International Master in Horticultural Science (IMaHS)

LIST OF COURSES AND TEACHING MODULES OFFERED AT UNIBZ IN THE THIRD SEMESTER.

Module	Semester	ECTS Credits
Production Chain Management	1	**12**
• Integrated Orchard and Vineyard Management *Canopy Management* *Soil and Water Management*		6
• Mineral Nutrition		3
• Applied Entomology in Horticultural Crops		3
Post-harvest Chain Management		**9**
• Supply Chain and Innovation Management		3
• Fruit Processing		3
• Post-harvest Management		3
Plant Protection and Disease Management		**9**
• Plant Protection Products and Residues	1	3
• Elements of Chemistry and Biochemistry of Agrochemicals 1	1	3
• Integrated Plant Disease Management	1	3
Efficient Resource Use in Production Systems		**9**
• Project Development and Management	1	3
• Applied Breeding and Sustainability	1	3
• Information and DSS in Fruit Production	1	3

Production Chain Management

INTEGRATED ORCHARD AND VINEYARD MANAGEMENT

Carlo Andreotti / Massimo Tagliavini

Learning Outcomes

The course will provide students with scientific and technical knowledge on the canopy and soil management in orchards, vineyards and nurseries. At the one hand, students will understand and critically consider the main factors involved in canopy architecture and its and management. At the other hand, the course will allow the students to use the available scientific knowledge and the modern technical tools to improve the management of ground cover, irrigation and fertilizer supply, in order make the best use of the natural resources and enhance soil fertility. Students will be able to adapt this knowledge to specific environmental and agricultural conditions for developing production systems that reconcile yields, fruit quality and environmental sustainability.

Course Contents

Students attending this class must possess basic knowledge of tree biology and physiology to fully understand the subjects presented during the course. These competences are obtained during the first level degree and in the first-year of the master program. The course is divided in two modules and will focus on the following topics:

A) Module CANOPY MANAGEMENT

Carlo Andreotti

- Introduction to the canopy structure (architectural models, fruiting habitus) and functionality (*Teaching unit length*: 2 hours)
  Relation between the vegetative and reproductive cycles
  Pruning as a tool to manage the competition between organs (roots, shoots, bud induction and differentiation, flowers, fruits, etc)
- Pruning techniques (*Teaching unit length*: 8 hours)
  Dormant pruning
  Summer pruning
  Mechanical pruning
  No pruning techniques
- Canopy training systems for low/intermediate/high density orchards (*Teaching unit length: 6 hours*)
  Training systems for fruit trees
  Training systems for grapevine
- Management of fruit load (*Teaching unit length*: 6 hours)
  Alternate bearing and fruit thinning
  Plant growth regulators to control tree growth and fruit quality

Control of ripening in grapevine

- Protection systems (Teaching unit length: 2 hours)
  Shading nets, hail nets, plastic tunnel against rain, wind barriers
- Production systems in nurseries *(Teaching unit length: 6 hours)*
  Production techniques
  Nursery management and legislation

B) Module SOIL AND WATER MANAGEMENT

Massimo Tagliavini

- Management of root growth and root activity (*Teaching unit length: 4 hours)*
  Root distribution
  Environmental and cultural control on roots
  Beneficial use of interactions between roots and micro-organisms in the rhizosphere
  Root pruning

- Mineral nutrient supply *(Teaching unit length: 10 hours)*
  Nutrient needs
  Nutrient availability
  Nutrient cycling within trees and ecosystems
  Soil and foliar nutrient supply; fertigation techniques
  Management of nutrient-related physiological disorders

- Water management *(Teaching unit length: 10 hours)*
  Soil water availability and water needs
  Plant and soil-based methods for irrigation scheduling
  Water stresses and irrigation strategies for enhancing fruit quality
  Strategies to enhance WUE and reduce water losses
  Regulated deficit irrigation and partial root drying
  Irrigation systems

- Orchard- and vineyard-floor Management systems *(Teaching unit length: 4 hours)*
  Ground-cover vegetation and ground-cover systems
  Weed control methods
  Green Manure

- Control of soil sickness and replant problems *(Teaching unit length: 2 hours)*

Teaching Methods

Frontal lessons make up 60% of the time allotted to this course. The remaining 40% of the time is dedicated to lab- and field-activities, and visits.

Readings/Bibliography
Lecture notes made available after the lesson on the on-line platform of unibz; handouts and articles provided by the instructor through internet services managed by unibz. Selected chapters from *FAO Irrigation and drainage paper 66*(available online), *Fundamental of temperate zone tree fruit production (*2005) and *Apple, Botany production and uses* (2003).

Assessment Methods
Oral exam at the end of the course on the entire program (frontal lessons and exercises/excursions). At least three questions on different subjects of the course will be asked. The number of questions is dependent from the quality and completeness of the answers given by the candidate.

Teaching Tools
Frontal lessons using ppt presentations. Use of software the computer room. Field exercises with the use of scientific instruments. Field visits.

MINERAL NUTRITION

Stefano Cesco

Learning Outcomes
The course aims at improving the knowledge about the mechanisms underlying the soil availability, root uptake, translocation and allocation of mineral nutrients in fruit tree crops. This knowledge will allow to manage the fertilization practices in orchards according to the physiological needs of plants.

Course Contents
General aspects of ion uptake mechanisms of plants: short (roots) and long (xylem and phloem) transport and allocation. Ion uptake by leaves (mechanisms underlying foliar fertilization). Forms and availability in the soil-plant system, plant contents, metabolic functions, symptoms of deficiency/excess, fertilizers and their field application of macro (N, P, K, Ca, Mg) and micronutrients (B, Zn, Fe, Mn, Cu) in relation to a sustainable and efficient use of the source. Examples of biofortification (Si, Se, Ni) and nutrient interactions (e.g. N vs Fe, N vs S, Fe vs S).

Teaching Methods
The course consists of lectures (*18 hours frontal lessons*) during which the Professor presents the different topics. Practical lessons and laboratory activities (*12 hours excursions/laboratory*) conducted by the Teacher and the Teaching Assistants are also foreseen.

Readings/Bibliography
Mineral Nutrition of Higher Plants, Ed: Petra Marschner, Academic press, 2012, ISBN: 978-0-12-384905-2

Assessment Methods

Assessment (*at the end of the course*) is conducted via oral examination that includes a) questions to assess the knowledge and understanding of the course topics and b) questions designed to assess the ability to transfer these skills to case studies of crop production. Space will also be dedicated to the evaluation of the ability to rework the experience of the laboratory.

Attribution of a single final mark awarded on the basis of the following criteria: the clarity of the response, the ability to summarize, evaluate, and establish relationships between topics, the independence of judgment, the ability to rework.

Teaching Tools

Course topics will be presented using Power Point presentations and at the end of a single lesson a paper copy will be distributed directly to students.

APPLIED ENTOMOLOGY IN HORTICULTURAL CROPS

Sergio Angeli

Learning Outcomes

By the end of the course, students should acquire knowledge that enables them to: identify the key pest insects of the major horticultural crops and small fruit crops; understand the pest complexes of the agro-ecosystems; have a broad idea of chemical ecology and tritrophic interaction amongst host plants, pests and their natural enemies; plan a monitoring program for pest insects; link sustainable agriculture with pest control; understand the fit of IPM in fruit cropping systems, with traditional and alternative control measures. The main goal of this course is to learn how to improve economic values of plants while defending and improving the environment and the ecosystem services such as self pest-regulation and pollination.

