

Ministry of Education
Federal University of Santa Maria
Rural Science Center
Graduate Program in Soil Science

Course: Soil Fertility and Plant Nutrition

Identification

Code: SOL 850

Credits: 5 (3 hours theory - 2 hours practice)

Level: Master and doctorate

Professor: Gustavo Brunetto

System: Annual (I semester)

Discipline objectives

The course aims to enable the student to relate soil use and management aspects that affect nutrient availability and understand the uptake mechanisms and role of nutrients in plant metabolism. It aims to help students understand the principles, perform the necessary procedures, and interpret the results obtained by methods of assessing nutrient availability in the soil and nutritional status of plants while aiming to build and maintain soil fertility, which consider the viability and its relationship to the quality of the environment.

Syllabus

The soil as an open, reactive, and biodynamic system; nutrient uptake and assimilation by plants; techniques for assessing nutrient availability as tools for building and maintaining soil fertility.

Methodology and/or teaching instruments

Lectures and laboratory procedures, individual thematic seminars, group work, overhead projector, slide projector, and blackboard.

Forms of evaluation

Written tests, seminars, class participation, essays on specific topics, and reports on practical classes.

Program: Title and Breakdown of Units

Unit 1

Plant nutrients

- 1.1 - Background and classification of nutrients
- 1.2 - General functions and essentiality criteria for nutrients
- 1.3 - Introduction to soil fertility: concepts of soil fertility and productivity
- 1.4 - Biodynamic aspects of nutrient availability
- 1.5 - Soil as a supplier of nutrients: quantity, intensity and capacity factors, buffering power, and endogenous and exogenous factors

Unit 2

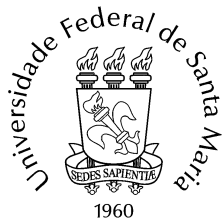
Nutrient uptake and assimilation

- 2.1 - Plant root system and nutrient uptake
- 2.2 - Mechanisms of nutrient uptake: uptake by roots and leaves
- 2.3 - Kinetic and morphological parameters: estimations and applications

Unit 3

Acidity and liming

- 3.1 - Nutritional problems in acid soils
- 3.2 - Origin and factors of soil acidity



Ministry of Education
Federal University of Santa Maria
Rural Science Center
Graduate Program in Soil Science

- 3.3 - Role of aluminum in plant nutrition and soil fertility
- 3.4 - Role of organic matter in the phytotoxicity of aluminum
- 3.5 - Methods for determining soil acidity and lime requirements
- 3.6 - Soil acidity correction: neutralization reaction, use, and quality of lime materials
- 3.7 - Liming effects on soil chemical, biological, and physical properties
- 3.8 - Liming in no-till land-use systems

Unit 4

Nitrogen

- 4.1 - Nitrogen as an abiotic factor in agroecosystems
- 4.2 - Nitrogen acquisition and assimilation by higher plants
- 4.3 - Forms of soil preparation and use of cover crops and organic residues and their relationship with nitrogen accumulation and bioavailability
- 4.4 - Biological and industrial fixation
- 4.5 - Mineral and organic nitrogen fertilizers and their use. Uses of urea and organic compounds of animal origin
- 4.6 - Nitrogen losses to the environment, pollutant potential, and forms of control

Unit 5

Phosphorus

- 5.1 - Phosphorus as an abiotic component in agroecosystems
- 5.2 - Forms of phosphorus in the soil and physiological functions in the plant
- 5.3 - Factors that affect the bioavailability of phosphorus in soil
- 5.4 - Methods for analyzing bioavailable phosphorus: principles, laboratory procedures, and interpretation of results
- 5.5 - Phosphorus as a factor of pollution and imbalance in natural systems
- 5.6 - Efficient use of fertilizers

Unit 6

Potassium

- 6.1 - Functions of potassium in plants and forms of occurrence in the soil
- 6.2 - Factors that affect the balance and capacity of the soil to supply potassium
- 6.3 - Interaction of potassium with other nutrients
- 6.4 - Bioavailability assessment methods: principles, procedures, and interpretation of results
- 6.5 - Potassium losses to the environment
- 6.6 - Potassium fertilizers and their use

