COURSE OUTLINE BRIEFS

DEPARTMENT OF SOIL & ENVIRONMENTAL SCIENCES

SARGODHA UNIVERSITY
Pathway to Progress

FACULTY OF AGRICULTURE

OVERVIEW

Food production is a function of crop yield and soil is the only natural resource on which the food production depends. Hence, soils are crucial to life on earth. Soil is one of our most important and basic natural resource essential for crop production. Soils are integral components of entire agro ecosystems. Soil is a complex and variable medium and its study and management is not simple. Consequently, discipline of Soil Science is very comprehensive.

To make things understandable and manageable, Soil Science is divided into number of branches including Genesis, Taxonomy, Classification, Survey and Mapping, Physics, Chemistry, Mineralogy, Biology, Fertility, Salinity, Erosion and Conservation.

The Department of Soil and Environmental Sciences has an infrastructure, which is at par with the international standards. The research laboratories of the Department are well-equipped with good facilities. It has its own Soil Analysis Laboratory which provides high quality analysis of soiland water for farmers, and researchers. The institute is actively engaged in research on different aspects of Soil Microbiology and Biochemistry, Soil Physics and Environmental Sciences, Soil Fertility and Plant Nutrition, Soil and Water Chemistry, Environmental Pollution and Saline Agriculture.Advisory services to farmers are also rendered upon request.

The Department offers BSc(Hons.), MSc (Hons) and PhD programs. It has well qualified and dedicated faculty. Most of them are PhDs having experience of working in foreign countries. The dedications of the faculty members have also been recognized by various national and international organizations.

Academic Programs Offered

1. B.Sc. (Hons.) Agriculture (Soil Science)
2. M.Sc. (Hons.) Soil Science
3. PhD Soil Science

B.Sc. (Hons.) Agriculture

Eligibility: At least 45% marks in intermediate or equivalent.
Duration: 04 Year Program (08 Semesters)
Degree Requirements: 136 Credit Hours

Semester-I

Course Code	Course Title	Credit Hours
SAES-5801	Introduction to Soil Science-I	3(2+1)
AGRO-5901	Basic Agriculture	3(2+1)
ZOOL-6141/ MATH-5128	Introduction to Biology-I (for Pre-Engineering students)/ Mathematics (for Pre-Medical students)	3(3+0)/ 3(3+0)
URCI-5109	Introduction to Information & Communication Technologies	3(2+1)
URCE-5102	English-II (Language Comprehension & Presentation Skills)	3(3+0)
URCI-5105/ ISLS-5108	Islamic Studies/ Ethics (for Foreigner or Non-Muslims)	2(2+0)/

Semester-II

AGRO-5902	General Crop Production	3(2+1)
SAES-5802	Introduction to Soil Science-II	3(2+1)
FWRW-5701	Introduction to Forest and Watershed Management	3(2+1)
AEXT-5401	Introduction to Agricultural Extension and Rural Development	3(3+0)
URCE-5103	English-III (Academic Writing)	3(3+0)
URCP-5106	Pakistan Studies	2(2+0)

Semester-III

PLBG-5201	Introductory Genetics	3(2+1)
ENTO-5101	Introductory Entomology	3(2+1)
PLPT-5301	Introduction to Plant Pathogens	3(2+1)
HORT-5601	Introductory Horticulture	3(2+1)
FWRW-5702	Introduction to Rangelands and Wildlife Management	3(2+1)
AGEC-5501	Introduction to Agricultural Economics	3(3+0)
URCC-5110	Citizenship Education and Community Engagement	3(3+0)

Semester-IV

PLBG-5202	Introductory Plant Breeding	3(2+1)

ENTO-5102	Applied Entomology	3(2+1)
PLPT-5302	Introductory Plant Pathology	3(2+1)
HORT-5602	Horticultural Crop Production	3(2+1)
FSAT-5101	Introduction to Food Science and Technology	3(2+1)
STAT-5126	Statistics for Agricultural Sciences	3(3+0)

Semester-V

AEXT-6408	Communication Skills in Agricultural Extension	3(2+1)
SAES-6803	Physical Properties of Soil	3(2+1)
SAES-6804	Chemical Properties of Soil	3(2+1)
SAES-6805	Instrumentation and Laboratory Techniques	3(1+2)
SAES-6806	Soil Genesis and Morphology	3(2+1)
SAES-6807	Plant Growth under Stress Environment	2(2+0)

Semester-VI

SAES-6808	Soil Fertility Evaluation	2(2+0)
SAES-6809	Salt-Affected Soils and Water Quality	3(2+1)
SAES-6810	Soil Fertility and Fertilizer Use	3(2+1)
SAES-6811	Soil Survey and Land Evaluation	3(2+1)
SAES-6812	Soil and Water Conservation	3(3+0)
SAES-6813	Nutrient Management in Degraded Soils	3(3+0)

Semester-VII

SAES-6814	Carbon Sequestration in Soil	2(2+0)
SAES-6815	Soil Microbiology	3(2+1)
SAES-6816	Environmental Pollution and Management	3(3+0)
SAES-6817	Research Project and Scientific Writing	3(2+1)
SAES-6818	Trace Elements in Agriculture	3(2+1)
SAES-6819	Saline Agriculture	2(2+0)

Semester-VIII

AGEC-6523	Agribusiness, Marketing and Trade	3(3+0)
SAES-6820	Soil - Water - Plant Relationship	3(3+0)
SAES-6821	Land Degradation and Management	3(3+0)
SAES-6822	Municipal and Agro Waste Management	3(3+0)
SAES-6823	Research Project / Internship	4(0+4)

M.Sc. (Hons.) Soil Science

Eligibility: BSc (Hons) / BSc 4 Years or equivalent (16 Years of Education) in the relevant field with minimum CGPA 2.50/4.00 + Departmental Test
Duration: 2 Years
Semesters: 4
Degree Requirements: Minimum 30 Credit Hours (24 credit hours course work + 6 credit hours thesis and research)

Course Code	Title of the Course	Credit Hours
SAES-7101	Principles and Uses of Laboratory Equipment	3(0+3)
SAES-7102	Soil Chemistry	3(2+1)
SAES-7103	Soil Fertility and Plant Nutrition	3(2+1)
SAES-7104	Soil Microbiology and Biochemistry	3(2+1)
SAES-7105	Soil Classification	3(2+1)
SAES-7106	Salt-Affected and Waterlogged Soils	3(3+0)
SAES-7107	Soil Physics	3(2+1)
SAES-7108	Soil Mineralogy	3(3+0)
SAES-7109	Special Problem	1(1+0)
SAES-7110	Seminar	1(1+0)
SAES-7111	Soil - Plant Relationship	3(3+0)
SAES-7112	Principles and Applications of Bioremediation	3(3+0)
SAES-7113	Soil Ecology	3(3+0)
STAT-7151	Statistical Methods for Agricultural Research-I	3(3+0)

PhD Soil Science

Eligibility: MSc (Hons) Soil Science or equivalent with minimum CGPA 3.00/4.00 + Departmental Test
Duration: Minimum 03 Years
Semesters: 06
Degree Requirements: Minimum 18 credit hours course work, comprehensive exam, thesis and research

Course Code	Title of the Course	Credit Hours
SAES-8101	Advanced Soil Chemistry	3(3+0)
SAES-8102	Advanced Soil Fertility	3(3+0)
SAES-8103	Advanced Soil Microbiology	3(3+0)
SAES-8104	Advanced Soil Physics	3(3+0)
SAES-8105	Advanced Research Methods and Technical Writing	3(3+0)
SAES-8106	Advanced Techniques in Bioremediation	3(3+0)
SAES-8107	Integrated Nutrient Management	3(3+0)
SAES-8108	Organic Agriculture	3(2+1)
SAES-8109	Special Problem	1(1+0)
SAES-8110	Seminar	1(1+0)
SAES-8111	Soil Quality and Management	3(3+0)
SAES-8112	Nutrient Acquisition and Transport	3(3+0)
SAES-8113	Biochar: Concept and Application	3(3+0)
SAES-8114	Waste water impact on soil Health	3(2+1)
STAT-8131	Statistical Methods for Agricultural Research-II	3(3+0)

BSc
(Hons)
AGRICULTURE
SOIL SCIENCES

SAES-5801 Introduction to Soil Science-I 3(2+1)

This is an introductory course designed to introduce the concept and significance of soil science for agriculture students at the undergraduate level. It provides information to the students about soil science and its branches as well as their environmental significance. This course also delivers knowledge to the students about the weathering of rocks and minerals as well as their classification. This course gives information to the students about the physical properties of soil and their significance in agriculture. This subject also improves the awareness of the students about the impact of agricultural and industrial wastes on our environment. In addition, this course also improves the skills of the students on how to collect soil and water samples for Physico-chemical analysis. Laboratory exercise will be designed to develop student competency for analysis of irrigation water and soil samples. Ability to highlight and support the importance of both water and soil quality analysis for judicious use of resources.

Contents

1. Introduction to Soil and environment: definition of earth, geology and soil science
2. Disciplines of soil science; lithosphere, hydrosphere and biosphere
3. Soil forming rocks and minerals: types and their formation.
4. Weathering of rocks and minerals: definition. Agents and classification
5. Parent materials: definition and types, Soil formation: definitions, processes and factors
6. Soil profile: definition and description, Physical properties of soil and their significance
7. Introduction to soil classification and land use capability classes
8. Soil, water and air pollution: sources and types

Practical

1. Methods of soil sampling and handling
2. Preparation of saturated soil paste
3. Determination of soil water contents
4. Analysis of irrigation water, report writing and interpretation.
5. Textural analysis of soil

Recommended Texts

1. Bashir, E. & R. Bantel. (2001). *Soil science*. Islamabad: National Book Foundation.
2. Brady, N.C. & R.R. Weil. (2007). *The nature and properties of soils* (14th ed.). Upper Saddle River, NJ: Pearson Education.

Suggested Readings

1. Brady, N.C. & R.R. Weil. (2009). *Elements of the nature and properties of soils* (3rd Ed.). Upper Saddle River, NJ: Pearson Education.
2. Hillel, D. (2008). *Soil in the environment:* , Burlington, MA: Crucible of Terrestrial Life. Elsevier Inc.
3. Das, D.K. (2011). *Introductory soil science* (3rd ed.). New Delhi: Kalyani Publ.

AGRO-5901 Basic Agriculture 3(2+1)

The main aim of this course is to provide the basic knowledge and background of Pakistan's Agriculture. Basic Agriculture is a graduate-level course which gives the students a basic knowledge of agriculture/ It will enable the students to understand the basic terminologies of agriculture, its different branches, allied disciplines, salient features of Pakistan's agriculture including climate, land resources etc. as well as the problems of Pakistan agriculture. There will be a detailed discussion about the various agro-ecological zones of Pakistan. Basic knowledge about agricultural inputs such as seed, fertilizer, irrigation etc. will be communicated. Crop growth-related problems like weeds, insect pests will be elaborated. The students will be able to understand the conventional and international system of land measurement. The knowledge of post-harvest technology is also shared with the students.

Contents

1. Agriculture, history, importance, branches and allied sciences.
2. Salient features of Pakistan's agriculture, Climate, land and water resources.
3. Agro ecological zones of Pakistan. Farming systems.
4. Tillage: objectives and types. Seed: types and quality.
5. Crop nutrients, manures and fertilizers, sources and methods of application.
6. Irrigation: systems, types and management. Crop protection measures.
7. Crop rotation. Harvesting, processing, storage and marketing of farm produce.
8. Agro-based industries, Environmental pollution and health hazards.

Practical

1. Land measuring units, Demonstration of hand tools and tillage implements.
2. Identification of meteorological instruments, Identification of crop plants, weeds and seeds.
3. Identification of organic and inorganic fertilizers.
4. Calculation of nutrient-cum-fertilizer unit value.
5. Demonstration of various irrigation methods, Field visits.

Recommended Texts

1. Bashir, E. and Bantel, R.. (2001). *Soil science,* Islamabad: National Book Foundation.
2. Brady, N.C. and Weil, R.R. (2013). *Elements of the nature and properties of soils. (3rd ed.).* Upper Saddle River, NJ: Pearson Education.

Suggested Readings

1. Hillel, D. (2008). *Soil in the environment: crucible of terrestrial life.* Burlington, MA: USA, Elsevier Inc.
2. Singer, M. J. and Munns, D. N. (2002). *Soils- An introduction. (5th ed.).* Upper Saddle River, NJ: Prentice-Hall, Inc.
3. Das, D.K. (2011). *Introductory soil science. (3rd ed.).* New Delhi: Kalyani Publication.

ZOOL-6141 Introduction to Biology-I 3(3+0)

This subject aims to yield students with a sense of practical relevance of biology to everyday life. This will make students comprehend life by understanding some of the molecular processes that occur in and around cells, to make students cognizant of biologic phenomenon (nature, body, etc.) on an evolutionary, ecological, behavioral, physiologic, tissue, cellular, and molecular level. In this subject, students will examine how life is organized into hierarchical levels; how living organisms use and produce energy; how life grows, develops, and reproduces; how life responds to the environment to maintain internal stability; and how life evolves and adapts to the environment. Moreover, it will also enable them to investigate the biological molecules, homeostasis in vertebrates, and the influence of hormones on the coordination and control systems of the animal body. Upon completion of this subject students will be having an enhanced knowledge and appreciation of the basics of growth and development plans of animals and can develop cogent and critical arguments based on the course material.

Contents

1. Introduction: Nature and scope of biology, Branches of biology
2. Relationship between biology and psychology
3. Biological molecules: Carbohydrates, Proteins, Fats, Nucleic acids, Water
4. The cell: Structure and function of cell, Cell organelles, Different types of cells
5. Homeostasis: Osmoregulation, Structure and functions of Nephron, Thermoregulation
6. Coordination and control: Structure and physiology of Neuron
7. Introduction to central and peripheral nervous system, Hormones
8. Basics of growth and development: Embryonic and post embryonic development

Recommended Texts

1. Michael, J. and Lenardo. (2013). *Immune homeoststis: methods and protocol*. London: Humana press.
2. Campbell, M. and Christopher J. P. (2016). *Organismal homeostatis*. NYC: Momentum press.

Suggested Readings

1. Lisa A. U., Michael L. C., Steven A. W., Peter V. M., Jane B. R. and Neil A. C. (2016). Campbell *biology*. London: Pearson
2. Cambell, N. A. Mitchell, l. G. and Reece, J. B. (2009). *Biology: concepts and connections.* San Francisco: Addison Wesley, Longman
3. Anna A. S., Richard B. P. (2019). An introduction to conservation biology. Sinauer Associates is an imprint of Oxford University Press

MATH-5128 **Mathematics** **3(3+0)**

To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines. Mathematics, as a study of patterns, both practical and abstract, involves analytical thought, logical reasoning, problem-solving skills, and precise communication. Because of its power and versatility, mathematics has often been called the "Queen of the Sciences." There is no field of scientific inquiry that does not express itself through the language of mathematics. An undergraduate degree in mathematics provides an excellent foundation for students who are interested in pursuing an advanced degree in mathematics or in a related specialized profession. Mathematics can also provide an excellent foundation for students considering professional degrees in such allied fields such as Law, Business Administration, or Medicine. The kinds of analytical and logical thinking skills that one develops while studying mathematics are precisely the skills that recruiters look for in potential employees. Jobs involving significant mathematical background also consistently rank near the top of the list in annual career surveys.

Contents

1. Real Numbers
2. Relations and Functions
3. Inequalities
4. Quadratic Functions and Complex Numbers
5. Linear Equations and Quadratic Equations: Formation of Linear equation
6. Solving Linear equation involving one variable
7. Solution of Quadratic equation by factorization method
8. Solution of quadratic equation by square completion methods
9. Solution of quadratic equation by quadratic formula
10. Application of quadratic equation
11. Sequence and Series, Types of Sequences; A. P, A. M., G. P., H. P
12. Trigonometric Functions, Trigonometric Applications
13. Graph of Functions and Modelling, Limits and Continuity
14. Derivatives, Integration, Probability and Binomial Theorem.

Recommended Texts

1. Gantert, A. X. (2009). *Algebra 2 and trigonometry*. New York: AMCOS School Publication INC.
2. Kaufmann, J. E. (1994). *College algebra and trigonometry* (3th ed.). Boston: PWS-Kent Pub. Co.

Suggested Readings

1. Swokowski, E. W. (1993). *Fundamentals of algebra and trigonometry* (8th ed.). Boston: PWS-Kent Pub. Co.
2. Nauman, K. (2019). Basic mathematics-I: algebra and trigonometry (2nd ed.). Lahore: Al-Hassan Pub.
3. Anton, H. (1999). *Calculus: a new horizon* (6th ed.). New York: John Wiley. Stewart, J. (2012). *Calculus* (7th ed.). Belmont: Brooks/Cole

URCI-5109 Introduction to Information & Communication Technologies 3(2+1)

The course introduces students to information and communication technologies and their current applications in their respective areas. Objectives include a basic understanding of computer software, hardware, and associated technologies. They can make use of technology to get maximum benefits related to their study domain. Students can learn how the Information and Communications systems can improve their workability and productivity. How Internet technologies, E-Commerce applications and Mobile Computing can influence the businesses and workplace. At the end of the semester, students will get a basic understanding of Computer Systems, Storage Devices, Operating systems, E-commerce, Data Networks, Databases, and associated technologies. They will also learn Microsoft Office tools that include Word, PowerPoint, Excel. They will also learn Open office being used on other operating systems and platforms. Specific software's related to specialization areas are also part of course. The course will also cover Computer Ethics and related Social media norms and cyber laws.

Contents

1. Introduction, Overview and its types.
2. Hardware: Computer Systems & Components, Storage Devices and Cloud Computing.
3. Software: Operating Systems, Programming and Application Software,
4. Introduction to Programming Language
5. Databases and Information Systems Networks
6. The Hierarchy of Data and Maintaining Data,
7. File Processing Versus Database Management Systems
8. Data Communication and Networks.
9. Physical Transmission Media & Wireless Transmission Media
10. Applications of smart phone and usage
11. The Internet, Browsers and Search Engines.
12. Websites Concepts, Mobile Computing and their applications.
13. Collaborative Computing and Social Networking
14. E-Commerce & Applications, IT Security and other issues
15. Cyber Laws and Ethics of using Social media
16. Use of Microsoft Office tools (Word, Power Point, Excel)
17. Mobile apps or other similar tools depending on the operating system.
18. Other IT tools/software specific to field of study of the students if any

Recommended Texts

1. Vermaat, M. E. (2018). *Discovering computers: digital technology, data and devices.* Boston: Course Technology Press.

Suggested Readings

1. Timothy J. O'Leary & Linda I. (2017). *Computing essentials*, (26th ed.). San Francisco: McGraw Hill Higher Education.
2. Schneider, G. M., & Gersting, J. (2018). *Invitation to computer science*. Boston: Cengage Learning.

URCE-5102 Language Comprehension & Presentation Skills 3(3+0)

The course aims at developing linguistic competence by focusing on basic language skills in integration to make the use of language in context. It also aims at developing students' skills in reading and reading comprehension of written texts in various contexts. The course also assists in developing students' vocabulary building skills as well as their critical thinking skills. The contents of the course are designed based on these language skills: listening skills, pronunciation skills, comprehension skills and presentation skills. The course provides practice in accurate pronunciation, stress and intonation patterns and critical listening skills for different contexts. The students require a grasp of the English language to comprehend texts as an organic whole, to interact with reasonable ease in structured situations, and to comprehend and construct academic discourse. The course objectives are to enhance students' language skill management capacity, to comprehend text(s) in context, to respond to language in context, and to write a structured response(s).

Contents

1. Listening skills
2. Listening to isolated sentences and speech extracts
3. Managing listening and overcoming barriers to listening
4. Expressing opinions (debating current events) and oral synthesis of thoughts and ideas
5. Pronunciation skills
6. Recognizing phonemes, phonemic symbols and syllables, pronouncing words correctly
7. Understanding and practicing stress patterns and intonation patterns in simple sentences
8. Comprehension skills
9. Reading strategies, summarizing, sequencing, inferencing, comparing and contrasting
10. Drawing conclusions, self-questioning, problem-solving, relating background knowledge
11. Distinguishing between fact and opinion, finding the main idea, and supporting details
12. Text organizational patterns, investigating implied ideas, purpose and tone of the text
13. Critical reading, SQ3R method
14. Presentation skills, features of good presentations, different types of presentations
15. Different patterns of introducing a presentation, organizing arguments in a presentation
16. Tactics of maintaining interest of the audience, dealing with the questions of audience
17. Concluding a presentation, giving suggestions and recommendations

Recommended Texts

1. Mikulecky, B. S., & Jeffries, L. (2007). *Advanced reading power: extensive reading, vocabulary building, comprehension skills, reading faster*. New York: Pearson.
2. Helgesen, M., & Brown, S. (2004). *Active listening: building skills for understanding.* Cambridge: Cambridge University Press.