Course Contents

The course is designed to provide graduate students with an overview of pest insects and pest management strategies, emphasizing ecological principles and their applications within the major agro-ecosystems of fruit trees cultivation. Pest insect biology and management of the fruit production systems in temperate regions will be considered, as apple, grape, cherry, plum, peach, strawberry and other small fruit.

Specific attention will be given to beneficial insects, biological control and IPM strategies. The course will cover the following topics: Overview on general entomology; Key pest insect species of apple, grape, cherry, plum, peach, strawberry and other small fruit; Chemical ecology and Tritrophic interactions; Synthetic insecticides and Integrated Pest Management; Biological Control, Benefical Insects in Organic Farming and Botanical Insecticides; Pollination Services; Case topics selected by the students.

Teaching Methods
This course involves consists of 18 hr of frontal lectures and 12 hr of practical part. The frontal lectures and topics are presented by the Professor. Practical parts, lab activities, and excursions are explained by the Professor and the Teaching Assistants. Numerous papers are brought to class for review. The practical part provides instruction mainly in key pest insect identification and biology of horticultural crops, extraction of botanical insecticides, insecticidal activity, etc.

Readings/Bibliography
Aluja M., Leskey T.C., Vincent C. (Eds.) 2009 "Biorational Tree-Fruit Pest Management", CABI Publishing, Wallingford, UK, 295 pp. ISBN: 1845934849. Heikki M.; Hokkanen T., Lynch J.M. (Eds.) 1996 "Biological Control - Benefits and Risks", Cambridge University Press, UK, 326 pp. ISBN: 9789048126651. Koul O., Cuperus G.W., Rolff J. (Eds.) 2007 "Ecologically Based Integrated Pest Management", CABI Publishing, Wallingford, UK, 462 pp. ISBN: 9781845930646. Lichtfouse E., Navarrete M., Debaeke P., Véronique S., Alberola C. (Eds.) 2007 "Sustainable Agriculture", Springer, the Netherlands, 919 pp. ISBN: 9789048126651. Pedigo L.P., Rice M.E. 2009 "Entomology and pest management", 6th Ed. Pearson Prentice Hall Upper Saddle River (NJ), 784 pp. ISBN: 0135132959. Peshin R., Dhawan A.K. (Eds.) 2009 "Integrated Pest Management, Volume 2: Dissemination and Impact", Springer, New York (NY), 634 pp. ISBN: 1402089899. Schowalter T.D. 2011 "Insect Ecology: An Ecosystem Approach", 3rd Ed. Academic, San Diego (CA), 633 pp. ISBN: 0123813514.

Assessment Methods
Coursework will be weighted as follows: final written exam (70%), student seminar (15%) exercises and excursions (15%). It will not be possible to pass the course if the final written exam has a mark lower than 18.

Teaching Tools
Generally, Power Point presentations are available in the course reserve collection database of the Faculty 1 day after each single lecture. Additional material are provided by the Professor.

Post-Harvest Chain Management

SUPPLY CHAIN AND INNOVATION MANAGEMENT
Christian Fischer

Learning Outcomes
Supply chain management (SCM) is concerned with the coordination of the physical flow of goods and services across space, time and different types of organizations. In this course, SCM is approached from the point of view of (industrial, or business-to-business) marketing, strategic management and transaction cost economics always

With a focus on the fruit industry. The course offers an introduction into the topic and aims at providing the participants with a basic understanding of the involved issues, concepts and methods, so that they can apply them in their later job activities. In addition, the participants will learn and be able to apply the basics of innovation management, in particular collaborative innovation activities across the supply chain.

Course Contents

1) Introduction
2) Fundamentals of supply chain management
3) Fundamentals of innovation management
4) Applications to the fruit industry
5) Summary

Teaching Methods

24 hours frontal lessons, 6 hours group work.

Readings/Bibliography

- Lecture materials and slides
- Fawcett, S., Ellram, L. and Ogden, J. (2007): *Supply Chain Management – From Vision to Implementation*. Pearson Prentice Hall, Upper Saddle River, NJ, USA
- Fischer, C. (2010): Opportunities for innovation in specialised fruit & vegetable retailing – results from an Auckland greengrocers survey. In: Hewlett, E. & Johnson, J. (eds), Proceedings of the Australasian Postharvest and Managing Quality in Chains Conference, Napier, New Zealand, 2009. ISHS *Acta Horticulturae* 880. Pages 91-97.

Assessment Methods

Final exam at the end of the course. In addition, there is study project to complete which contributes up to 30% of the final module mark.

Teaching Tools

Teaching materials (slides, scientific articles etc) made available on unibz's Leganto platform.

FRUIT PROCESSING

Matteo Scampicchio

Learning Outcomes

By the end of the course, students should acquire knowledge that enables them to: identify the main key processing steps used during fruit transformation; understand the main effects of the processing on the quality characteristics of the processed fruits; have a detailed overview of main chemical and biological events occurring during fruit juice production, jam preparation, fruit drying and storage; understand

the possible preventive measure to control or even enhance the stability and shelf life of the processed fruits.

Course Contents

The course is designed to provide graduate students with an overview of the main processing steps used during the transformation of fruits, emphasizing the chemical, physical and biological changes occurring during processing. Specific attention will be given to the production of fresh cut fruits, fruit juices, jams, jellies and marmalades and dried fruits. Accordingly, the course will cover the following topics:

1. Fresh cut fruits;
2. Fruit juice processing
3. Enzyme use in fruit processing
4. Fruit preserves and jams making
5. Use of pectins in fruit processing
6. Drying of fruits
7. Thermal processing of fruits
8. Hurdles technologies and
9. Fruit by-products.

Teaching Methods

This course involves consists of 20 hr of frontal lectures and 10 hr of practical part. The frontal lectures and topics are presented by the Professor. Practical parts, lab activities, and excursions are explained by the Professor and the Teaching Assistants. The frontal lectures will be offered with digital slides, videos and the lecture of selected scientific literatures. The practical part includes exercises with spreadsheet at the PC, laboratory activity for the measurement of the main quality fruit attributes and some practical laboratory activity on the use of enzymes and pectins in fruit processing.

Readings/Bibliography

The content of the course is based on the following bibliography:

- Slides presented during the lectures.
- Mircea Enachescu Dauthy, in: Fruit and vegetable processing, FAO AGRICULTURAL SERVICES BULLETIN No. 119, freely available online at http://www.fao.org/docrep/V5030E/V5030E00.htm

Furthermore, for a deeper understanding of the topic presented during the course, it is recommended the reading of the following book:

- Diane M. Barrett, Laszlo Somogyi, Hosahalli S. Ramaswamy in: *Processing Fruits: Science and Technology*, Second Edition, CRC Press.

Assessment Methods
Coursework will be weighted as follows: final written exam (100%). It will not be possible to pass the course if the final written exam has a mark lower than 18.

Teaching Tools
Generally, Power Point presentations are available in the course reserve collection database of the Faculty 1 day after each single lecture. Additional material is provided by the Professor.

