COURSE OUTLINE BRIEFS

DEPARTMENT OF PLANT BREEDING AND GENETICS

SARGODHA UNIVERSITY
Pathway to Progress

FACULTY OF AGRICULTURE

OVERVIEW

The Department of Plant Breeding and Genetics, the College of Agriculture, is one of the most important and oldest departments of the University and has a luminous history in training manpower and conducting scientific agricultural research. It aims at training manpower for the integrated use of conventional and modern biotechnological techniques for breeding varieties of different crops.

The Plant Breeding and Genetics became full fledge department in January 2012.Currently, the Department has produced four PhD scholars, 52 MSc (Hons) Agriculture major PBG and 107 BSc (Hons) Agriculture graduates.

The Department is equipped with highly qualified faculty and PBG Lab. In addition to academic activities, the teaching staff is also involved in research activities for the genetic improvement of different crops like wheat, maize, sunflower, pulses, and different fodder crops through classical breeding, mutation and biotechnology at graduate- and post-graduate levels.

This Department is a place of career opportunities and has the potential to fight against poverty by introducing multi-purpose crop varieties and improved plant genotypes with an objective to optimize diverse traits controlling yield and quality.

Academic Programs Offered

1. BSc (Hons) Agriculture (Major in Plant Breeding and Genetics)
2. MSc (Hons) Plant Breeding and Genetics
3. PhD Plant Breeding and Genetics

BSc (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)/ 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)
PLBG-6203	Principles of Genetics	3(2+1)
PLBG-6204	Breeding Field Crops	3(2+1)
PLBG-6205	Cytogenetics	3(2+1)
PLBG-6206	Fundamentals of Plant Biometry	3(2+1)
PLBG- 6207	Breeding Cereal Crops	3(2+1)

Semester-VI

PLBG-6208	Breeding Fibre Crops	3(2+1)
PLBG-6209	Breeding Sugar Crops	3(2+1)
PLBG-6210	Breeding Maize and Millets	3(2+1)
PLBG-6211	Biodiversity and Plant Genetic Resources	3(3+0)
PLBG-6212	Molecular Genetics	3(2+1)

Semester-VII

PLBG-6213	Breeding Oilseed Crops	3(2+1)
PLBG-6214	Breeding Pulse Crops	3(2+1)
PLBG-6215	Breeding Vegetable Crops	3(2+1)
PLBG- 6216	Modern Techniques in Plant Breeding	3(2+1)
PLBG-6217	Experimentation in Plant Breeding	3(2+1)
PLBG-6218	Fundamentals of Research & Scientific Writing	2(1+1)

Semester-VIII

AGEC-6523	Agribusiness, Marketing and Trade	3(3+0)
PLBG-6219	Breeding Fodder and Forage Crops	3(2+1)
PLBG-6220	Breeding Minor Crops	2(1+1)
PLBG-6221	Crop Variety Registration and Intellectual Property Rights	2(2+0)

PLBG 6222	Genomics in Agriculture	2(1+1)
PLBG-6223	Research Project / Internship	4(0+4)

MSc (Hons) Plant Breeding and Genetics

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: 02 Year Program (04 Semesters)
Degree Requirements: Minimum 30 Credit Hours (24 Credit Hours of Course Work+ 06 of Dissertation)

PLBG 7101	Principles of Plant Breeding	3(2+1)
PLBG 7102	Advanced Genetics	3(3+0)
PLBG 7103	Molecular Plant Breeding	3(2+1)
PLBG 7104	Cytogenetics of Crop Plants	3(2+1)
PLBG-7105	Breeding and Genetics of Fodder Crops	3(2+1)
PLBG-7106	Mutation Breeding	3(2+1)
PLBG-7107	Cotton Genetics and Breeding	3(2+1)
PLBG-7108	Genetics and Breeding of Sugar Crops	3(2+1)
PLBG-7109	Special Problem	1(1+0)
PLBG 7110	Seminar	1(1+0)
PLBG-7111	Genetic Engineering in Plants	3(2+1)
PLBG-7112	Genetics of Plant Disease and Insect Resistance	3(2+1)
PLBG-7113	Development of Hybrid and Seed Production	3(2+1)
PLBG-7114	Biometrical Techniques in Plant Breeding	3(2+1)
STAT-7151	Statistical Methods for Agricultural Research-I	3(3+0)

PhD Plant Breeding and Genetics

Eligibility: MPhil/MS Plant Breeding and Genetics in the relevant field from HEC recognized institution with at least CGPA 3.00 out of 4.00.
Duration: 03-05 Year Program (06-10 Semesters)
Degree Requirements: 18 Credit Hours Course Work + Dissertation

PLBG-8101	Breeding for Stress Environments	3(2+1)
PLBG-8102	Population Genetics	3(3+0)
PLBG-8103	Cereal Genetics and Breeding	3(2+1)
PLBG-8104	Genetics and Breeding of Oilseed Crops	3(2+1)
PLBG-8105	Evolution of Field Crops	3(3+0)
PLBG-8106	Advanced Cytogenetics	3(3+0)
PLBG-8107	Plant Genomics	3(2+1)
PLBG-8108	Advanced Methods in Plant Breeding	3(2+1)
PLBG-8109	Special Problem	1(1+0)
PLBG 8110	Seminar	1(1+0)
STAT-8152	Statistical Methods for Agricultural Research-II	3(3+0)

BSc
(Hons)
AGRICULTURE- PLANT BREEDING & GENETICS

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 to the students of agriculture at undergraduate level. It provides information to the students about soil science, its branches, their environmental significance, weathering of rocks and minerals, their classification, physical properties of soil and their significance in agriculture. The course would provide awareness to the students about impact of agricultural and industrial wastes on our environment. In addition, this course also teaches the students, skills to collect soil and water samples for physico-chemical analysis. Laboratory exercises are designed to develop skills for analysis of irrigation water and soil samples which would highlight and support the importance of both water and soil quality analysis for judicious use of resources.

Contents

1. Introduction to Soil and environment
2. Definition of earth, geology and soil science
3. Disciplines of soil science
4. Lithosphere, hydrosphere and biosphere
5. Soil forming rocks and minerals: types and their formation
6. Weathering of rocks and minerals: definition. Agents and classification
7. Parent materials: definition and types
8. Soil formation: definitions, processes and factors
9. Soil profile: definition and description
10. Physical properties of soil and their significance
11. Introduction to soil classification and land use capability classes
12. 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., & Bantel, R. (2001). *Soil Science*. Islamabad: National Book Foundation.
2. Brady, N.C., & Weil, R.R. (2007). *The Nature and Properties of Soils* (14th ed.). New Jersey: Pearson Education.

Suggested Readings

1. Brady, N.C., & Weil, R.R. (2009). *Elements of the Nature and Properties of Soils* (3rd ed.). New Jersey, USA: Pearson Education.
2. Hillel, D. (2008). *Soil in the Environment: Crucible of Terrestrial Life*. Burlington: Elsevier.
3. Das, D.K. (2011). *Introductory Soil Science* (3rd ed.). New Delhi: Kalyani Publications.

AGRO-5901 Basic Agriculture 3(2+1)

Basic Agriculture is a course designed to provide the students with the basic knowledge of agriculture. It will enable the students to understand the basic terminologies of agriculture, its different branches, allied disciplines, salient features of agriculture in Pakistan including climate and land resources. There will be detailed discussions about the various agro-ecological zones of Pakistan. Basic knowledge about agricultural inputs such as seed, fertilizer, irrigation and post-harvest technology would be communicated to the students. The students will be able to understand the conventional and international system of land measurements. 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
3. Climate, land and water resources
4. Agro ecological zones of Pakistan
5. Farming systems
6. Tillage: objectives and types
7. Seed: types and quality
8. Crop nutrients, manures and fertilizers, sources and methods of application
9. Irrigation: systems, types and management
10. Crop protection measures
11. Crop rotation
12. Harvesting, processing, storage and marketing of farm produce
13. Agro-based industries
14. Environmental pollution and health hazards

Practical

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

Recommended Texts

1. Bashir, E. & Bantel, R. (2001), *Soil Science*, Islamabad: National Book Foundation.
2. Brady, N.C., & Weil, R.R. (2013). *Elements of the Nature and Properties of Soils* (3rd ed.). New Jersey: Pearson Education.