Suggested Readings

1. Roach, C. A., & Wyatt, N. (1988). *Successful listening*. New York: Harper & Row.
2. Horowitz, R., & Samuels, S. J. (1987). *Comprehending oral and written language*. San Diego: Academic Press.

URCI-5105 **Islamic Studies** **2(2+0)**

Islamic Studies engages in the study of Islam as a textual tradition inscribed in the fundamental sources of Islam; Qur'an and Hadith, history and particular cultural contexts. The area seeks to provide an introduction to and a specialization in Islam through a large variety of expressions (literary, poetic, social, and political) and a variety of methods (literary criticism, hermeneutics, history, sociology, and anthropology). It offers opportunities to get fully introductory foundational bases of Islam in fields that include Qur'anic studies, Hadith and Seerah of Prophet Muhammad (PBUH), Islamic philosophy, and Islamic law, culture and theology through the textual study of Qur'an and Sunnah. Islamic Studies is the academic study of Islam and Islamic culture. It majorly comprises of the importance of life and that after death. It is one of the best systems of education, which makes an ethical groomed person with the qualities which he/she should have as a human being. The basic sources of the Islamic Studies are the Holy Qur'an and Sunnah or Hadith of the Holy Prophet Muhammadﷺ. The learning of the Qur'an and Sunnah guides the Muslims to live peacefully.

Contents

1. Study of the Qur'an
2. Study of the Hadith (Introduction to Hadith literature, Selected Ahadith (Text and Translation)
3. Introduction to Qur'anic Studies
4. Basic Concepts of Qur'an
5. History of Quran
6. Basic Concepts of Hadith
7. History of Hadith
8. Kinds of Hadith
9. Uloom –ul-Hadith
10. Sunnah & Hadith
11. Seerat ul-Nabi (PBUH)
12. Pact of Madinah, Khutbah Hajjat al-Wada' and ethical teachings of Prophet (PBUH).
13. Legal Position of Sunnah
14. Islamic Culture & Civilization
15. Characteristics of Islamic Culture & Civilization
16. Historical Development of Islamic Culture & Civilization
17. Comparative Religions and Contemporary Issues
18. Impact of Islamic civilization

Recommended Texts

1. Hassan, A. (1990). *Principles of Islamic jurisprudence*. New Dehli: Adam Publishers.
2. Zia-ul-Haq, M. (2001). *Introduction to al-sharia al-Islamia*. Lahore: Aziz Publication.

Suggested Readings

1. Hameedullah, M. (1957). *Introduction to Islam*. Lahore: Sh M Ashraf Publisher.
2. Hameedullah, M. (1980). *Emergence of Islam*. New Dehli: Adam Publishers.
3. Hameedullah, M. (1942). *Muslim conduct of state.* Lahore: Sh M Ashraf Publisher.

ISLS-5108 **Ethics** **2(2+0)**

This course is an introduction to the philosophical study of morality, including the theory of right and wrong behavior, the theory of value (goodness and badness), and the theory of virtue and vice. Besides providing familiarity with the primary questions addressed within moral philosophy and the most influential answers given by well-known philosophers, this course is designed to help students develop their abilities to read, explicate, analyze, and evaluate philosophical literature, write and express themselves well about their ethical positions, and think critically and analytically about ethical issues. This course is intended for the student who has had little or no prior exposure to philosophy. It will provide a broad but reasonably detailed examination of the central issues of moral philosophy and will also consider how these can be applied to several contemporary moral problems. This course has been designed to familiarize students to learn about some of the most important theories and figures of moral philosophy in the hope that you can develop a clear understanding of the questions that recur in ethical debate.

Contents

1. Overview of Moral Philosophy
2. Theoretical ethics
3. Moral concepts and justify moral principles and theories
4. Applied ethics: an Islamic point of view
5. Metaphysics and Morality
6. Moral Objectivism and Relativism
7. Features of moral objectivism
8. Qur'an and Sunnah on Ethics
9. Individual relativism:
10. God and Morality
11. Criticism and its manners
12. Reason and Emotion
13. Principles of moral reasoning
14. Ethics in *Seerah* and *Taswwuf*
15. Gender and Morality
16. Significant Muslim masters of ethics
17. Rule-utilitarianism, Moral foundations of authorities
18. The social contract, Libertarianism, Welfare liberalism.

Recommended Texts

1. Mackenzie, John S. LL. D. Glasg. (1983). *A manual of ethics*. London: University Tutorial Press.
2. Syed Sulaiman Nadwi. (1999). *Ethics in Islam.* Karachi: Darul-Ishaat.

Suggested Reading:

1. Williams, B. (1972). *Morality: An Introduction to ethics*. Cambridge: Cambridge University Press.
2. Steven M. Cahn and Peter Markie. (2019). *History, theory, and contemporary issues*. Oxford: Oxford University Press.

AGRO-5902 General Crop Production 3(2+1)

This course is aimed at acquainting the students with the basic concepts of Agronomy and crop production. It has been designed to develop understanding among students about the production technology of major and minor field crops grown under the agro-ecological conditions of Pakistan. In addition, the commonly followed cropping systems schemes and patterns by the farmers in the country are also discussed in detail indicating the potential opportunities and issues. It also deals with the scientific management of the crop environment and pests of field crops cultivated in the country. This course contains the practical aspects of crop production such as demonstration of improved sowing methods, intercultural operations, harvesting and threshing. The student will have a comprehensive knowledge of the production of the crop from sowing to the harvesting.

Contents

1. Concept of crop production.
2. Classification of field crops.
3. Cropping scheme, cropping patterns, cropping systems, cropping intensity.
4. Production technology of major field crops: cereals (wheat, rice, maize, barley).
5. Sugar crops (sugarcane, sugar beet) and fiber crops (cotton, jute).
6. Traditional oil seed crops (rapes, mustards, peanut, linseed, sesame etc.).
7. Non-traditional oil seed crops (sunflower, soybean, safflower).
8. Grain legumes (chickpea, lentil, green gram, black gram).
9. Fodders (berseem, lucerne, oats, sorghums, millets, mott grass, cowpea).
10. Special crops (tobacco).
11. Green manure crops (Guara, Dhancha. Pigeon pea, Senji etc.).

Practical

1. Identification of crops and their seeds.
2. Demonstration of improved sowing methods of crops.
3. Delinting of cotton seed, Raising of crop nurseries and transplanting.
4. Intercultural practices, Seed Inoculation.
5. Seed treatment with fungicides, Demonstration of harvesting and threshing operations.
6. Field visits.

Recommended Texts

1. Balasubramaniyan. (2004). *Principles and practices of agronomy*, agrobios. Jodhpur, India.
2. Khalil, I.A. and Jan, A. (2002) *Cropping technology.* Islamabad: National Book Foundation.

Suggested Readings

1. Martin, J.H. Waldren, R.P. and Stamp, D.L. (2006). *Principles of field crop production*. NYC: The McMillan.
2. Nazir, M.S., Bashir, E. and Bantel, R. (1994). *Crop production.* Islamabad: National Book Foundation.

SAES-5802 Introduction to Soil Science-II 3(2+1)

This is the continuity of course taught in the first semester designed to introduce the concept and importance of soil science for agriculture students at the undergraduate level. It provides information to the students about chemistry of soils; especially soil colloids and their environmental significance. How organic matter plays a role for enhancing the availability of macro and micronutrients from the soil environment. This subject also clears the concept of students about soil pH and its significance regarding nutrients availability from soil to plant. This course also delivers knowledge to the students on how to use sagaciously essential elements for better crop growth and production. Acquisition of specific and technical understanding of the students to select best management strategies for soil reclamation and land evaluation. In addition, this introductory course also improves the skills of the students on how to calculate percent nutrients in available fertilizer and their chemical analysis about their percent grade.

Contents

1. Soil colloids and clays: description and environmental significance
2. Sources of charges on soil colloids
3. Cation and anion exchange properties of soil and their significance
4. Basic cation saturation percentage, Soil pH and its importance
5. Buffering of soil, Soil organic matter: sources, composition and significance
6. Elements essential for plant growth: macro and micro nutrients, organic and inorganic fertilizers
7. Salt-affected and waterlogged soils: types, reclamation and management
8. Soil erosion: causes and remedies: soil and water conservation
9. Environmental impact of agricultural and industrial wastes

Practical

1. Fertilizers: Identification, composition and calculation of nutrient percentage
2. Fertilizer analysis for N, P and K, Soil analysis for EC and pH
3. Determination of soil organic matter

Recommended Texts

1. Bashir & Bantel. (2001). *Soil science*. Islamabad: National Book Foundation.
2. Brady, N.C. & R.R. Weil. (2007). *The nature and properties of soils* (14th ed.). Upper Saddle River, NJ: Pearson

Suggested Readings

1. Brady, N.C. & R.R. Weil. (2009). *Elements of the nature and properties of soils* (3rd ed.). Upper Saddle River, NJ: Pearson
2. Hillel, D. (2008). *Soil in the environment: crucible of terrestrial life*. Burlington, MA: Elsevier.
3. Singer, M.J., & Munns, D.N. (2002). *Soils - An introduction*. (5th ed.). Upper Saddle River, NJ: Prentice-Hall.

FWRW-5701 Introduction to Forest and Watershed Management 3(2+1)

Forest and Watershed management must heavily emphasize the understanding of forest resources in relation to the watershed with practical knowledge of forest survey and its analysis and interpretation in a valid manner. The objectives of studying this course are to acquaint the students with basic knowledge of Forestry, develop an understanding about principles used in Watershed management, to impart knowledge about forest resources in Pakistan, and to teach skills to the students about practical Forest and Watershed management in Pakistan. Watershed management is closely related to forest management as the selection and implementation of different forestry practices play a crucial role in it. Students will learn the different biological and engineering approaches to control and regulate the water flow and to reduce the sedimentation of the streams and lakes fed by this water.

Contents

1. Introduction to Forest and watershed management.
2. Forest resources of Pakistan (description, composition, distribution and status).
3. Importance of these natural resources of Pakistan.
4. Constraints and problems in natural resource management.
5. Principles of sustainable forest management.
6. Forestry practices (Agroforestry, social forestry etc.), Principles of Watershed Management.
7. Watersheds of various streams/rivers of Pakistan, their area, distribution, land use patterns
8. Past history, climatic, physiographic, ecological and socio-economic features.
9. Hydrological cycle.
10. Management problems and potentials of various watersheds, afforestation programmes.
11. Watershed as a source of power generation and irrigation.
12. Watershed research and education.

Practical

1. Identification of important forest tree species
2. Visits to various forest types and watershed areas.
3. Watershed measurements (instruments, area, drainage, flow etc.).

Recommended Texts

1. Franzel, S.; Scherr, S.J. (2001). *Trees on the farm*. London: CAB International.
2. Quraishi, M. A. A. (1999). *Basics of forestry and allied sciences*. Lahore: A-One Publishers..

Suggested Readings

1. Sheikh, M.I. (1999). *Forests and forestry in pakistan*. Lahore: A-One Publishers.
2. Quraishi, M.A.A. (2002). *Watershed management in Pakistan*. Faislabad: University Agriculture Faislabad.
3. Quraishi, M.A.A. and Siddiqui, M.T. (2002). *Practical manual of watershed management*. Faislabad: University Agriculture Faislabad.
4. Siddiqui, M.T., R.Sands and Shah, A.H. (2009). *Glossary of forestry terms.* Faisalabad: Pulschay Publishers.

AEXT-5401 Introduction to Agricultural Extension and Rural Development 3(3+0)

The main purpose of this course is to give a brief introduction of Agricultural Extension education at the undergraduate level. The students must know the history and philosophy of agricultural education in the development of the present era agricultural system across the world. The following such as concepts of Extension education and rural development, principles of effective extension work, concepts of program planning, research, program evaluation and their importance in agricultural extension and rural development work, Role of communication and ICTs in extension work and development activities in rural areas for the growth of the masses are important to disseminate among undergraduate students so that students will prepare themselves to learn more advance ideas in agricultural education and research. The students will be able to perform better in the dissemination of different agricultural technologies.

Contents

1. Agricultural extension; its definition, objectives and importance,
2. Types of education, Brief history/recent trends in agricultural extension,
3. Organizational setup of agricultural extension in Pakistan, Rural development
4. Elements of rural development process.
5. Rural development through agricultural extension work in Pakistan,
6. Characteristics and problems of Pakistani farmers,
7. Current issues and problems of rural development and extension work in Pakistan
8. Roles and duties of extension workers at various organizational levels,
9. Extension programs and activities since 1947 to date in Pakistan
10. Role of communication and ICT in Extension and Rural Development work,
11. Principles of effective extension work. Adoption and diffusion of agricultural innovations
12. Agricultural Technology and its application for Pakistani farmers,
13. Extension, research and farmer's linkages, Basic concept of planning
14. Monitoring and evaluation in Agricultural Extension.

Recommended Texts

1. Ray, G.L. (2006). *Extension communication and management*. New Delhi: Kalyani Publishers.
2. Ison, R. & Russell, D. (2004). *Agricultural extension and rural development: breaking out of knowledge transfer traditions*. Cambridge: Cambridge University Press.

Suggested Readings

1. Bashir, E. (2005). *Extension methods* (2nd ed.). Islamabad: National Book Foundation.
2. Narasaiah, M.L. (2003). *Approaches to rural development*. New Delhi: Discovery Publishing House.
3. Leeuwis, C. & Van den Ban, A. (2004). *Communication for rural innovation: rethinking agricultural extension* (3rd ed.). London: Wiley-Blackwell.

URCE-5103 **Academic Writing** **3 (3+0)**

Academic writing is a formal, structured and sophisticated writing to fulfill the requirements for a particular field of study. The course aims at providing an understanding of the writer's goal of writing (i.e. clear, organized and effective content) and to use that understanding and awareness for academic reading and writing. The objectives of the course are to make the students acquire and master academic writing skills. The course would enable the students to develop argumentative writing techniques. The students would be able to the content logically to add specific details on the topics such as facts, examples and statistical or numerical values. The course will also provide insight to convey the knowledge and ideas in an objective and persuasive manner. Furthermore, the course will also enhance the students' understanding of ethical considerations in writing academic assignments and topics including citation, plagiarism, formatting and referencing the sources as well as the technical aspects involved in referencing.

Contents

1. Academic vocabulary
2. Quoting, summarizing and paraphrasing texts
3. Process of academic writing
4. Developing argument
5. Rhetoric: persuasion and identification
6. Elements of rhetoric: Text, author, audience, purposes, setting
7. Sentence structure: Accuracy, variation, appropriateness, and conciseness
8. Appropriate use of active and passive voice
9. Paragraph and essay writing
10. Organization and structure of paragraph and essay
11. Logical reasoning
12. Transitional devices (word, phrase and expressions)
13. Development of ideas in writing
14. Styles of documentation (MLA and APA)
15. In-text citations
16. Plagiarism and strategies for avoiding it

Recommended Texts

1. Swales, J. M., & Feak, C. B. (2012). *Academic writing for graduate students: essential tasks and skills* (3rd ed.). Ann Arbor: The University of Michigan Press.
2. Bailey, S. (2011). *Academic writing: A handbook for international students* (3rd ed.). New York: Routledge.

Suggested Readings

1 Craswell, G. (2004). *Writing for academic success*. London: SAGE.
2 Johnson-Sheehan, R. (2019). *Writing today*. Don Mills: Pearson.
3 Silvia, P. J. (2019). *How to write a lot: A practical guide to productive academic writing* Washington: American Psychological Association

URCP-5106 **Pakistan Studies** **2(2+0)**

The course is designed to acquaint the students of BS Programs with the rationale of the creation of Pakistan. The students would be apprised of the emergence, growth and development of Muslim nationalism in South Asia and the struggle for freedom, which eventually led to the establishment of Pakistan. While highlighting the main objectives of national life, the course explains further the socio-economic, political and cultural aspects of Pakistan's endeavors to develop and progress in the contemporary world. For this purpose, the foreign policy objectives and Pakistan's foreign relations with neighboring and other countries are also included. This curriculum has been developed to help students analyze the socio-political problems of Pakistan while highlighting various phases of its history before and after the partition and to develop a vision in them to become knowledgeable citizens of their homeland.

Contents

1. Contextualizing Pakistan Studies
2. Geography of Pakistan: Geo-Strategic Importance of Pakistan
3. Freedom Movement (1857-1947)
4. Pakistan Movement (1940-47)
5. Muslim Nationalism in South Asia
6. Two Nations Theory
7. Ideology of Pakistan
8. Initial Problems of Pakistan
9. Political and Constitutional Developments in Pakistan
10. Economy of Pakistan: Problems and Prospects
11. Society and Culture of Pakistan
12. Foreign Policy Objectives of Pakistan and Diplomatic Relations
13. Current and Contemporary Issues of Pakistan
14. Human Rights: Issues of Human Rights in Pakistan

Recommended Texts

1. Kazimi, M. R. (2007). *Pakistan studies.* Karachi: Oxford University Press.
2. Sheikh, Javed Ahmad (2004). *Pakistan's political economic and diplomatic dynamics.* Lahore: Kitabistan Paper Products.

Suggested Readings

1. Hayat, Sikandar (2016). *Aspects of Pakistan movement.* Islamabad: National Institute of Historical and Cultural Research.
2. Kazimi, M. R (2009). *A concise history of Pakistan.* Karachi: Oxford University Press.
3. Talbot, Ian (1998). *Pakistan: a modern history*. London: Hurst and Company.

PLBG-5201 **Introductory Genetics** **3(2+1)**

To enable students to understand: Basic concepts of genetics, understanding, why the characters of offspring are similar to their parents, what can be the possible reason for the variation that the offspring show to their parents. Mechanism of heredity underlying laws of genetics and their practical manifestation in the form of various monohybrid as well as dihybrid crosses. Understanding the linkage and epistasis as potential reasons for deviation from the law of independent assortment. Understanding the concepts of allele and gene both at genotypic as well as phenotypic levels. Understanding the process and purposes of the cell cycle, meiosis, and mitosis, as well as the outcomes of these processes. Enabling the students to solve various genetic problems, making calculated and accurate predictions about the inheritance of genetic traits, and map the locations of genes. Chemical and molecular nature of nucleic acids i.e. RNA and DNA. Understanding the concept of gene expression from gene to its product.

Contents

1. Definition of genetics, concepts of heredity and variation.
2. Cell and cell divisions. Mendelian genetics: chromosome theory of heredity
3. Various genotypic and phenotypic ratios and their modifications.
4. Differences between allelic and non-allelic interactions (epistasis), illustration of epistasis.
5. Pleiotropy and multiple allelism. Multiple factor hypothesis. Linkage and crossing over.
6. Sex determination: sex linked and sex influenced traits.
7. Chromosomal aberrations.
8. Nucleic acids: nature, structure and function.
9. Classical vs modern concepts of gene.

Practical

1. Study of cell divisions and gametogenesis, Calculation of monohybrid and dihybrid ratios.
2. Numerical examples relating to gene interaction, multiple alleles and multiple factor inheritance.
3. Calculation of linkage from test cross and F_2 data.

Recommended Texts

1. Singh, B.D. (2004). *Genetics.* Kalyani Publishers, New Delhi, India.
2. Klug, W.S. & Cummings, M. R. (2003)). *Concepts of genetics.* (7th ed.), Pearson Education, Singapore.

Suggested Readings

1. Singh, P. (2003). *Elements of genetics.* (2nd ed.) Kalyani Publishers, Delhi, India
2. Stansfield, W.D. ((1988) *Theory and problems of genetics. NYC: McGraw-Hill*
3. Khan I.A. Azhar, F.M. Ali, Z. & Khan, A.A. (2008). *Solving numerical genetic problems.* Faisalabad: University Agriculture Faislabad.

ENTO-5101 Introductory Entomology 3 (2+1)

This course is aimed to make the students familiar with the basic information about the study of insects. The students would be able to know about arthropods and especially insects with their morphological features, identify insects of economic importance and acquire working skills for collecting, mounting, and preserving insects. Course briefs about the basic external and internal morphological and anatomical features along with their basic functioning principles. Students will learn as well about insect classification and nomenclature. They can easily identify the insect order, family and type and can properly collect, mount and preserve these invertebrates for further studies. Insect body features and their habits help for their identification. This is the basic course that enables the students to further understand the ways and techniques adopted for the control and management of economically important insect pests.