POST-HARVEST MANAGEMENT

Angelo Zanella

Learning Outcomes The course will provide students with scientific and technical knowledge on the post-harvest management of the main horticultural crops. An understanding will be developed concerning the interactions between the biological crop system at post-harvest, the surrounding environment and the influencing technical factors. This understanding will allow the students to manage future post-harvest challenges by adaptive knowledge.

Course Contents

Basic knowledge of fruit histology, physiology, ripening processes and biochemistry is assumed and will be deepened during the course. The course itself is divided in two sections:

A) Understanding the inter-linkage of post-harvest principles:

Reasons and scope for the post-harvest management; single post-harvest handling principles and inter-linkage; quality and safety management; potential of non-destructive quality evaluation techniques; definition, sources, prevention of post-harvest losses; influencing post-harvest ripening; adaptive storage procedures; innovation in storage technologies

B) Post-harvest handling of the main horticultural crop categories:

Post-harvest handling of following horticultural crop categories: tropical-, subtropical fruits, small fruits, pome fruits, stone fruits, fruit vegetables, flower- leafy- stem-vegetables, underground vegetables.

Teaching Methods

Frontal lessons will alternate with elements of flipped classroom and team-work with the aim of enhancing the degree of interaction and active knowledge acquisition, including lab-activities and visits.

Assessment methods: Written exam at the end of the course on the entire program (lectures, results of team-work and exercises/excursions), participation to team-work and lab activity.

Teaching tools: Frontal lessons aided by visual presentation. Flipped class room approach. Team work and team presentations. Lab demonstrations and exercises. Field visits.

Readings/Bibliography

Lecture notes made available after the lesson on the on-line platform of unibz; handouts and articles provided by the instructor through internet services managed by unibz.

Recommended supporting bibliography:

- R. Wills et al. (2016, 6th Ed.); Postharvest of fruit, vegetables & ornamentals; CAB International
- A. Kader et al. (2002); Postharvest technology of horticultural crops; University of California

Recommended supplementary bibliography:

- W.J. Florkowski, R.L. Shewfelt, et al. (2014); Postharvest Handling – A Systems Approach, Third Edition; Academic Press
- R. Wills et al. (2015); Advances in Postharvest Fruit and Vegetable Technology; CRC Press

Optional Course 1

Plant Protection and Disease Management

PLANT PROTECTION PRODUCTS AND RESIDUES

Sanja Baric

Learning Outcomes

The knowledge acquired will allow the understanding of European and national regulations on registration and application of plant protection products. The student will link the correct use of agrochemicals with the resulting residues on horticultural products. Students will also acquire tools to become constantly updated on the future evolution of the plant protection product portfolio.

Course Contents

- Review of the properties and the application of plant protection products
- European and national legislation on plant protection products
- Procedure for the approval of active substances of plant protection products including toxicological and ecotoxicological risk assessments
- Authorization of plant protection products
- Sustainable use of plant protection products
- Maximum residue levels of plant protection products

Teaching Methods

18 hours of frontal lectures combined with class discussions; 12 hours of exercises.

Readings/Bibliography

Handouts and selected papers shall be given to the students during the course.

Assessment Methods

Final written exam at the end of the course.

Teaching Tools
PowerPoint presentations of the lectures as well as technical and scientific papers will be made available through the online platform of the Free University of Bozen-Bolzano.

ELEMENTS OF CHEMISTRY AND BIOCHEMISTRY OF AGROCHEMICALS

Youry Pii

Learning Outcomes
The course aims at providing students with the knowledge and expertise on the agrochemicals modes of action and the fate of the chemicals in the agro-ecosystem. This knowledge will allow the sustainable management of this agricultural practice for the protection of cultures.

Course Contents
Classification of agrochemicals. Agrochemicals and their metabolism within cells: mode of action of fungicides (interference with respiration, biosynthesis of sterols, chitin, tubulin and nucleic acids); mode of action of insecticides (neurotoxic and decoupling insecticides); mode of action of herbicides (interference with photosynthesis, biosynthesis of amino acids and biosynthesis of lipids).
Agrochemicals metabolism in plants: reactions of oxidations, reduction, hydrolysis and conjugation. Agrochemicals fate in soil: movement (leaching, run-off, volatilization), adsorption (adsorption isotherms and adsorption coefficients) and degradation (photodecomposition, chemical and microbiological degradations).
European and Italian legislation of agrochemicals, labeling and their storage.
Practical exercise: determination of agrochemical adsorption and agrochemical degradation in soils.

Teaching Methods
The course consists of lectures (18 hours frontal lessons) during which the teacher will present all the topics foreseen in the course content. Practical lessons (12 hours) to be held in the laboratory by the teacher are also foreseen.

Readings/Bibliography
Gennari M. and Trevisan M. “Agrofarmaci - Conoscenze per un uso sostenibile” ISBN 978-88-8372-444-2
Müller F. “Agrochemicals : composition, production, toxicology, applications” ISBN 3-527-29852-5
Roberts T.R. “Metabolic pathways of agrochemicals” ISBN 0-85404-494-9; ISBN 0-85404-499-X

Assessment Methods
Assessment (at the end of the course) is carried out by oral examination, which will include:

i) questions to assess the knowledge and understanding of the course topics and

ii) questions designed to assess the ability of transferring the acquired skills to case studies. Also the knowledge acquired during the practical lessons will be assessed.

A single final mark will be awarded on the following criteria:

i) clarity of the answers

ii) ability to summarize, evaluate and establish relationships between topics

iii) independence of the judgment and

iv) the ability of reworking.

Teaching Tools

Course topics will be presented using PowerPoint presentation and at the end of each lesson a paper copy will be distributed directly to the students.

INTEGRATED PLANT DISEASE MANAGEMENT

Assunta Bertaccini

Learning Outcomes

The course emphasizes the importance and need of the integrated management of plant diseases within the integrated pest management approach, with the least possible disruption to the agro-ecosystems and the least hazard to people, animals, and environment. The course will enable the students: to acquaint with the principles of an integrated approach to plant disease management; to become familiar with the basic principles involving fungal, bacterial, phytoplasma and viral based diseases in plants; to acquire knowledge of the environmental factors influencing plant diseases, to gain an understanding of the influence of plant pathogens in crop-ecology finalized in rationalize disease control; to know the most successful plant protection strategies by physical, genetic, cultural, chemical and biological means; to gain knowledge of the use of predictive models.

Course Contents

The mission of the course is addressed to the study of the integrated plant disease management strategies that incorporate conventional and novel biological, cultural, chemical, genetic and other environmentally sound and economically profitable approaches. Discussion of the principles of managing insects, diseases in the context of developing stable agricultural systems. During the course it will be provided the basis of understanding, interpretation, selection, development and application of the most effective methods of Integrated Crop Management, with the least disruption to the environment. A more detailed understanding of the effects of pest pressure on crop productivity and the development of threshold levels for action will be developed.

