



Ministério da Educação
Universidade Federal de Santa Maria
Centro de Ciências Rurais
Programa de Pós-Graduação em Ciência do Solo

Course: Soil-Plant-Microorganism Interaction

Identification

Code: SOL888

Credits: 3 (2 horas teóricas – 1 horas práticas)

Level: Mestrado/Doutorado

Professor: Paulo Ademar Avelar Ferreira

System: Annual (II Semester)

Discipline objectives

To understand the biological, ecological, and molecular mechanisms that govern interactions among soil, plants, and microorganisms, with emphasis on promoting plant productivity and the sustainability of agricultural systems.

Syllabus

Integrated study of interactions among soil, plants, and microorganisms. Root biology and architecture; molecular signaling and plant–microorganism communication. Interactions with symbiotic, associative, and saprophytic microbiota. Role of the rhizosphere in plant–microorganism interactions. Rhizospheric, endophytic, and phylloplane microbial communities. Beneficial microorganisms: nitrogen fixers, nutrient solubilizers, plant growth promoters, and mycorrhizal fungi. Influence of soil management and agricultural practices on microbiota and their functions. Biotechnological applications: inoculants, biostimulants, biological control, and phytoremediation.

Methodology and/or teaching instruments

The course will be conducted in a way that integrates theoretical content with the previous academic and professional background of graduate students, promoting a collective and reflective construction of knowledge.

Activities will include dialogic lectures preceded by the prior reading of key texts by the students, followed by group discussions guided by the instructor. Critical analyses of scientific articles and book chapters will be encouraged, with syntheses conducted by the professor to reinforce key concepts and deepen understanding.

At the end of the semester, graduate students will present thematic seminars based on the activities developed throughout the course.

Forms of evaluation

Evaluation will be based on theoretical examinations and seminars. The final grade will strictly follow the system established in the Regulations of the Graduate Program in Soil Science of the Federal University of Santa Maria.

Program: Title and Breakdown of the units

Unit 1

Introduction to Soil–Plant–Microorganism Interactions

- 1.1 - Fundamental concepts and ecological/agronomic importance
- 1.2 - Compartments: rhizosphere, endosphere, rhizoplane, and phylloplane

Unit 2

Root Biology and Architecture

- 2.1 - Morphology, development, and plasticity
- 2.2 - Root exudates and their effects on microbiota

Unit 3

Molecular Signaling in Plant–Microorganism Interactions

- 3.1 - Chemical communication and perception
- 3.2 - Nodulation, mycorrhization, and microbial recruitment



Ministério da Educação
Universidade Federal de Santa Maria
Centro de Ciências Rurais
Programa de Pós-Graduação em Ciência do Solo

Unit 4

Symbiotic, Associative, and Saprophytic Soil Microbiota

- 4.1 - Diversity and function
- 4.2 - Factors influencing microbial community structure

Unit 5

Effect of the Rhizosphere on Plant–Microorganism Interactions

- 5.1 - Symbiotic and non-symbiotic relationships mediated by the rhizosphere
- 5.2 - Edaphic factors and management practices that modulate rhizosphere interactions

Unit 6

Mycorrhizal Fungi and Their Multifunctionality

- 6.1 - Role in nutrient uptake, organic matter formation, and soil quality
- 6.2 - Analysis of integrated practices aimed at reducing phosphorus fertilization and the use of arbuscular mycorrhizal fungi in agricultural and degraded areas

Unit 7

Biological Nitrogen Fixation

- 7.1 - Contribution to plant growth and nitrogen cycling
- 7.2 - Analysis of integrated practices aimed at reducing nitrogen fertilization and the use of nitrogen-fixing bacteria in agricultural and degraded areas

Unit 8

Other Beneficial Microorganisms

- 8.1 - Phosphorus and potassium solubilizers
- 8.2 - Plant growth-promoting bacteria

Unit 9

Impacts of Agricultural Management on Soil–Plant–Microorganism Interactions

- 9.1 - Tillage systems, crop rotation, and input use
- 9.2 - Regenerative agriculture and sustainable practices

Recommended References

BEDINI, S., AVIO, L., ARGESE, E., GIOVANNETTI, M. Effects of long-term land use on arbuscular mycorrhizal fungi and glomalin-related soil protein. *Agriculture, Ecosystems and Environment* 120:463-466, 2007.

BUCHANAN, B.B.; GRUISSEM, W.; JONES, R.L. *Biochemistry and molecular biology of plants*. 2nd Edition. Oxford: John Wiley & Son, LTD. 2015. 1264p.

MOREIRA, F.M.S.; SIQUEIRA, J.O. *Microbiologia e bioquímica do solo*. 2. ed. atual. e ampl. Lavras: Editora UFLA, 2006. 729p.

NAUTIYAL, C.S.; DION, P. (eds.) *Molecular mechanisms of plant microbe coexistence*. Berlin Heidelberg: Springer-Verlag. 2008. 483p.

SYLVIA, D.M, FUHRMANN J.J., HARTEL, P., ZUBERER, D.A. 2004. *Principles and applications of Soil Microbiology*. 2nd ed. Prentice Hall, New Jersey. 672p.

VARMA, A.; ABBOTT, L.; WERNER, D.; HAMPP, R. (eds.) *Plant surface microbiology*. Berlin Heidelberg: Springer-Verlag. 2008. 628p.

MADSEN, E.L. *Environmental Microbiology from genomes to biogeochemistry*. Blackwell Publishing, 2008. 490.



Ministério da Educação
Universidade Federal de Santa Maria
Centro de Ciências Rurais
Programa de Pós-Graduação em Ciência do Solo

BERTRAND, J.C., CAUMETTE, P.L., MATHERON, R., NORMAND, P., NGANDO, T.S. Environmental Microbiology: Fundamentals and Applications. Microbial Ecology. Springer Dordrecht Heidelberg New York London, 2011.