Suggested Readings

1. Hillel, D. (2008). *Soil in the Environment: Crucible of Terrestrial Life.* Burlington: Elsevier.
2. Singer, M. J., & Munns, D. N. (2002). *Soils- An Introduction* (5th ed.). New Jersey: Prentice-Hall.

3. Das, D.K. (2011). *Introductory Soil Science* (3rd ed.). New Delhi: Kalyani Publications.

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

The purpose of this course is to produce 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 phenomena (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 the students to investigate the biological molecules, homeostasis in vertebrates, and the influence of hormones on coordination and control systems of 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
2. Nature and scope of biology
3. Branches of biology
4. Relationship between biology and psychology
5. Biological molecules: Carbohydrates, Proteins, Fats, Nucleic acids, Water
6. The cell: Structure and function of cell, Cell organelles, Different types of cells
7. Homeostasis: Osmoregulation, Structure and functions of Nephron, Thermoregulation
8. Coordination and control: Structure and physiology of Neuron
9. Introduction to central and peripheral nervous system
10. Hormones
11. Basics of growth and development
12. Embryonic and post embryonic development

Recommended Texts

1. Campbell, M., & Christopher, J.P. (2016). *Organismal homeostasis*. New York: Momentum press.
2. Snow, A. L., & Leonardo, M. J. (Eds.) (2013). *Immune homeostasis: Methods and protocols*. New York: Humana Press.

Suggested Readings

1. Anna, A. S., & Richard, B. P. (2019). *An Introduction to Conservation Biology* (2nd ed.). Oxford: Oxford University Press.
2. Campbell, N. A., Mitchell, L. G., & Reece, J. B. (2009). *Biology: Concepts and connections* (6th ed.). San Francisco: Addison Wesley Longman.
3. Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Reece, J. B. (2017). *Campbell biology*. New York: Pearson.

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

This course is built upon the mathematical concepts, principles and techniques that are useful in almost all undergraduate programs. The main objectives of the course are to enhance student's competency in application of mathematical concepts in solving problems and to improve their level of quantitative approach. Upon the successful completion of this course students would be able to develop understanding about mathematical functions, building and solving linear and quadratic equations, matrices and determinants with application, sequences and series, and basic financial mathematics. This course has been designed to prepare the students, not majoring in mathematics, but with the essential tools of financial mathematics, algebra and geometry to apply the concepts and the techniques in their respective disciplines. The aim of teaching and learning mathematics is to encourage and enable students to recognize that mathematics permeates the world around us, appreciate the usefulness, power and beauty of mathematics, enjoy mathematics and develop patience and persistence when solving problems.

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: factorization, square completion method & quadratic formula
8. Application of quadratic equation
9. Sequence and Series
10. Types of Sequences; A. P, A. M., G. P., H. P
11. Trigonometric Functions, Trigonometric Applications
12. Graph of Functions and Modelling
13. Limits and Continuity
14. Derivatives, Integration
15. Probability and Binomial Theorem

Recommended Texts

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

Suggested Readings

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

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. The students will learn the basic understanding of computer software, hardware, and associated technologies to get maximum benefit related to their study domain. Students will learn how the information and communications systems can improve their work ability and productivity, how Internet technologies like e-commerce applications and mobile computing can influence the businesses and workplace. At the end of semester, students will get 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 includes Word, Power Point, 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 the course. The course will also cover computer ethics, 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
15. IT Security and other issues
16. Cyber Laws and Ethics of using Social media
17. Use of Microsoft Office tools (Word, Power Point, Excel)
18. Mobile apps or other similar tools
19. Other IT tools/software specific to field of study

Recommended Texts

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

Suggested Readings

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

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

The course seeks to develop a 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 helps 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 English language to comprehend texts as 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 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. Helgesen, M., & Brown, S. (2004). *Active listening: Building skills for understanding*. Cambridge: Cambridge University Press.
2. Mikulecky, B. S., & Jeffries, L. (2007). *Advanced reading power: Extensive reading, vocabulary building, comprehension skills, reading faster*. New York: Pearson.

Suggested Readings

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

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

Islamic Studies is the academic study of Islam and Islamic culture. 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. It engages the students in the study of Islam as a textual tradition inscribed in the fundamental sources of Islam; Qur'an and Hadith, history and cultural contexts. The subject seeks to introduce Islam through a large variety of expressions (literary, poetic, social, and political) and through a variety of methods (literary criticism, hermeneutics, history, sociology, and anthropology). It provides introduction to foundations of Islam 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. It is one of the best systems of education which grooms a person with the qualities which he/she should have as a human being.

Contents

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

Recommended Texts

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

Suggested Readings

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

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 own ethical positions, and think critically and analytically about ethical issues. This course is intended for the students who have 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 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, J. S. LL. D. G. (1983). *A manual of ethics*. London: University Tutorial Press.
2. Nadwi, S. S. (1999). *Ethics in Islam*. Karachi: Darul-Ishaat.

Suggested Readings

1. Cahn, S. M., & Markie, P. (2019). *History, theory, and contemporary issues*. Oxford: Oxford University Press.
2. Williams, B. (1972). *Morality: An introduction to Ethics*. Cambridge: Cambridge University Press.

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

This course will acquaint the students with the basic concepts of Agronomy and crop production. It has been designed to develop understanding among the students about production technology of major and minor field crop 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 crop environment and pests of field crop 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 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
4. Raising of crop nurseries and transplanting
5. Intercultural practices
6. Seed Inoculation
7. Seed treatment with fungicides
8. Demonstration of harvesting and threshing operations
9. Field visits

Recommended Texts

1. Balasubramaniyan, P., & Palaniappan, S. P. (2004). *Principles and practices of agronomy*. Jodhpur: Agrobios.
2. Khalil, I.A., & Jan, A. (2002) *Cropping technology*. Islamabad: National Book Foundation.

Suggested Readings

1. Martin, J.H., Waldren, R.P., & Stamp, D.L. (2006). *Principles of field crop production* (4th ed.). New York: The McMillan.
2. Nazir, M.S., Bashir, E., & Bantel, R. (Eds.) (1994). *Crop production*. Islamabad: National Book Foundation.

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

This course provides information to the students about chemistry of soils especially soil colloids and their environmental significance. How organic matter play a role for enhancing availability of macro and micronutrients from soil environment? This subject also clears the concept of the students about soil pH and its significance regarding nutrients availability from soil to plant. This course also delivers knowledge to the students 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 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
5. Soil pH and its importance
6. Buffering of soil
7. Soil organic matter: sources, composition and significance
8. Elements essential for plant growth: macro and micronutrients, organic and inorganic fertilizers
9. Salt-affected and waterlogged soils: types, reclamation and management
10. Soil erosion: causes and remedies: soil and water conservation
11. 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
3. Soil analysis for EC and pH
4. Determination of soil organic matter

Recommended Texts

1. Bashir, E., & Bantel, R. (2001). *Soil Science*. Islamabad: National Book Foundation.
2. Brady, N.C., & R.R. Weil. (2007). *The Nature and Properties of Soils* (14th ed.). New Jersey: Pearson Education.

Suggested Readings

1. Brady, N.C. & R.R. Weil. (2009). *Elements of the Nature and Properties of Soils* (3rd ed.). New Jersey: Pearson Education.
2. Hillel, D. (2008). *Soil in the Environment: Crucible of Terrestrial Life.* Burlington: Elsevier.
3. Singer, M.J., & Munns, D.N. (2002). *Soils - An Introduction.* (5th ed.). New Jersey: Prentice-Hall.

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

Forest and Watershed management emphasize the understanding of forest resources in relation to 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 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 different biological and engineering approaches to control and regulate water flow and 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.)
7. Watershed Management: Principles, Watersheds of various streams/rivers of Pakistan, their area, distribution, land use patterns, climatic, physiographic, ecological and socio-economic features
8. Hydrological cycle
9. Management problems and potentials of various watersheds, afforestation programmes
10. Watershed as a source of power generation and irrigation
11. 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.* Wallingford: CAB International.
2. Quraishi, M. A. A. (1999). *Basics of Forestry and Allied Sciences*. Lahore: A-One Publishers.