The course will provide the main elements involved in the integrated plant disease management: Exclusion — keep pathogens, vectors and infected plants out of disease-free areas. Eradication — destroy a disease organism after it has become established (destruction of infected plants, disinfection of storage bins, containers and equipment, and/or soil disinfection by fumigation, pasteurization, solarization or drenching). Protection – use a physical barrier such as a row cover or chemical applications available to prevent a disease from becoming established. Resistance — plant resistant varieties. Therapy – use chemicals that are systemic in the plant.
Avoidance – use good cultural practices such as planting date selection, seedbed preparation and water management to avoid disease.
Evaluation of the benefits and risks of the treatments and choose the best solution with the least negative environmental impact. The challenge, when using pesticides, is topic the one that will cause the least harm to non-target organisms in the forest or landscape.
Discussion of the new scenario of crop protection created by the policy on the use of pesticides started 20 years ago by the European Union to reduce their impact on health and environment. It is a topic that should be known since the new legislation for crop protection is becoming a very complex practice, because it is based on technical means more and more difficult to use also for legislative limitation. The EU policy is changing the regulatory framework for the homologation and use of products for plant protection in member states and this will have an impact in the different European countries.

Readings/Bibliography
Handouts and selected paper will be given to the students during the lecture by the instructor.

Teaching Methods
The course will be subdivided in two parts: The first concentrated on the different control methods of the main plant pathogens, giving more emphasis and preference to host-resistance, cultural practices and biological control other than the use of pesticides. The second part in the laboratory for the identification of the main pathogens and better study the most advanced methods to control plant pathogens responsible of the most important crop diseases.

Assessment Methods
At the end of a course it will be a final exam that tests the acquired knowledge and abilities. The students should produce a power point presentation on a subject chosen with the instructor of about 15 minutes long. Then questions on the main subjects of the course will follow. The final grade will be calculated by arithmetic mean among the integrated courses.

Teaching tools
PC, slide projection and handouts.

Optional Course 2

Efficient Resource Use in Production Systems

INFORMATION AND DSS IN FRUIT PRODUCTION

Raimondo Gallo

Learning Outcomes

The course aims to introduce the student to issues of decision-making processes of the agro-environment enterprises, mainly focusing on the requirements of farms oriented to fruit productions. Theoretical and practical aspects of the use of Farm Information Systems (FIS) and interactions between Information and Communication Technologies (ICT) and farm mechanization components will be presented and discussed in an integrated way. Relevant emphasis will be given to the designing, implementation and use of farm databases, particularly in view of their integration with GIS tools.

Course Content

The course will cover the following topics:

1. **ICT REQUISITES FOR PRECISION HORTICULTURE (PH).** The ICT's frontier in the context of agro-environmental and horticulture farming systems, between the emerging needs of precision farming and information management. The new requirements of the fruit supply full chain for traceability, reporting of processes and activities, automation in field process controls, site-specific farm management. The importance of automating data-logging and farm monitoring; types of monitoring and surveys classifications (environmental, crop and operational).
2. **ICT COMPONENTS.** Their general classifications in view of their use within the horticultural contexts. Basic electronic devices: sensors, actuators and identification systems; stand-alone and integrated applications in horticulture farming systems. Positioning systems (GPS and DGPS receivers). Computing hardware solutions: data-loggers, handhelds, personal computers and servers; data-transfer and communication systems, client-server architectures. Computing software solutions: general outlines on Farm-databases and necessity of a reference Farm-ontology. Fundamentals of Database Management Systems (DBMS) in farm applications. GIS outlines: mapping systems and geo-reference problems; backgrounds and layers; entities and attributes; links to databases; importing of GPS-paths from farm machinery activities.
3. **PH APPLICATIONS.** Operational monitoring: the role of moving- and stationary-user point mechanization; the tractor as data-logger and information carrier; Computerized Farm Registers (CFR): general features and functionalities; basic structural frameworks (tractor-oriented e implement-oriented); inference engine algorithms to interpret the meaning of

farm operational raw-data: from the elementary and single field-activity to the farm historical memory. Crop monitoring: optical and acoustic sensors for performing remote- and proximal-sensing applications; discussion of some case-studies to detect the vigor and the volume of the crop canopy; from thematic maps to prescription-maps. Outlines on prescription farming solutions and related VRT technologies for automating field processes.

Teaching Methods

The course consists of lectures (18 hours frontal lessons) during which the Professor presents the different topics. Practical lessons and laboratory activities (12 hours laboratory) conducted by the Teacher and the Teaching Assistants are planned as well, to show DBMS and Crop Monitoring applications.

Readings/Bibliography

- E.C. Oerke, R. Gerhards, G. Menz (2010). Precision Crop Protection - the Challenge and Use of Heterogeneity. Springer, London - New York, pp.441.
- M. A. Oliver Springer (2010). Geostatistical Applications for Precision Agriculture. Springer, London - New York, pp.331.
- T.A. Brase (2006). Precision agriculture. Thomson Delmar Learning, pp.224.
- B. Hofmann-Wellenhof, H. Lichtenegger, and J. Collins, (2001). GPS Theory and Practice , Springer-Verlag, Wien, pp.370.

Assessment Methods

Assessment (at the end of the course) is conducted via oral examination that includes:

i) questions to assess the knowledge and understanding of the course topics

ii) questions designed to assess the ability to transfer these skills to case studies of crop production, and

iii) ability to manage the experiences carried out in laboratory, with special regards to the use of DBMS for PH.

Attribution of a single final mark awarded on the basis of the following criteria: the clarity of the response, the ability to summarize, evaluate, and establish relationships between topics, the independence of judgment, the ability to rework**.**

Teaching Tools

Course topics will be presented using Power Point presentations and at the end of a single lesson a paper copy will be distributed directly to students.

APPLIED BREEDING AND SUSTAINABILITY

Luca Dondini

Learning Outcome

Students have to demonstrate a good knowledge about the breeding approaches to select plant material suitable for the conditions where it has to be grown and with the right quality for the end-users. An increased yield is still the most important trait but sustainable plant production requires plant adaptation to abiotic stresses as well as resistance to pests and diseases. It is important for students to know the approaches for plant selection for specific traits.

Course Contents

Students should have a background in agriculture and horticulture, all with knowledge about basic elements of genetics.
Lectures are organized in two parts (frontal and lab practice).

Frontal lectures (18 hours)

Introduction: basic concepts about fruit trees and implications in fruit tree breeding. Strategies for conventional (double-pseudo test cross) and advanced (principles of in vitro culture, somaclonal variability and in vitro selection, development of molecular markers for MAS) breeding.

Overview of the main breeding goals for sustainable production and related applications:

- Breeding for resistance to biotic and abiotic stresses
- Breeding for low input production (habitus, self thinning and self-fertility)
- Breeding of rootstocks
- Application of genetic transformation for sustainable production in fruit tree species
- Cisgenic plants and breeding by DNA editing.

Lab practice (12 hours):

- Molecular marker analysis on a panel of genotypes for selected traits- Visit to an experimental farm

Readings/Bibliography

Handouts and selected papers.

Teaching Methods

The course will be divided in two parts: the first part is focused on the main breeding strategies in fruit tree species and the relative applications for plant sustainable production. The second part in the laboratory, to learn by experience a technique for DNA extraction and test plant DNAs by PCR by using markers linked to specific traits.

Assessment Methods
Oral exam: One question about topics of the lab activities and two questions regarding topics of the frontal lectures.

Teaching Tools
Beamer, equipments in the biotechnology lab.