Contents

1. Introduction
2. Phylum Arthropoda and its classification
3. Metamorphosis and its types
4. External and internal morphology and physiology
5. Insect classification and nomenclature
6. Salient characters of insect orders with important families and examples of important members

Practical

1. Characters of classes of Arthropoda
2. Collection and preservation of insects
3. Morphology and dissection of a typical insect
4. Temporary mounts of different types of appendages of insects
5. Observations for types of metamorphosis

Recommended Texts

1. Lohar, M.K. (1998). *Introductory entomology*. Hyderabad: Kashif Publications.
2. McGavin, G. C. (2001). *Essential entomology: an order-by-order introduction*. Oxford: Oxford University Press.

Suggested Readings

1. Tonapi, G.T. (1994). *Experimental Entomology, an Aid to Lab. and Field Studies.* Dehli: C.B.S. Publishers and Distributors.
2. Mani, M.S. (1990). *General Entomology (4th ed.)*. Dehli: Oxford & IBH Publishing Co. Pvt. Ltd.

PLPT-5301 Introduction to Plant Pathogens 3(2+1)

Plant pathology is a science that studies plant diseases and attempts to improve the chances for survival of plants when they are faced with unfavorable environmental conditions and parasitic microorganisms that cause disease. As such, plant pathology is challenging, interesting, important, and worth studying in its own right. It is also, however, a science that has a practical and noble goal of protecting the food available for humans and animals. Plant diseases, by their presence, prevent the cultivation and growth of food plants in some areas; or food plants may be cultivated and grown but plant diseases may attack them, destroy parts or all of the plants, and reduce much of their produce, i.e., food before they can be harvested or consumed. The objective of this course is to acquaint the students with basic concepts and identification of plant pathogens. The course covers all aspects of plant pathogens which include their economic importance, morphology, reproduction and ecology. The course also covers the classification of different plant pathogens. In addition to plant pathogens, phanerogamic parasites, viroids and fastidious bacteria will also be covered briefly during this course.

Contents

1. Introduction; economic importance
2. General characteristics (morphology, reproduction and ecology)
3. Identification of plant pathogens including fungi, prokaryotes, viruses, viroids, nematodes
4. Taxonomic position of economically important plant pathogens

Practical

1. Orientation of laboratory equipment
2. Sterilization of glassware
3. Preparation of media and isolation of different plant pathogens
4. Study of characteristics of various plant pathogens through slides
5. Live specimens and their comparative account/study

Recommended Texts

1. Agrios, G. N. (2005). *Plant Pathology* (5th ed.). *Burlington: Elsevier.*
2. Ahmad, I., & Bhutta, A.R. (2005) *Textbook of introductory Plant Pathology*. Islamabad: National Book Foundation.

Suggested Readings

1. Bos, L. (1999). *Plant viruses, unique and intriguing pathogens: a textbook of plant virology*. Netherlands: Backhuys Publishers.
2. Mehrotra, R. S., & Aggarwal, A. (2003). *Plant pathology* (2nd ed.). New Delhi: Tata McGraw Hill.
3. Ravichandra, N. G. (2013). *Fundamentals of plant pathology*. India: PHI Learning.
4. Windham, M. T., Trigiano, R. N., & Windham, A. S. (2003). *Plant pathology: concepts and laboratory exercises*. London: Taylor and Francis.

HORT-5601 Introductory Horticulture 3(2+1)

This course is aimed to make the students familiar with the basic information about the study of horticultural plants such as fruits, vegetables and ornamental plants. The course covers all aspects of Horticultural crops. The student will learn the division of horticulture and classification of horticultural plants as well as plant parts and their modifications. This course would help understand students regarding, propagation methods, punning, training and laying out of an orchard, vegetable farm This course will help students to identify the key issues being faced by the growers such as purchasing of plants from a nursery, establishing an orchard, pruning, training and windbreaks. Taking this course would broaden their vision regarding the horticulture industry at domestic and international levels. Students will be able to identify existing gaps and will be trained to solve those issues.

Contents

1. Introduction, history, importance and future scope
2. Definition and divisions of horticulture
3. Classification of horticultural crops, Plant parts, their modifications and functions
4. Plant environment; climate (temperature, light, humidity etc) and soil (structure, texture, fertility)
5. Phases of plant growth, Propagation of horticultural plants

Practical

1. Visit of nurseries, commercial gardens and public parks
2. Identification and nomenclature of important fruits, vegetables and ornamental plants
3. Garden tools and their uses, Media and its preparation.
4. Techniques of propagation

Recommended Texts

1. Christopher, E. P. (2012). *Introductory horticulture*. New Dehli: Biotech books.
2. Carrol,L., J.R.Shry and H.E. Reily. (2011). *Introductory horticulture* (8th ed.). Albany: Delmar-Thomson Learning.

Suggested Reading

1. Hartmann, H.T., D.E. Kester, E.T. Davies and R.L. Geneve. (2009). *Plant propagation–principles and practices* (7th ed.). New Delhi: Prentice-Hall.
2. Peter, K.V. (2009). *Basics of horticulture.* New Dehli: New India publishing Agency.

FWRW-5702 Introduction to Rangelands and Wildlife Management 3(2+1)

The course will introduce the students with the knowledge of rangelands and their importance as major land use in Pakistan. Students will be able to know the characteristics of rangelands of the country and complexities associated with the management of rangelands. The course describes the range ecosystem, its components and types of range vegetation in different ecological zones of the country with a brief discussion of the botany of range grasses, shrubs and trees, range plant ecology, range animal behavior, rangeland stocking rate and selection of grazing system. There is a comprehensive discussion on the principles of scientific management of all the components of the range ecosystem and its relation with wildlife. The key objectives of this course are to introduce the students with the rangeland resources and associated wildlife of Pakistan, to make the students identify major range vegetation types and wildlife species of the country and to provide information about the problems of rangelands and their scientific management

Contents

1. Introduction to Rangelands, scope and importance.
2. Basic terminology, Components of Rangelands
3. Constraints and problems of rangelands.
4. Rangeland Resources of Pakistan; ecological zones and vegetation types.
5. Range ecosystem, Principles of Rangeland Management.
6. Grazing systems of the world, Grazing systems and grazing pattern in Pakistan.
7. Range improvement techniques, Wildlife: Definition and values,
8. Ecosystem concept, characteristics and management requirements for regional eco-systems
9. Introduction to protected areas (National Park, Game Reserve and Wildlife Sanctuary).
10. Introduction to National Parks of Pakistan.

Practical

1. Identification and preservation of important Grasses and Plant species of a rangeland.
2. Visits to various Rangeland types and Plantations.
3. Quantitative analysis of range vegetation, Identification of important wildlife species.

Recommended Texts

1 Holechek, J. (1989). *Range management, principles and practices*. Newberry: Prentice Hall.
2 Quraishi, M. A. A., G.S. Khan and Yaqoob, M. S. (1993). *Range management in Pakistan*. Faisalabad: University of Agriculture.

Suggested Readings

1. Mohammad, N. (1989). *Rangeland management in Pakistan*. NARC Published by ICIMOD.
2. Stoddard, L.A., A.D. Smith and Box, T.W. (1975). *Range management.* New York: McGraw Hill.
3. Quraishi, M.A.A., Ishaque, M. (1995). *Practical manual of range management*. Faisalabad: University of Agriculture.

AGEC-5501 Introduction to Agricultural Economics 3(3+0)

The objective of this course is to introduce the students to economic principles and the economic way of thinking. This course is helpful for students to teach them the basic economics foundation about the allocation of scarce resources, that scarcity forces choice, tradeoffs exist and that every choice has an opportunity cost. After completing the course, students will develop an understanding of the basic concepts of economics and their application in agriculture. Students should read content and complete course assignments before deadlines. Students are expected to actively participate in discussions and submit exercises in-time. Students are also expected to complete exams on the date and time allotted. It is their responsibility to be familiar with and understand all previously covered material before each new chapter.

Contents

1. Definitions and overview of economics and related terms; Subject Matter & Scope;
2. Contents of consumer behavior; Scale of preferences; Utility, Indifference Curve & related concepts;
3. Demand & Supply analysis; Elasticity of Demand and Supply; Market Equilibrium.
4. Production, factors of production, laws of return and their significance in agriculture;
5. Concept of macroeconomics; approaches to national income estimation;
6. Growth, Unemployment & Inflation;
7. Important macroeconomic issues in agriculture sector of Pakistan.

Recommended Texts

1. Parkin, M. (2010). *Economics*. Addison Weslay Publishing Company.
2. Penson, J. B., Capps O. Rossen C. P., & Woodward, R. (2013). *Introduction to agricultural economics*. New Jersey: Prentice Hall.

Suggested Readings

1. Mankiw, N. Gregory. (2011). *Principles of economics*. Mason: Cengage learning Publisher.
2. Penson, J. B., Capps, O., Rossen C. P., & Woodward, R. (2013). *Introduction to agricultural economics*. New Jersey: Prentice Hall.
3. Cramer, G., Jensen C. W., & Southgate, D. D. (2001). *Agricultural economics and agribusiness*. NYC: Wiley Publisher.

URCC-5110 Citizenship Education and Community Engagement 3 (3+0)

In recent years, community engagement has become a central dimension of governance as well as policy development and service delivery. However, efforts to directly involve citizens in policy processes have been bedeviled by crude understandings of the issues involved, and by poor selection of techniques for engaging citizens. This course will provide a critical interrogation of the central conceptual issues as well as an examination of how to design a program of effective community engagement. This course begins by asking: Why involve citizens in planning and policymaking? This leads to an examination of the politics of planning, conceptualizations of "community" and, to the tension between local and professional knowledge in policymaking. This course will also analyze different types of citizen engagement and examine how to design a program of public participation for policymaking. Approaches to evaluating community engagement programs will also be a component of the course. Moreover, in order to secure the future of society, citizens must train younger generations in civic engagement and participation. Citizenship education is education that provides the background knowledge necessary to create an ongoing stream of new citizens participating and engaging with the creation of a civilized society.

Contents

1. Introduction to Citizenship Education and Community Engagement: Orientation
2. Introduction to Active Citizenship: Overview of the ideas, Concepts, Philosophy and Skills
3. Identity, Culture and Social Harmony: Concepts and Development of Identity
4. Components of Culture and Social Harmony, Cultural & Religious Diversity
5. Multi-cultural society and inter-cultural dialogue: bridging the differences, promoting harmony
6. Significance of diversity and its impact, Importance and domains of inter-cultural harmony
7. Active Citizen: Locally active, Globally connected
8. Importance of active citizenship at national and global level
9. Understanding community, Identification of resources (human, natural and others)
10. Human rights, Constitutionalism and citizens' responsibilities: Introduction to human rights
11. Universalism vs relativism, Human rights in constitution of Pakistan
12. Public duties and responsibilities, Social Issues in Pakistan
13. Social action and project: Introduction and planning of social action project
14. Identification of problem, Ethical considerations related to project
15. Assessment of existing resources

Recommended Texts

1. Kennedy, J. K. Brunold, A. (2016). *Regional context and citizenship education in Asia and Europe*. New York: Routledge Falmer.
2. Macionis, J. J. Gerber, M. L. (2010). *Sociology*. New York: Pearson Education

Suggested Readings

1. British, Council. (2017). *Active citizen's social action projects guide.* Scotland: British Council
2. Larsen, K. A. (2013). *Participation in community work: international perspectives.* Vishanthic Sewpaul, Grete Oline Hole.

PLBG-5202 Introductory Plant Breeding 3(2+1)

Students will understand the basis of plant breeding, The application of genetic principals for the improved heredity of plants. How to improve yield, quality, disease resistance, drought and frost-tolerance and important characteristics of the crops. How to create desired genotypes and phenotypes for specific breeding objectives as per crop. This manipulation involves either controlled pollination, genetic engineering, or both, followed by artificial selection of progeny. The process of creating variation and then utilizing the variation for the plant improvement. Understanding how to exploit the available natural variation and if natural variation is not having selection potential then the method of artificial creation of variation. Understanding the Reproductive mechanisms in major crops, Application of genetic principles in crop improvement, understanding breeding methods in self-pollinated crops and the principal of breeding self-pollinated crops as homozygosity. The comparative advantage of different breeding methods in terms of time required for breeding a crop variety. Understanding breeding methods in cross-pollinated crops

Contents

1. Introduction to plant breeding and its role in crop improvement.
2. Reproductive systems in major crop plants.
3. Genetic variation and its exploitation, creation of variation through genetic recombination
4. Breeding self-pollinated crops: introduction, mass selection, pure line selection; hybridization
5. Pedigree method, bulk method and backcross techniques.
6. Breeding cross-pollinated crops: introduction, mass selection, recurrent selection.
7. Development and evaluation of inbred lines.
8. Development of hybrids, synthetic and composite populations.
9. Breeding clonally propagated crops. New trends in plant breeding.

Practical

1. Descriptive study of floral biology.
2. Scientific names, chromosome number and ploidy level of important field crops.
3. Selfing and crossing techniques in major crops.
4. List of approved varieties in major field crops.
5. Field visits of different research organizations.

Recommended Texts

1. Sleper, D. A. & Poehlman, J.M. (2006)). *Breeding field crops*. Ames: Iowa University Press.
2. Chahal, G.S. & Gosal, S.S. (2003). *Principles and procedures of plant breeding.* New Delhi: Narosa Publishing House.
3. Singh, B. D. (2003). *Plant breeding: principles and methods*. Kalyani Publishers: New Delhi.

Suggested Readings

1. Singh, P. (2003).. *Essentials of plant breeding.* New Delhi: Kalyani Publishers.
2. Khan, M.A (Editor). (1994). *Plant breeding.* Islamabad: National Book Foundation.
3. Acquaah, G. (2009). *Principles of plant genetics and breeding*. London: John Wiley & Sons.

ENTO-5102 Applied Entomology 3 (2+1)

The students would be able to acquire knowledge of different practical aspects of entomology. For instance, they will learn to identify the major insect pest species of agricultural, horticultural and forest crops, vegetables, fruits, stored grains and household pests. The course aims to demonstrate the students about the identification of insect pests, their control methods and pesticide application equipment with the basic objective to enhance farmer's productivity through better management and control of insect pests. Moreover, the course includes the basic information and introduction related to entomological cottage industries (i.e. honeybee farming, silkworm rearing and lac culture) in order to enhance the productivity of the farming community. This course is the continuation of the introductory course which involves the techniques and practices used for the application of the basic entomological knowledge for the control and management of economically important agricultural insect pests and the best possible utilization of useful aspects of insects.

Contents

1. Introduction
2. Causes of success and economic importance of insects
3. Principles and methods of insect control i.e. cultural, biological, physical, mechanical
4. Reproductive, legislative, chemical and bio-technological control
5. Introduction to IPM; insecticides, their classification, formulations and application equipment
6. identification, life histories, mode of damage and control of important insect pests
7. Entomological industries: apiculture, sericulture and lac-culture

Practical

1. Collection, identification and mode of damage of insect pests of various crops, fruits, vegetables
2. Insecticide formulations, their dilutions and safe handling
3. Use of application equipment, instructions in apiculture, sericulture and lac-culture

Recommended Texts

1. Atwal, A.S. (2005). *Agricultural pests of southeast Asia and their management*. Ludhiana: Kalyani Publishers.
2. Pedigo, L. P., & Rice, M. E. (2014). *Entomology and pest management* (6th ed.). NYC: Waveland Press Inc.

Suggested Readings

1. Duncton, P.A. (2007). *The Insect: beneficial and harmful aspects.* Ludhiana: Kalyani Publishers.
2. Mathews, G.A. (2004). *Pesticide application methods* (3rd ed.). NYC: John Wiley & Sons, Inc.

PLPT-5302 Introductory Plant Pathology 3(2+1)

Plant Pathology or Phytopathology is the branch of agriculture, which deals with the study of plant diseases. The detailed study includes the importance and occurrence, symptoms, cause, etiology, disease cycle, epidemiology and management of diseases. The disease may be defined as "abnormal changes in physiological processes which disturbs the normal activity of plant organs". The disease is a condition in which the functions of the organism are improperly discharged or, in other words, it is a state, which is physiologically abnormal and threatens the life of the being or organs. The disease is a variation from normal physiological activity, which is sufficiently permanent or extensive to check the performance of normal functions by the plant or completion of its development. The objective of this course is to acquaint the students with basic concepts of Plant Pathology. The course comprises a history of different plant diseases, their symptoms, etiology, epidemiology and management. The course also has a brief introduction of different plant pathogens which include fungi, viruses, bacteria and nematodes. The course also covers the historical background of different plant pathogens and the discoveries related to the management of different diseases.

Contents

1. Introduction and history of plant pathology
2. Basic characteristics of fungi, bacteria, viruses and nematodes
3. Concept of disease in plants; economic importance of plant diseases
4. Nature and cause of (biotic and abiotic) diseases
5. Components of plant disease development
6. Diagnosis of plant diseases
7. Principles of plant disease management
8. Introduction to IDM and IPM; symptoms, etiology
9. Mode of infection, disease cycle and management of representative diseases of agricultural
10. Horticultural crops

Practical

1. Demonstration of lab equipment and reagents
2. Collection, preservation and identification of plant diseases based on symptoms
3. Isolation and inoculation techniques
4. Demonstration of Koch's postulates

Recommended Texts

1. Agrios, G. N. (2005). *Plant pathology* (5th ed.). Burlington: Elsevier.
2. Chaube, H.S., & Singh, R. (2002). *Introductory plant pathology*. New Delhi: International Book Distributing Co.

Suggested Readings

1. Mehrotra, R.S., & Aggarwal, A. (2003). *Plant pathology* (2nd ed.). New Delhi: Tata McGraw Hill.
2. Strange, R.N. (2006). *Introduction to Plant pathology*. NYC: John Wiley & Sons.

HORT-5602 Horticultural Crop Production 3(2+1)

The objective of this course is to familiarise students with the production of horticultural crops such as fruit, vegetables and ornamental crops. Students are expected to understand various stages of fruit, vegetables and ornamental plants phenology and physiology in order to solve related problems for horticultural crops. After completing this course student will be able to grow and manage Horticultural crops successfully on a commercial scale. This course would help understand students regarding the key phenomenon related to fruits such as incompatibility, fruits set, and biennial bearing. Similarly, students will also learn about disease and insect problems in vegetables and ornamental plants. This course will help students to identify the key issues being faced by the growers such as alternate bearing, fruit drop and possible options to control these issues using different approaches.

Contents

1. Establishment of orchards, vegetable farms and ornamental gardens
2. Site selection, layout methods, wind breaks and their role.
3. Management practices; irrigation, manures and fertilizers, training and pruning, cultivation.
4. Climate, soil, propagation, rootstocks, cultivars, important pests, harvesting, post-harvest handling
5. Marketing of important horticultural crops (fruits, vegetables and ornamentals) of the region.

Practical

1. Practice in layout methods
2. Selection of plants from nursery, propagation methods
3. Planting and after care.
4. Production techniques and identification of important cultivars of horticultural crops of the region

Recommended Texts

1. Acquaah, G. (2009). *Horticulture: principles and practices*. New Delhi: Prentice Hall.
2. Adams, C. R., K.M. Bamford and M. P. Early. (2012). *Principles of horticulture.* NYC: Routledge.

Suggested Readings

1. Singh, B. (2007). *Horticulture at a glance.* Ludhiana: Kalyani Publishers.
2. Pradeepkumar, T., B. Suma, Jyothibhaskar, K.N. Satheesan, K.V. Peter. 2008. *Management of horticultural crops* (Part 1). *Horticulture Science Series Vol. 11*. New Delhi: New India Publishing Agency.
3. Yadav, P.K. (2007). *Fruit production technology*. Lucknow: International Book Distributing.

FSAT-5101 Introduction to Food Science and Technology 3 (2+1)

This is an introductory course that enables the students to understand the basics of food science and technology. Students will explore and gain an understanding into the history of Food Science and the factors that have shaped Food Science in Pakistan, the organizations involved in Food manufacturing, food regulatory processes, Food composition, its classification depending on sources, consumption patterns and basic analysis of food components. The course is the study of the physical, biological, and chemical makeup of food; the causes of food deterioration; and the concepts underlying food processing. Food scientists and technologists apply scientific disciplines including chemistry, engineering, microbiology, and nutrition to the study of food to improve the safety, nutrition, wholesomeness and availability of food. Depending on their area of specialization, food scientists may develop ways to process, preserve, package, and/or store food according to industry and government specifications and regulations. It could involve enhancing the taste, making it last longer, making sure it's safe to eat, or even boosting its nutritional content.

