Lecturer	Title of the Course	Brief description	Hours
Ercoli Laura	Journal club on plant/soil Interactions	The course aims to discuss some cutting-edge scientific papers published in research journals on the topic of the soil-plant interactions under the challenging climate change scenario. Students present a summary of the chosen paper that the whole group has read. Then, the discussion begin. Attendees ask clarifying questions, inquire about different aspects of the experimental design, critique the methods, and praise (or criticize) the results.	10
Ercoli Laura	Applied Agroecology	The course provides students with a comprehensive view of soil-plant interactions at the field scale in order to optimize the management of the cropping system and its impacts on soil and crop. It addresses the interactions between plants, soil and soil organisms, the roles played by soil organisms in decomposition of organic material and nutrient cycling. Other topics include the importance of soil organisms for soil fertility, mycorrhizas and their effects on crop productivity. The course will also provide detailed information on plant nutrition and fertilizer and biostimulant application.	20
Mensuali Anna	Advanced plant tissue cultures techniques	The course aims to introduce students to in vitro technologies for crop species. They well be enabled to orient themselves in the choice of in vitro culture to use, according to their work and / or research objectives in the field of plant biology, breeding, biodiversity conservation, production of secondary metabolites. Basic information on plant in vitro culture and novel approaches for in vitro propagation will be provided. The course will be structured as follows: classroom lectures, lab experience, bibliographic research, seminars	20

Mensuali Anna	In vitro plant cultures as biofactories	The course will be focused on the production of useful plant secondary metabolites. Biological basis of in vitro plant cells, tissues and organs culture. Callus culture and cell suspension. Bioreactors. Evaluation of cultured cells viability. Strategies to increase secondary metabolites production. Biotransformations. Immobilized cells. "Hairy roots". Production of metabolites from undifferentiated cells or from in vitro plant differentiated biomass. Plant biotechnologies applied to the cultivation of aromatic and medicinal plants. Plant cell cultures as novel foods. Presentation of case studies. The course will be structured as follows: classroom lectures, lab experience, bibliographic research, seminars	20
Mensuali Anna	Plants in urban environment	The main urban production systems will be illustrated with particular attention to the most innovative ones : vertical farm, windows farm, dynamic architecture, social gardens, nutraceutical value of vegetables, vegetables in food education etc. National and international "Community Garden" and Social Gardens will be presented. Vegetable production in extreme environments (contaminated soil, Antarctic station, space environment) , The main vegetable species in Italy cultivated will be briefly described. The course will be structured as follows: classroom lectures, bibliographic research, seminar and guided tour to "Community garden" in Pisa.	10
Perata Pierdomenico	Experimental plant physiology	The course is aimed to provide a forum of discussion about experiments performed by PhD students within the framework of their PhD projects. Contributions from experimental activities of post-docs and Ms students are also planned. The Course is active during the whole year, with one-two hour class every week. The presentations are discussed and placed in the context of the future publication of results thanks to the contribution of all the participants to the class. The main topics discussed are the research themes described in the PlantLab website: www.plantlab.santannapisa.it.	40
Pucciariello Chiara	Principles of plant-microbe molecular intera	The course "Principles of Plant-Microbe Molecular Interactions" faces friendly and hostile interactions between plants and microorganisms, focusing on molecular recognition processes and signal exchange. The contents of the course include: molecular strategies of plant-microbe interactions; plant defense mechanisms to hostile microorganisms: pathogenesis or resistance; plant-microbe symbiotic interactions: legume-rhizobia and arbuscular mycorrhiza fungi–plant associations; molecular methods for studying plant-microbe interactions; improvement of plant protection/fitness through molecular techniques. The bibliography of reference includes selected recent scientific publications.	20

Sebastiani Luca	Experimental approaches and data analysis i	This course introduces the basic statistical concepts for experimental planning and analysis of experimental data in plant science. Theoretical distributions that best represent the plant science data will be studied. The t-test, analysis of variance and regression and correlation analysis will be presented. Experimental designs useful research in plant science will be introduced. The course will use R and R-studio programs.	20
Sebastiani Luca	An introduction to R	This course introduces the use of R, an open-source program for statistical analysis and graphical restitution. Students guided in R and R-Studio features. The basic commands will be explained. Example of how to do a script of commands will be done. Objects will be created in R (vectors, dataframes) and operations with them will be performed. Students will be instructed on how to read data from external files (txt, xlsx, csv) and how to apply functions for graphical restitution of data.	10
Tonutti - Sebastiani	Trends in horticultural science (journal club)	The course is organized as "Journal club". Students will be assigned specific papers , published on top Journals, dealing with innovative topics concerning Horticultural Science. Students will present the data and the main results of these articles and will comment these papers in the class, with a discussion involving all participants. In addition to the scientific hypotheses, students will be asked , in particular, to analyze and evaluate the methodological aspects and the experimental plans of the papers, pointing out the strength and the weaknesses of the articles.	20
Tonutti Pietro	Ethylene physiology in plant science and hor	Ethylene , the gaseous hormone, has many and diverse roles in plant growth and development. In addition, some plant growth regulators are practically used to amplify or repress the ethylene responses. After some historical aspects regarding the discovery of ethylene, the course will analyze and describe the physiological, biochemical and molecular mechanisms regulating ethylene biosynthesis, perception and signal transduction in model species such as Arabidopsis and , concerning fruit crops, tomato. Ripening physiology in relation to ethylene will also be described in climacteric and non-climacteric fruits.	20
Tonutti Pietro	Fruit ripening and postharvest physiology	Fruit ripening is the developmental stage, genetically controlled, characterized by a number a processes, some of them strictly correlated often under the control of ethylene. Ripening allows fruits to reach the edible feature through the acquisition of specific quality parameters. The different factors (pre- and post-harvest) affecting the quality parameters will be described. The specific changes occurring during ripening in terms of physiology (respiration, ethylene biosynthesis) and commercial parameters (e.g. colour, texture, aroma) will be analyzed. Special emphasis will be dedicated to the description of the effects of storage techniques (refrigeration, controlled/modified atmosphere) on the evolution of ripening.	20