Suggested Readings

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

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

The purpose of this course is to give a brief introduction of Agricultural Extension education at undergraduate level. The students must know the history and philosophy of agricultural education in the development of present era agricultural system across the world. The 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 dissemination of different agricultural technologies.

Contents

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

Recommended Texts

1. Ison, R., & Russell, D. (2004). *Agricultural Extension and Rural Development: Breaking out of Knowledge Transfer Traditions.* Cambridge: Cambridge University Press.
2. Ray, G.L. (2006). *Extension Communication and Management*. New Delhi: Kalyani Publishers.

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.). New Jersey: Wiley-Blackwell.

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

Academic writing is a formal, structured and sophisticated writing to fulfill the requirements for a field of study. The course aims at providing understanding of 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 the 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 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. Bailey, S. (2011). *Academic writing: A handbook for international students* (3rd ed.). New York: Routledge.
2. 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.

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 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 course 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, J. A. (2004). *Pakistan's Political Economic and Diplomatic Dynamics.* Lahore: Kitabistan Paper Products.

Suggested Readings

1. Hayat, S. (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, I. (1998). *Pakistan: A Modern History*. London: Hurst and Company.

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

The course provides an overview of Genetics. Genetics is a field of biology that studies how traits are passed from parents to their offspring. The passing of traits from parents to offspring is known as heredity, therefore, genetics is the study of heredity. This introduction to genetics takes you through the basic components of genetics such as DNA, genes, chromosomes and genetic inheritance. Genetics is built around molecules called DNA. DNA molecules hold all the genetic information for an organism. It provides cells with the information they need to perform tasks that allow an organism to grow, survive and reproduce. A gene is one particular section of a DNA molecule that tells a cell to perform one specific task. Heredity is what makes children look like their parents. During reproduction, DNA is replicated and passed from a parent to their offspring. This inheritance of genetic material by offspring influences the appearance and behaviour of the offspring. The environment that an organism lives in can also influence how genes are expressed.

Contents

1. Definition of genetics, concepts of heredity and variation
2. Cell and cell divisions. Mendelian genetics: chromosome
3. Theory of heredity, 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
6. Multiple factor hypothesis
7. Linkage and crossing over
8. Sex determination: sex-linked and sex influenced traits
9. Chromosomal aberrations
10. Nucleic acids: nature, structure and function
11. Classical vs modern concepts of gene

Practical

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

Recommended Texts

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

Suggested Readings

1. Khan, I.A., Azhar, F.M., Ali, Z., & Khan, A.A. (2008). *Solving Numerical Genetic Problems*. Faisalabad: University of Agriculture.
2. Singh, P. (2003). *Elements of Genetics* (2nd ed.). Delhi: Kalyani Publishers.
3. Stansfield, W.D. (1988). *Theory and Problems of Genetics* (4th ed.). New York: McGraw-Hill Book.

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. 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. The course briefs about the basic external and internal morphological and anatomical features along with their basic functioning principles. Students will learn about the insect classification and nomenclature so that 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 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 with a reference to typical insect, 'ak' grasshopper, *Poekiloceruspictus*
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 (digestive, reproductive, excretory, nervous, circulatory and tracheal systems)
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*. USA: Oxford University Press.

Suggested Readings

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

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. 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 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 and economic importance
2. General characteristics (morphology, reproduction and ecology)
3. Identification of plant pathogens including fungi, prokaryotes, viruses, viroids, nematodes, fungus like organisms and phanerogamic parasites
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 Academic Press.
2. Ahmad, I., & Bhutta, A.R. (2005) *Textbook of introductory Plant Pathology*. Islamabad: NBF Publisher.

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.). India: Tata McGraw Hill Education.
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*. UK: Taylor and Francis.

HORT-5601 Introductory Horticulture 3(2+1)

Students will learn the fundamentals of plant structure and how cells, tissues, organs and whole plants develop and function. Students will then explore how environmental factors affect growth and development, and how humans manipulate them to produce horticultural crops: fruits, vegetables, flowers and landscape plants. Students will learn the division of horticulture and classification of horticultural plants as well as plant parts and their modifications. This course would help understand 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 nursery, establishing an orchard, pruning, training and wind breaks. Taking this course would broaden their vision regarding the horticulture industry at domestic and international level. Labs are designed to emphasize and reinforce the principles covered in lecture and will give students a hands-on introduction to horticulture.

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
5. Climate (temperature, light, humidity etc)
6. Soil (structure, texture, fertility etc)
7. 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. Carrol, L., Shry, J.R., & Reily, H.E. (2011). *Introductory Horticulture* (8th ed.) Albany: Delmar-Thomson Learning.
2. Christopher, E. P. (2012). *Introductory Horticulture*. New Delhi: Biotech books.

Suggested Reading

1. Hartmann, H.T., Kester, D.E., Davies, E.T., & Geneve, R.L. (2009). *Plant Propagation–Principles and Practices* (7th ed.). New Delhi: Prentice-Hall India Learning.
2. Peter, K.V. (2009). *Basics of Horticulture*. New Delhi: New India publishing Agency.

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

The course will introduce the students with knowledge of rangelands and their importance as major land use in Pakistan. Students will be able know the characteristics of rangelands of the country and complexities associated with management of rangelands. The course describes the range ecosystem, its components and types of range vegetation in different ecological zones of the country with 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 principles of scientific management of all the components of range ecosystem and its relationship with wildlife. The key objectives of this course are to introduce 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, basic terminology
2. Components of Rangelands, Constraints and problems of rangelands
3. Rangeland Resources of Pakistan; ecological zones and vegetation types
4. Range ecosystem, Principles of Rangeland Management
5. Grazing systems of the world, Grazing systems and grazing pattern in Pakistan
6. Range improvement techniques
7. Wildlife: Definition and values
8. Ecosystem concept, characteristics and management requirements for regional eco-systems in Pakistan including arid, wetland, forest, mountain and coastal ecosystems
9. Introduction to protected areas (National Park, Game Reserve and Wildlife Sanctuary)

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
4. Identification of important wildlife species

Recommended Texts

1. Holechek, J. (1989). *Range Management, Principles and Practices*. Newberry: Prentice Hall.
2. Quraishi, M. A. A., Khan, G.S., & 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. Quraishi, M.A.A., & Ishaque, M. (1995). *Practical Manual of Range Management*. Faisalabad: University of Agriculture.
3. Stoddard, L.A., Smith, A.D., & Box, T.W. (1975). *Range Management.* New York: McGraw Hill.

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 understanding of the basic concepts of economics and their application in agriculture. Students should read content and complete course assignments prior to 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 prior to 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*, (10th ed.). Boston: Addison Wesley Publishing.
2. Penson, J. B., Capps O., Rossen, C. P., & Woodward, R. (2013). *Introduction to Agricultural Economics* (5th ed.). New Jersey: Prentice Hall.

Suggested Readings

1. Cramer, G. L., Jensen, C. W., Southgate Jr., D. D. (2001). *Agricultural Economics and Agribusiness* (8th ed.). New Jersey: Wiley Publisher.
2. Mankiw, N. G. (2011). *Principles of Economics* (5th ed.). Mason: South-Western Cengage learning Publisher.
3. Penson, J. B., Capps, O., Rossen C. P., & Woodward, R. (2013). *Introduction to Agricultural Economics* (5th ed.). New Jersey: Prentice Hall.

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

In order to secure the future of a 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. Community engagement seeks to better engage the community to achieve long-term and sustainable outcomes, processes, relationships, discourse, decision-making, or implementation. 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 policy making. This course will also analyze different types of citizen engagement and examine how to design a program of public participation for policy making. Approaches to evaluating community engagement programs will also be a component of the course.

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
13. Social Issues in Pakistan: Introduction to the concept of social problem, Causes and solutions
14. Social Issues in Pakistan (Poverty, Equal and Equitable access of resources, unemployment)
15. Social Issues in Pakistan (Agricultural problems, terrorism & militancy, governance issues)
16. Social action and project: Introduction and planning of social action project
17. Identification of problem, Ethical considerations related to project
18. Assessment of existing resources

Recommended Books

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 Books

1. British, Council. (2017). *Active Citizen's Social Action Projects Guide.* Scotland: British Council.
2. Larsen, K. A., Sewpaul, V., & Hole, G. O. (Eds.). (2013). *Participation in Community Work: International Perspectives.* New York: Routledge.