Contents

1. Introduction to food science, food technology, relationship with other disciplines
2. Career opportunities. Significance of food science and technology
3. Food industry: history, developments, important food industries in Pakistan
4. Food sources: plants, animals and marine
5. Food constituents and their functions: water, carbohydrates, lipids, proteins, vitamins, minerals.
6. Classification of foods on the basis of perishability and pH
7. Food spoilage agents: enzymes, microorganisms, pests, physical factors
8. Principles of food preservation: prevention or delay of autolysis, microorganisms and pests

Practical

1. Use of basic food laboratory equipment.
2. Estimation of Moisture, Fat, Protein, Carbohydrates, Fiber and Ash content in food samples.
3. Determination of soluble solids, total solids, pH, Acidity, total sugars
4. Specific gravity and Refractive index.

Recommended Texts

1. Awan, J. A. (2018). *Food science and technology*. Faisalabad: Unitech Communications.
2. Robert, L. S., Ramirez, A. O., Clarke, A. D. (2015). *Introducing food science*. NYC: CRC Press.

Suggested Readings

1. Stewart, G. F., & Amerine, M. A. (2012). *Introduction to food science and technology*. London: Elsevier.
2. Potter, N. N., & Hotchkiss, J. H. (2012). *Food science*. London: Springer.

STAT-5126 Statistics for Agricultural Sciences 3(3+0)

This course is designed for undergraduate programs in agriculture sciences. The objective of this course is to impart basic and applied knowledge about statistics for collection, presentation, analysis and interpretations of data related to agriculture issues. After completing this course agriculture students will be able to understand the general concepts of basic statistics, conduct agriculture surveys, to understand the design of experiments and other statistical tools. These statistical concepts are further will be helpful to complete research related to agriculture sciences. Moreover, students will also learn some statistical software such as Minitab, SPSS and Design Expert to improve their computational and analytical skills. This course will be able to understand and analyze the agricultural problems in the field as well as in lab conditions.

Contents

1. Definition and importance of Statistics in Agriculture.
2. Data, Different types of data and variables
3. Classification and Tabulation of data.
4. Frequency distribution, Graphical representation of data.
5. Measure of Central tendency and Measure of Dispersion.
6. Calculation of averages, Range, variance, Standard deviation and coefficient of variation.
7. Regression and Correlation Analysis: Simple and Multiple regression, correlation cases.
8. Sampling and its types: Probability and non-Probability Sampling
9. Sampling distribution of mean and difference between two means.
10. Inference Theory: Estimation and testing of hypothesis, Type-I and type-II error
11. Testing of hypothesis about mean and difference between two means using Z- and t-test
12. Test of association of attributes using χ^2 (chi-square) Testing hypothesis about variance.
13. ANOVA and its assumptions, One-way ANOVA, Two-way ANOVA.

Recommended Texts

1. Muhammad, F. (2000). *Statistical methods and data analysis*. Lahore: Ilmi Kitab Khana.
2. Rao, G. N. (2007). *Statistics for agricultural sciences* (2^{nd} ed.). London: BS Publication.

Suggested Readings

1. Lawal, B. (2014). *Applied statistical methods in agriculture, health and life sciences*. NYC: Springer.
2. Sahu, P. K. (2016). *Applied statistics for agriculture, veterinary, fishery, dairy and allied fields*. NYC: Springer.
3. Crawshaw, J. & Chambers, J. A. (1994). *Concise course in A. level statistic with world examples.* NYC: Springer

AEXT-6408 Communication skills in Agricultural Extension 3(2+1)

The world has now embraced the largest revolution so far in the history of mankind called the communication revolution. Everything has been tagged to communication. Where countries are unable to resolve their issues through wars, communication provides a way to resolve mutual conflicts not only between two individuals, groups but also between the countries. Communication has a lot more important in human growth and development. The main aim of this course is to develop effective communication skills among students. How to develop communication ethics and techniques with other stakeholders in society is also important to learn. At the end of this course, the students will be able to: define the given concepts of communication, identify the types of communication, conduct interviews and will be able to demonstrate improved communication skills.

Contents

1. Concept, Purpose and scope of communication in Agricultural extension;
2. Forms of communication in the past, present and future;
3. Communication and the concept of global community;
4. Communication as the problem solving approach;
5. Communication process, elements and their role in effective communication;
6. Principles of communication; Basic communication models;
7. Forms of communication: interpersonal, intrapersonal and impersonal
8. Written, verbal and non-verbal communication;
9. Barriers to communication and measures to overcome these barriers.

Practical

1. The students will be involved in developing and critically analyzing different messages
2. Each student will have to design a project for class presentation
3. Students will have to practice different forms of communication in the class.

Recommended Texts

1. Calvert, P. (2000). *The communicator's handbook. tools, techniques and technology* (4th ed.). New Delhi: Maupin House Publishing.
2. Muhammad, S. (2005). *Communication skills & leadership development.* Faisalabad: Unitech Communications.

Suggested Readings

1. Murphy, H. A., Hildebrandt, H. P. & Thomas, J. P. (2000). *Effective business communication.* International Series. Islamabad: National Book Foundation.

SAES-6803 Physical Properties of Soil 3(2+1)

Soils properties are largely determined by its parent material and weathering during its formation. Plant growth is influenced by the properties of the soil. The amount of water, air and nutrients available for plant growth is affected by the soil's physical properties and other management practices. The aim of this course is basically to develop understanding among the students about the physical properties of soils and apply their knowledge for solving physical degradation problems. This course will help in understanding the behavior of soil physical properties in supporting the crop growth and engineering uses. At the completion of course, the students will be able to understand the importance of physical properties of soil in crop growth and its use for engineering purposes, the role of different tillage practices in crop growth and in management of water and soil, identify important problems about different physical properties and the management practices regarding physical degradation of soil.

Contents

1. Soil physical condition and plant growth, Soil texture, specific surface area and importance
2. Soil crusting and surface sealing with their role in seedling emergence
3. Particle and bulk density: description and significance
4. Total porosity and pore-size distribution and root development
5. Soil air composition and aeration, Soil temperature and its management, Soil color
6. Soil consistency and strength and interpretation for soil mechanics
7. Soil water and water potential and plant available water.
8. Water and solute movement through soil, Soil compaction: causes and remedies
9. Soil tillage systems and tilth, Soil physical environment and root architecture

Practical

1. Textural analysis: sieve, hydrometer, pipette and feel methods
2. Determination of bulk and particle density, Total soil porosity estimation,
3. Aggregate stability estimation, Measurement of soil water contents and soil temperature
4. Soil color and its interpretation, Determination of soil strength/soil penetrometer resistance

Recommended Texts

1. Brady, N.C. & Weil, R.R. (2009). *Elements of the nature and properties of Soils* (3rd ed.). Upper Saddle River, NJ: Pearson
2. Jury, W.A. & Horton, R. (2004). Soil physics (6th ed.). New Jersey: John Wiley.

Suggested Readings

1. Hillel, D. (2008). *Soil in the environment: crucible of terrestrial life*. Burlington, MA: Elsevier.
2. Brady, N.C. & Weil, R.R. (2007). *The nature and properties of soils* (14th ed.). Upper Saddle River, NJ: Pearson

SAES-6804 Chemical Properties of Soil 3(2+1)

Soils are characterized by physical, chemical and biological properties. This course highlights the chemical properties of soils and their importance for plant growth and productivity. The aim of this course is to teach students basic concepts of soil chemistry, soil composition and electrochemical potentials, colloidal chemistry of inorganic constitutes and impact of soil reactions on mineral nutrient availability. Chemical properties of the soil are important to soil fertility and plant growth. At the completion of this course, students will be able to understand soil chemistry and soil formations, the need for acidic soil reaction, chemical characterization of saline and sodic soil, nature of clay and organic complex and its impact on soil fertility. The chemical side of soil is extremely important of course and is about the correct balance of the available nutrients in the soil. The students will also be able to learn how soil chemical properties are interlinked with soil biology and soil physical parameters.

Contents

1. Soil colloids: Inorganic and organic, Layer silicate clays, allophanes and sesquioxides
2. Charge characteristics of colloids: sources and significance
3. Ion exchange and Zero point of charge, Diffuse double layer theory
4. Soil pH and buffering capacity, Base saturation percentage
5. Exchange equations (Langmuir, Frendlich and Gapon)
6. Sorption and desorption in soils

Practical

1. pH with and without different electrolytes, and soil to water ratios
2. Soluble and extractable cations in soil, Cation exchange capacity of three different textured soils
3. Base saturation percentage , Estimation of lime content in soil

Recommended Texts

1. Bohn, H.L., McNeal, D.L. & O'Connor, G.A. (2001). *Soil chemistry* (3rd ed.). New Jersey: John Wiley.
2. Essington, M.E. (2004). *Soil and water chemistry: an integrated approach*. Boca Raton: CRC Press.

Suggested Readings

1. Sposito, G. (2008). *The chemistry of soils* (2nd ed.). Oxford: Oxford University Press.
2. Tan, K.H. (2009). *Environmental soil science* (3rd ed.). Greensboro: CRC Press.

SAES-6805 Instrumentation and Laboratory Techniques 3(1+2)

This course is designed to introduce the concept and significance of instrumentation and laboratory techniques to soil science students. This course is aimed to teach the students how soil and plant samples are collected, processed, analyzed and interpreted. The principles and use of laboratory equipments and analytical techniques for *Soil and Plant Analysis* are discussed in detail in this course. The students will be able to use laboratory instruments and collect, handle and analyze soil and plant samples. It provides information to the students about safety measures in the laboratory, storage and disposal of chemicals. This course is helpful to deliver a hands-on experience in basic and indispensable instrumentation skills required in the field of soil science. Students will learn the basics of laboratory safety, aseptic technique, measurements and calculations and preparation of solutions/samples. This course also helpful for all agricultural students to a better understanding about instruments that are frequently used in Pakistan.

Contents

1. Quality assurance, Safety measures in laboratory
2. Storage and disposal of chemicals, S.I. and derived S.I. units
3. Extraction, digestion and dry ashing
4. Analytical techniques

Practical

1. Soil and plant sampling and preparation
2. Preparation of standard solutions
3. Introduction to specialized equipments.
4. Principle and operation of conductivity metry, potentiometry, spectrophotometry, emission
5. Spectroscopy and absorption spectroscopy
6. Assessment of analytical results

Recommended Texts

1. Carter, M.R. & Gregorid, E.G. (2008). *Soil sampling and methods of analysis* (2nd eds.). Boca Raton: Taylor & Francis.
2. Ryan, J., Estefan, G. & Rashid, A. (2001). *Soil and plant analysis*. Laboratory Manual. International Centre for Agricultural Research in the Dry Areas. Aleppo, Syria.

Suggested Readings

1. Smith, K.A. & Cresser, M.S. (2003). *Soil and environmental analysis: modern instrumental techniques*. Boca Raton: CRC Press.
2. Tandon, H.L.S. (2005). *Methods of analysis of soils, plants, waters, fertilizers and organic manures*. Fertilizer Development and Consultation Organization, New Delhi, India.

SAES-6806 Soil Genesis and Morphology 3(2+1)

Around the globe, many soil classifications systems have been developed to categorize soils into groups based on morphological and/ or chemical properties. The most widely used classification system is the Soil Taxonomy system that was made known by the United States Department of Agriculture (USDA). This system is a morphogenetic system that utilizes both quantitative factors and soil genesis themes and assumptions to guide soil groupings. Factors and processes of soil formation, interpretative soil morphology and local pedogenic processes and introduction to USDA soil classification system are discussed in this course. The students will be able to understand and describe morphological features and taxonomic relations of different soils. Soil genesis, with special reference to soil-forming factors responsible for the development of the solum, or true soil, time, parent material, topography, climate and organisms are the main course contents. The students will know how the properties of soils affect their uses, and be able to evaluate alternative treatments, amendments and/or locations of different uses of soil/substrate.

Contents

1. Weathering of rocks and minerals; types of parent materials
2. Soil genesis and factors affecting, Pedogenic processes
5. Soil morphology, Description of soil profiles; special soil features
6. Soil taxonomy: categories and nomenclature
7. Soil orders in Pakistan: extent and their significance

Practical

1. Soil profile description of important soil series
2. Field trips
3. Identification of soil orders

Recommended Texts

1. Buol, S.W., Walker, M.P., Southard, R.J. & McDaniel, P.A. (2003). *Soil genesis and classification* (5^{th} ed.). Ames: Iowa University Press.
2. Wilding, H. (1994). *Factors of soil formation.* madison: SSSA Special Publication.

Suggested Readings

1. Schaetzl, R. & Anderson, S. (2005*). Soils: genesis and geomorphology*. Cambridge: Cambridge University Press.
2. Soil Survey Staff. (2006). *Keys to soil taxonomy* (10^{th} ed.). Washington: Pearson.

SAES-6807 Plant Growth under Stress Environment 2(2+0)

Stress in plants refers to external conditions that adversely affect growth, development or productivity of plants. Different types of stresses such as drought, excessive watering, extreme temperatures, salinity and mineral toxicity negatively impact growth, development, yield and seed quality of crop and other plants. But the main objective of the course is to develop an understanding of the students about different environmental stresses (i.e. biotic and abiotic) and how these stresses are affecting plant growth. The students will learn how drought, waterlogging, salinity and high temperature negatively affect plant growth. This course will also deliver knowledge about different phenotypic changes that plants can adopt under various stresses. This course will provide information regarding different techniques of soil and plant sampling under stressed conditions. Endogenous application of plant growth regulators, molecular mechanisms controlling plant growth as well as a description of transgenic plants will enable the students to manage plant growth under different stresses.

Contents

1. Type of stresses: nutrients, salinity/sodicity, water, heat, oxygen and mechanical
2. Effect of different stresses and their interactions on plant growth
3. Mechanisms of tolerance to different stresses
4. Management of plant growth under stressed environments
5. Soil and plant sampling techniques for various stresses
6. Demonstration of plant growth under stressed conditions

Recommended Texts

1. Taiz, L. & Zeiger, E. (2006). *Plant physiology* (4th ed.). Sunderland: Wadsworth Publication.
2. Gupta, U.S. (2004). *Physiology of stressed crops*. Enfield: Science Publishers.

Suggested Readings

1. Marschner, P. (2003). *Mineral nutrition of higher plants*. San Diego: Elsevier.
2. Havlin, J.L., Tisdale, S.L, Nelson, W.L. & Beaton, J.D. (2013). *Soil fertility and fertilizers: an introduction to nutrient management* (8th ed.). Upper Saddle River, NJ: Pearson.

SAES-6808 **Soil Fertility Evaluation** **2(2+0)**

The students will be able to diagnose deficiency and toxicity symptoms of different nutrients in plants. It is evident that for optimum crop productivity the soil nutrient status, i.e. the fertility of the soil should be maintained by appropriate and efficient nutrient management. In the agricultural sciences, soil fertility and plant nutrition played an important role in increasing crop yields. The importance of this field has increased due to limited natural resources (land and water), the need for more sustainable agricultural systems, and concern about environmental pollution. After completion of the course, students are able to contextualize discussions on plant nutrient management and their role in plant growth and productivity; Present basic acid, calcareous and salt-affected soils. In addition, students also be able skill to explain the roles of soil microorganisms and fauna and identify them and understand composition and application methodology, luxury consumption, nutrient interactions, deficiency symptoms, visual diagnosis.

Contents

1. Introduction and Review
2. Objectives of soil fertility evaluation
3. Nutrient deficiency and toxicity symptoms and causes
4. Tissue testing in the field and in the laboratory
5. Method and time of sampling and handling
6. Critical concentration of nutrients in the plant
7. Biological testing: Laboratory, green house and field trials
8. Soil testing: Sampling, handling and analysis
9. Critical nutrient ranges in soils; Correlations, calibration and recommendations

Recommended Texts

1. Havlin, J.L., Tisdale, S.L, Nelson, W.L. & Beaton, J.D. (2013). *Soil fertility and fertilizers: an introduction to nutrient management* (8th ed.). Upper Saddle River, NJ: Pearson.
2. Mengel, K. & Kirkby, E.A. (2005). *Principles of plant nutrition* (5th ed.). New York: Kluwer Academic Publishers.

Suggested Readings

1. Westerman, R.L. (1990). *Soil testing and plant analysis*. Madison: Soil Science Society of America.
2. Marschner, P. (2003). *Mineral nutrition of higher plants*. San Diego: Elsevier.
3. Bashir & Bantel. (2001). *Soil science*. Islamabad: National Book Foundation.

SAES-6809 Salt-Affected Soils and Water Quality 3(2+1)

This course is designed to give students a good grasp of the theoretical and of practical aspects of the problems, reclamation and management of salt-affected soils. The course will start with a general overview describing the nature and extent of salinity, and the basic concepts underlying the diagnosis and the selection of salinity management options. This course aims at understanding the problems of irrigation waters and strategic treatment/management options about the sustainable and safe use of such low-quality waters in agriculture. In addition, the students will be equipped with the pre-requisite knowledge and skills necessary to become good researchers. At the completion of the course, the students will become able to understand issues related to salt-affected soils and low-quality waters, mathematical relationships to calculate SAR of soil solution from analysis of irrigation water, calculate average root zone salinity and salt balance and strategies for the reclamation and management of salt-affected soils.

Contents

1. Salt-affected soils, classification, properties and extent
2. Salination and sodication: Gapon and pHc equations,
3. Systems of characterization of salt-affected soils
4. Chemistry of soil solution, Root zone salinity, Reclamation and management of salt-affected soils
5. Irrigation water: Criteria and classification, Groundwater: Characteristics and resources
6. Salinity build up and prediction, Waterlogged soils: Causes, impact and management
7. Bio-saline Agriculture

Practical

1. Field visits and sampling of salt-affected soils and irrigation water
2. Saturated soil extract analysis, SAR calculation and ESP prediction
3. Irrigation analysis, classification and interpretation
4. Gypsum requirement of soil and brackish irrigation water
5. Demonstration of in-situ soil reclamation techniques

Recommended Texts

1. Bohn, H.L., McNeal, B.L. & Connor, G.A.O. (2001). *Soil chemistry* (3rd ed.). NYC: John Wiley.
2. Ghafoor, A., Qadir, M. & Murtaza, G. (2004*). Salt-affected soils: principles of management*. Lahore: Allied Book Center.

Suggested Readings

1. Essington, M.E. (2004). *Soil and water chemistry: an integrated approach*. Boca Raton: CRC Press.
2. Molden, D. (2007). *Water for food, water for life: a comprehensive assessment of water management in agriculture*. Colombo, Earthscan.

SAES-6810 Soil Fertility and Fertilizer Use 3(2+1)

In agricultural sciences, the importance of this course is increasing day by day due to limited natural (water and land) resources, the need for more sustainable agricultural systems, and concern about environmental pollution. This course will introduce the students to the applied aspects of soil fertility and fertilizer use. The principles and methods of sampling and monitoring nutrients deficiency and toxicity symptoms will be covered, including soil quality criteria, and the diagnosis and monitoring of plant growth performance. It is evident that for optimum crop productivity the soil nutrient status, i.e. the fertility of the soil should be maintained by appropriate and efficient nutrient management. However, in order to make the best decisions about plant nutrition, it is a basic course for soil science students. This course will improve the knowledge by presenting and discussing the various management options for preventing and controlling plant nutrition problems in plants and soils.

Contents

1. Crop growth, factors affecting and growth expressions
2. Essential plant nutrients: functions, deficiency and toxicity
3. Nitrogen gains and losses in soil, Nitrogen fertilizers and their fate in soil
4. Phosphorus forms and P-fertilizers behavior in soil
5. Potassium forms, amount and exchange equilibrium in soil
6. Calcium, magnesium and sulfur forms and amount in soil
7. Crop responses; factor affecting and residual effects
8. Integrated plant nutrient management, Nutrients behavior in submerged soil
9. Nutrient role in human and plant health
10. Possible new essential elements (Co, Na, Si, Se, Ni, Li and Cs)

Practical

1. Fertilizers identification and composition, Fertilizer requirement calculation
2. Determination of available P and K in soil, plant analysis for N, P and K
3. Field visits for identification of nutrients deficiency and toxicity symptoms
4. Visit to fertilizer factories, soil fertility institutes and demonstration trials

Recommended Texts

1. Ahmad, N. & Rashid, M. (2003). *Fertilizer and their use in Pakistan: an extension guide.* Islamabad: Planning Commission, National Fertilizer Development Centre.
2. Havlin, J.L., Tisdale, S.L, Nelson, W.L. & Beaton, J.D. (2013). *Soil fertility and fertilizers: an introduction to nutrient management* (8th ed.). Upper Saddle River, NJ: Pearson.