Bartolini Susanna	Aspetti bioagronomici e proprietà salutistiche delle specie frutticole minori e dei piccoli frutti	The course is addressed to PhD students with the aim to extend the study on fruit tree species. It includes the minor fruit tree species and small fruits varieties which play a key role for the valorisation of marginal areas, using sustainable production systems. 'Minor fruits', such as chestnut, walnut, hazelnut, almond, persimmon, and 'small fruits', such as blueberry, raspberry, strawberry, blackberry, will be studied under the biological and agronomical aspects, highlighting the nutraceutical traits and health benefits of fruits.	20
Bartolini Susanna	Biological cycles and perennial species floral phenology under current and changing climate conditions	The course deals with the biological cycles and phenology evolution of the main fruit tree species of Mediterranean temperate areas. Relationships between different factors involved in biological processes, and interactions between genotype and environment will be proposed. The knowledge and study of these elements is extremely topical for the purpose of enhancing genetic resources in a future scenario considering that the current climate change is seriously impacting on phenological phases of fruit tree species.	20
Dell'Acqua Matteo	Introduction to genomics	An introductory course focusing on genomics and applied genomics. We will discuss about elements of genetics and genome organization; Sequencing approaches of first, second, and third generation; applications of genomics to study different aspects of genomes and groups of genomes, including epigenetics, transcriptomics, metagenomics, pangenomics, ancient DNA, environmental DNA; rudiments of sequence alignment approaches; use of genomics for the characterization of diversity in populations; elements of quantitative genetics and genomic selection approaches.	20
Pellegrino Elisa	Introduction to systematic review and meta-	Introduction: How and why perform a Meta-Analysis, and when does it make sense? Effect Size and Precision, effect Sizes Based on Means, Effect Sizes Based on Binary Data (2×2 Tables), effect Sizes Based on Correlations; Converting Among Effect Sizes, Factors that Affect Precision Fixed-Effect Versus Random-Effects Models, Fixed-Effect Model, Random-Effects Model, Fixed-Effect Versus Random-Effects Models: Worked Examples Heterogeneity, Identifying and Quantifying Heterogeneity , Prediction Intervals. Worked ExamplesPower Analysis for Meta-Analysis Publication Bias. Reporting the Results of a Meta-Analysis. The course is based on the use of the software: Comprehensive Meta-Analysis Software (CMA), and on lectures and practical session. The student can prepare it own dataset and work on it or work in shaded datasets.	10

Pellegrino Elisa	Multivariate data analysis for complex exper	The course is based on theoretical lectures and pratical session using Primer 7 and PERMANOVA + software . Resemblance measurementsin a multivariate structure and evaluation of the effects of data pre-treatment. Classification methods. Non-parametric and parametric ordering methods (e., nMDS, metric mMDS). ANOSIM, global and pairwise tests. Measures of biodiversity, test and diversity of curves. Diversity and taxonomic. Permutational ANOVA and MANOVA (PERMANOVA) for the multivariate analysis of data in complex designs, partitioning variation based on the choice of similarity measures and permutation methods. Dispersion homogeneity test (PERMDIPS). Unconstrained principal Coordinates analysis (PCO) or constrained ordering using Distance-based linear models (DISTLM) and distance-based redundancy analysis (dbRDA) and canonical analysis of principal coordinates (CAP).	20
Rossetto Rudy	Geographic information systems: theory and	Theory and application of Geographic Information Systems (GIS) is an entry-level course designed for students with little to no-formal GIS training aiming at developing the necessary skills to integrate GIS into their scientific curriculum. As location-aware technologies becomes increasingly important, GIS constitute relevant tools for analyzing scientific spatially-distributed data. Students will learn the basics of GIS and how to prepare and store data in spatial database, to analyze spatial data, and to use cartography techniques to communicate results by means of maps and graphs. Specific applications to the agronomic research area will be presented and discussed.	20
to be defined	Scientific English	The Course conducted by a native English speaker has the dual purpose of consolidating English language proficiency and developing both oral and written communication skills in science. Ample space is left for conversation and critical review of papers	30
Francesca Di Donato – Denise Amram - Caterina Sganga	Open Science e Data Management	The course covers all modern aspects of Open Science and provides the tools and standards required to embed Open Science in research workflows. After a brief overview of the foundations of key IP rights, data protection principles and non-personal data regimes, it focuses on the concept and application of Open Science in Horizon Europe, the ongoing reform of the research assessment system in the EU, meaning and practice of open access publishing and data FAIRification. Specific attention will be devoted to research data management, Data Management Plans, the use of existing Research Infrastructure (RI) to disseminate research data and other outputs, and the definition and implementation of the European Open Science Cloud (EOSC).	12