Unit 7

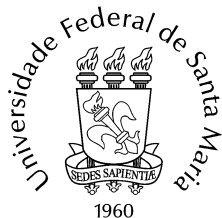
Secondary nutrients and micronutrients

- 7.1 - Absorption, transport, and redistribution and physiological role of calcium, magnesium, and sulfur
- 7.2 - Evaluation of the availability and input sources of secondary macronutrients
- 7.3 - Role in the plant and evaluation of micronutrient bioavailability
- 7.4 - Micronutrients as contaminating and unbalancing factors in natural systems
- 7.5 - Mineral inputs as sources of heavy metal contaminants

Unit 8

Organic fertilization

- 8.1 - Ground cover and animal manure: characteristics and agronomic use
- 8.2 - Nutrient biocycling
- 8.3 - Green fertilization and essential nutrient stock
- 8.4 - Environmental problems associated with the use of organic fertilizer



Ministry of Education
Federal University of Santa Maria
Rural Science Center
Graduate Program in Soil Science

Unit 9

Efficient use of fertilizers and other inputs

- 9.1 - Soil management and nutrient availability: forms of addition and residual effects
- 9.2 - Gypsum: reaction in the soil and agricultural use
- 9.3 - Eutrophication of aquatic systems and soil by the use of mineral and organic inputs

Unit 10

Fertility diagnosis and liming and fertilizer recommendation systems

- 10.1 - Soil sampling and implications for fertility evaluation
- 10.2 - Soil analysis calibration procedures
- 10.3 - Experimental techniques and interpretation of results
- 10.4 - Fertilization philosophies
- 10.5 - Fertilization tables: principles, construction, and use

Recommended literature

BARBER, S.A. **Soil nutrient bioavailability**. New York: J. Wiley & Sons, 1984. 398p.

BOLT, G.H.; BOODT, M.F.De; HAYES, M.H.B. et al. **Interactions at the Soil Colloid – Soil Solution Interface**. Dordrecht: Kluwer Academic Publishers, 1991. 602p.

BORKERT, C.M. & LANTMANN A.F. Edit. **Enxofre e micronutrientes na agricultura brasileira**. Londrina, EMBRAPA/CIAPAR/SBCS, 1988. 317p.

BULL, L.T., ROSOLEM, C.A. **Interpretação de análise química de solo e planta para fins de adubação**. Botucatu: FEPAF, 1989. 360p.

CQFS-RS/SC (Comissão de Química e Fertilidade do Solo - RS/SC). **Manual de Adubação para os Estados do Rio Grande do Sul e de Santa Catarina**. Sociedade Brasileira de Ciência do Solo. 2016. 180p.

DONAGEMA, G.K. **Manual de métodos de análise de solo**. 2.ed. Rio de Janeiro: EMBRAPA SOLOS, 2011. 230p.

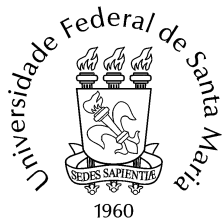
FERNANDES, M.S. ed. **Nutrição mineral de plantas**. 2. ed. SBCS. 2018. 670p.

FERREIRA, M.E., CRUZ, M.C.P. da. **Micronutrientes na agricultura**. Piracicaba: POTAFOS, 1991. 734p.

FRIES, M.R.; DALMOLIN, R.S.D. **Atualização em recomendação de adubação e calagem: ênfase em plantio direto**. Santa Maria: UFSM/Departamento de Solos, 1997. 131p.

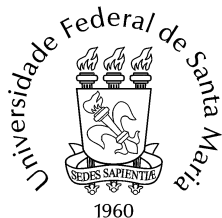
KAMINSKI, J.; VOLKWEISS, S. J.; BECKER, F.C. **Anais do II Seminário sobre corretivos da acidez do solo**. Santa Maria: UFSM/Departamento de Solos, 1989. 224p.

KAMINSKI, J. **Uso de corretivos da acidez do solo no plantio direto**. Pelotas, SBCS/Núcleo Regional Sul. 2000. 123 p. (Boletim Técnico, 4)



Ministry of Education
Federal University of Santa Maria
Rural Science Center
Graduate Program in Soil Science