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

This course is designed to help understand the basis of plant breeding and the application of genetic principles for the improved heredity of plants. The objectives of the course include: 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? 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 principle of breeding self-pollinated crops as homozygosity. Students will also learn about comparative advantage of different breeding methods in terms of time required for breeding a crop variety and understand 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, mutation and heteroploidy
4. Breeding self-pollinated crops: introduction, mass selection, pure line selection; hybridization, pedigree method, bulk method and backcross techniques
5. Breeding cross-pollinated crops: introduction, mass selection, recurrent selection
6. Development and evaluation of inbred lines
7. Development of hybrids, synthetic and composite populations
8. Breeding clonally propagated crops
9. 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* (5th ed.) Ames, USA: Iowa State 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*. New Delhi: Kalyani Publishers.

Suggested Readings

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

ENTO-5102 Applied Entomology 3 (2+1)

The students would be able to acquire the 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. Course aims to demonstrate the students about the identification of insect pests, their control methods and pesticide application equipment with basic objective to enhance farmer's productivity through better management and control of insect pests. Moreover, 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 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 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, reproductive, legislative, chemical and bio-technological control
4. Introduction to IPM; insecticides, their classification, formulations and application equipment
5. identification, life histories, mode of damage and control of important insect pests of various crops, fruits, vegetables, stored grains, household, termites and locust
6. Entomological industries: apiculture, sericulture and lac-culture

Practical

1. Collection, identification and mode of damage of insect pests of various crops, fruits, vegetables, stored grains and household
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.). USA: Waveland Press.

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.). New York: John Wiley & Sons.

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. 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. 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 history of different plant diseases, their symptoms, etiology, epidemiology and management. The course also has brief introduction of different plant pathogens which include fungi, viruses, bacteria and nematodes. The course also covers historical background of different plant pathogens and the discoveries related to 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 and 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 Academic Press.
2. Chaube, H.S., & Singh, R. (2002). *Introductory Plant Pathology*. India: International Book.

Suggested Readings

1. Mehrotra, R.S., & Aggarwal, A. (2003). *Plant Pathology* (2nd ed.). India: Tata McGraw Hill Education.
2. Strange, R.N. (2006). *Introduction to Plant Pathology*. USA: John Wiley & Sons.

HORT-5602 Horticultural crop production 3(2+1)

The objective of this course is to familiarise students with 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's related with fruits such as incompatibility, fruits set, and biennial bearing. Similarly, students will also learn about disease and insect problem 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 and weed control
4. Climate, soil, propagation, rootstocks, cultivars, important pests, harvesting, post-harvest handling and 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* (4th ed.). New Delhi: Prentice-Hall India Learning.
2. Adams, C. R., Bamford, K.M., & Early, M. P. (2012). *Principles of Horticulture* (6th ed.). New York: Routledge.

Suggested Readings

1. Singh, B. (2007). *Horticulture at a Glance*. Ludhiana: Kalyani Publishers.
2. Pradeepkumar, T. (2008). *Management of horticultural crops* (Vol. 11). New Delhi: New India Publishing.
3. Yadav, P.K. (2007). *Fruit Production Technology*. Lucknow: International Book.

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

This is an introductory course which enables the students to understand the basics of food science and technology. Students will study 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. Students will explore and gain an understanding into the history of food science and the factors that have shaped food science in Pakistan, organizations involved in food manufacturing, food regulatory processes, food composition, its classification depending on sources, consumption pattern and basic analysis of food components.

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, 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*. (2nd ed.). Florida: CRC Press.

Suggested Readings

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

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

This course is designed for undergraduate programs of 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 student will be able to understand the general concepts of basic statistics, to conduct agriculture surveys, to understand design of experiments, and other statistical tools. These statistical concepts are further will be helpful to complete a research related to agriculture sciences. Moreover, over students will also learn some statistical software such as Minitab, SPSS and Design Expert to improve their computational and analytical skills. Through this course, students will be able to understand and analyze the agricultural problems in 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, Simple random sampling, stratified random sampling, Systematic sampling, Sampling and non-sampling error
9. Sampling distribution of mean and difference between two means
10. Inference Theory: Estimation and testing of hypothesis, Type-I and type-II error, testing of hypothesis about mean and difference between two means using Z-test and t-test, Paired t-test
11. Test of association of attributes using χ^2 (chi-square) Testing hypothesis about variance
12. ANOVA and its assumptions, One-way ANOVA, Two-way ANOVA

Recommended Texts

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

Suggested Readings

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

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

The world has embraced the largest revolution so far in the history of mankind called communication revolution. Everything has been tagged to communication. Communication provides the way to resolve mutual conflicts not only between two individuals, groups but also between the countries. Communication has lot more importance in the development of leadership qualities among the masses of civil society. The aim of this course is to develop the communication and leadership skills among future extensionists. At the completion of this course, the students will be able to conceptualize the concepts communication process and demonstrate improved communication/leadership skills being used for agricultural technology dissemination among different stakeholders.

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
7. Basic communication models
8. Forms of communication: interpersonal, intrapersonal and impersonal; 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 extension messages. Each student will have to design a project for class presentation
2. 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.). USA: 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.* Islamabad: NBF.

PLBG-6203 Principles of Genetics 3(2+1)

Students will be able to understand the basic concepts of genetics. The course will help understanding how a single gene controls multiple characters in a single organism, understanding the mechanism of epistasis as potential reasons for deviation from law of independent assortment, understanding the concepts of multiple allele both at genotypic as well as phenotypic level, understanding process of polygenic inheritance with the real-world examples, as well as the outcomes of these processes, understanding the process of sex determination in different living organisms and how different traits are controlled by autosomal as well as genes located on sex chromosomes, understanding the mechanism of linkage and crossing over, understanding different techniques for gene and chromosome mapping, chemical and molecular nature of nucleic acids i.e. RNA and DNA and gene mutation, and understanding the concept of gene expression from gene to its product. The course will enable the students to solve various genetics problems, making calculated and accurate predictions about inheritance of genetic traits, and map the locations of genes.

Contents

1. Pleiotropy and various types of gene interactions
2. Multiple alleles. Polygenic inheritance
3. Sex determination systems and sex-linked inheritance
4. Genic balance theory. Holandric genes. Extra chromosomal inheritance
5. Linkage and crossing over. Three-point and multipoint linkage tests and chromosome mapping
6. Properties of genetic material. DNA as genetic material
7. Watson and Crick Model of DNA structure and its implications
8. Genetic code, RNA and protein synthesis
9. Gene mutation

Practical

1. Solving problems on dihybrid and multi hybrid segregating generations and backcrosses
2. Numerical examples relating to multiple allelism and polygenic inheritance, sex linked inheritance, linkage and crossing over
3. Chromosome mapping

Recommended Texts

1. Singh, B.D. (2004). Genetics. New Delhi, India: Kalyani Publishers.
2. Stansfield, W.D. (1988) Theory and Problems of Genetics (4th ed.). New York: McGraw Hill.

Suggested Readings

1. Brooker, R.J. (2018.*) Concepts of Genetics*. New York: McGraw-Hill Education.
2. Ramakrishnan, V. (2018). *Gene machine* (1st ed.). India: Harper Collins Publishers.
3. Klug, W.S., & Cummings, M.R. (2018). *Concepts of Genetics.* New Delhi, India: Dorling Kindersley.

PLBG-6204 Breeding Field Crops 3(2+1)

This is a graduate level course of plant breeding and genetics. This course focuses on the strategies, objectives and history of plant breeding, genetic variation and its exploitation, development of double haploids, heteroploidy, mutation breeding, breeding self-pollinated crops, breeding cross pollinated and vegetatively propagated crops, ideotype breeding, use of heterosis and its theories. In this course components of genetic variation, estimates of heritability and genetics advance are included to understand the expected gain in next generation. Genetic engineering and tissue culture techniques are included in this course to familiar the students with latest techniques used in plant breeding. Visits to different research institutes/organizations/universities are the important part of course to aware the students about plant research activities being done in these organizations. At the end of the course, students will be able to understand various breeding methods in self and cross-pollinated crops, male sterility, self-incompatibility, mutation breeding, data recording from field and its interpretation.

