University of Zagreb Faculty of Agriculture
Svetošimunska cesta 25, 10000 Zagreb
Phone: +385 (0)1 2393 777
E-mail: dekanat@agr.hr
Web: www.agr.unizg.hr

Applied plant nutrition (146051)

Course coordinators

Prof. Marko Petek, PhD, **Prof. Zed Rengel, PhD**

Course description

To give applicable and advanced knowledge on the biological and chemical processes affecting plant availability, function and losses of nutrients applied in mineral and organic fertilizers into soil as well as amendments used in agricultural and horticultural crop production. With this knowledge students become able to evaluate soil nutrient status and crop nutrient demand, to diagnose nutrient deficiencies of agricultural and horticultural crops, and to plan fertilisation strategies at the crop and farm level.

ECTS: **6.00**

English language: **L2**

E-learning: **L2**

Teaching hours: 60
Lectures: 34
Laboratory exercises: 16
Seminar: 8
Field exercises: 2

Lecturer

- Prof. Marko Petek, PhD
- Prof. Zed Rengel, PhD

Associate teacher for exercises

- Assoc. Prof. Tomislav Karažija, PhD
- Prof. Marko Petek, PhD

Associate teacher for seminars

- Prof. Marko Petek, PhD

Grading

Sufficient (2): 60-70 %
Good (3): 71-80 %
Very good (4): 81-90 %
Excellent (5): 91-100 %

Type of course

- Graduate studies / Environment, agriculture and resource management (Compulsory course, 2 semester, 1 year)

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General competencies

To give applicable and advanced knowledge on the biological and chemical processes affecting plant availability, function and losses of nutrients applied in mineral and organic fertilizers into soil as well as amendments used in agricultural and horticultural crop production. With this knowledge students become able to evaluate soil nutrient status and crop nutrient demand, to diagnose nutrient deficiencies of agricultural and horticultural crops, and to plan fertilization strategies at the crop and farm level.

Types of instruction

- Lectures
- Laboratory practice/exercises
  As part of the laboratory exercises basic chemical analysis of soil are performed for the purpose of writing the recommendations for fertilization of horticultural plants.
- Field work
  As a part of field work soil sampling in the field is performed.
- Seminars
  Seminar is independent work of each student (or group(s) of students) where students (as a team) elaborate issues related to plant nutrition and propose practical solutions.

Learning outcomes

Learning outcome	Evaluation methods
Evaluate importance of nutrient status and demand of soil, other growing media and crops, based on soil and plant analyses,	Participating in the discussions, partial exam, oral exam, final exam.
Diagnose nutrient deficiency symptoms in common agricultural and horticultural crop plants,	Participating in the discussions, partial exam, oral exam, final exam.
Apply advanced principles to fertilization strategy planning, taking into account soil nutrient mineralization and optimal use of available organic manures (stable manure, compost, green manures),	Participating in the discussions, partial exam, oral exam, final exam.
Discuss the role of fertilization as well as mineral and organic manures on agriculture sustainability issues,	Participating in the discussions, partial exam, oral exam, final exam.
Understand the importance of soil and plant sampling as well as analyzing.	Participating in the discussions, partial exam, oral exam, final exam.
Understand the basic methods relevant to plant and soil analyses,	Participating in the discussions, partial exam, oral exam, final exam.
Prepare reports on the basis of analytical results.	Participating in the discussions, partial exam, oral exam, final exam.

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Working methods

Teachers' obligations

Teachers' obligations are to teach students and present in a simple and understandable way educational course content. To assess the level to which students have adopted educational objectives and achieved the expected learning outcomes. To evaluate the learning outcomes of students through the set of evaluation criteria set out in grading system (grades insufficient (1) to excellent (5)), that is compatible with the ECTS system, by using interrogation techniques in the form of the questions through written and oral evaluation.