PROJECT DEVELOPMENT AND MANAGEMENT

Hans Karl Wytrzens

Learning Outcome
Upon successful completion of the course, students will be able to:

- Display basic knowledge of underlying theories and concepts of project organization (Knowing and Understanding)
- Understand the development of project ideas (Knowing and Understanding).
- Check feasibility of projects; formulate project objectives, deliverables, exclusions, and limits (Applying).
- Plan and implement project activities professionally (Applying).
- Assess critically project management documents and processes (Judging).
- Form and lead a project team (Applying).

Course Contents
The course offers a practical introduction to project development and management. It shows the applicability of project management in horticulture as well as fruit production by focusing on

- feasibility checks and systematic development of project ideas
- project phases, types and context (stakeholder analysis)
- project plans (scope planning, work breakdown structure, scheduling, resource planning, budgeting)
- implementation activities (team building, and motivating, controlling, and steering projects)
- project reports and evaluations
- project closure

Readings/Bibliography
Lecture notes made available after the lesson on the on-line platform of unibz; handouts provided by the instructor through internet services managed by unibz. Recommended supporting literature:

- Project Management Institute (2013) A Guide to the Project Management Body of Knowledge (PMBOK® Guide)—Fifth Edition
- Wytrzens H.K. (2017) Projektmanagement. 5. Auflage; Facultas

Teaching Methods

Theory input (as frontal presentation) is followed up by interactive exercises, discussions, practical teamwork and case study training. Systematic feedback from the teacher rounds each teaching unit off.

Assessment Methods

Written exam at the end of the course on the entire program (lectures, and exercises) (50 % to 100% of the overall course mark) and results of a teamwork case study (0 – 50 % of the overall mark).

Teaching Tools

Beamer for frontal lessons parts (aided by visual presentation); pinboard, flipchart, and moderation cards for the participatory coaching approach; pictures and short descriptions for case study examples.

Thesis topics for IMaHS students offered at UNIBZ - a.y. 2019-20

(in alphabetical order by professor name)

Prof. Andreotti carlo.andreotti@unibz.it

Subject: Fruit production/Viticulture

1. **Title**: Use of biostimulants to promote drought tolerance in fruit crops.

Scientific Leader: Prof. Carlo Andreotti

Summary: this thesis project aims to evaluate the effectiveness of some biostimulant products (i.e. seaweed extracts, protein hydrolysates, silicon and mycorrhizal fungi) as promoters of drought tolerance in fruit crops. Experiments will investigate the physiological and growing performances of drought-stressed plants treated with different biostimulant compounds. The project is focused on strawberry and grapevine as model specie.

Duration: to be defined according to aims of the research and model crop

Expertises/competences achieved during the research training: management of an experimental trial under field/greenhouse conditions, leaf gas exchange measurements, monitoring of vegetative/reproductive growth, characterization of fruit development and quality (whenever possible), analysis of biochemical indicators of water stress.

2. **Title**: Evaluation of the potential impacts of biochar application on grapevine cultivation: effects on soil-water relation, grapevine water status and N cycle.

Scientific Leader: Prof. Carlo Andreotti/ dr. Damiano Zanotelli

Summary: research activities are foreseen both in vineyard (located in the area of Meran, BZ) and under semi-controlled environment (grapevines cultivated in pots under tunnel conditions). The goal is to investigate the impacts of the use of biochar as amendment on soil and vine water status and on N cycle in grapevine. The methodology used for the experiments will be the follow: continuous measurements of volumetric soil water content, periodical analysis of leaf water potential, gas exchanges at leaf level, leaf temperature and fluorescence. As for the analysis of the N-cycle in grapevine, plants will be treated with a labelled nitrogen fertilizer. The results of the spectrometric isotopic analysis of 15N concentration in leached solutions and in the different vine's organs (roots, trunk, branches, shoots and bunches) will describe the overall Ncycle, therefore delivering useful information to be implemented in optimized fertilization programs developed for biochar amended vineyards. Master thesis projects within the research activities described above can be discussed with the scientific leaders and tailored to the specific interests and requests of the student.

Duration: May-September 2020 (field and lab work)

Expertises/competences achieved during the research training: monitoring of vine water status, leaf gas exchange measurements, fluorescence

measurements, quality characterization of grape berries, isotopic analysis.

3. **Title**: Canopy management techniques to control grapevine berry ripening.

Scientific Leader: Prof. Carlo Andreotti

Summary: The recent trend toward an increasing warming of the temperature is determining new ripening dynamics of grape berries that often lead to excessive sugar accumulation in fruits and alcohol development in wines. This somehow conflicts with the actual trend of wine markets that is increasingly asking for fresh, easy-to-drink, low alcohol wines. Moreover, other important quality traits of grapes and wines such as color, aroma, acidity and pH are detrimentally affected by ripening processes that occur largely during the hottest period of the season. Aim of the thesis project is the study of the effect of different canopy management approaches (such as the use of antitraspirant products, leaves removal, timing of the pruning) on the maturation dynamic, final quality and incidence of grapevine ripening disorders in Sauvignon blanc berries.

Duration: June-September 2020 (field work + lab work)

Expertises/competences achieved during the research training: management of an experimental trial under vineyard conditions, canopy management techniques, leaf gas exchange and fluorescence measurements, quality characterization of grape berries.

Dr. Sergio Angeli Sergio.Angeli@unibz.it

Subject: Entomology

4. **Title**: Study of herbivore-induced plant volatiles as a new insect control strategy for sustainable agriculture

Scientific Leader: Sergio Angeli

Summary: This project will focus on horticultural crops -we are working on both apple and grape- and their key pest insects, characterizing the herbivore-induced plant volatile compounds, released by plants under attach of specific pests. The ecological role of these compounds and their possible use in pest control will also be investigated. The project is in collaboration with several institutions, as Laimburg Research Center, Fondazione Mach, Swedish University of Agricultural Sciences, University of Göttingen.

Duration: 2-4 months.

Competences achieved during the research training: Students will conduct lab experiments dealing with insect infested plants, gas-chromatography/mass-spectrometry and/or protontransfer-reaction/mass-spectrometry. Field experiments on trapping insects could also be included.

5. **Title**: Testing ‘smart’ trap for monitoring of pest insects

Scientific Leader: Sergio Angeli

Summary: This project will focus on a new technology of trapping devises for pest insects, called ‘Smart Traps’ or ‘E-traps’, in collaboration with the partner company FOS srl. These remote-sensing traps will be tested in South Tyrol and in Emilia Romagna for the first time adding specific pheromones or other volatiles considering pest species of the main crops. The luring chemicals for each tested species will be developed by internal knowledge of our research group. The student will help our research group in setting the experiments, classify the trapped insects during the string/summer 2020, training neuro-fuzzy inference for the automatic detection of the pest insects and recording the archived results. The project is in collaboration with FOS srl and Laimburg.

Duration: 2-35 months

Competences achieved during the research training: Students will conduct mainly field experiments, however computational analysis, and remote image recognition may also be included.

6. **Title**: Developing new yeast-based trapping lure for the exotic species Drosophila suzukii

Scientific Leader: Sergio Angeli

Summary: This project is part of an EU-project in collaboration with Laimburg Research Center and Swedish University of Agricultural Sciences. We are focusing on the development of a yeast-based trapping system to control the invasive species Drosophila suzukii as a new ecofriendly pest management strategy. The student will join a task force of three research teams and may learn one of more aspects related to the GC-MS identification of volatile compounds of the years headspace, D. suzukii electroantennography and field experiments.