Suggested Readings

1. Elsworth, L. & Relay, W.O. (2009). Fertilizers: properties, applications and effects. NYC: Nova Science Publication.
2. Russell, E.J. (2011). *The fertility of the soil* (1st ed.). Cambridge: Cambridge University Press.

SAES-6811 Soil Survey and Land Evaluation 3(2+1)

Techniques used for survey and characterization of soil and their suitability for various uses will be discussed in this course. After this course, students will be able to understand the terminology and concepts about land evaluation, use of soil survey information for the assessment of land quality, the various methods available for land suitability assessment, use of land quality assessment as an input to decision making on optimization of sustainable land use and management. Acquisition of high-level know-how for mapping soils and correctly interpreting soil maps and soil databases. Acquisition of specific and technical understanding of soil mapping and land evaluation. Understanding soil biological status for land evaluation and soil conservation. The students will plan work directly with soils, make land use and management decisions, or be involved in projects requiring practical application of soil science principles. Understanding soil biological status for land evaluation and soil conservation.

Contents

1. Soil and landform, Kinds and levels of soil survey, Aerial photographs and their interpretation
2. Stereoscopic vision theory, Field traverse selection
3. Purposes, characteristics and identification of mapping units
4. Mapping legends, mapping and taxonomic units, Interpretation and use of soil survey reports
5. Land capability and suitability classification,
6. Application of GIS, GPS and remote sensing in soil survey

Practical

1. Reading of topographic maps and calculation of slope percentage
2. Stereoscope: Types and uses, Interpretation of aerial photographs
3. Demonstration of GIS, GPS and remote sensing techniques, Field visits

Recommended Texts

1. Burt, R. (2004). *Soil survey laboratory methods manual soil survey investigations*. Report No. 42, Version 4.0. *Washington: Pearson.*
2. Lagacherie, P., McBratney, A. & Voltz, M. (2007). *Digital soil mapping - an introductory perspective*. Elsevier Publishers, Amsterdam, The Netherlands.

Suggested Readings

1. Soil Survey Division Staff. (2002). *Soil survey manual*. USDA, University Press of Pacific, Washington, DC, USA.
2. Dent, D., & Young, A. (1981). *Soil survey and land evaluation*. George Allen & Unwin., UK.
3. Soil Survey Staff. (2006). *Keys to soil taxonomy* (10^{th} ed.). *Washington: Pearson.*

SAES-6812 Soil and Water Conservation 3(3+0)

This course covers the contents of soil and water management and conservation important to students of agricultural, and environmental sciences. Processes that degrade the soil and water resources of Pakistan are examined, and their measurement, avoidance and management discussed. Soil and water are the two fundamental natural resources and aim to maintain soil fertility and productivity by reducing the runoff rate as well as reducing the land slope. In this course, students will learn various ways and means of soil and water losses and how these losses can be decreased with various strategies for soil conservation. It will also help to develop an understanding of the students that how cover crops help to prevent erosion and put nutrients back into the soil, keeping it healthy, more sustainable and contributes to better harvests. After this course, students can guide the farming community on how to get rid of the erosion problem and conserve their soils.

Contents

1. Soil erosion: description, types and impact on environment
2. Water and wind erosion: types, causes and damages
3. Gravity erosion and landslides
4. Erosion prediction: modified Universal Soil Loss Equation; wind erosion equations
5. Erosion control and management: agronomic, engineering and bioengineering practices
6. Hydrological cycle and its components
7. Water conservation and management practices, and water harvesting techniques
8. Strategies for soil, water and environment conservation
9. Socio-economic issues of soil and water conservation

Recommended Texts

1. Bhushan, L.S., Abrol, I.P. & Rao, M.S.R.M. (1998). *Soil and water conservation: challenges and opportunities* (2nd ed.). Rotterdam: Balkema.
2. Ehlers, W. & Michael, G. (2003). *Water dynamics in plant production*. Cambridge: CAB Publishing.

Suggested Readings

1. Fangmeier, D.D., Elliot, W.J. & Workman, S.R. (2006). *Soil and water conservation engineering* (5th ed.). NYC: Thomson Delmar Learning.
2. Morgan, R.P.C. (2005). *Soil erosion and conservation*. Essex, Longman.
3. Unger, P.W. (2006). *Soil and water conservation Handbook.* NYC: Haworth Food and Agriculture Products Press.

SAES-6813 Nutrient Management in Degraded Soil 3(3+0)

Soil degradation is an increasingly serious problem in Pakistan due to soil and water erosion. The course will cover the general overview describing the nature and extent of degraded soil, and the management options. The students will be able to diagnose soil problems and then management of nutrients in different types of degraded soils. Different factors that cause land degradation like waterlogging, soil salinity, and erosion will be discussed. This course also improves the understanding about nutrient management techniques to increase the fertility status of depleted soils. In addition, the students will be equipped with the pre-requisite knowledge and skills necessary to become a good researcher. This will in turn help develop research aptitude among the graduates which will go a long way in their practical carrier. At the completion of the course, the students will become able to understand the issues related to degraded soils and their management to increase productivity.

Contents

1. Degraded soils: Introduction, causes and types
2. Nutrient dynamics in degraded soils
3. Nutritional limitations and potentials of different degraded soils
4. Macro and micro nutrients
5. Causes and processes of nutrient deficiency and toxicity
6. Approaches for nutrient management in degraded soils
7. Fertilizer use, integrated, agronomic and genetic

Recommended Texts

1. Havlin, J.L., Tisdale, S.L, Nelson, W.L. & Beaton, J.D. (2013). *Soil fertility and fertilizers: an introduction to nutrient management* (8th ed.). Upper Saddle River, NJ: Pearson.
2. Fageria, N.K., Baligar, V.C. & Jones, C.A. (1997). *Growth and mineral nutrition of field crops* (2nd ed.). Denver: CRC Press

Suggested Readings

1. Tanji, K.K. (1990). *Agricultural Salinity Assessment and management:* Manuals and Reports on Engineering Practices No. 71, American Society of Civil Engineers, New York, USA.
2. Pessarakali, M. (1999). *Handbook of plant and crop stress*. NYC: Marcel Dekker.
3. Unger, P.W. (2006). *Soil and water conservation handbook*. NYC: Haworth Food and Agriculture Products Press.

SAES-6814 Carbon Sequestration in Soil 2(2+0)

Soil carbon is probably the most import component in soils as it affects their physical, chemical and biological properties. Protecting soil carbon stocks and the process of soil carbon sequestration, or flux of carbon into the soil, have become integral parts in managing the global carbon balance. Therefore, this course is designed with aim that the students will learn effective organic carbon sequestration techniques for reduced carbon emission. It will develop the knowledge among the students that how carbon sequestration, long-term storage of carbon dioxide or other forms of carbon plays a pivotal role to either mitigate or defer global warming and avoid dangerous climate change. Soil is a carbon sink and implications of its release to the atmosphere, relation of soil management with carbon emission, and international carbon budget & trade will be taught in the course. It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases, which are released by burning fossil fuels.

Contents

1. Introduction to carbon sequestration
2. Description and historical perspective of carbon cycle
3. Estimates and rate of carbon emission and climate change
4. Partitioning and transformations of carbon in soil
5. Soil and crop management strategies for carbon sequestration in soil; Crop residue incorporation
6. Composting, agronomic practices
7. Biochar production, application, challenges and opportunities
8. Land use patterns in relation to carbon emission
9. International carbon trading

Recommended Texts

1. Hartemink, A.E. & McSweeney, K. (2014). *Soil carbon*: *progress in soil science*. Switzerland: Springer.
2. Lal, R., Suleimenov, M., Stewart, B.A., Hansen, D.O. & Doraiswamy, P. (2007). *Climate change and terrestrial carbon sequestration in central Asia*. Netherlands: Taylor and Francis.

Suggested Readings

1. Piccolo, A. (2012). *Carbon sequestration in agricultural soils*. Berlin Heidelberg: Springer.
2. Verheijen, F. G. A., Jeffery, S., Bastos, A.C., van der Velde, M. & Diafas, I. (2010). *Biochar application to soils: a critical scientific review of effects on soil properties, processes and functions*. Luxembourg: Official publications.
3. Havlin, J.L., Tisdale, S.L, Nelson, W.L. & Beaton, J.D. (2013). *Soil fertility and fertilizers: an introduction to nutrient management* (8^{th} ed.). Upper Saddle River, NJ: Pearson.

SAES-6815 Soil Microbiology 3(2+1)

It is an introductory course designed to introduce the concept and significance of soil microbiology for agriculture students. This course improves the awareness of students about the practical application of soil microbiology for the productivity of crop, environmental factors that affecting soil microflora and organic matter decomposition, immobilization and mineralization of carbon in the soil, microbial transformations in flooded soils, and their impacts on crops and quality of our environment. Moreover, it is also helpful for students to gain information about the microbial transformation of nitrogen, phosphorus, potassium, sulfur, iron and manganese as well as their impacts on soil health and crop productivity. It also improves the attention of the students about the impact of agricultural and industrial waste materials on our environment. In addition, this introductory course also advances the skills of the students how to prepare the biofertilizers and their significant effects on the quality of our environment and soil health.

Contents

1. Introduction and historical prospective
2. Distribution, functions and classification of bacteria, archaea, actinomycetes, fungi, algae & fauna
3. Growth phases and environmental factors affecting soil microflora
4. Microbial ecology, Soil organisms and their interactions
5. Soil organic matter decomposition; immobilization and mineralization of carbon
6. Microbial fixation and release of CO_2
7. Microbial transformations of nutrients under aerobic and anaerobic soil conditions.
8. Microbial inoculants for N and P

Practical

1. Introduction to laboratory equipments, Media preparation
2. Measurement of microbial population and activity in soil
3. Algal culturing and their microscopy, Study of mineralization, nitrification and denitrification

Recommended Texts

1. Barton, L.L. & Northup, D.E. (2011). *Microbial ecology*. Hoboken: John Wiley.
2. González, M.B.R. & González-López, J. (2014). *Beneficial plant-microbial interactions- ecology and applications*. Boca Ratoon: Taylor & Francis

Suggested Readings

1. Khan, M.S., Zaidi, A. & Musarrat, J. (2009). *Microbial strategies for crop improvement*. NYC: Springer.
2. Maier, R.M., Pepper, I.L. & Gerba, C.P. (2009). *Environmental microbiology* (2nd ed.). San Diego: Academic Press Inc.

SAES-6816 Environmental Pollution and Management 3(3+0)

The aim of this course is to teach students about soil, water and air pollution and its impact on soil, plants and human health. The students will be able to know about the sources, causes of pollution and their remedies. The aim of this course is basically to develop an understanding of students that why pollution prevention or control is needed to improve environmental quality. The students will be able to learn that how the amount of damage to a particular medium (air, water, land) varies according to the type of pollutant, the amount of pollutant disposed, and the distance from the source of pollution. The course will enable the students to perceive the knowledge that how pollution prevention techniques reduce waste created at the source, avoiding the generation of waste, protects the environment by reducing the risk of toxic releases. The principal avenues for crop improvement will be explored.

Contents

1. Introduction to soil, water and air pollution
2. Sources and causes of pollution
3. Types of pollutants: inorganic, organic and radioactive
4. Fate of pollutants: adsorption, precipitation, degradation, movement and plant uptake
5. Degradation of pollutants: chemical, biological and light
6. Factors affecting movement of pollutants in soil
7. Impact of pollutants on soil, plant, animal and human health
8. Water pollution: drinking and irrigation; BOD, COD and eutrophication
9. Atmospheric pollutants; greenhouse gases
10. Strategies for pollution control
11. Management and control: control measure at source, soil and water treatment, public awareness
12. Legislation and socio-economic issues of environmental pollution

Recommended Texts

1. Ashfar, M. & Saleem, M.A. (2010). *Environmental pollution and agriculture*. Lahore: Pak Book Empire.
2. Asthana, D.K. & Asthana, M. (2003). *Environment problems and solutions*. New Delhi: Chand & Co.

Suggested Readings

1. Cunningham, W.P., Cunningham, M.A. & Saigo, B.W. (2007). *Environmental science*: *a global concern* (9th ed). NYC: McGraw Hill.
2. Harrison, R.M. (2001). *Pollution*: *causes, effects and control* (4th ed.). Cambridge: The Royal Society of Chemistry
3. Pakistan Environmental Protection Act. (1997). Govt. of Pakistan.

SAES-6817 Research Project and Scientific Writing 3(2+1)

The aim of this course is basically to develop understanding among the students about the write up of technical reports, synopsis and thesis and scientific projects. Scientific writing, while an indispensable step of the scientific process, is often overlooked in undergraduate courses in favor of maximizing class time devoted to scientific concepts. However, the ability to effectively communicate research findings is crucial for success in the biological sciences. The precise learning of this course will enable the students to achieve these tasks successfully. This course will enable the students to conceive problem-oriented research, plan, execute and document research results. Problem-oriented research plan, execution and documentation of research results will be discussed in this course. The students will be able to search literature, plan and execute research projects and publish research reports. By increasing undergraduate exposure to the scientific writing process, we hope to better prepare undergraduates for productive careers.

Contents

1. The purpose and kinds of research
2. General consideration and identification of the problem
3. Background reading and review of literature: objectives, sources, collection and citation
4. Preparation of research project: title, objectives, methodology, work plan and budget.
5. Scientific writing
6. Editing and evaluating the final draft.

Practical

1. Exercise of writing research proposal
2. Assigning different titles to the students
3. Exercise of collecting materials from different sources on assigned topics
4. Oral presentation

Recommended Texts

1. Blaxter, L., Hughes, C. & Tight, M. (2006). *How to research* (3rd ed.). Berkshire: Open University Press McGraw Hill.
2. Ghafoor, A. (2007). *Manual for synopsis and thesis preparation*. Faisalabad: Agriculture University Faisalabad.

Suggested Readings

1. Harrad, S., Batty, L., Diamond, M. & Arhonditsis, G. (2008). *Students projects in environmental science*. West Sussex: John Wiley.
2. Katz, M.J. (2009). *From research to manuscript - a guide to scientific writing* (2nd ed.). Frankfurt: Springer-Verlag.

SAES-6818 Trace Elements in Agriculture 3(2+1)

The total concentration of trace elements in soils, their chemical forms, mobility and availability to the food chain provide the basis for a range of problems in the crop, animal and human health. It is important to recognize, however, that anthropogenic inputs of trace elements, in particular heavy metals, from industrial and urban sources may add to and indeed at times surpass those from natural geological sources. Therefore, this course is designed to equip the students with expertise about nutritional importance and the environmental hazards of trace elements in agriculture. Sources and bio-geo-chemistry of trace elements, bioavailability and toxicity and environmental contamination issues are discussed. This course will enable students about trace elements that are part of enzymes, hormones and cells in the body therefore, essential for normal plant growth. Trace elements are essential nutrients and their relative deficiency or excess can potentially affect optimum development to a considerable extent. Students will learn to boost up supplies of trace elements for appropriate plant growth. The excessive application of trace elements than normal will cause water pollution and other hazards for humanity.

Contents

1. Biogenic and geo-genic sources of trace elements.
2. Trace elements in agriculture (Zn, Mn, Cu, Fe, Mo, Co, B, Cl): nutritional aspects, availability
3. Micronutrients: forms in soils and factors affecting their availability
4. Use of trace elements as commercial fertilizers.
5. Critical limits and functions in plants and their mobility.
6. Trace elements status of Pakistan soils and their response to various crops.
7. Study of National Environmental Quality Standards (NEQS) in soil and water.

Practical

1. Analytical tests for trace elements in soil and plant.
2. Deficiency and toxicity symptoms

Books Recommended

1. Adriano, D.C. (2001). *Trace elements in the terrestrial environment*: *biogeochemistry, bioavailability and risks of metals*. NYC: Springer.
2. Bell, R.W.& Dell, B. (2008). *Micronutrients for sustainable food, feed, fiber and bio-energy production*. Paris: International Fertilizer Industry Association (IFA).

Suggested Readings

1. Kabata-Pendias, A. & Pendias, H. (2001). *Trace elements in soils and plants* (3rd ed.). Boca Raton: CRC Press.
2. Mortvedt, J.J., Cox, F.R., Shuman, L.M. & Welch, R.M. (1991). *Micronutrients in agriculture* (2nd ed.). Madison: Soil Science Society of America. Inc.

SAES-6819 **Saline Agriculture** **2(2+0)**

With the continued increase of the world population, the requirements for food, fresh water, and fuel are bigger every day. This way an urgent necessity to develop, create, and practice a new type of agriculture, which has to be environmentally sustainable and adequate to the soils. The students will be able to utilize salt-affected soils without reclamation only through appropriate management techniques. It will make the profitable use of salt-affected soils at status-quo. This course is the basic need of the farming community as financially the majority of the farmers have small landholding and are classified as poor in terms of economics. Through this course, students will be able to use salt-affected soils as such without spending money. Farmers may get some profit from their wastelands that will improve their social status. Slowly and gradually reclamation process of salt-affected soils will also start that will contribute towards the healthy soil.

Contents

1. Saline agriculture: Definition, history and prospects in Pakistan
2. Components and approaches of saline agriculture
3. Breeding, physiology, agronomy and nutrition
4. Plants growth in degraded environments
5. Plants for saline agriculture: Crops, grasses, bushes and trees
6. Saline agriculture as a sustainable farming system
7. Future of saline agriculture in the context of` global climate change

Recommended Texts

1. Qureshi, R.H. & Barrett-Lennard. (1998). *Saline agriculture for irrigated land in Pakistan*: *a handbook*. Canberra: Australian Centre for International Agricultural Research (ACIAR).
2. Ahmad, R. & Malik, K.A. (2002). *Prospects for saline agriculture*. Dordrecht : Kluwer Academic Publishers.

Suggested Readings

1. Pessarakali, M. (1999). *Handbook of plant and crop stress*. NYC: Marcel Dekker Inc.
2. Gupta, U.S. (2004). *Physiology of stressed crops*. Enfield: Science Publishers.
3. Marschner, P. (2003). *Mineral nutrition of higher plants*. San Diego: Elsevier.

AGEC-6523 Agribusiness, Marketing and Trade 3(3+0)

Students will be involved in learning activities that generally prepare them to apply the economic and business principles involved in the organization, operation, and management of the farm, ranch or agribusiness. Typical instructional activities include hands-on experiences with applying modern economic and business principles involved in the organization, operation, and management of agricultural businesses including the production and marketing of agricultural products and services and know-how of new trends in international trade of agricultural commodities. After completing the course, students will be well equipped with the basic concepts of Agribusiness and Trade. Students should read content and complete course assignments before deadlines. Students are expected to actively participate in discussions and submit exercises in-time. Students are also expected to complete exams on the date and time allotted. It is their responsibility to be familiar with and understand all previously covered material before each new chapter.

Contents

1. Definition, concepts, Important features and scope of Agribusiness Management,
2. Elements and Functions of management;
3. Forms of business organizations;
4. Agribusiness financial management;
5. Agricultural Marketing; Marketing channels, functionaries and margins;
6. Role of agri. marketing in economic development;
7. Agricultural marketing problems;
8. The changing world and interdependence;
9. Basis of trade; gains from trade;
10. Concept of absolute and comparative advantage; pattern of trade;
11. Brief introduction of major trade agreements.

Recommended Texts

1. Kohls, R.L., UhI, J.N. & Hurt, C. (2007). *Marketing of agricultural products*. New Jersey: Prentice Hall.
2. Salvatore, D. (2007). *International economics*. Wiley Publisher.

Suggested Readings

1. Hoekman, B. M., Mattoo, A., & English, P. (2002). *Development, trade and the WTO-a hand book*, Washington D.C: The World Bank.
2. Downey, W.D. & Erickson, S. P. (2002). *Agribusiness management*, Singapore: McGraw Hill Education.

SAES-6820 Soil-Water-Plant Relationship 3(3+0)

Water is introduced to the soil by an irrigation system, by a regulated water table, or by precipitation. It is stored in the soil matrix and then extracted by plant roots to meet the plant evapotranspirational needs. This course on soil plant-water relationships treats the physical properties of soils and plants that affect the movement, retention, and use of water and that must be considered in designing and operating systems for conservation irrigation. The students will be able to learn how soil texture and structure greatly affect water infiltration, permeability, and water-holding capacity. Plant growth depends on two important natural resources, soil and water. The basic soil, water, and plant relationships are important to agricultural products. Water is the most essential for plant life. Water plays a very vital and important role in the soil and plant growth relationship. Mechanisms of water and nutrient movement in soils and plants and their relationships with plant growth will be discussed in this course. After completion of this course, the students will be able to understand water and nutrient movement in soil and plant and adaptation of plants to adverse soil water conditions.