Contents

1. History, achievements, objectives, and strategies of plant breeding
2. Genetic variability: basis of plant breeding, components of variability
3. Threshold characters: penetrance and expressivity
4. Breeding methods in sexually (self and cross-pollinated) and asexually propagated crops
5. Development of doubled haploids
6. Mutation breeding
7. Wide hybridization
8. Estimation of heritability
9. Heterosis: genetic basis and exploitation
10. Male sterility and self-incompatibility
11. Breeding crops for biotic and abiotic stresses
12. Ideotype breeding and its limitations
13. Role of biotechnology in plant breeding

Practical

1. Selfing and crossing techniques in field crops
2. Data recording using descriptors, its analysis and interpretation
3. Assessment of variability in crops for biotic and abiotic stresses
4. Visits to field and research institutes

Recommended Texts

1. Singh, B.D. (2007). *Plant Breeding: Principles and Methods*. New Delhi, India: Kalyani Publishers.
2. Sleper, D.A., & Poehlman, J.M. (2006*). Breeding Field Crops*. (5th ed.). Ames, USA: Iowa State University Press.

Suggested Readings

1. Singh, P. (2004*). Essentials of Plant Breeding*. New Delhi, India: Kalyani Publishers.
2. Chahal, G.S., & Gosal, S.S. (2002). *Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches.* Oxford, UK: Alpha Science International.
3. Acquaah, G.(2009). *Principles of Plant Genetics and Breeding*. UK: John Wiley & Sons.

PLBG-6205 Cytogenetics 3(2+1)

This is a graduate level course of plant breeding and genetics and it focuses on structure and functions of cell organelles, chromosomal structure, functions and their abnormalities. At the end of the course, students will be able to understand cell cycle regulation, meiosis, mitosis, karyotype and cytological basis of crossing over. Students will practically learn preparation of preservatives, fixatives and stains, and visually see different mitotic and meiotic stages. This course covers theoretical demonstration of cytogenetic concepts such as description of cell organelles and their role in inheritance, genetic regulation of cell cycle, cytological differences in mitosis and meiosis, morphology and classification of chromosomes, fine structure of chromosomes, specialized chromosomes (polytene and lamp brush), heterochromatin and euchromatin, karyotype analysis of crop species, construction of ideograms, arm ratio and centromere index, flow cytometry for chromosome analysis, chromosome banding techniques, structural and numerical changes in chromosomes, cytological basis and proofs of crossing over.

Contents

1. Description of cell organelles and their role in inheritance
2. Genetic regulation of cell cycle
3. Cytological differences in mitosis and meiosis
4. Morphology and classification of chromosomes
5. Fine structure of chromosomes
6. Specialized chromosomes (polytene and lamp brush)
7. Heterochromatin and euchromatin
8. Karyotype analysis of crop species, construction of ideograms, arm ratio and centromere index
9. Flow cytometry for chromosome analysis
10. Chromosome banding techniques
11. Structural and numerical changes in chromosomes
12. Cytological basis and proofs of crossing over

Practical

1. Preparation of different solutions, preservatives, fixatives and stains for cytological studies
2. Collection of suitable plant material for cytological studies
3. Observation of chromosomes at various mitotic and meiotic stages
4. Use of colchicine for chromosome duplication
5. Micrometry

Recommended Texts

1. Singh, R.J. (2003). *Plant Cytogenetics*. Baton Rouge, USA: CRC Press.
2. Ravindranath, N.H. (2002). *Elements of Modern Cytology, Genetics and Evolution.* New Delhi, India: Kalyani Publishers.

Suggested Readings

1. Clark, M.S., & Wall, W.J. (1996). *Chromosomes: The Complex Code.* London, UK: Chapman and Hall.
2. Jahier, J., Chevre, A.M., Delourme, R., Eber, F., & Tanguy, A.M. (1996). *Techniques of Plant Cytogenetics.* New York, USA: Science Publishers.
3. Singh, B.D. (2004). Genetics. New Delhi, India: Kalyani Publishers.

PLBG-6206 Fundamentals of Plant Biometry 3(2+1)

Biometry is an integral part of plant breeding. Information on various biometrical techniques is commonly used in plant breeding and genetics, especially the principles and usage of biometrics in crop improvement. The prime objective of this course is to provide comprehensive theoretical information on the application of various biometrical techniques in plant breeding and genetics. The purpose of this course is to provide graduate students with sufficient and efficient statistical techniques and procedures for dealing with data collected from their experiments. This will enable students in detail how to run their experiments scientifically, collect data, analyze and draw valid conclusions, and make sound decisions. It focuses on the variance, heritability, correlation, regression, and different genetic models. Concept of quantitative, qualitative traits and their analysis. It will enable students to understand application of biometrical techniques in genetics and breeding, recording and analyzing qualitative and quantitative data and various statistical techniques used in plant breeding.

Contents

1. Concept of quantitative, qualitative traits and their analysis
2. Chi-square test
3. Variance and covariance
4. Parental-offspring regression and correlation
5. Heritability types, selection pressure, selection differential, response to selection and genetic advance
6. Heterosis, hetero-beltiosis, potence ratio and combing ability
7. Introduction to different genetic models

Practical

1. Estimation of correlations, regression, heritability, selection differential, response to selection, genetic advance, heterotic effect and inbreeding depression

Recommended Texts

1. Singh, R.K., & Chaudhary, B.D. (2004*). Biometrical Methods in Quantitative Genetics Analysis.* New Delhi, India: Kalyani Publishers.
2. Singh, P. (2000). *Biometrical Techniques in Plant Breeding* (2nd ed.). New Delhi, India: Kalyani Publishers.

Suggested Readings

1. Baker, W.A. (1992). *Manual of Quantitative Genetics* (5th ed.). Pullman, USA: Academic enterprises.
2. Ali, Z. (2010). *Analyzing and Understanding Genetic Problems: Classical and Conventional Approach.* Germany: VDM Verlag.
3. Gomez, K. A., & Gomez A. A. (1984). *Arturo Statistical procedures in agricultural research* (2nd ed.). New York: John Wiley and sons.

PLBG-6207 **Breeding Cereal Crops** **3(2+1)**

Cereals are considered as the grains of life and the foundation of human civilization. Cereals grains are the amalgamation of endosperm, germ, and bran. The course focuses on importance, status, evolution and breeding techniques in cereals. It describes the procedure of variety development. Today cereals have passed a series of genetic manipulation, re-arrangement of genetic architecture, polyploidization to compete all biotic and abiotic stresses, like diseases, water stress, winter hardiness, salinity, frost, mineral toxicity etc. It will enable students to understand applications of genetic principles in cereal breeding, various reproductive systems in cereals, variety development and release procedures. This course is designed to enhance the research skills among the students to compete the changing world, focusing on cereal crops and its byproducts. Students will practically handle segregating populations and data recording. At the end of the course students will be able to understand the genetics and breeding behavior of cereal crops and its estimation.

Contents

1. Importance of cereals; wheat, rice, barley, oats and triticale
2. Status of cereals; global and local perspective
3. Evolution, origin, and phenology of cereal crops
4. Breeding techniques and objectives in cereals
5. Yield and quality parameters in cereals
6. Breeding for biotic and abiotic stresses
7. Procedure for variety development
8. Preliminary and multi-location yield trials (NUYT, Micro Yield Trials)
9. Genetic improvement using novel techniques
10. Exploitation of male sterility systems for hybrid development in cereals

Practical

1. Development of genetic material using appropriate mating techniques
2. Assessment of various phenological stages in cereal crops
3. Handling of segregating populations
4. Early generation testing. Data recording of various plant attributes using descriptors

Recommended Texts

1. Sleper, D.A., & Poehlman, J.M. (2006). *Breeding Field Crops* (5th ed.). Ames, USA: Iowa State University Press.
2. Morris, P.C., & Bryce, J.H. (Ed.). (2000). *Cereal Biotechnology*. New York, USA: Woodhead.

Suggested Readings

1. Nanda, J.S. (2000). *Rice Breeding and Genetics: Research Priorities and Challenges.* Lahore, Pakistan: Pak Book Corporation.
2. Heyne, E.G. (Ed.). (1987). Wheat and Wheat Improvement (2nd ed.). *Agronomy Monograph 13.* Madison, Wisconsin, USA: ASA, CSSA and SSSA.