Students' obligations

Students' main obligation is regularly attend classes. Further, actively participate in discussions, ask and answer questions in lectures and seminars. Independently solve tasks of theoretical and practical problems. Seminar papers must be prepared and presented individually or in groups and actively participate in the discussion.

Methods of grading

Evaluation elements	Maximum points or Share in evaluation	Grade rating scale	Grade	Direct teaching hours	Total number of average student workload	ECTS
Class attendance (lectures + excercises) Actively participation in class	10			58	45	1
Partial exam 1 (PE1)	20	0-59 % 60-70 % 71-80 % 81-90 % 91-100 %	Insufficient (1) Sufficient (2) Good (3) Very good (4) Excellent (5)		25	1
Partial exam 2 (PE2)	20	0-59 % 60-70 % 71-80 % 81-90 % 91-100 %	Insufficient (1) Sufficient (2) Good (3) Very good (4) Excellent (5)		25	1
Seminar (S)	20				25	1
Oral exam (OE)	30	0-59 % 60-70 % 71-80 % 81-90 % 91-100 %	Insufficient (1) Sufficient (2) Good (3) Very good (4) Excellent (5)			2
Correction exam*	(20%)*	0-59 % 60-70 % 71-80 % 81-90 % 91-100 %	Insufficient (1) Sufficient (2) Good (3) Very good (4) Excellent (5)		(25)	(1)

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Evaluation elements	Maximum points or Share in evaluation	Grade rating scale	Grade	Direct teaching hours	Total number of average student workload	ECTS
Final exam (FE)**	100**	0-59 % 60-70 % 71-80 % 81-90 % 91-100 %	Insufficient (1) Sufficient (2) Good (3) Very good (4) Excellent (5)		60	6
Total	100 %	PE1+PE2+S+OE /4 or FE		58	180	6

Evaluation elements	Description	Deadline	Recoupment
Class attendance (lectures + excercises) Actively participation in class	Active participation in class may raise the grade		
Seminar (S)	Grading scale depends on the presented knowledge and writing skills		
Correction exam*	* The student has the possibility to fix a grade of one partial exam, or to take one partial exam in case he was not able to access during the regular partial exams' period		
Final exam (FE)**	** If the student does not pass the course through partial exams, take the final exam in the exam period consisting of a written and oral exam		
Partial exam 2 (PE2)	Exam covers microelements, elements with toxic effects, fertilizers and fertilization, soil and plant analysis.	14th week	Possible through separate exam writting (2ECTS)
Seminar (S)	Students select a topic related to course, make presentation, present and answer to questions.	15th week	Possible with agreement (1 ECTS)
Correction exam		15th week	
Oral exam (OE)	Oral evaluation.	Exam period	
Final exam (FE)**	Evaluation of the theoretical acquired knowledge, analytical skills, critical thinking and, identifying and solving of practical problems.	Exam period	