Contents

1. Functions and properties of water
2. Components of soil and plant water potentials
3. Soil-plant-water relations
4. Movement of water and ions in soil and plant
5. Water absorption and root stem pressure
6. Water and mineral nutrient uptake
7. Photosynthesis and transpiration
8. Soil-plant-atmosphere continuum
9. Adaption of plants to adverse soil-water conditions

Recommended Texts

1. Hillel, D. (2008). *Soil in the environment: crucible of terrestrial life*. Burlington, MA: Elsevier.
2. Jury, W.A. & Horton, R. (2004). *Soil physics* (6th ed.). Hoboken: John Wiley.

Suggested Readings

1. Kirkham, M.B. (2005). *Principles of soil and plant water relations* (1st ed.). San Diego: Elsevier.
2. Kramer, P.J. & Boyer, J.S. (1995). *Water relations of plants and soils*. San Diego: Academic Press.
3. Rending, V.V. & Taylor H.M. (1989). *Principles of soil-plant inter relationships*. NYC: McGraw Hill.

SAES-6821 Land Degradation and Management 3(3+0)

This course is designed to increase the awareness of undergraduate students about types of degraded lands and their effective utilization for crop production. The students should be able to know the causes of land degradation and their management for crop productivity. The subject-specific skills of the students is expected to be improved to deal with problematic soils and the use of treated wastewater. The students also be able to calculate soil amendment requirements for reclamation of problematic soils according to set goals and identify hazards associated with irrigation water including different salts and toxicity hazards. Knowhow of the students about the practical use of land degradation and management for crop production, environmental factors affecting the soil organic matter decomposition, and their impacts on crops. It also helps to understand the drought, low and erratic precipitation, global warming and climate change and their impacts on soil health and crop production in Pakistan.

Contents

1. Land resources and their uses in global and Pakistan perspective
2. Causes and types of degraded lands
3. Nutrient dynamics and management in degraded lands
4. Threats to national land use
5. Drought; low and erratic precipitation, lowering of water table; global warming &climate change
6. Water and wind erosion, Nutrient and organic matter depletion
7. Salinization of soil and water, Sea water intrusion
8. Soil physical degradation: Crusting and compaction
9. Water-logging, Land sliding

Recommended Texts

1. Chisholm, A. & Dumsday, R. (2009). *Land degradation: problems and policies*. London Cambridge.
2. Johnson, D.L. & Leiois, L.A. (2007). *Land degradation: creation and destruction* (2nd ed.). NYC: Rowman & Littlefield Publishers.

Suggested Readings

1. Pessarakali, M. (2010). *Handbook of plant and crop stress* (3rd ed.). NYC: Marcel and Dekker Inc.
2. Wong, M.H., Wong, W.C. & Baker, A.J.M. (1999). *Remediation and management of degraded lands*. Boca Raton: CRC Press.
3. Havlin, J.L., Tisdale, S.L, Nelson, W.L. & Beaton, J.D. (2013). *Soil fertility and fertilizers: an introduction to nutrient management* (8th ed.). Upper Saddle River, NJ: Pearson.

SAES-6822 Municipal and Agro Waste Management 3(3+0)

Introduction to waste management and its relevance to agriculture and natural sources. The students will be able to utilize the knowledge attained for the conversion of waste material into useful products. Knowledge regarding the types and extent of municipal and agro wastes generation and their transformation into useful products will be shared in this course. The aim of this course is basically to develop an understanding of students why municipal and agro-waste management or control is needed to preserve precious environmental resources and to improve environmental quality. The course will enable the students to perceive the knowledge that how waste management techniques reduce or eliminates waste created at the source, avoiding the generation of waste, protects the environment by reducing the risk of toxic releases. Disposal of hazardous waste in agriculture i.e. pesticides, herbicides and different agrochemicals. Environmental impact of traditional-agriculture and farming on water, soil and air.

Contents

1. Municipal and agro based waste: sources, types and composition
2. Nature and management of waste water
3. Solid waste management and role of community
4. Methods and technologies in solid waste management
5. Utilization of municipal waste as organic fertilizer and soil conditioner
6. Production of energy from municipal waste
7. Ethical issues of municipal and agro based waste management
8. International waste management strategies

Recommended Texts

1. Cheremisioff, N.P. (2002). *Handbook of solid waste management and waste minimization technologies*. Burlington: Elsevier.
2. Dhamija, U. (2006). *Sustainable solid waste management: issues, policies, and structures*. New Delhi: Academic Foundation.

Suggested Readings

1. Ghafoor, A. (2010). *Environmental pollution*: *types, sources and management*. Lahore: Allied Book Centre.
2. Pepper, I.L., Gerba, C.P. & Brusseu, M.L. (2006). *Environmental and pollution science* (2nd ed). San Diego: Elsevier.
3. Pichtel, J. (2005). *Waste management practices: municipal, hazardous and industrial*. Boca Raton: CRC Press.

SAES-6823 **Research Project/Internship** **4(0+4)**

This course will include orientation regarding literature review and project planning, e.g., title, hypothesis, objectives, methodology, execution, report writing, presentation and evaluation. The mode of evaluation of the progress of work will be determined by the respective supervisor and host institution (if any). In the case of research projects, each student will research under the supervision of the respective supervisor and will write a report. In addition, the change of life stages from a student to a professional is not always very simple. Students have to face many challenges when they enter into professional life. They have to adjust themselves according to the professional environment by implementing their conceptual knowledge in the new world of work. Internship programs are the opportunities for educational institutes to upgrade the student's enrollment and prepare their curriculum. For students, internships are the experience of practical work. As companies prefer those graduates who have the required skills and practical knowledge, internships supply valuable employees and competent job applicants to the companies. Internship programs enable students to get training during their course programs and save companies' supervision and training costs by providing them trained employees.

MSc
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SOIL SCIENCES

SAES-7101 Principles and Uses of Laboratory Equipments 3(0+3)

Proper use of laboratory equipment is required to work safely with hazardous chemicals. Maintenance and regular inspection of laboratory equipment are an essential part of this activity. Many of the accidents that occur in the laboratory can be attributed to improper use or maintenance of laboratory equipment. The aim of this course is basically to develop an understanding among the students about the use and handling of modern laboratory equipment. Students will be able to collect soil, plant, water and fertilizer samples accurately. The precise working in the laboratory regarding solution preparation and safety measures will also be taught to the students. Students will be able to use laboratory instruments and collect, handle, and analyze soil and plant samples. This course provides information to the soil science students about safety measures in the laboratory, storage and disposal of chemicals.

Contents

1. Quality management, assurance and control measures
2. Analytical errors, analysis and control
3. Development of standard operating procedures
4. Use of basic laboratory equipment: Spectrophotometer: UV and visible range Flame photometer
5. Atomic absorption spectrophotometer, Ion meter and selective ion electrodes and EM-38 & EC
6. Introduction, principles and usage of specialized equipment: Inductively coupled plasma meter
7. Elements of analytical report writing

Recommended Texts

1. DeLevie, R. (1997). *Quantitative chemical analysis*. McGraw-Hill Co. Inc. New York, USA.
2. Harris, D.C. (2006). *Quantitative chemical analysis* (7th ed.). W. H. Freeman & Co. NY, USA.

Suggested Readings

1. Pansu, M. & Gautheyrou, J. (2007). H*andbook of soil analysis: mineralogical, organic and inorganic methods*. London: Springer.
2. Smith, A.K. & Cresser, M.S. (2004). *Soil and environmental analysis: modern instrumental techniques* (3rd ed.). NYC:Marcel & Dekker.
3. Spark, D.L. (1996). *Methods of soil analysis*: *chemical methods*. SSSA, ASA Series No.5. Madison, WI, USA.

SAES-7102 **Soil Chemistry** **3(2+1)**

Soil chemistry is the branch of soil science that deals with the chemical composition, chemical properties, and chemical reactions of soils. Soil reactions and processes occur over a wide range of spatial and temporal scales. Soil chemistry is concerned with the chemical reactions and processes involving these phases. The aim of this course is to teach students regarding the concept of soil chemistry, soil composition and electrochemical potentials, colloidal chemistry of inorganic constitutes and impact of soil reactions on mineral nutrient availability. Chemical properties of the soil are important to soil fertility and plant growth. After this course, students will be able to understand soil chemistry and soil formations, the need for acidic soil reaction, chemical characterization of saline and sodic soil, nature of clay and organic complex and its impact on soil fertility. The students will also be able to learn how soil chemical properties are interlinked with soil biology and soil physical parameters.

Contents

1. Chemical equilibria in soil, water and solute interactions
2. Soil solution-solid interaction, Mineral dissolution: congruent and incongruent
3. Neo-formation of minerals in soil, Thermodynamics and applications in soil
4. Organic matter: composition and fractionation
5. Surface chemistry of soil matrix, Sorption and desorption models
6. Ion exchange: selectivity coefficients, equivalent fraction concept: Hysteresis in ion exchange
7. Anion exclusion, Complementation effect, Zeta potential
8. Reactions of metal chelates in soils
9. Chemical behavior of ions / elements in aerated and submerged soils
10. Buffering reactions in soil, Chemical remediation of contaminated soils and water

Practical

1. Determination of CEC and base saturation, Developing K vs Ca + Mg activity ratios in laboratory
2. Determination of phosphorous adsorption isotherm
3. Comparative fit (data from 3) to Freundlich and Langmuir models
4. Developing titration curves

Recommended Texts

1. Bohn, H.L., McNeal, B.L. & Connor, G.A.O. (2001). *Soil chemistry* (3rd ed.). NYC: John Wiley.
2. Essington, M.E. (2004). *Soil and water chemistry*. Boca Raton: CRC Press.

Suggested Readings

1. Sparks, D.L. (2003). *Environmental soil Chemistry* (2nd ed.). San Diego: Academic Press.
2. Sposito, G. (2003). *The chemistry of soils* (2nd ed.). Oxford: Oxford University Press.

SAES-7103 Soil Fertility and Plant Nutrition 3(2+1)

Soil fertility refers to the ability of soil to sustain agricultural plant growth, i.e. to provide plant habitat and result in sustained and consistent yields of high quality. This course will enable the students to get an understanding of soil fertility and plant nutrition, management techniques for improving nutrient use efficiency as well as interactions of plant nutrition with plant diseases. It is necessary to increase crop yields and maintain good crop quality for the expanding world population. This can only be accomplished if there is a good understanding of the factors affecting the nutrient contents of plants. This course covers the mechanisms of controlling nutrient uptake, translocation and accumulation by plants. There is also some discussion of soil factors controlling the supply and availability of nutrients for the plants. The effect of good plant nutrition and increasing plant resistance and tolerance to diseases will also be discussed in this course.

Contents

1. Basic soil-plant-relationship in plant nutrition
2. Plant nutrient behavior in soils
3. Nutrient behavior in submerged soils
4. Soil fertility evaluation: soil test calibration and plant analysis; External and internal nutrient
5. Fertilizer management strategies: nutrient availability and fertilizer use efficiency:
6. Nutrient-water and other interactions
7. Specific effects of fertilizers: plant, human and animal health
8. Environmental implications of fertilizer use

Practical

1. Soil and Plant Analysis for NPK
2. Interpretation of Soil and Plant Analysis results
3. Create and learn deficiency symptoms of nutrients

Recommended Texts

1. Barker, A.V. & Pilbeam, D.J. (2007). *Handbook of plant nutrition*. Boca Raton: CRC Press.
2. Bhatti, A.U. (2005). *Spatial variability & its management in agriculture*. Islamabad: Higher Education Commission.

Suggested Readings

1. Elsworth, L. & Relay, W.O. (2009). *Fertilizers: properties, applications and effects*. NYC: Nova Science Publication.
2. Havlin, J.L., Tisdale, S.L, Nelson, W.L. & Beaton, J.D. (2013). Soil fertility and fertilizers: an introduction to nutrient management (8^{th} ed.). Upper Saddle River, NJ: Pearson.

SAES-7104 Soil Microbiology and Biochemistry 3(2+1)

Soil microbiology is the study of microorganisms in the soil, their functions, and how they affect soil properties. It is believed that between two and four billion years ago, the first ancient bacteria and microorganisms came about on Earth's oceans. This course is designed to introduce the concept and significance of soil microbiology for agriculture students at the postgraduate level. Factually, this subject is practically more informative for expanding the study of earth, water, and air systems, including the interaction of indigenous microbes with organic and inorganic pollutants, the behavior of pathogens introduced into these systems and the discovery and application of new microbes and their products to benefit human health and welfare. The main objective of the course is to create an understanding of the essential role played by microorganisms in both environmental deterioration and the control of pollution.

Contents

1. Rhizosphere: plant-microbes and microbe-microbe interactions
2. Microbial cycling of elements: macro and micronutrients and heavy metals
3. Biochemistry and biotechnology of BNF; application in agriculture and environment
4. Mycorrhizal symbiosis
5. Plant growth regulators, phytotoxins and siderophores: microbiology and biochemistry
6. Composting: microbiology and biotechnology; agricultural and environmental application
7. Microbial metabolism
8. Bioremediation of contaminated soils: biodegradation and detoxification
9. Use of stable isotopes in microbiological research
10. Metabolic and nucleic acid based analysis of soil microbial diversity
11. Bio-fertilizers: present and future prospects

Practical

1. Isolation of bacteria, actinomycetes and fungi, Enrichment techniques
2. Organic matter decomposition rates and C: N ratio effect
3. Inoculation techniques, Biological N_2 fixation measurement techniques

Recommended Texts

1. Barton, L.L. & Northup, D.E. (2011). Microbial Ecology. Hoboken: John Wiley.
2. González, M.B.R. & González-López, J. (2014). Beneficial Plant-microbial Interactions- Ecology and Applications. Boca Ratoon: Taylor & Francis

Suggested Readings

1. Khan, M.S., Zaidi, A., & Musarrat, J. (2009). *Microbial strategies for crop improvement*. NYC: Springer.
2. Maier, R.M., Pepper, I.L., & Gerba, C.P. (2009). *Environmental microbiology* (2nd ed.). San Diego: Academic Press Inc.
3. Paul, E.A. (2007). *Soil Microbiology, Ecology and biochemistry* (3rd ed.). Oxford: Elsevier.

SAES-7105 **Soil Classification** **3(2+1)**

Soil classification deals with the systematic categorization of soils based on distinguishing characteristics as well as criteria that dictate choices in use. Soil classification systems are established to help people predict soil behavior and to provide a common language for soil scientists. The National Cooperative Soil Survey and the USDA developed the Soil Taxonomy classification system, which is used worldwide. The course is aimed to develop relations among different soil categories and their importance for a particular use. The students will be able to classify soils and devise strategic and efficient land use. The students will be able to understand and describe morphological features and taxonomic relations of different soils, soil genesis, with special reference to the soil-forming factors responsible for the development of the solum, or true soil, time, parent material, topography, climate and organisms. The students will know how the properties of soils affect their uses and are able to evaluate alternative treatments, amendments and/or locations of different uses of soil/substrate.

Contents

1. Concepts and importance
2. Introduction to soil taxonomy
3. Criteria of classification
4. Properties diagnostic to categories
5. Diagnostic horizons and other diagnostic properties
6. Soil moisture regimes: Classes and importance
7. Soil temperature regimes: Classes and importance
8. Categories and nomenclature
9. Keys to categories: Order, suborder, great group and sub group FAO
10. Agro ecological zones and soils of Pakistan

Practical

1. Profile description representing important soil orders
2. Classify research farm soil to sub group level.
3. Designation of genetic horizons found in Pakistan.
4. Identification of taxonomic names: orders, suborders, great groups, subgroups, families and series

Recommended Texts

1. Buol, S.W., Southard, R.J., Graham, R.C. & McDaniel, P.A. (2003). *Soil genesis and classifications* (2nd ed.). Boca Raton: CRC Press.
2. Bhatti, A.U. (2005). *Spatial variability & its management in agriculture*. Islamabad: Higher Education Commission.

Suggested Readings

1. FAO. (1998). *World reference base for soil resources*. Rome:. FAO
2. Soil Survey Division Staff. (2005). *Soil survey manual*. Washington: Pearson.
3. Soil Survey Staff. (2011). *Keys to soil taxonomy (11th ed.)*. Washington: Pearson.

SAES-7106 Salt-Affected and Water-Logged Soils 3(3+0)

Salt-affected soils occur in all continents and under almost all climatic conditions. Their distribution, however, is relatively more extensive in the arid and semi-arid regions compared to the humid regions. The nature and properties of these soils are also diverse such that they require specific approaches for their reclamation and management to maintain their long-term productivity. This course will create awareness among the students about the problems, reclamation and management of salt-affected soils. This course is also aimed at understanding the problems of irrigation waters and strategic treatment/management options about the sustainable and safe use of such low-quality waters in agriculture. In addition, the students will be equipped with the pre-requisite knowledge and skills necessary to become a good researcher. This course will create awareness among the students about the problems, reclamation and management of salt-affected and waterlogged soils. This will in turn help develop research aptitude among the postgraduates which will go long way in their practical carrier.

Contents

1. Salt-affected and waterlogged soils in Pakistan and global perspective
2. Genesis of saline and sodic soils
3. Classification systems of salt-affected soils
4. Effects of salinity and sodicity on soil characteristics
5. Derivation and applications of Gapon equation
6. Plant responses to saline and sodic conditions
7. Amelioration strategies and economic feasibility for salt-affected soils
8. Water requirements for reclamation
9. Concept of leaching fraction and its applications
10. Soil waterlogging: causes, soil and plant responses and amelioration strategies
11. Environmental and economic impacts of salinity and waterlogging

Recommended Texts

1. Ghafoor, A., Qadir, M. & Murtaza, G. (2004). *Salt-affected soils: principles of management*. Lahore: Allied Book Centre.
2. Maliwal, G.L. & Somani, L.L. (2010). *Nature, properties and management of saline and alkali soils*. Udaipur: Aggrotech Publishing Academy.

Suggested Readings

1. Pessarakli, M. (2010). *Hand book of plant and crop stress* (3rd ed.). NYC: Marcel & Dekker Inc.
2. Pierzynski, G.M., Sims, J.T. & Vance, G.F. (2000). Soils and environmental quality. Boca Raton: CRC Press.
3. Schjonning, P., Elmholt, S. & Christensen, B.T. (2004). *Managing soil quality challenges in modern agriculture*. Cambridge: CABI Publisher.

SAES-7107 **Soil Physics** **3(2+1)**

Soil physics is the study of soil's physical properties and processes. It is applied to management and prediction under natural and managed ecosystems. Soil physics deals with the dynamics of physical soil components and their phases as solids, liquids, and gases. The students will be able to understand soil physical conditions for optimal plant growth. The aim of this course is basically to develop an understanding of the students about the physical properties of soils and apply their knowledge for solving physical degradation problems for the betterment and getting higher yields. Students will become able to understand the importance of physical properties of soil in crop growth and its use for engineering purposes, as well as the role of different tillage practices in crop growth and in the management of water and soil. After this course, students can identify important problems regarding different soil physical properties and address these problems by suitable management practices regarding the physical degradation of soil.

Contents

1. Soil physical properties and inter-relationships
2. Nature and physical behavior of clay and clay minerals
3. Properties of water: Molecular, fluid and colligative
4. Soil water potential and its components
5. Measurement of water in soil, Water characteristics curves: Hysteresis
6. Saturated and unsaturated water flow
7. Infiltration models: Horton, Kostiakov, Green and Ampt, and Philip's: Flow in capillary tubes
8. Free and artificial drainage: Drainage design equations
9. Heat flow in soil: Thermal properties; Factor affecting; heat flow equations
10. Transport of gases and water vapors through soil
11. Solute transport in soil; Solute conservation and convection-dispersion equation
12. Estimation of crop water requirement

Practical

1. Measurement of soil water, soil strength, particle density, soil water characteristic curves
2. Problem sets

Recommended Texts

1. Hillel, D. (1998). *Environmental soil physics*. San Diego: Elsevier.
2. Hillel, D. (2004). *Introduction to environmental soil physics*. San Diego: Elsevier.

Suggested Readings

1. Hillel, D. (2008). *Soil in the environment: crucible of terrestrial life*. Burlington, MA: Elsevier.
2. Jury, W.A. & Horton, R. (2004). *Soil physics* (5^{th} ed.). NYC: Wiley.