PLBG-6208 **Breeding Fiber Crops** **3(2+1)**

This is a graduate level course of plant breeding and genetics. It focuses on the major fiber crops, their genetic resources and breeding methods. In this course, students will study history of fiber crops, their classification and botanical description. Main focus is on cotton as fiber crop followed by jute. Different breeding methods to develop new cotton genotypes including Bt cotton and development of hybrid cotton are important part of this course. Fiber quality traits and their genetics to improve them and visits to different cotton research institutes and cotton industry are the segments of this course. At the end of the course, students will be able to understand developmental history of various fiber crops (cotton, jute, flax, hemp, sisal etc.), ideotype breeding in cotton, fiber quality attributes and breeding methods for incorporating resistance against biotic and abiotic stresses. Student will learn selfing and crossing techniques of different fiber crops and testing of fiber traits.

Contents

1. Introduction to fiber crops. Role of fiber crops in national and international economy
2. Current breeding work on cotton and other fiber crops
3. Cotton genetic resources: species grown in Pakistan
4. Objectives of breeding fiber crops
5. Breeding methods
6. Concepts of ideotype breeding in cotton
7. Colored and organic cotton
8. Genetics of host-plant resistance
9. Fiber quality attributes and their relationship with morphological traits
10. Development of hybrid and transgenic cotton
11. Scope and perspective of *Bt* cotton in Pakistan

Practical

1. Selfing and crossing techniques in fiber crops
2. Identification of different species of cotton
3. Collection of data on different quantitative traits of cotton, data analysis and its interpretation
4. Testing of fiber traits in cotton
5. Visit to research stations and fiber testing laboratories

Recommended Texts

1. Sleper, D.A., & Poehlman, J.M. (2006). *Breeding Field Crops* (5th ed.). Ames, USA: Iowa State University Press.
2. Singh, P. (2004). *Cotton Breeding.* New Delhi. India: Kalyani Publishers.

Suggested Readings

1. Shiron, J. (2004). *Transgenic Cotton.* Beijing, China: Science Press.
2. Johnie, N.J., & Saha, S. (2001). *Genetic improvement of Cotton-emerging techniques*. New Delhi, India: Oxford and IBH Publishing.
3. Chahal, G.S., & Gosal, S.S. (2002). *Principles and Procedures of Plant Breeding*: *Biotechnological and Conventional Approaches.* Oxford, UK: Alpha Science International.

PLBG-6209 Breeding Sugar Crops 3(2+1)

This is a graduate level course of plant breeding and genetics. It focuses on major sugar crops; the sugarcane and sugar beet. The course consists of sugar crops importance, origin, classification and the botanical features. It will also enhance the understanding sugar crops genetics, genetic resources and breeding methods for crop improvement of sugar crops. It is need of hour to understand, how modern cane evolve and how current status of sugarcane can be maintained even improve, all over the world. The students will know about the flowering constraints in sugarcane breeding and about artificial induction of flowering in sugarcane. It will enable the students to understand the breeding methods in sugar crops, constraints in sugarcane breeding and different genetic systems in sugar crops, selection strategies and development of new varieties, different modern approaches used to enhance sugarcane production in sugarcane crops, and identifying different sugarcane species and varieties using morphological descriptors.

Contents

1. Importance, origin, classification and botanical features of sugar crops
2. Genetics and cytogenetics of sugar crops
3. Evolution of noble cane and present status
4. Flowering: a breeding constraint, artificial induction of flowering and hybridization techniques
5. Selection strategies and development of new varieties
6. Sugarcane improvement through modern approaches
7. Exploitation of somaclonal variation and micropropagation for improvement of sugarcane
8. Sugar beet: genetic resources, induction of flowering and seed production strategies

Practical

1. Identification of sugarcane species and varieties using morphological descriptors
2. Study of sugarcane flowering mechanisms
3. Morphological features of sugar beet varieties
4. Evaluation of sugarcane and sugar beet for quality parameters
5. Visit to sugar industries/research institutes

Recommended Texts

1. Draycott, A.P. (2006). *Sugar beet*. Oxford, UK: Blackwell Publishing.
2. Sleper, D.A., & Poehlman, J.M. (2006). *Breeding Field Crops* (5th ed.). Ames, Iowa, USA: Iowa State University Press.

Suggested Readings

1. Mohan. C. (2018). *Sugarcane biotechnology*: *Challenges and Prospects*. New York: Springer.
2. Kalpana S. (2018). *Biotechnology to Enhance Sugarcane Productivity and Stress tolerance* (1st ed.). Florida: CRC press.
3. Henry, R.J., & Kole, C. (2010). *Genetics, Genomics and Breeding of Sugarcane*. London, UK: Taylor and Francis.
4. Malik, K.B. (2009). *Cane and Sugar Production.* Lahore, Pakistan: Punjab Agriculture Research Board.
5. James, G. (2004*). Sugarcane*. Ames, Iowa, USA: Blackwell Publishing.

PLBG-6210 Breeding Maize and Millets 3(2+1)

This is a graduate level course of plant breeding and genetics. It focuses on the importance, breeding, hybrid seed production and quality parameters of maize ad millet. Maize is the important grain crop in the country and consume about 70% in the poultry industry therefore, most of the research institutes and private companies shifted their attention from synthetic to hybrids and producing hybrid seeds for farmers. So, this course highlighted different components of the maize hybrid seed production like development of inbred lines, different types of hybrids, evaluation of inbred lines and different breeding methodologies to improve maize and millet crops. Heterosis and its different types and how heterosis can be exploited also important components of hybrid seed production. It will enable students to understand evolutionary pathways of maize and millet, breeding methods in maize and millet, hybrid maize production and its scope. Students will practically learn inbred line development and hybrid production.

Theory

1. Economic importance and origin of maize and millets
2. Types of maize and their significance
3. Breeding methods: various selection procedures, recurrent selection and development of inbred lines
4. Heterosis, its significance, genetic basis and exploitation
5. Combining ability analysis
6. Hybrid seed production of maize and millets, and use of male sterility
7. Population improvement and handling of segregating generations
8. Quality protein maize (QPM)
9. Breeding for biotic and abiotic stresses
10. Maize and millet improvement through modern biotechnological techniques
11. Current scenario and future prospects in maize breeding

Practical

1. Handling of inbred lines and hybrid material in maize
2. Development of various crosses and populations in maize and millets
3. Layout of experiments and recording of data on various growth stages at vegetative and reproductive phases
4. Visit to maize and millets research institutes and industry

Recommended Texts

1. Dana. S. (2001). *Plant Breeding*. Kolkata, India: Partha Sankar Basu Publishing.
2. Sprague, G. F., & Dudley, J. V (ed.). (1988). Corn and Corn Improvement (3rd ed.). *Agronomy Monograph 18*. Madison, Wisconsin, USA: ASA, CSSA and SSSA.

Suggested Readings

1. Chaudhry, A.R. (1983). *Maize in Pakistan*. Faisalabad, Pakistan: Punjab Agric. Res. Coordination Board, Univ. of Agric.
2. Hallauer, A.R., & Miranda, J.B. (1988). *Quantitative Genetics in Maize Breeding*. (1st ed.). Ames, Iowa: Iowa State University Press.
3. FAO. (1980). *Improvement and production of Maize, Sorghum and Millet* (Vol. 2). Rome, Italy: FAO.

PLBG-6211 Biodiversity and Plant Genetic Resources 3(3+0)

This is the graduate level course of plant breeding and genetics. It focuses on importance of biodiversity in plant breeding. Biodiversity is the shortened form of two words "biological" and "diversity". It refers to all the variety of life that can be found on Earth (plants, animals, fungi and micro-organisms) as well as to the communities that they form and the habitats in which they live. Germplasm are living genetic resources such as seeds or tissues that are maintained for the purpose of plant breeding, preservation, and other research uses. It is the sum total of heredity material that is all the alleles of genes, present in a crop species and its wild relatives. This course will cover strategies of germplasm collection in the form of land races, obsolete varieties, varieties under cultivation, breeding lines, wild forms and wild relatives, conservation like In-Situ & Ex-Situ and role of novel techniques in germplasm identification and preservation.