Duration: 2-5 months

Competences achieved during the research training: Students will learn about volatile compounds, odour coding, host plant volatiles, insect trapping, yeast cultures.

7. **Title**: Bee pollination service and pesticides

Scientific Leader: Sergio Angeli

Summary: This project focus on the impact of pesticides, particularly, neonicotinoids, on bee health and their pollination service. The student will join a regional project in collaboration with Fondazione Mach and the University of Trento, on sublethal effects of imidacloprid and thiametoxam on bee colony performance and possible disorientation.

Duration: 2-3 months

Competences achieved during the research training: Students will learn about pesticide residues, apiculture and modelling of population dynamic.

Prof. Sanja Baric Sanja.Baric@unibz.it

Subject: Plant Pathology

8. **Title**: Molecular genetic characterization of subpopulations of the chestnut blight fungus, its parasite and its host plant in South Tyrol
Scientific Leader: Prof. Sanja Baric

Summary: The European chestnut is the third frequent permanent culture in South Tyrol that provides vital ecosystem services and an important additional income to many farmers. Chestnut trees, however, are vulnerable to an invasive fungal disease caused by Cryphonectria parasitica. The disease affects the bark and underlying vascular tissues and can lead to the death of parts of the plant or of the entire tree. In addition to sanitation measures, biological disease control strategies have been implemented, which rely on human-mediated distribution of hypovirulent fungal strains. In order to contribute to a better understanding of the epidemiology of this serious chestnut disease in South Tyrol and to the refinement of control strategies, extensive field surveys and molecular genetic analyses involving the fungal pathogen, its hypovirus and its host plant are going to be performed. The Master's thesis project can focus on different topics: (A) Study of the interaction between the hypovirus and the fungus at the gene expression level by quantitative PCR; (B) Molecular genetic characterization of chestnut trees grown in different areas of South Tyrol by applying microsatellite DNA analysis; (C) Performance of in vitro and in
vivo virulence tests on specific chestnut cultivars, with the scope to identify the most effective biocontrol agent for different chestnut genotypes present in South Tyrol.

Duration: 6 months

Expertise/competences achieved during the research training: Collection of samples in the field; Isolation of nucleic acids from plant tissues or fungal isolates; Use of molecular methods, such as PCR, quantitative PCR or microsatellite DNA analysis; Application of computational methods for analysis of molecular, genotyping or population genetic data; Performance of virulence tests in the laboratory or screenhouse

Possible external collaborations: Associations of chestnut growers and forestry service of the Autonomous Province of Bozen-Bolzano

9.Title: Molecular genetic variability of postharvest disease pathogens of apple from different cultivation areas in South Tyrol

Scientific Leader: Prof. Sanja Baric

Summary: Postharvest diseases can deteriorate the quality and quantity of the produce and have a considerable economic impact. As apple is the most important crop in the Autonomous Province of Bozen-Bolzano, the proposed research project aims to investigate the molecular genetic variability of a group of common fungal postharvest pathogens of apple, which will be defined together with the student. Inoculation experiments

will be performed in order to assess the virulence of genetically distinct isolates. Furthermore, the development of the disease in selected apple cultivars will be determined. The thesis shall contribute to a better understanding of the diversity and biology of postharvest pathogens of apple present in South Tyrol and to the implementation of improved disease management strategies.

Duration: 6 months

Expertise/competences achieved during the research training: Isolation of plant pathogens from apples with fruit decay; Microbiological methods for cultivation of fungal plant pathogens; Microscopic and molecular methods (multilocus sequence typing) for determination and characterization of fungal plant pathogens; Computational methods for analysis DNA sequence data as well as phylogenetic and population genetic analyses; Photo documentation and description of macroscopic disease symptoms

Possible external collaborations: Possibility to collaborate with the Laimburg Research Centre

Prof. Stefano Cesco Stefano.cesco@unibz.it

Dr. Youri Pii Youri.pii@unibz.it

Subject: Mineral nutrition of horticultural plants

10.Title: Interaction between roots-soil-microorganisms for the mineral nutrient acquisition in horticultural plants

Scientific Leader: prof. Stefano Cesco/prof. Tanja Mimmo/dr. Youry Pii

Summary: the understanding of the complex interacions occuring between plant, soil and microorganisms within the acquisition of mineral elements is receiving great attention in the last years. Indeed, soil microorganisms, and in particular Plant Growth-Promoting Rhizobacteria (PGPR), have been demonstrated to influence both the biogeochemical cycle of mineral elements, and hence their availability to plants, and the plants molecular mechanisms underlying

the nutrient acquisition. The aim of this research topic will be to shed further light on the profitable interaction between plants and PGPR, with particular attention to the acquisition of macro- (N, P, S) or micronutrients (e.g. Fe) in both nutrient starvation and heavy metal toxicity conditions. The activity will consist in running experiments with horticultural crops (e.g. cucumber, tomato, apple, grapevine plants) both in hydroponic system and in soil-based systems (e.g. pot experiments, RHIZOtest system), to investigate the nutrient acquisition process from soil chemistry, physiological, molecular and biochemical point of view.
Duration: 6-9 months including work in the growth chamber and in the lab.

Expertises/competences achieved during the research training: Students will acquire expertise in the chemical, physiological and molecular aspects of the plant mineral nutrition.

Possible external collaborations: none.

Prof. Raffaella Di Cagno Raffaella.DiCagno@unibz.it

Subject: Fruits and fruit by-products fermentation

11. Title: Exploitation of fruits and fruits by-products through lactic acid fermentation

Scientific Leader: Prof. Raffaella Di Cagno

Summary: Lactic acid fermentation represents the easiest and the most suitable way for increasing the daily consumption of fresh-like fruits. Lactic acid bacteria are a small part of the autochthonous microbiota of fruits. The diversity of the microbiota markedly depends on the intrinsic and extrinsic parameters of the plant matrix. Notwithstanding the reliable value of the spontaneous fermentation to stabilize and preserve raw fruits, a number of factors are in favor of using selected starters. Several evidences were described in favor of the use of selected autochthonous starters, which are tailored for the specific plant matrix. Pro-technological, sensory and nutritional criteria for selecting starters were considered as well as several functional properties, which were ascribed to autochthonous lactic acid bacteria. The main features of the protocols used for the manufacture of traditional, emerging and innovative fermented fruits are considered. Tailored lactic acid bacteria starters combined with yeasts or food grade enzymes completely exploit the potential of fruits and their by-products, which enhances the hygiene, sensory, nutritional and shelf life properties.

Duration: 6 months

Expertise/competences achieved during the research training: Laboratory skills for the microbiological and biochemical characterization of fruits.

Possible external collaborations: -

Dr. Raimondo Gallo Raimondo.gallo@unibz.it

Subject: Information and DSS in fruit production

12. Title: a new concept of farm information system application for operative monitoring tasks.

Scientific Leader: Dr. Raimondo Gallo

Summary: operational monitoring is an important operation necessary to perform a proper management of the input and output of a farm as well as to better assess the fleet of machines present in the farm, in terms of fuel consumption, operative time assessment and predictive maintenance. Field-dataloggers and active tags will be installed on the tractor and on the implements, respectively ensuring the coupling between the tractor and the implement. Thanks to the use of the datalogger all the required operative parameters are collect and sent to a server where they are elaborated by well-defined procedures to obtain specific information about the operative task carried out. During this activity the student, under

supervision, will install all the devices on the power units and implements and he will manage them during the entire period of the study. Randomly, he will conduct manually elemental time study to assess the time spent during the different operations. Thus, the obteined results will be then compare with the same obtained by FIS elaboration. Then, the student will compare both results to assess the accuracy and precision of the developed procedures. Beside this, the student will be also involved in the development of new interpretative algorithms.