SAES-7108 Soil Mineralogy 3(3+0)

Soils are originally from rocks, and their chemical and physical properties mimic these rocks. Because these minerals are small, they dominate the clay portion of the soil. This characterization of soil minerals determines the soil chemical properties, and how fertile it will be. Knowledge of soil mineralogy gives the students an understanding of the nature and properties of soil which provides the basis for the existence of life. Such knowledge enables them to understand many facets of land use including misuse and is often a key to solving specific environmental problems and to conserve the soil for future generations. Soil mineralogy is concerned with the inorganic minerals found in the pedosphere and to the depth of weathering. The study of formation, occurrence, properties, composition and classification of minerals present in the soil is called soil mineralogy. At the end of the course, the students will be able to understand that how minerals greatly affect physical properties, exert a strong impact on chemical processes, and affect soil fertility and productivity through the release of minerals and their subsequent reactions with plant nutrients.

Contents

1. Concept and significance, Chemical and structural classification of soil minerals
2. Carbonate, sulphate, sulphide and phosphate minerals
3. Oxides and hydroxide of Al, Fe and Mn
4. Phyllosilicate in soils: structure and morphological characteristics
5. Kaolin, halloysite and serpentine minerals
6. Allophane and imogolite, Micas: structures, weathering and effect on K availability
7. Vermiculite: structure and properties in relation to K/NH_4
8. Smectites: structure and properties in relation to CEC
9. Chlorites and Inter-stratification in layer silicates
10. Tectosilicates: feldspar, quartz and zeolite
11. Clay mineral economy of Pakistan
12. Impacts of soil minerals composition on environment

Recommended Texts

1. Akhtar, M.S. (2001). *Soil mineralogy*. In: Bashir & Bantel (eds.). Soil Science. Islamabad: National Book Foundation.
2. Brindley, G.W. & Brown, G. (1984). *Crystal structures of clay minerals and their X-ray identification*. London: Mineralogical.

Suggested Readings

1. Dixon, J.B. & Schulze, D.G. (2002). *Soil mineralogy with environmental applications*. Madison : Soil Science Society of America.
2. Brady, N.C. & Weil, R.R. (2009). *Elements of the nature and properties of soils* (3rd ed.). Upper Saddle River, NJ: Pearson

SAES-7109 **Special Problem** **1(1+0)**

The special problem is intended to instruct students on proper techniques for scientific research and methodologies. The students are expected to prepare a directed assignment and collect information and material related to current research interest. The special problem means an assignment that is expected to be temporary and is designated as a special assignment by the academic supervisor in its sole discretion. The main purpose of the special problem is to increase the learning capabilities of students. The more we use our brains, the more they develop. Students learn a lot more when they read or practice something by themselves. Similarly, the purpose of assignments is to increase the practical skills of students. The main objectives of the special problem assigned to students are: to enhance the knowledge of a subject, helps to develop writing skills and to enhance time management and organizing skills. It enhances your planning and organizing skills: The special problem makes you do your work by prioritizing the needs and time frames. It helps you in completing all your tasks very peacefully instead of creating any panic. Scopes for improvement: Special problem writing work gives students a lot of scopes to improve themself.

SAES-7110 **Seminar** **1(1+0)**

The seminar is intended to instruct students on proper techniques for the presentation of scientific material. Each student is expected to prepare and present a scientific seminar and to submit written documentation supporting that seminar. A seminar is a form of academic instruction, either at an academic institution or offered by a commercial or professional organization. It has the function of bringing together small groups for recurring meetings, focusing each time on some particular subject, in which everyone present is requested to participate. Seminars provide a chance to interact with experts from the specific field. Discussing the relevant topics of the particular subject, students tend to learn about the latest information and new skills related to the concerned subject. Seminars are important and beneficial for those who have difficulty learning in a typical classroom setting where reading and writing are required. There is often a sense of friendship associated with seminar attendance because everyone is attending with a like interest in learning about a subject important to them. Attending a seminar has numerous benefits, including improving communication skills, gaining expert knowledge, networking with others and renewing motivation and confidence.

SAES-7111 Soil-Plant Relationship 3(3+0)

Soil is one of the most important national resources of any country. Soils are the natural sites for all terrestrial plants, developing roots in the soil space that anchor them in the soil, and absorbing water, oxygen and nutrients from the soil through their root system. This requires good root ability and distance to bedrock. The course is designed to address the intricacies of soil and plant relations for crop production. The students will be able to understand hypoxia and salinity interactive effect on plant growth and the importance of mycorrhizae, water and nutrient uptake and translocation to aerial parts. Mechanisms of nutrient movement in soils and plants and their relationships with plant growth will be discussed in this course. The students will be able to learn how soil texture and structure greatly affect water infiltration, permeability, and water-holding capacity. The basic soil and plant relationships are important to agricultural products. After completion of this course, the students will be able to understand nutrient movement in soil and plant and adaptation of plants to adverse soil conditions.

Contents

1. Soil-plant-environment relationship
2. Plant root system: growth distribution, forms and factors affecting
3. Root hairs and CEC of roots; shoot-root relationship
4. Rhizosphere: root exudates and factors affecting; pH, redox potential and significance
5. Mycorrhizae: types and mechanisms for water and nutrient uptake
6. Uptake and transport of ions: movement in soil and plant
7. Mechanisms of ion transport across membranes: Ion release into xylem, xylem
8. Water movement from soil to plant root and within plant
9. Water use efficiency and transpiration ratio
10. Water stress, hypoxia and plant growth
11. Mechanisms of salt tolerance; salinity-hypoxia interaction
12. Plant responses and adaptation to extreme environments

Recommended Texts

1. Kirkham, M.B. (2005). *Principles of soil and plant water relations*. San Diego: Elsevier.
2. Marschner, P. (2012). *Marschner's Mineral nutrition of higher plants* (3rd ed.). Orlando: Academic Press.

Suggested Readings

1. Mengel, K & Kirkby, E.A. (2001). *Principles of plant nutrition* (5th ed.). Dordrecht: Kluwer Academic Publishers.
2. Rendig, V.V. & Taylor, H.M. (1989). *Principles of soil-plant inter-relationships*. NYC: McGraw Hill.

SAES-7112 Principle and Applications of Bioremediation 3(3+0)

Bioremediation is a waste management technique that involves the use of organisms to remove or neutralize pollutants from a contaminated site. According to the EPA, Bioremediation is a "treatment that uses naturally occurring organisms to break down hazardous substances into less toxic or non-toxic substances." This course will enable students how organisms are used to neutralize or remove contamination from waste. Different aspects including biodegradation and bioremediation, principles and processes of bioremediation, soil and water pollution and its impact on environment and approaches for the remediation of contaminated sites will be discussed in this course. These organisms would then be able to break down the organic pollutant at a correspondingly faster rate. Bioremediation is often used to help clean up oil spills. At the end of the course, students will be able to understand that how bioremediation provides these pollution-eating organisms with fertilizer, oxygen, and other conditions that encourage their rapid growth.

Contents

1. Biodegradation: Assimilation of nutrients, lag phase, enzyme induction, acclimation, activation
2. Cometabolism: Substrates, enzymes and reaction; Environmental significance
3. Factors affecting biodegradation: Biotic and Abiotic,
4. ioremediation: Advantages/disadvantages, strategies and applications
5. *In Situ* Bioremediation: Land farming, prepared beds and soil piles, bioventing & biosparging
6. Ex Situ Bioremediation: Bioreactors, biofilters, cometabolism, anaerobic process
7. Bioremediation of inorganic pollutants: Biosorption, reduction, solubilization/ oxidation

Recommended Texts

1. Adriano, D.C., Bollag, J.M., Frankenberger, W.T. & Sims, R.C. (1999). *Bioremediation of contaminated soils.* Madison: Agronomy Monograph
2. Alexander, M. (1999). *Biodegradation and bioremediation* (2nd ed.). San Diego: Academic Press.

Suggested Readings

1. Sylvia, D.M., Fuhrmann, J.J., Hartel, P.G. & Zuberer, D.A. (1998). *Principles and applications of soil microbiology.* Upper Saddle River, NJ: Prentice Hall.
2. Hurst, C.J., Crawford, R.L., Knudsen, G.R., McInernery, M.J. & Stetzenbach, L.D. (2002). *Manual of environmental microbiology*. Washington, DC: American Society for Microbiology.
3. Chemical Fixation and Solidification of Hazardous Wastes. (1990). *Printed and produced by Penn*. State Copy Centers and sold at Penn State Bookstore.

SAES-7113 **Soil Ecology** **3(3+0)**

Soil ecology is the study of how soil organisms interact with other organisms and their environment, their influence on and response to numerous soil processes and properties form the basis for delivering essential ecosystem services. The students will be able to understand various microorganisms present in soil and how soils play an important role in all of our natural ecological cycles-carbon, nitrogen, oxygen, water and nutrient. Soil ecology is the study of the interactions among soil biology and between biotic and abiotic. The nature of the substrate, although important in water is especially vital in the terrestrial environment. At the end of the course, the students will be familiar to understand that how soil microorganisms affect soil physical, chemical and microbial properties, transformations of plant materials into the more stable forms of organic compounds that make up the humus which is important to the maintenance of the organic fraction of soil.

Contents

1. Introduction, Viruses, Bacteria, Soil environment, Bacteria and archaea, Fungi, Algae
2. Soil animals, Microbial energetic, Microbial metabolism, Microbial growth and interactions
3. Environmental limits to microbial activity, Soil aggregates, Rhizosphere
4. Soil organic matter composition, Formation of soil organic matter
5. Decomposition and carbon mineralization
6. Composting, Xenobiotic metabolism I, Xenobiotic metabolism II, Nitrogen fixation process
7. Symbiotic nitrogen fixation (S. Boyle), Nitrogen mineralization (S. Boyle)
8. Nitrogen immobilization, Nitrification, Denitrification
9. Trace gases, Sulfur cycle, Phosphorus cycle
10. Mycorhizae I, Mycorrhizae II, Aromatic Nomenclature, Nitrogen cycle
11. Mycorrhizae, Metals

Recommended Texts

1. Barton, L.L. & Northup, D.E. (2011). *Microbial Ecology*. Hoboken: John Wiley.
2. González, M.B.R. & González-López, J. (2014). B*eneficial Plant-microbial Interactions - Ecology and Applications*. Boca Ratoon: Taylor & Francis

Suggested Readings

1. Khan, M.S., Zaidi, A. & Musarrat, J. (2009). *Microbial strategies for crop improvement*. NYC: Springer.
2. Maier, R.M., Pepper, I.L. & Gerba, C.P. (2009). *Environmental microbiology* (2nd ed.). San Diego: Academic Press Inc.
3. Paul, E.A. (2007). *Soil microbiology, ecology and biochemistry* (3rd ed.). Oxford: Elsevier.

STAT-7151 Statistical Methods for Agricultural Research-I 3(3+0)

This course designed for MSc (Hons)/MPhil programs of agriculture sciences. This course provides the applied statistics background for a survey and experimental work in Agriculture. Case studies and critical examples are used to work through commonly experienced research problems (from sampling designs to the ethical consideration) and to explain how they may be approached, solved or prevented with statistical means. The importance of statistical science in agriculture is obvious, where the collection, analysis and interpretation of numerical data are concerned. Statistical principles apply in all areas of experimental work and they have a very important role in agricultural experiments. Statistics play an important role in experimentation. While many scientific problems could be solved by different statistical procedures. Furthermore, some statistical software knowledge will be provided to the students to improve their analytical skills. These activities are further supporting the student's research.

Contents

1. Importance of Statistics in agriculture research.
2. Selection of statistical tools based on scale of measurements.
3. Analysis of Count and Frequency data.
4. Measures of central tendency and dispersion.
5. Some concepts of hypothesis testing. T, Z, Chi-square and F tests. Contingency Tables.
6. Diversity Indices.
7. Concept of ANOVA and its types.
8. Correlation Analysis: Simple correlation, multiple correlation, and Partial correlation.
9. Regression Analysis: Simple and multiple regression.
10. Generalized linear models: logistic regression, Poisson regression, Gamma regression
11. Non-linear regression.
12. Dose Response Curves.

Recommended Texts

1. Montgomery, D. C. (2017). *Design and analysis of experiments* (9th ed.). New York: Wiley.
2. Rao, G. N. (2007). *Statistics for agricultural sciences* (2nd ed.). New Delhi: BS Publication.

Suggested Readings

1. Lawal, B. (2014). *Applied statistical methods in agriculture, health and life sciences*. NYC: Springer.
2. Sahu, P. K. (2016). *Applied statistics for agriculture, veterinary, fishery, dairy and allied fields*. NYC: Springer.
3. Gbur, E. E., Stroup, W. W., McCarter, K. S., Durham, S., Young, L. J., Christman, M., West, M. & Kramer, M. (2012). *Analysis of generalized linear mixed models in the agricultural and natural resources sciences*. NYC: Soil Science Society of America.

PhD
SOIL SCIENCES

SAES-8101 Advanced Soil Chemistry 3(3+0)

Soil chemistry is the branch of soil science that deals with the chemical composition, chemical properties, and chemical reactions of soils. Soil reactions and processes occur over a wide range of spatial and temporal scales. Soil chemistry is concerned with the chemical reactions and processes involving these phases. This course aims to teach students regarding the concept of soil chemistry, soil composition and electrochemical potentials, colloidal chemistry of inorganic constitutes and impact of soil reactions on mineral nutrient availability. Chemical properties of the soil are important to soil fertility and plant growth. After this course, students will be able to understand soil chemistry and soil formations, need for acidic soil reaction, chemical characterization of saline and sodic soil, nature of clay and organic complex and its impact on soil fertility. The students will also be able to learn how soil chemical properties are interlinked with soil biology and soil physical parameters.

Contents

1. Chemical thermodynamics of soils: Processes and variables
2. Chemical potentials: Metal oxides, hydroxides and silicates clays
3. Kinetics of soil chemical reactions, Precipitation and dissolution in soil environment
4. Surface electro-chemistry of colloids: Sorption of trace metal ions; Selectivity and pH
5. Inter-particles attraction: Solid-solid and solid-liquid interaction
6. Chemistry of submerged soils, Chemical transformations of selective elements in soils
7. Contamination of soils with organic and inorganic pollutants
8. Risk assessment of trace metals in soil and water
9. Integrated management of polluted environment
10. Sorption theory: Description and application for decontamination of soils and water
11. Recent developments in soil and environmental chemistry
12. Systems for waste water treatment: Physical, chemical and bio-chemical

Recommended Texts

1. Conklin, J.A.R. (2005). *Introduction to soil chemistry analysis and instrumentation*. NYC: Wiley.
2. Kumar, A. (2004). *Environmental contamination and bio-reclamation.* New Delhi: APH Publishing Corporation.

Suggested Readings

1. Schjonning, P., Elmholt, S. & Christensen, B.T. (2004). *Managing soil quality challenges in modern agriculture*. Cambridge: CABI Publisher.
2. Sparks, D.L. (2003). *Environmental soil chemistry* (2nd ed.). San Diego: Academic Press.
3. Sposito, G. (2003). *The chemistry of soils* (2nd ed.). *Oxford: Oxford University Press.*

SAES-8102 Advanced Soil Fertility 3(3+0)

Soil fertility refers to the ability of soil to sustain agricultural plant growth, i.e. to provide plant habitat and result in sustained and consistent yields of high quality. This course will enable the students to get an understanding of soil fertility and plant nutrition, management techniques for improving nutrient use efficiency as well as interactions of plant nutrition with plant diseases. It is necessary to increase crop yields and maintain good crop quality for the expanding world population. This can only be accomplished if there is a good understanding of the factors affecting the nutrient contents of plants. This course covers the mechanisms of controlling nutrient uptake, translocation and accumulation by plants. There is also some discussion of soil factors controlling the supply and availability of nutrients for the plants. The effect of good plant nutrition and increasing plant resistance and tolerance to diseases will also be discussed in this course.

Contents

1. Growth expression: Mitscherlich and Quadratic equations
2. Plant responses to applied nitrogen: Mathematical description
3. Stubble management and N availability, Effect of forms nitrogen on plant growth
4. Ammonia absorption, losses and toxicity
5. Phosphate phase equilibria in soils: Dissolution, precipitation, retention reaction at microsites:
6. Reaction products and changes in applied P, Soil phosphate buffering capacity and availability
7. Potassium equilibria in soil: Quantity/intensity relationship and availability
8. Modeling nutrient uptake by plants, Modeling nutrient losses
9. Nutrition and plant disease interactions, Mineral nutrition of horticultural plants
10. Modern concept in soil fertility: Hydroponics, tunnel farming and roof top / pot culture
11. Formulation of fertilizer recommendations, Integrated plant nutrient management system
12. Soil variability and its control in field experiments

Recommended Texts

1. Barker, A.V. & Pilbeam, D.J. (2007). *Handbook of Plant Nutrition*. Boca Raton: CRC Press.
2. Bhatti, A.U. (2005). *Spatial Variability & its Management in Agriculture*. Higher Education Commission, Islamabad, Pakistan.

Suggested Readings

1. Elsworth, L. & Relay, W.O. (2009). *Fertilizers: properties, applications and effects*. NYC: Nova Science Publication.
2. Havlin, J.L., Tisdale, S.L, Nelson, W.L. & Beaton, J.D. (2013). *Soil fertility and fertilizers: an introduction to nutrient management (8th ed.).* Upper Saddle River, NJ: Pearson.
3. Mengel, K. & Kirkby, E.A. (2001). *Principles of plant nutrition (5th ed.).* Berlin: International Potash Institute.

SAES-8103 Advanced Soil Microbiology 3(3+0)

Soil microbiology is the study of microorganisms in the soil, their functions, and how they affect soil properties. It is believed that between two and four billion years ago, the first ancient bacteria and microorganisms came about on Earth's oceans. This course is designed to introduce the concept and significance of advanced soil microbiology for agriculture students at the postgraduate level. Factually, this subject is practically more informative for expanding the study of earth, water, and air systems, including the interaction of indigenous microbes with organic and inorganic pollutants, the behavior of pathogens introduced into these systems and the discovery and application of new microbes and their products to benefit human health and welfare. There will be a number of examples used in this course to illustrate important learning points. The main objective of the course is to create an understanding of the essential role played by microorganisms in both environmental deterioration and the control of pollution. This course will be helpful to a wide range of soil science scholars and will stimulate students to new and original approaches to environmental challenges relating to soil microbiology.

Contents

1. Advances in soil and environmental microbiology
2. Microbiology of the terrestrial and aquatic environment
3. Organic pollutants: Sources and types, biodegradation and bioremediation
4. Biotransformation of metal pollutants
5. Metabolic and nucleic acid-based analysis of soil microbial diversity:
6. Extraction of bacterial DNA from soil, Recombinant DNA techniques, PCR
7. Recent trends and approaches in soil and environmental microbiology
8. Soil enzymes and their role

Recommended Texts

1. Barton, L.L. & Northup, D.E. (2011). *Microbial ecology*. Hoboken: John Wiley.
2. González, M.B.R. & González-López, J. (2014). *Beneficial plant-microbial interactions- ecology and applications*. Boca Ratoon: Taylor & Francis.

Suggested Readings

1. Khan, M.S., Zaidi, A. & Musarrat, J. (2009). *Microbial strategies for crop improvement*. NYC: Springer.
2. Maier, R.M., Pepper, I.L. & Gerba, C.P. (2009). *Environmental microbiology* (2nd ed.). San Diego: Academic Press Inc.
3. Paul, E.A. (2007). *Soil microbiology, ecology and biochemistry* (3rd ed.). Oxford: Elsevier.

SAES-8104 Advanced Soil Physics 3(3+0)

Soil physics is the study of soil's physical properties and processes. It is applied to management and prediction under natural and managed ecosystems. Soil physics deals with the dynamics of physical soil components and their phases as solids, liquids, and gases. The aim of this course is basically to develop understanding among the students about the physical properties of soils and apply their knowledge for solving physical degradation problems. This course will help in understanding the behavior of soil physical properties in supporting the crop growth and engineering uses. After the course, students will become able to understand the importance of physical properties of soil in crop growth and its use for engineering purposes, coupled with the role of different tillage practices in crop growth and management of water and soil, identify important problems regarding different soil physical properties and identify the management practices regarding physical degradation of soil.

Contents

1. Water flow equations and their applications
2. Thermodynamic potentials and chemical potential of soil water
3. Use of models for artificial drainage and factors influencing drainage
4. Heat flow equations: Application and calculations
5. Application of gas flow equations
6. Pollutant transport in soil environment: Analytic solutions of the CDE model
7. Mobile-immobile water flow model for solute transport
8. Behavior assessment model for pesticide and hormones transport
9. Application of soil physics for remediation of hazardous wastes
10. Spatial variability analysis of soil properties and significance
11. Analysis of frequency distribution
12. Techniques for characterizing variability
13. Irrigation water scheduling; Water balance; Old and modern concepts of irrigation
14. Irrigation and water use efficiency
15. Calculation of evapo-transpiration by various methods

Recommended Texts

1. Bhatti, A.U. (2005). *Spatial variability and its management in agriculture*. Islamabad: Higher Education Commission.
2. Hillel, D. (1998). *Environmental soil physics*. San Diego: Academic Press Inc.