Contents

1. Importance of plant biodiversity, characteristics of wild and domesticated plant species
2. Origin and distribution patterns of crop species
3. Centers of origin and genetic diversity
4. Wild relatives of crops, Exploration of genetic resources
5. Principles and strategies of germplasm collection
6. Seed bank and its role in biodiversity conservation
7. Mechanism of gene banking: maintenance, evaluation and conservation (*Insitu* and *exsitu*)
8. Utilization of genetic resources in crop research and plant breeding
9. Introduction to national and international germplasm centers
10. Visit to gene banks

Recommended Texts

1. Dhillon, B.S., Tyagi, R.K., & Lal, A. (2004). *Plant Genetic Resource Management*. New Delhi, India: Narosa.
2. Singh, B.D. (2007). *Plant Breeding: Principles and Methods*. New Delhi, India: Kalyani Publishers.

Suggested Readings

1. Sleper, D. A., & Poehlman, J. M. (2006). *Breeding field crops* (5th ed.). USA: Blackwell Publishing.
2. Brown, A. H. D., Frankel, O. H., Marshall, D. R., & Williams, J. T. (Eds.). (1989). *The use of plant genetic resources*. Cambridge: Cambridge University Press.

PLBG-6212 Molecular Genetics 3(2+1)

This course of plant breeding and genetics will enable students to understand concept of genetic codes and gene function and basics of genetic engineering and biotechnology so that these tools may be utilized as modern breeding tools in crop improvement. This involves DNA amplification and Polymerase Chain Reaction, Gel electrophoresis, Primer designing and DNA fingerprinting. This also includes basic understanding regarding jumping genes or Transposable elements, different form of jumping genes, Gene cloning techniques in crop plants. Course will also include basic understanding of Gene mapping, Marker assisted analysis and QTL mapping. Students will practically learn PCR, DNA fingerprinting, tissue culture and other modern techniques. At the end of the course students will develop a thorough understanding of Chemistry of nucleic acids; DNA replication; types of RNA, DNA transcription and translation, features of the genetic code, split gene and redundant DNA, gene mutation, molecular basis of gene mutation and factors affecting mutation rate.

Contents

1. Chemistry of nucleic acids; DNA replication; types of RNA, DNA transcription and translation
2. Features of the genetic code, split gene and redundant DNA
3. Gene mutation, molecular basis of gene mutation and factors affecting mutation rate
4. Transposable elements. Gene cloning techniques in crop plants
5. Gene mapping
6. Marker assisted analysis and QTL mapping

Practical

1. DNA extraction, isolation and quantification
2. DNA amplification/PCR
3. Gel electrophoresis, Primer designing

Recommended Texts

1. Klug, W.S., & Cummings, M.R. (2010). *Concepts of Genetics*. New Delhi, India: Dorling Kindersley.
2. Rothwell, V.N. (1993). *Understanding Genetics: A Molecular Approach* (2nd ed.). New York, USA: John Wiley and Sons.

Suggested Readings

1. Bilgrami, K.S., & Pandey, A.K. (1992). *Introduction of Biotechnology*. New Delhi, India: CBS Publishers.
2. Maniatis, T., Fritsch, E.F., & Sambrook, J. (1989). *Molecular Cloning. A Laboratory Manual*. New York, USA: Cold Spring Harbor Lab Press.
3. Singh, B.D. (2004). *Genetics*. New Delhi, India: Kalyani Publishers.

PLBG-6213 Breeding Oilseed Crops 3(2+1)

This graduate level course of plant breeding and genetics focuses on the importance and breeding of oil seed crops. It will enable students to understand status of oilseeds in Pakistan, significance of conventional and non-conventional oilseed crops and breeding methods in oilseed crops. Students will learn the estimation of oil quality. The course demonstrates importance of oilseed crops breeding in reference to high per capita oil consumption. The course is about understanding fatty acid profile of different oil seed crops so that these biochemical markers can act as a good selection tool for high quality unsaturated oils. It will also develop understanding regarding the optimization of oilseed crops breeding with reference to different crops. This also develops understanding regarding Genetics of male sterility and its use in hybrid seed production of various oilseed crops. This course also covers basics such as identification of oilseed crops, their reproductive biology along with estimation of oil quality.

Contents

1. Introduction to conventional and non-conventional oilseed crops
2. Status of edible oil in national economy
3. Significance of brassica, sunflower, groundnut, cotton, oil palm, olive, soybean as oilseed crop, and production constraints
4. Industrial oilseed crops (castor beans, Jatropha, Coconut, Jojoba)
5. Origin and classification of oilseeds
6. Breeding objectives, strategies and methodologies of oilseed crops
7. Genetics of male sterility and its use in sunflower hybrid seed production and other oilseed crops
8. Development of double-zero varieties in rapeseed mustard crops

Practical

1. Identification oilseed crops, their reproductive biology
2. Estimation of oil quality
3. Development of breeding populations of oilseed crops and selection practices in segregating populations
4. Visit to oilseed research institutes and industry

Recommended Texts

1. Nagata, T., & Tabata, S. (Ed.). (2003). *Brassica and Legumes: From Genome Structure to Breeding.* New York, USA: Springer Verlag.
2. Robbelen, G., & Downey, R.K (1990). *Oil Crops of the World: their Breeding and Utilization*. New York, USA: McGraw-Hill Publishing.

Suggested Readings

1. Verma, D.P.S. (1996). *Soybean:* Genetics, Molecular Biology and Biotechnology. In *Biotechnology in Agriculture* Series, *No 14.* USA: CABI Publishing.
2. Kimber, D., & McGregor, D.I. (1995). *Brassica Oilseeds: Production and Utilization.* UK: Cambridge University Press.
3. Sleper, D.A., & Poehlman, J.M. (2006). *Breeding Field Crops* (5th ed.). Ames, USA: Iowa State University Press.

PLBG-6214 **Breeding Pulse Crops** **3(2+1)**

This course focuses on introduction to pulse crops, significance of pulses in human diet, botanical description of different pulse crops like chickpea, lentil, mung bean, black gram, dry peas, common beans etc., breeding methods in pulse crops, hybridization of pulse crops and its limitation, mutation breeding and limitations of use of physical and chemical mutagens in pulse crops breeding. The course provides information about status of pulses in Pakistan, over view of research activities being done in different research institutes/organizations and reasons of low yield of pulses in Pakistan. Visit to different pulse crops research institutes and pulse factories are the segments of this course. It will enable students to understand significance and status of pulses, constraints in pulse breeding, mutation breeding to develop new pulse varieties, use of different physical and chemical mutagens, limitation of hybridization of pulse crops, breeding methods for biotic and abiotic stresses and role of biotechnology to improve pulse crops.

Contents

1. Introduction to pulse crops. Significance of pulses in human diet
2. Status of pulses in Pakistan: an overview, reasons of low yield in pulse crops
3. Botanical description, and breeding methods in pulse crops
4. Intra and Inter-specific hybridization in pulse crops
5. Limitations in hybridization
6. Special consideration on fertilizer, and irrigation responsive cultivars, reduced photoperiod sensitivity and biotic and abiotic stresses
7. Genetic mechanism of nitrogen fixation in pulses
8. Role of mutation breeding in pulses.
9. Use of innovative tools for improvement of pulses

Practical

1. Reproductive biology of important pulses
2. Hybridization techniques in major pulse crops
3. Phenological data notes and analysis
4. Study of rhizobium nodulation and nitrogen fixation in various pulse crops
5. Visit to research stations

Recommended Texts

1. Sleper, D.A., & Poehlman, J.M. (2006). *Breeding Field Crops*. Ames, Iowa, USA: Iowa State University Press.
2. Singh, D.P. (Ed.). (2001). *Genetics and Breeding of Pulse Crops*. New Delhi, India: Kalyani Publishers.

Suggested Readings

1. Ali, M. (2006). *Drought Management Strategies for Pulse crops*. Udaipur, India: Agrotech.
2. Nagata, T., & Tabata, S. (Ed.). (2003). *Brassica and Legumes - From Genome Structure to Breeding*. New York, USA: Springer Verlag.
3. Persley, G.J. (Ed.). (1984). *Tropical Legume Improvement*. Canberra, Australia: Biotech Anutech.

