techniques for the diagnosis of plant pathogens and mycotoxigenic fungi

1.7.5 - Main biotechnological applications in plant pathology with particular regard to disease resistance (hypersensitivity, SAR, plantibodies, genes transferring, GMO applied in biological control)

1.8 Contents for Mycotoxins
1.8.1 - Chemical and biological characteristics of mycotoxins
1.8.2 - Mycotoxigenic fungi
1.8.3 - Deterioration of feeds and foods, and contamination by mycotoxins
1.8.4 - Preventive and control measures

2. ENTOMOLOGY AND APPLIED ZOOLOGY

2.1 Contents for Basic and Applied Agricultural Zoology
2.1.1 - Organisation of living matter
2.1.2 - Animal physiology
2.1.3 - Reproductive modalities and strategies, and development
2.1.4 - Ethology and ecology (behaviour, societies, symbiosis, migrations, communication systems, populations, communities and ecosystems, population dynamics, geonemy and habitat, zoogeographic areas, population control)
2.1.5 - Morphology, biology and ethology (life history and reproductive strategies), ecology (population dynamics, effects of abiotic and biotic factors on the populations), and monitoring of snails, slugs, mouse and rats affecting crops and living in green areas and synanthropic environments

2.2 Contents for Basic Entomology
2.2.1 - Taxonomy of insects
2.2.2 - Biological features of insects
2.2.3 - Internal and external morphology of insects
2.2.4 - Physiology of insects
2.2.5 - Life history and reproductive strategies of insects (reproduction and ontogeny, diapauses, dispersal, polymorphism, intraspecific relationships, etc.)
2.2.6 - Ecology of insects (interspecific relationships; abiotic factor effects; population structures, size and dynamics)
2.2.7 - Symptoms and damages caused by insects to plants

2.3 Contents for Applied Agricultural Entomology
2.3.1 - Morphology, biology and ethology (life history and reproductive strategies), ecology (abiotic and biotic interactions and effects), symptoms and damages of insects harmful to the main agricultural crops (including ornamentals, greenhouse and soil-less crops, and plant products) and living in synanthropic environments, and principles of their integrated management
2.3.2 - Morphology, biology and ethology (life history and reproductive strategies), ecology (abiotic and biotic interactions and effects) of the natural enemies of the main phytophagous insects and principles for their application in the integrated management

2.4 Contents for Agricultural Acarology
2.4.1 - Taxonomy
2.4.2 - Morphology, biology and ethology (life history and reproductive strategies), ecology (population dynamics, effects of abiotic and biotic factors on the populations) and injuriousness of mites affecting the main agricultural crops (including ornamentals, greenhouse and soil-less crops, and plant products), and principles of their integrated management
2.4.3 - Morphology, biology and ethology (life history and reproductive strategies), and ecology (population dynamics, effects of abiotic and biotic factors on the populations) of the natural enemies of the main phytophagous mites and principles for their application in the integrated management

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2.5 Contents for **Agricultural Nematology**

2.5.1 - **Taxonomy**

2.5.2 - Morphology, biology and ethology (life history and reproductive strategies), ecology (population dynamics, effects of abiotic and biotic factors on the populations) and injuriousness of nematodes affecting the main agricultural crops (including ornamentals, greenhouse and soil-less crops, and plant products), and principles of their integrated management

2.5.3 - Morphology, biology and ethology (life history and reproductive strategies) and ecology (population dynamics, effects of abiotic and biotic factors on the populations) of the natural enemies of the main phytophagous nematodes and principles for their application in the integrated management

2.6 Contents for **Plant-Pest Interactions**

2.6.1 - Co-evolutionary interactions between phytophagous organisms and their host-plants (strategies applied by phytophagous insects, mites and nematodes to infest plants)

2.6.2 - Trophic relationships between phytophagous organisms and their host-plants

2.6.3 - Morphological, biochemical and physiological alterations induced by phytophagous organisms in their host plants

2.6.4 - Defence mechanisms of plants against phytophagous organisms

2.6.5 - Plant pathogens vectored by phytophagous organisms (transmission mechanisms, effects on biology and physiology of the vector)

2.7 Contents for **Diagnosis and Applied Biotechnology**

2.7.1 - Monitoring and sampling procedures in agricultural entomology, acarology and nematology

2.7.2 - Identification of phytophagous insects, mites and nematodes on the basis of their morphology and symptoms induced on the host plant

2.7.3 - Identification of natural enemies of phytophagous insects, mites and nematodes on the basis of their morphology

2.7.4 - Biological, biochemical and molecular techniques for the diagnosis of phytophagous organisms and their natural enemies

2.7.5 - Main biotechnological applications in agricultural entomology, acarology and nematology with particular regard to plant-resistance/tolerance, attractant and repellent means, plant secondary volatile and non-volatile metabolites.

3. **WEED SCIENCES**

3.1 Contents for **Weed Management and Control**

3.1.1 - Biology and ecology of weeds (dormancy, reproduction strategies, time and space spreading, germination and emergence, seed-bank evolution in soil)

3.1.2 - Quantitative and qualitative direct and indirect damages caused by weeds (obstacles to cropping activities, weed-crop competition, allelopathy and parasitic plants, weed hosting pests, allergies)

3.1.3 - Alien invasive weeds

3.1.4 - Integrated weed management (agronomic, mechanical, physical, biological, chemical and ecological strategies) and control in the main agricultural crops (orchards, herbaceous and horticultural crops), turf grasses and extra agricultural areas

4. **GENETICS IN PLANT MEDICINE**

4.1 Contents for **Plant breeding for resistance**

4.1.1. - Plant genetic resources, origin and evolution of PGR’s, centres of plant genetic diversity, safeguard, collecting, conservation and valorisation of germplasm