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Weekly class schedule

1. The role of plant nutrition in modern agricultural production; Biogenic elements, classification; Macroelements 1. L - Role of plant nutrition on environmental impact and effect on the overall health of plants, yield and food quality. Macro and microelements, properties and role. Nitrogen and phosphorus in the soil and plant.
2. Macroelements 2. - Distribution and behavior of micronutrients in soil 1. L+Pe-L - Potassium, calcium, magnesium and sulfur in the soil and plant. Organic and inorganic equilibria, adsorption and transport in soil (iron, zinc, copper).
3. Distribution and behavior of micronutrients in soil 1.; Distribution and behavior of micronutrients in soil 2. Pe-L - Organic and inorganic equilibria, adsorption and transport in soil (iron, zinc, copper). Organic and inorganic equilibria, adsorption and transport in soil (manganese, molybdenum, boron).
4. Rhizosphere chemistry relevant for micronutrient uptake by plants. Pe-L - Factors that influence the availability of microelements.
5. Heavy metals in plants. Media for plant growth. Factors affecting the nutrients uptake. L - Accumulation of heavy metals in plants and maximum permissible concentrations in food. Growing plants on soil, substrates and hydroponics. Effect of water pH, temperature, etc. to receive nutrients.
6. Nutrient's forms. Nutrients inflow to the roots. The entry of nutrients into the root. Types of plant nutrition (through soil and foliar nutrition). L - Ions, chelates, mass flow, diffusion flux, ion exchange. Passive and active movement. Moving across biological membranes. Theories of the entry of nutrients into the cell. Factors affecting the availability of plant nutrients in the soil (the role of plant roots and soil). The mechanism of intake over aboveground organs (leaf and stem) and the factors that affect it.
7. Classification of fertilizers, fertilization. Legislation. Organic fertilizers and fertilization. L - Organic and mineral fertilizers. Fertilization - preventive, curative. Legislation related to fertilizers in Croatia and the EU. Types and forms of organic fertilizers.
8. Mineral fertilizers and fertilization. Foliar fertilizers and nutrient solutions. L - Types and forms of mineral fertilizers. Concentrations for the foliar application and the nutrient solution.
9. Soil fertility control. Soil sampling. Lab+F - Guidelines of soil sampling for different plant species. Soil sampling in the field.
10. Determination of physiologically active phosphorus and potassium in the soil. Determination of total nitrogen in the soil and plant material. Lab - Determination of physiologically active phosphorus and potassium in the soil. Determination of total nitrogen in the soil and plant material.
11. Determination of soil pH and physiologically active lime in the soil. Foliar analysis. Lab - Determination of soil pH and physiologically active lime in the soil. Gudelines of plant material sampling for different plant species.
12. Determination of nitrate in plant material. Determination of phosphorus and potassium in plant material. Lab - Determination of nitrate in plant material. Determination of phosphorus and potassium in plant material.
13. Preparation and analysis of nutrient solution. Interpretation of laboratory findings and recommendations for fertilization. Lab+L - Preparation and analysis of nutrient solution. Interpretation based on the results of chemical analysis of soil, foliar analysis, nutrient contrentrations presented yields and planned yield.
14. Seminar. S - Making recommendations for fertilization based on chemical analysis of soil and the needs of plant species. Oral presentation of seminar.
15. Seminar. Written exam. S-WE - Making recommendations for fertilization based on chemical analysis of soil and the needs of plant species. Oral presentation of seminar.

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Obligatory literature

1. Mengel K., Kirkby E.A., Kosegarten H., Appel T. (2001) Principles of Plant Nutrition, 5th edition, Boston
2. Marschner H. (1995) Mineral Nutrition of Higher Plants, Academic Press. London, San Diego, NewYork, Boston, Sydney, Tokyo, Toronto.
3. Finck A. (1982) Fertilizers and Fertilization, Introduction and Practical Guide to Crop Fertilization Weinheim, Deerfield beach, Florida Basel.
4. Bergmann W. (1992) Nutritional Disorders of Plants, Development,Visual and Analytical Diagnosis

Recommended literature

1. J. Keller, H.K. Mohring (1966): Die Düngung in der gärtnerischen Praxis, Paul Parley, Hamburg.
2. Phillip J. Craul (1992): Urban Soil in Landscape Design, Jon Wiley and Sons, INC, New York.
3. K. Mengel, E.A. Kirkby, H. Kosegarten, T. Appel (2001): Principles of Plant Nutrition, 5th edition, Boston.
4. W. Bergmann (1992): Nutritional Disorders of Plants, Gustav Fisher Verlag Jena, Stuttgart.
5. Fardossi, A. Baumgarten, K. Bauer (2003): Richlinien für die Sachgerechte Dügung im Weinbau, Wien.
6. Finck (1982): Fertilizers and Fertilization, Introduction and Practical Guide to Crop Fertilization, Basel.

Similar course at related universities

- Crop physiology and Nutrition, University of Hochenheim.
- Biochemistry in Plant Nutrition, Justus-Liebig-University of Giesen.
- Plant Nutrition and Nutrient Management, University of Nebraska-Lincoln.

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