Suggested Readings

1. Hillel, D. (2008). *Introduction to environmental soil physics*. San Diego: Elsevier.
2. Hillel, D. (2008). *Soil in the environment: crucible of terrestrial life*. Burlington, MA: Elsevier.

SAES-8105 Advanced Research Methods and Technical Writing 3(3+0)

Research is the process of solving problems and finding facts in an organized way. Sometimes, Research is used for challenging or making a contribution to generalizable knowledge. Research is "creative and systematic work undertaken to increase the stock of knowledge, including knowledge of humans, culture and society, and the use of this stock of knowledge to devise new applications." It involves the collection, organization, and analysis of information to increase our understanding of a topic or issue. The aim of this course is basically to develop awareness and understanding among the students about the write up of technical reports, synopsis and thesis and scientific projects. The precise learning of this course will enable the students to achieve these tasks successfully. This will in turn help to develop research aptitude among the post-graduate students which will go a long way in their practical carrier. Problem-oriented research plan, execution and documentation of research results will be discussed. The students will be able to search literature, plan and execute research projects and publish research reports.

Contents

1. Research: Definition, types and phases
2. Inductive and deductive approaches of research
3. Literature review: Sources of scientific information and data basis
4. Hypothesis development, Research protocol and methodologies
5. Methods and ways to control plagiarism
6. Writing of research proposal
7. Project execution: Data collection, handling, analyzing and presentation
8. Project report writing, Writing scientific paper
9. Preparation of scientific presentation
10. Ethics in research and scientific writing

Recommended Texts

1. Bates, D.J. (1994). *Writing with precision*. Washington: Acropolis Books.
2. Blaxter, L., Hughes, C. & Tight, M. (2002). *How to research* (2nd ed.). New Delhi: Viva Books.

Suggested Readings

1. Greenfield, T. (2002). *Research methods for postgraduates*. Oxford: Oxford University Press.
2. Little, M.T. & Hills, F.J. (1978). *Agricultural experimentation: design and analysis*. NYC: Wiley.
3. Luellen, R.W. (2002). *Fine-tuning your writing*. Madison: Wise Owe Publishing Company.

SAES-8106 Advanced Techniques in Bioremediation 3(3+0)

Bioremediation is a waste management technique that involves the use of organisms to remove or neutralize pollutants from a contaminated site. According to the EPA, Bioremediation is a "treatment that uses naturally occurring organisms to break down hazardous substances into less toxic or non-toxic substances." This course will enable students how organisms are used to neutralize or remove contamination from waste. Different aspects including biodegradation and bioremediation, principles and processes of bioremediation, soil and water pollution and its impact on environment and approaches for the remediation of contaminated sites will be discussed in this course. These organisms would then be able to break down the organic pollutant at a correspondingly faster rate. Bioremediation is often used to help clean up oil spills. At the end of the course, students will be able to understand that how bioremediation provides these pollution-eating organisms with fertilizer, oxygen, and other conditions that encourage their rapid growth.

Contents

1. Terminology and definitions, Regulatory Background
2. Characteristics of wastes, Non-radioactive wastes
3. Inorganic wastes, Organic wastes, Mixed wastes, Radioactive wastes
4. Inorganic wastes, Organic wastes, Mixed wastes
5. Characterization and Identification of contaminated sites
6. Technologies for remediation
7. Established technologies: Principles and practices, Solidification/stabilization
8. On-site incineration, Off-site incineration
9. Innovative technologies: Principles and practices
10. Vacuum extraction, *Ex-situ* bioremediation
11. *In-situ* bioremediation, Soil washing
12. *In-situ* flushing, *In-situ* vitrification, Solvent extraction, Dechlorination
13. Chemical treatment, *Ex-situ* supercritical oxidation

Recommended Texts

1. Adriano, D.C., Bollag, J.M., Frankenberger, W.T. & Sims, R.C. (1999). *Bioremediation of contaminated soils*. Madison: SSSA, Agronomy Monograph.
2. Alexander, M. (1999). *Biodegradation and bioremediation* (2nd ed.). San Diego: Academic Press.

Suggested Readings

1. Sylvia, D.M., Fuhrmann, J.J., Hartel, P.G. & Zuberer, D.A. (1998). *Principles and applications of soil microbiology*. Upper Saddle River, NJ: Prentice Hall
2. Hurst, C.J., Crawford, R.L., Knudsen, G.R., McInernery, M.J. & Stetzenbach, L.D. (2002). *Manual of environmental microbiology*. Washington: American Society for Microbiology.

SAES-8107 Integrated Nutrient Management 3(3+0)

Integrated Nutrient Management refers to the maintenance of soil fertility and of plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all possible sources of organic, inorganic and biological components in an integrated manner. The students will be able to diagnose deficiency and toxicity symptoms of different nutrients in plants. In the agricultural sciences, integrated nutrient management played an important role during the 20th century in increasing crop yields. Currently, the importance of this field is increasing day by day due to limited natural resources (land and water), the need for more sustainable agricultural systems, and concern about environmental pollution. It is evident that for optimum crop productivity the soil nutrient status should be maintained by appropriate and efficient nutrient management strategies by coupling organic and inorganic sources. After learning this course students will be able to know the role of various nutrients in soil and plant and the benefits of using organic and inorganic nutritional sources.

Contents

1. Introduction, Soil-Plant Relationships
2. Nutrient forms, transformations and plant availability as influenced by chemical and biological
3. Nitrogen, Phosphorus, Potassium, Sulfur, Calcium, Magnesium
4. Micronutrients
5. Soil Acidity and Alkalinity, Soil pH and management of acid and alkaline soils
6. Characteristics and use of fertilizers and soil amendments
7. Soil testing procedures, application for soil fertility management
8. Soil Fertility Evaluation, Fundamentals of Nutrient Management,
9. Nutrients, Water & Interactions, Economics of Plant-Nutrient Use

Recommended Texts

1. Barker, A.V. & Pilbeam, D.J. (2007). *Handbook of plant nutrition. Boca Raton:* CRC Press.
2. Bhatti, A.U. (2005). *Spatial variability and its management in agriculture*. Islamabad: Higher Education Commission.

Suggested Readings

1. Elsworth, L. & Relay, W.O. (2009). *Fertilizers: properties, applications and effects*. NYC: Nova Science Publication.
2. Havlin, J.L., Tisdale, S.L, Nelson, W.L. & Beaton, J.D. (2013). *Soil fertility and fertilizers: an introduction to nutrient management* (8th ed.). Upper Saddle River, NJ: Pearson.

SAES-8108 Organic Agriculture 3(2+1)

Organic Agriculture is a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effect. The students will be able to understand how organic agriculture reduces human and animal health hazards by reducing the level of residues in the product. Organic agriculture helps in maintaining environmental health by reducing the level of pollution. It helps in keeping agricultural production at a higher level and makes it sustainable. Different natural methods like crop rotation, biological pest control, compost etc. will be discussed. At the end of the course, students will be able to implement their knowledge in the field and give recommendations to farmers about the use of fertilizers as well as pesticides by following the dosage limitations strictly.

Contents

1. The roots of organic agriculture, Soil organic matter and plant health,
2. Nutrient management opportunities and challenges, Biodynamic farming,
3. Community Supported Agriculture (CSA), Growing to the market,
4. The role of research in organic agriculture,
5. Cooperative distribution and marketing of organic produce,
6. Organic Forage and Livestock Production,
7. Soils and Nutrient Cycling, Organic Crop Production,
8. Organic Agriculture Case Study, Organic Agriculture Profession,
9. Organic Farming Work Placement, Issues in Organic Agriculture,
10. Marketing and Business Management in the Organic Agriculture Sector

Practical

1. Comparison of organic residues,
2. Residue quality assessment on the basis of lignin content,
3. C/N ratio in relation to nutrient decomposition and mineralization

Recommended Texts

1. Barker, A.V. & Pilbeam, D.J. (2007). *Handbook of plant nutrition*. Boca Raton: CRC Press.
2. Bhatti, A.U. (2005). *Spatial variability and its management in agriculture*. Islamabad: Higher Education Commission.

Suggested Readings

1. Elsworth, L. & Relay, W.O. (2009). *Fertilizers: properties, applications and effects*. NYC: Nova Science Publication.
2. Havlin, J.L., Tisdale, S.L, Nelson, W.L. & Beaton, J.D. (2013). *Soil fertility and fertilizers: an introduction to nutrient management* (8^{th} ed.). Upper Saddle River, NJ: Pearson.

SAES-8109 **Special Problem** **1(1+0)**

The special problem is intended to instruct students on proper techniques for scientific research and methodologies. The students are expected to prepare directed assignments and collect information and material related to current research interest. The special problem means an assignment that is expected to be temporary and is designated as a special assignment by the academic supervisor in its sole discretion. The main purpose of the special problem is to increase the learning capabilities of students. The more we use our brains, the more they develop. Students learn a lot more when they read or practice something by themselves. Similarly, the purpose of assignments is to increase the practical skills of students. The main objectives of the special problem assigned to students are: to enhance the knowledge of a subject, helps to develop writing skills and to enhance time management and organizing skills. It enhances your planning and organizing skills: The special problem makes you do your work by prioritizing the needs and time frames. It helps you in completing all your tasks very peacefully instead of creating any panic. Scopes for improvement: Special problem writing work gives students a lot of scopes to improve themself.

SAES-8110 **Seminar** **1(1+0)**

The seminar is intended to instruct students on proper techniques for the presentation of scientific material. Each student is expected to prepare and present a scientific seminar and to submit written documentation supporting that seminar. A seminar is a form of academic instruction, either at an academic institution or offered by a commercial or professional organization. It has the function of bringing together small groups for recurring meetings, focusing each time on some particular subject, in which everyone present is requested to participate. Seminars provide a chance to interact with experts from the specific field. Discussing the relevant topics of the particular subject, students tend to learn about the latest information and new skills related to the concerned subject. Seminars are important and beneficial for those who have difficulty learning in a typical classroom setting where reading and writing are required. There is often a sense of friendship associated with seminar attendance because everyone is attending with a like interest in learning about a subject important to them. Attending a seminar has numerous benefits, including improving communication skills, gaining expert knowledge, networking with others and renewing motivation and confidence.

SAES-8111 Soil Quality and Management 3(3+0)

Soil quality is how well soil does what we want it to do. More specifically, soil quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation. After studying this course, the students will be able to understand basic principles of soil quality and learn to assess and evaluate soil quality parameters related to agricultural production and environmental quality including soil resilience capabilities and its conservation. It is primarily important to learn about the management of soil quality because it is the soil upon which all types of life (plant, animal and human) depends on for food availability. Soil quality is the capacity of the soil to function within the ecosystem boundaries to sustain biological productivity and maintain environmental quality. After sustaining soil quality, food security can be assured which will provide a guarantee for a healthy and prosperous society. Soil fertility and productivity can be achieved only through the management of soil quality.

Contents

1. Soil quality and its assessment: Indicators and guidelines
2. Soil management in contrasting environments
3. Maintenance of soil productivity
4. Impact of vegetation change on soils
5. Nutrient cycles in relation to soils with special reference to carbon and nitrogen cycles
6. Soils as a source or sink of greenhouse gases
7. Soil conservation and carbon dynamics
8. Biological diversity and ecosystem function in soils
9. Soil resilience and conservation: Concept, importance, classification, indicators and management

Recommended Texts

1. lanco-Canqui, H. & Lal, R. (2008). *Principles of soil conservation and management*. Berlin: Springer.
2. Frossard, E., Blum, W.E.H. & Warkentin, B.P. (2006). *Function of soils for human societies and the environment*. London: Geological Society.

Suggested Readings

1. Fullen, M.A. & Catt, J.A. (2004). *Soil management: problems and solutions*. London: Arnold Publishers.
2. White, R.E. (2005). *Principles and practice of soil science*: (4th ed.). The Soil as a Natural Resource.
3. Pepper, L., Gerba, C. & Brusseu, M. (2006). *Environmental and pollution science* (2nd ed). San Diego: Elsevier.

SAES-8112 Nutrient Acquisition and Transport 3(3+0)

There are twenty-one nutrients that are essential for plant growth and development. Thirteen are absorbed by the roots. After taken in by the roots, the nutrients move into the plant and are used for various functions and processes. Nutrient absorption and utilization are not a simplistic process. There are essentially two phases. First, the nutrient must reach the root surface. Then, it must move into cells of the plant. This course will create awareness among the students about the mineral nutrient availability, transport and acquisition in the plant body. This course will highlight the kinetics of nutrient uptake by plant cells and the molecular biology of nutrient transporters in plant membranes. In addition, the students will be equipped with pre-requisite knowledge of potassium, sulfate, phosphate and nitrogen transport in plants. This will in turn help to the mechanism of nutrient long-distance transport in xylem and phloem tissue. The nutrient is the chemical elements that affect the metabolism of the plant, which results in the vegetative and reproductive growth of the plant body.

Contents

1. oot architecture, soil-root interaction and nutrient acquisition
2. Relation between transpiration and nutrient uptake
3. Role of cell wall in nutrient uptake
4. Nutrient transport in root and nutrient uptake mechanism
5. Membrane transport of nutrients and different ion channels; P-type, F-type and V-type
6. ATPases; Cation and anion channels
7. Plasma membrane H+-ATPase, Physiology and molecular biology
8. Role of plasma membrane H+-ATPase, Nutrient uptake, apoplastic pH and P acquisition
9. Plant approaches to acquire macro- and micronutrients
10. Sodium acquisition and transport in plant, Redox potential and nutrient acquisition
11. Plant nutrient-acquisition strategies and soil aging

Recommended Texts

1. Ae, N., Arihara, J., Okada, K. & Srinivasan, A. (2001). *Plant nutrient acquisition. new perspectives*. Berlin: Springer.
2. Bassirad, H. (2005). *Nutrient acquisition by plant*: *an ecological perspective*. Berlin: Springer.

Suggested Readings

1. Marschner, P. (2011). *Marschner's mineral nutrition of higher plants* (3rd ed.). London: Academic Press.
2. Rengel, Z. (2002). *Hand book of plant growth*. NYC: Marcel Dekker.
3. Sohi, S., Lopez-Capel, E., Krull, E. & Bol, R. (2009). *Biochar, climate change and soil: a review to guide future research*. CSIRO Land and Water Science Report, Centre for Bioenergy and Climate Change, Harpenden, UK.

SAES-8113 Biochar: Concept and Application 3(3+0)

Biochar is an organic matter that has undergone combustion under low to no oxygen conditions (i.e. pyrolysis) resulting in a recalcitrant, high carbon material specifically for use as a soil amendment. Recently, fervent interest in the production of biochar to address issues of fertility, water holding capacity, remediation, climate change mitigation, etc., led to a much greater understanding of the complexities of this potential amendment in altering soil biological, chemical, and physical properties. After learning this course students will be able to understand biochar, its production technology, the impact of biochar on climate change, the economics of biochar production and utilization. The effects of biochar on soil nutrient transformations and soil fertility will also be discussed. The students will be able to understand how the application of biochar improves soil productivity. As a soil amendment, biochar helps to improve the earth's soil resource by increasing productivity and crop yields, reducing soil acidity, reducing the need for some chemical and fertilizer inputs and potentially providing other soil benefits.

Contents

1. Background and introduction of biochar
2. Physical, chemical and biological properties of biochar
3. Impact of biochar on soil properties, Change and stability of biochar in soil
4. Biochar and soil nutrient transformations, Biochar and climate change
5. Biochar and emission of greenhouse gases, Biochar production technology
6. Economics of biochar production and utilization
7. Socio-economic assessment of biochar projects
8. Some essential concepts for commercial success of biochar

Recommended Texts

1. Bates, A. (2010). *The biochar solution: carbon farming and climate change*. Gabriola Island: New Society Publishers.
2. Lehmann, J. & Joseph, S. (2009). *Biochar for environmental management: science and technology*. London: Earthscan.

Suggested Readings

1. Verheijen, F.G.A., Jeffery, S., Bastos, A.C., van der Velde, M. & Diafas, I. (2010). *Biochar application to soils: A critical scientific review of effects on soil properties, processes and functions*. Luxembourg: Official Publications.
2. Marschner, P. (2011). *Marschner's mineral nutrition of higher plants* (3rd ed.). London: Academic Press.

SAES-8114 Waste Water Impact on Soil Health 3(2+1)

Water quality is defined by several parameters known as physical, chemical and biological. The quality of the water resources is vulnerable to a wide range of chemical components including organic pollutants, salts, nutrients heavy metals, sediments, etc. Wastewater reuse as agriculture water is increasing international interest. The aim of this course is basically to develop an understanding of students why municipal and agro wastewater management or control is needed to preserve precious environmental resources and to improve the environmental quality. Water is a fundamental natural resource with the point of view of crop production. Knowledge regarding the types and extent of municipal and agro wastes water generation will be discussed. The students will be able to learn that how the amount of damage to a particular medium (air, water, land) varies according to the type of waste, the amount of waste and disposed of. The course will enable the students to perceive knowledge that how waste water is damaging soil physical, biological and chemical properties.

Contents

1. Definition and types of waste water
2. Sources of waste water
3. Chemical composition of waste water
4. Impact of waste water on physical properties of soil
5. Impact of waste water on chemical properties of soil
6. Impact of waste water on biological properties of soil

Practical

1. Collection of waste water from different sources
2. Analysis of waste water for heavy metals
3. Analysis of waste water for critical levels of deleterious pathogens.

Recommended Texts

1. Ashfar, M. & Saleem, M.A. (2010). *Environmental pollution and agriculture*. Lahore: Pak Book Empire.
2. Asthana, D.K. & Asthana, M. (2003). *Environment problems and solutions*. New Delhi: Chand & Co.

Suggested Readings

1. Cheremisioff, N.P. (2002). *Handbook of solid waste management and waste minimization technologies*. Burlington: Elsevier.
2. Clinic, C., Ignazio, M. & Lodovica, G.M. (2008). *Sustainable development and environmental management*: *experiences and case studies* (1st ed.). Dordrecht: Springer.
3. Cunningham, W.P., Cunningham, M.A. & Saigo, B.W. (2007). *Environmental science: a global concern* (9th ed.). NYC: McGraw Hill.

STAT-8131 Statistical Methods for Agricultural Research-II 3(3+0)

This course designed for PhD programs in agriculture sciences. Modern agricultural production is characterized by some particularities and many different activities. So, it arises from different problems and different nature of agricultural materials data which require different approaches to the use of statistical methods. Statistics is a discipline which mainly deals with data quantifications. Even in the case of nonnumerical data, statistical methods use transformations to change nonnumerical data to numerical data, with the aim of achieving some level of quantification to make conclusions about the matter of interest. Many data in agriculture are of a numerical character which are accompanied with the existence of the variability of data. Statistics can be used as a tool for agricultural research. For these reasons "statistics can, however, help the research worker to design his experiments and to evaluate objectively the resulting numerical data". So, this course is mainly focused on the advanced design of experiment tools which will be helpful to find out the factors of output related to agriculture experiments. Moreover, students will also learn some statistical software like Minitab, R, Design Expert etc. to analyze their experimental data. The knowledge of statistical software will improve the computational and analytical skills of the students.

Contents

1. Basic principles of experimental design.
2. Layout analysis of CRD, RCBD, Latin Square Designs.
3. Estimation of Missing Observations in RCBD and Latin Square Design.
4. BIBD, PBIBD, Split plot Designs and its variations.
5. Multiple comparison tests, Effect of violation of assumptions of underlying ANOVA.
6. Factorial Experiments, 2n, 3n… Pn, Mixed levels factorial experiments.
7. Confounding and its types. Fractional replication. Application and construction of contrasts.
8. Response surface methodology, Introduction of multivariate analysis.
9. Principle component analysis, Factor analysis
10. Cluster Analysis, Correspondence analysis.

Recommended Texts

1. Muhammad, F. (2000). *Statistical methods and data analysis*. Lahore: Ilmi Kitab Khana.
2. Montgomery, D. C. (2017). *Design and analysis of experiments* (9^{th} ed.). NYC: Wiley.

Suggested Readings

1. Box, G. E. P., W. G. & Hunter, J. S. (1978). *Statistics for experimenters*. New York: Wiley.
2. Dillon, W. R. & Goldstein, M. (1984). *Multivariate analysis: methods and applications*. New York: Wiley.
3. Cox, D. R. (2000). *The theory of the design of experiments*. NYC: Chapman Hall.