- MARCHNER, P. **Mineral nutrition of higher plants**. London: Academic Press, 2012. 889p.
- MATTOS et al. Ed. Calagem e adubação de pastagens. In: **Simpósio sobre calagem e adubação de pastagens**. Nova Odessa, SP. Potafos, Piracicaba, 1986. 476p.
- MENGEL, K., KIRKBY, E.A. **Principles of plant nutrition**. Bern.:International Potash Institute, 1987. 687p.
- MONIZ, A.C.; FURLANI, A.M.'C.; SCHAFFERT, R.E. et al. **Plant-soil interactions at low pH: Sustainable agriculture and forestry production**. Campinas:SBCS, 1997. 314p.
- NOVAIS, R.F. & SMYTH, T.J. **Fósforo em solo e planta em condições tropicais**. Viçosa: UFV-DPS, 1999. 399p.
- NOVAIS, R.F.; ALVAREZ V., V.H.; BARROS, N.F., FONTES, R.L.F., CANTARUTTI, R.B.; NEVES, J.C.L.ed. **Fertilidade do solo**. SBCS. 2007. 1017p.
- OLIVEIRA, A.J.; LOURENÇO, S.; GOEDERT, W.J. **Adubação fosfatada no Brasil**. Brasília:EMBRAPA, 1982. 326p.
- RAIJ, B.VAN; QUAGGIO, J. A.; CANTARELLA H. et al. **Análise química do solo para fins de fertilidade**. Campinas:Fundação Cargill, 1987. 170p.
- RHEINHEIMER, D.S. et al. **Acidez do solo e consumo potencial de calcário no Estado do Rio Grande do Sul**. UFSM/DS, 2000. 32p. (Boletim Técnico, 1).
- RHEINHEIMER, D.S. et al. **Situação da fertilidade dos solos no Estado do Rio Grande do Sul**. UFSM/DS, 2001. 42p. (Boletim Técnico, 2).
- SANTOS, G.A.; SILVA, L.S.; CANELLAS, L.P.; CAMARG, F.A.O. Coord. **Fundamentos de Matéria Orgânica do Solo**. 2ed. Porto Alegre, Genesis, 2008, 836p.
- SIQUEIRA, et al. **Inter-relação fertilidade, biologia do solo e nutrição de plantas**. SBCS. UFL/Departamento de Solos, Lavras, MG. 1999. 818p.
- SPARKS, D.L., SUAREZ, D.L. **Rates of soil chemical processes**. Madison:SSSA, 1991. 302p.
- SPARKS, D.L. **The chemistry of soils**. New York. Oxford University Press, 1989. 277p.
- SPOSITO, G. **The surface chemistry of soils**. New York:Oxford Univ. Press, 1989. 277p.
- STEVENSON, F.J. **Nitrogen in agricultural soils**. Madison:ASA, 1982. 940p.
- SUMNER, M. E. Ed. **Handbook of Soil Science**. London, CRCPress, 1999. Vol.1 e 2. 2116p.
- TEDESCO, M. J.; GIANELLO, C.; BISSANI, C. et al. **Análise de solo, planta e outros materiais**. 2.ed. Porto Alegre:UFRGS/DS. 1995. 443p. Boletim Técnico, 5.



Ministry of Education
Federal University of Santa Maria
Rural Science Center
Graduate Program in Soil Science

TISDALE, S. L., NELSON, W. L.; BEATON, J.D. **Soil fertility and fertilizers**. Toronto: The Macmillan Company, 1984. 754p.

TÓPICOS EM CIÊNCIA DO SOLO. SBSCS. volume I. (2000), volume II (2002), volume III (2003), volume IV (2005), volume V (2007), volume VI (2009).

YAMADA, T.; ROBERTS, T.L., ed. **Potássio na agricultura brasileira**. Piracicaba, POTAFOS. 2005. 841p.

YAMADA, T.; ABDALLA, S.R.S., ed. **Fósforo na agricultura brasileira**. Piracicaba, POTAFOS. 2004. 726p.

YAMADA, T.; ABDALLA, S.R.S.; VITTI, G.C. ed. **Nitrogênio e enxofre na agricultura brasileira**. Piracicaba, IPNI. 2007. 722p.

WIETHÖLTER, S. **Calagem no Brasil**. Passo Fundo, Embrapa/Trigo, 2000. 104p. (Documentos, 22)

Suggested journals for consultation

Agriculture, Ecosystems & Environment

Annual Review of Plant Biology

Annual Review Plant Physiology

Geoderma

Nutrient Cycling Agroecosystems

Pesquisa Agropecuária Brasileira

Plant and Soil

Plant Physiology

Plant Physiology and Biochemistry

Revista Brasileira de Ciência do Solo

Science of the Total Environment

Soil & Tillage Research

Soil Science

Soil Science & Plant Nutrition

Soil Science Society of America Journal