4.1.2. - Genetic structure of plant populations, qualitative and quantitative traits and selection criteria

4.1.3 - Plant breeding methods for self-pollinated, cross-pollinated and somatically-propagated species

4.1.4 - Approaches to increase genetic variation

4.1.5 - Breeding for yield, quality and tolerance to biotic and abiotic stresses

4.1.6 - Transgenic resistance to pathogens and pests

4.1.7 - Types and sources of plant resistance to pathogens and pests

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4.1.8 - Plant-pathogen co-evolution
4.1.9 - Variation in pathogen populations and methods to manage plant resistance
4.1.10 - Resistances to diseases in most important agricultural crops
4.1.11 - Methods for testing and selecting for plant resistance to pathogens and pests

5. INTEGRATED PEST MANAGEMENT

5.1 Contents for Integrated Pest Management, Biological Control and Organic Agriculture
5.1.1 - Integrated Pest Management (definition, regulations, official guidelines, private labels, role in the quality certification of agricultural products)
5.1.2 - Biological control of plant pathogens and phytophagous organisms (definition, regulations, strength and weak aspects)
5.1.3 - Predation and parasitism (tri-trophic relationships, host/prey location, acceptance and manipulation, selection and selectivity)
5.1.4 - Plant protection in organic agriculture (definition, regulations)
5.1.5 - Tools for the control of plant pathogens and phytophagous organisms (agronomic, physical, genetic, biological, biotechnological and chemical control)
5.1.6 - Semiochemicals (pheromones and other attractants) and strategies for their application (monitoring, mass-trapping, sexual confusion, mating disruption, etc.)
5.1.7 - Decision Supporting Systems (forecasting models, expert systems and warning systems)
5.1.8 - Environmental-friendly integrated pest management strategies for the main agricultural crops grown in field as well as in greenhouse, and for synanthropic environments

5.2 Contents for Plant Protection Products (PPPs)
5.2.1 - European and national regulations on registration and usage of PPPs
5.2.2 - Concepts of Maximum Residue Allowed and Safety Interval
5.2.3 - Correct usage of PPPs for the safety of environment, workers and consumers
5.2.4 - Biocontrol agents, natural substances and synthetic PPPs
5.2.5 - Fungicides, insecticides, acaricides, herbicides, nematocides and other PPPs, hints on biocides
5.2.6 - Chemical and functional classification of PPPs according to their mode of action
5.2.7 - Formulations of PPPs
5.2.8 - Methods for evaluating the biological activity of PPPs
5.2.9 - Resistance to PPPs in target organisms (genetic and physiological bases, population genetics, monitoring methods, preventive measures)

5.3 Contents for Environment and Plant Interactions with PPPs
5.3.1 - Absorption, translocation and accumulation of PPPs in plants
5.3.2 - Plant metabolism of PPPs (detoxification reactions: red-ox, hydrolysis, conjugation, role of glutathione, glucose and amino acids)
5.3.3 - Transformation of PPPs in plants
5.3.4 - Environmental fate of PPPs (diffusion, volatilization and mass transfer, adsorption, persistence, photo-transformation, chemical degradation, microbial and enzymatic degradation, polymerization, oxidative coupling, chemical and biotechnological processes of soil remediation, sorption isotherms and analysis of PPPs in the soil)
5.3.5 - Environmental sustainability and food safety
5.3.6 - Analytical methods for the determination of pesticide residues
5.3.7 - Eco-toxicological assessment of pesticides

5.4 Contents for Engines for PPPs Applications
5.4.1 - Doses and volumes of distribution, deposit, residue, conditions for a correct distribution, mode of use of PPPs
5.4.2 - Classification of treatments with PPPs and equipments for their distribution
5.4.3 - Sprayers for water-driven distribution of PPPs (analysis and evaluations of droplet populations, sprayer inspection and calibration)
5.4.4 - Equipments for pesticide treatments in greenhouse crops
5.4.5 - GIS technology and its applications in crop protection
6. PHYTOSANITARY LAWS

6.1 Contents for Quarantine and Mandatory Control
   6.1.1 - Concepts of quarantine and mandatory control
   6.1.2 – International, European and national regulations on quarantine and mandatory control

6.2 Contents for Phytosanitary Quality of Plant Propagation Materials
   6.2.1 - Phytosanitary requirements for plant propagation material (CAC and certified materials)
   6.2.2 - Methods and techniques for plant sanitation
   6.2.3 - Selection, storage and usage of pathogen-free plant clones
   6.2.4 - Phytosanitary certification programmes
SERVING TOPICS \( \geq 75 \text{ ECTS} \)

This group includes topics of agricultural sciences which should support the core topics (i.e.: competences not included in the core topics but crucial for the master course).

The minimum number of ECTS concerning these contents is mandatory for all University partners.

1. CROP PRODUCTION
- Plant biology
- General principles of crop management
  - Agro-meteorology
  - Principles of modelling and forecasting methods
  - Statistics and experimental methodology in agriculture
- Herbaceous crops
- Horticulture and ornamental crops
- Fruit production
- Glasshouse and soil-less crops
- Plant genetics

2. CHEMISTRY, BIOCHEMISTRY AND MICROBIOLOGY
- Soil science
- Biochemistry and plant physiology
- Basic and agricultural microbiology

3. AGRICULTURAL ENGINEERING MANAGEMENT
- Agricultural engineering
- Rural engineering
- Agricultural hydraulics

THESIS \( \geq 30 \text{ ECTS} \)

Experimental work and preparation of the thesis on topics coherent with the educational objectives of the master course.

The minimum number of ECTS concerning thesis is mandatory for all University partners.