Duration: 6-9 months including work in field for data collection and laboratory for data analysis

Expertises/competences achieved during the research training: Students will acquire knowledge on the use of Field-datalogger and sensor for the identification. He will also acquire confidence with software for data analysis (excel, postgrass, and GIS). Most of the work will involve field measurements and data analysis.

Possible external collaborations: Laimburg Research Centre or private farmer to identify.

13. Title: Apple bloom charge assessment through image processing
Scientific Leader: Dr. Raimondo Gallo

Summary: the assessment of the bloom charge in apple orchards is a required operation necessary to regulate the flower production in order to maintain a proper amount of flower ensuring a proper amount and quality of fruits. Nowadays, a technical solution able to perform an automatic apple flowers quantification and localization does not still exist, therefore it is not possible to perform a focused flower thinning application. The aim of the present project is to develop a new system based on image processing for the automatic recognition of the flower. The analysis must be able to distinguish the background (small leaves, landscapes, poles, irrigation system) from the target of our interest. Then, considering only the areas identified as flower, through pixel counting application, it will possible to calculate the density and localization of the flowers on the canopy. The results are then used to develop new representative maps employable to drive an automatic flower thinning. During this activity the student, under supervision, will set up an artificial row with flowered ornamental plants. In this way any problem due to the flowering timing and to the short flowering period will be avoid. Then, the student will take pictures following different procedures and analyse them through software for image processing to be able to extract only the target. After then the student will also study alternatives for the automatization of the analysis procedures, through the implementation of new interpretative algorithms.

Duration: 6-9 months including work in field for data collection and laboratory for data analysis

Expertises/competences achieved during the research training: Students will acquire knowledge on the use of software for image processes (Matlab, software for image processing). He will also acquire confidence with software for data analysis MATLAB. Most of the work will involve

laboratory measurements and data analysis.
Possible external collaborations: Laimburg Research Centre

Prof. Christian Fischer christian.fischer@unibz.it
Subject: horticultural economics, management and marketing

14. Thesis topics in the field of agricultural/horticultural economics, management and marketing are available on request during the year. Please note that a minimum level of German language skills is often required for a thesis collaboration with an external organization.

Prof. Matteo Scampicchio matteo.scampicchio@unibz.it
Subject: Fruit Processing

15. **Title**: Valorization of fruit peels and seeds by "green" extraction technologies
Scientific Leader: Prof. Matteo Scampicchio
Summary: Fruit industry generates a large amount of by-products, which have short stability, limited economic value and negative impact on the environment. For this purpose, this project aims to develop new procedures for the valorization of fruit by-products, like peels and seeds. The technologies used will consist of supercritical carbon dioxide extraction. This technique allows to extract essential oils without the need of solvents. The essential oil will be characterize by modern analytical techniques to determine their content in terms of essential fatty acids, polyphenols, antioxidants and vitamins. The functional activity of these essential oils will be evaluated as the capacity to retard lipid oxidation.
Duration: 6 months
Expertise/competences achieved during the research training: Extraction techniques; Laboratory skills for the chemical characterization of fruits.
Possible external collaborations: -

16. **Title**: Determination of fruit quality by electronic nose and tongue
Scientific Leader: Prof. Matteo Scampicchio
Summary: This project aims to develop rapid method for the monitoring of the quality changes occurring to fruits during their processing or storage. For this purpose, innovative untarget analytical methodologies will be used. These include the use of the so-called electronic nose and electronic tongues. Such devices consist of an array of sensors that can provide a fingerprint of the product. By monitoring the changes to this fingerprint as a function of time, it is possible to build prediction methods for the

estimation of the shelf life and stability of fruit products.

Duration: 6 months

Expertise/competences achieved during the research training: Laboratory skills related to the quality control of transformed fruit products.

Possible external collaborations: -

Dr. Hannes Schuler Hannes.schuler@unibz.it

Subject: Molecular Ecology of insect pests of agricultural importance

17. **Title**: Investigating factors that influence phytoplasma transmission by insects

Scientific Leader: dr. Hannes Schuler

Summary: Phytoplasmas are bacterial pathogens responsible for a wide range of plant diseases. The most important phytoplasma diseases in South Tyrol are the Apple proliferation and Grapevine yellows such as Bois noir and Flavescence doreé. These diseases are responsible for high yield losses and great economic impact and are transmitted by sap-sucking insects. Although the biology of the vector and the phytoplasma are well-studied, factors affection the vector capacity of the insects are currently less understood. Major aspect of this project is to investigate the genetic diversity of vector insects and to genetically characterize vector and nonvector species. Moreover, the bacterial community of different insect species will be studied as potential factor inhibiting the transmission of phytoplasma.

Duration: 4-6 months

Competences achieved during the research training: Collections and taxonomic identification of insects; extraction, sequencing and characterization of the DNA; bioinformatic analysis of the data.

Possible external collaborations: Laimburg Research Centre; Università Politecnica delle Marche; Boku, Vienna

18. **Title**: Population genetic studies of invasive insect pests

Scientific Leader: dr. Hannes Schuler

Summary: Invasive species are a common threat of agriculture worldwide and have a vast impact in fruit production in South Tyrol. In this project we investigate the population structure of various invasive insect species. A specific focus of the project will be Tephritid fruit flies such as the eastern cherry fruit fly Rhagoletis cingulata, the walnut fruit flies Rhagoletis completa and R. suavis and the buckthorn fly Rhagoletis batava which were recently introduced in Europe and are currently spreading. Population genetic studies of native and invasive populations will be performed to reconstruct the invasion routes and study the dynamics the ongoing invasions. Additionally, tephritids that are occasionally occurring

in South Tyrol such as the Mediterranean fruit fly Ceratitis capitata and species that did not invade Europe yet including the apple maggot Rhagoletis pomonella and the western cherry fruit fly Rhagoletis indifferens will be studied.

Duration: 4-6 months

Competences achieved during the research training: Collections and taxonomic identification of insects; extraction, sequencing and characterization of the DNA; bioinformatic analysis of the data.

Possible external collaborations: University of Notre Dame (USA)

19. **Title**: Characterization of the parasitoid community of the Brown marmorated stink bug in South Tyrol

Scientific Leader: dr. Hannes Schuler

Summary: The Brown marmorated stink bug Halyomorpha halys is an invasive insect pest that was recently introduced to Europe and is now widespread in most European countries. In South Tyrol this species was detected for the first time in 2016 and subsequently invaded most agricultural areas. By feeding on a broad range of different fruits and vegetables this bug is causing significant economic damage. Several native parasitoid species have been described to attack the invasive stink bug. By using a traditional rearing method and a novel molecular approach we will comprehensively study of the parasitoid community of H. halys in South Tirol and estimate their potential for biological control.

Duration: 4-6 months

Competences achieved during the research training: Insect rearing and preparation of egg masses; rearing of eggs and insects; extraction, sequencing and characterization of the DNA; bioinformatic analysis of the data.

Possible external collaborations: Laimburg Research Centre

Prof. Massimo Tagliavini massimo.tagliavini@unibz.it

Subject: Orchard and vineyard management/crop ecosystems

20. **Title**: Evaluation of light environment manipulation to improve apple growth conditions

Scientific Leader: Dr. Leonardo Montagnani/ Prof. Massimo Tagliavini

Summary: In natural conditions, light availability in the different parts of the apple tree crown can be influenced only by pruning and tree row organization. However, light availability in the different parts of the crown can be regulated also by the use of protective nets and reflective strips. The use of these physical techniques can lead, as expected agronomic result, to the reduction of sunburns on the fruits and to an increase in productivity. The student will be in charge of measuring light conditions within an apple orchard canopy and evaluating its spatial and temporal

variability. The student will measure total and diffuse incident light in different periods of the day during spring and summer in different parts of the apple canopy, under full sun and under different types of protective nets and reflective strips. Total and diffuse light measurements will be performed by the sensor BF5, Delta Devices, UK. Then, photosynthesis measurements will be carried out by the analyser LC Pro, ADC Bio Scientific Ltd, UK. Furthermore, estimation of leaf area index in different crown parts will be performed by the LI-3000C Portable Leaf Area Meter, Li-Cor, USA. Measurements will be carried out at the Laimburg experimental center of Vadena (BZ), in collaboration with the personnel of that institution.

Duration: 4-6 months

Competences achieved during the research training: as expected final result, obtained with the combination of the collected data, will be the modeling of the overall photosynthesis of the apple tree at canopy level in the various light conditions, as affected by the different protective nets and reflective strips.

21. **Title**: Effect of the Keep in Touch system used against pests on photosynthesis of apple trees

Scientific Leader: Dr. Thomas Holz and Dr. Markus Kelderer (Laimburg Center)/ Dr. Leonardo Montagnani/ Prof Massimo Tagliavini

Summary: the student will monitor in detail the light intensity (total and diffuse) inside the canopy of apple trees under keep in Touch cover as compared to control trees. LAI data will be also obtained. Leaf photosynthesis and leaf transpiration will be measured on leaves grown under differential light regimes. Vegetative and reproductive data will be recorded as well. Fruit damaged caused by excessive light intensity and temperature will be assessed. The activity will be carried out at the Laimburg Res. Center

Duration: 6 months from April 2020

22. **Title**: Evaporative cooling to reduce high temperature damages on apple fruits

Scientific Leader: Dr. Leonardo Montagnani/ Prof Massimo Tagliavini

Summary: One of the problems affecting the apple production quality is the possibility that in conditions of strong solar radiation load and high temperatures fruit sunburns take place, threatening production value. In the future, this problem will be exacerbated, considering the foreseen increase of frequency and intensity of heat waves because of the undergoing climatic change. The student will be in charge of measuring micrometeorological conditions in the different parts of the canopy (air temperature and relative humidity, solar radiation) and more specifically the temperature of the fruits by the use of a high resolution thermocamera (FLIR T640, FLIR Systems, US). In fact, fruits in reason of the small

surface dissipating the thermal load can reach the threshold of critical temperature and can be damaged. The student then will evaluate the effect of the use of water spraying on the crown (evaporative cooling), both in terms of fruit temperature variation and fruit quality. As expected result, there is the development of a method for the recognition of critical stress conditions and fruit damage start, and the evaluation of the effects of a spraying system to reduce the thermal stress through evaporative cooling.

Duration: 4-6 months

23. **Title**: Assessing the effect of irrigation frequencies and volume of wetted soil on apple orchard

Scientific Leader: prof. Massimo Tagliavini/dr. Damiano Zanotelli **Summary**: Irrigation is a necessary agronomic practice in orchards to maintain high yields and fruit quality. This research will be carried out in an existing apple orchard where drip irrigation system will wet three different portions of soil (single line, double line, single line with partial root drying) when soil water potential reaches two levels of soil water availability. Irrigation will be guided based on the trend of soil water potential measured by tensiometers connected to the electro-valve of the irrigation system. The activity will consist on collecting the data of soil water content in the different irrigation treatments, monitor plant water potential by using a pressure chamber, measure physiological behaviour of plant via the use of a portable leaf gas exchange instrument (ADClc pro), and detect the occurrence of water stress with the use of a thermocamera or the fluorimeter (Walz). Measurement of shoot and fruit growth will also be taken throughout the growing season. Final fruit production will be compared among treatments in terms of quantity and quality.

Duration: approx.6 months including lab and field work

Expertise/competences achieved during the research training: Students will acquire expertise in sustainable irrigation management. Most of the work will involve field measurements and data analysis. **External collaborations**: Laimburg Research Centre.

24. **Title**: Assessing CO2 and H2O exchange as well as the water use efficiency of a vineyard in relation to key environmental variables **Scientific Leader**: Dr. Damiano Zanotelli/ Dr. Leonardo Montagnani/ prof. Massimo Tagliavini/

Summary: knowing the physiological response of grapevine to climatic variables is of a pivotal importance to understand and possibly predict the behaviour of this crop under future climatic scenario. To cope with this objective, an eddy covariance tower, equipped with instruments to measured key environmental variables simultaneously with the CO2 and H2O ecosystem exchanges, will be installed in a vineyard located in the municipality of Caldaro (BZ). The activity will consist in analysing the time series of CO2 and H2O fluxes; partition the net ecosystem carbon fluxes

into gross primary production (GPP) and ecosystem respiration; analyse their diurnal and seasonal pattern in relation to key environmental variables such as air temperature, vapour pressure deficit, solar radiation and wind velocity; compare GPP and evapotranspiration to assess the daily and seasonal course water use efficiency of the vineyard, investigating on the environmental reasons explaining its variability. **Duration**: approx.6 months including field work and data analysis **Expertises/competences achieved during the research training**: Students will acquire expertise in eco-physiology. Beside a required collaboration in field maintenance and calibration of measuring instruments, most of the work will involve analysis of large datasets, so a good background in data handling, using software like Excel or R, is welcome.

External collaborations: Laimburg Research Centre.

25. **Title**: Assessing the physiological response of two grapevines white varieties (Chardonnay and Sauvignon blanc) subjected to two distinct irrigation regimes

Scientific Leader: prof. Massimo Tagliavini/ Dr. Damiano Zanotelli **Summary**: Two distinct irrigation treatment (full and deficit irrigated) with three replicates each, will be created in the summer 2020 in two adjacent vineyard of cv. Chardonnay and Sauvignon blanc, respectively, with the aim to investigate the physiological response to the two cultivars to different level of water availability. The activity will consist in periodically measuring stem water potential using a Schölander bomb to check grapevine water status, and measure simultaneously leaf gas exchange and leaf chlorophyll fluorescence using the newly available GFS-3000 in combination with the Image-Pam fluorimeter (both from WALZ company). Biometric data on yield and berry quality will be carried out as well.

Duration: approx.6 months including field work and data analysis **Expertise/competences achieved during the research training**: Students will acquire expertise in measurements of physiological leaf gas exchange and chlorophyll fluorescence, laboratory analysis on berry quality, and data analysis.

External collaborations: Laimburg Research Centre.