PLBG-6215 Breeding Vegetable Crops 3(2+1)

Vegetables are considered as the protective food items, full of nutrition. Keeping in view the importance of vegetable crops, this graduate level course was included in plant breeding and genetics. It mainly focuses on the importance and classification of the different season's vegetable crops. Understanding the breeding methods of vegetable crops will enable the students to be familiarize with the constraints in vegetable breeding and hybridization programs. This course will also train the students about all possible improvement strategies in vegetables. Understanding the mechanism of hybrid seed production in vegetables as well as off season vegetable production. The solution of major issue in vegetable breeding such as quality, biotic and abiotic stresses and improvement in shelf-life have revolutionized the vegetable production industry. At the end of this course students will be able to understand the significance and role of innovative tools in vegetable improvement. Students will learn selfing and crossing techniques of important vegetable crops.

Contents

1. Introduction, importance and classification of vegetable crops
2. Reproductive systems of important vegetable crops
3. Breeding objectives of vegetable crops
4. Constraints in breeding and hybridization of vegetables and possible improvement strategies
5. Pure and hybrid seed production in vegetables
6. Breeding vegetables for off-season cultivation
7. Breeding for quality, biotic and abiotic stresses and shelf-life
8. Role of innovative tools for improvement of vegetable crops

Practical

1. Study of reproductive biology of important vegetables
2. Selfing and crossing techniques in major vegetables
3. Layout of field experiments and data recording for various genetic parameters
4. Visit to research stations

Recommended Texts

1. Arya, P.S. (2003). *Vegetable Breeding, Production and Seed Production.* New Delhi, India : Kalyani Publisher.
2. Kalloo, G., & Bergh, B.O. (Eds.) (1999). *Genetic Improvement of Vegetable Crops.* New York, USA: Pergamon Press.

Suggested Readings

1. Swiader, J.M., Ware G.W., & McCollum, J.M. (1992). *Producing Vegetable Crops* (4th ed.). Danville, Illinois, USA : Interstate Publisher.
2. Bassett, M.J. (ed.) (1986) *Breeding Vegetable Crops*. Westport, Connecticut, USA: Avi Publishing.
3. Sleper, D.A., & Poehlman, J.M. (2006). *Breeding Field Crops* (5th ed.). Ames, USA: Iowa State University Press.

PLBG-6216 Modern Techniques in Plant Breeding 3(2+1)

This is a graduate level course of plant breeding and genetics. It will enable students to understand modern breeding tools in crop improvement and application of new techniques in plant breeding. Introduction to modern techniques includes basics of molecular biology, DNA amplification and Polymerase Chain Reaction, DNA fingerprinting, methods of genetic transformation. The study of Molecular markers and marker assisted selection in plant breeding. This also includes In-vitro culture techniques. Biotechnological approaches to drought tolerance, salt tolerance, pest resistance and protein quality in various field crops. Eventually it will cover Importance of transgenic plants and Introduction to genomics. Genomics can be used on a personal level to decrease transplant rejection, predict genetic diseases that a person may have inherited, determine the risks of genetic diseases for an individual's children. It focuses on emerging trends of genomics in relation to Agriculture and Crops Breeding. Students will practically learn PCR, DNA fingerprinting, tissue culture and other modern techniques.

Contents

1. Basics of molecular biology
2. Introduction to modern techniques
3. DNA amplification and Polymerase Chain Reaction
4. DNA fingerprinting
5. Methods of genetic transformation
6. Molecular markers and marker assisted selection in plant breeding
7. *In-vitro* culture techniques
8. Biotechnological approaches to drought tolerance, salt tolerance, pest resistance and protein quality in various field crops
9. Importance of transgenic plants
10. Introduction to genomics

Practical

1. Safety measures in the biotech laboratory
2. Orientation to various lab equipment
3. Introduction to aseptic techniques, autoclaving, sterilization, use of laminar flow and fume hoods
4. Handling of Laboratory Chemicals
5. Preparation of stock-solutions, adjusting pH, making dilutions
6. Media preparation
7. Callus formation and micro-propagation

Recommended Texts

1. Loodish, H. (2004*). Molecular Cell Biology* (5th ed.). New York, USA: John Wiley and Sons.
2. Paul, C., & Harry, K. (2004). *Handbook of Plant Biotechnology*. New York, USA: John Wiley and Sons.

Suggested Readings

1. Razdan, M.K. (Ed.) (2003). *Introduction to Plant Tissue Culture* (2nd ed.). New York, USA: Intercept.

2. Brown, T.A. (2000). *Essential Molecular Biology: A Practical Approach.* New York, USA: Oxford University Press.
3. Brown, T.A. (2010). *Gene cloning and DNA analysis: An introduction*. UK: Wiley-Blackwell.

PLBG-6217 Experimentation in Plant Breeding 3(2+1)

This is a graduate level course of plant breeding and genetics. It focuses on introduction to experimentation in plant breeding, concepts of different experimental units, treatment and local control, concept and methodology of different experimental designs like completely randomized design (CRD), randomized complete block design (RCBD), Latin square design and augmented, lay-out of these designs in field and laboratory and their limitations, components of variance (genetic and environmental) from mean squares, concept of analysis of variance to construct ANOVA table, least significant differences (LSD), different methods to estimates of broad sense and narrow sense heritability and genetics advance to understand the expected gain in next generation. It will enable students to understand concepts of biostatistics, various experimental layout in the field and in laboratory, selection of suitable design to conduct experiment, collection of data from field and lab and its manipulation, use of different statistical software. Students will learn software for estimation of basic statistics.

Contents

1. Concept of experimental units
2. Treatments and local control
3. Major designs (Augmented, CRD & RCBD) and their lay-out for experiments under field and lab conditions
4. Basic statistics of variability and comparison tests
5. Concepts of variances in non-segregating and segregating populations for broad and narrow-sense heritability
6. Concepts of variance components (genetic and environmental) from expected mean squares for heritability estimation
7. Concepts of selection intensity, differential and response, realized heritability and expected genetic advance

Practical

1. Use of softwares for estimation of basic statistics
2. Construction of ANOVA
   Numerical problems related to estimation of genetic, environmental and phenotypic variances/co-variances from ANOVA/ANCOVA

Recommended Texts

1. Gomez, K.A., & Gomez, A.A. (1984). *Statistical Procedures for Agricultural Research* (2nd ed.). New York: John Wiley & Sons.
2. Singh, R.K., & Chaudhary, B.D. (2004*). Biometrical Methods in Quantitative Genetic Analysis.* New Delhi, India: Kalyani Publishers.

Suggested Readings

1. Khan, M.A. (Ed.) (1994). *Plant Breeding.* Islamabad, Pakistan: National Book Foundation.
2. Baker, W.A. (1992). *Manual of Quantitative Genetics* (5th ed.) Pullman, USA: Academic enterprises.

3. Ali, Z. (2010). *Analyzing and Understanding Genetic Problems: Classical and Conventional Approach.* Germany: VDM.

PLBG-6218 Fundamentals in Research and Scientific Writing 2(1+1)

This graduate level course will apprise students/researchers of Plant Breeding and Genetics of the correct techniques and knowledge of writing technical reports, progress reports, thesis synopses, research proposals for post-graduate research, technical writing, theses etc. This course is designed for students who wish to gain an understanding of the limits and potentials of scientific research, and for those who intend to research social phenomena scientifically. This course is intended to facilitate student's awareness of the research process and their ability to conduct research in an ethical and thorough manner using appropriate research strategies. This course has technical and critical components. This course will allow the students and researchers who undertake this course to fully understand all the technical concepts and processes and applying these concepts which are required in order to complete their research in field and labs to accomplish technical pieces of writings such as the ones mentioned above.

Contents

1. Introduction of concept of science and scientific method
2. The concept, purpose and kinds of research project and Scientific Reports
3. Collection and organizing source materials: reviewing the literature and preparing bibliography
4. The techniques of composition: rules of scientific writing, word usage in scientific writing, style for composing scientific writing
5. Writing thesis, scientific papers, and project reports; table of contents, list of tables, the use of scientific quotations, illustrations, appendices, statistics and tables, standard abbreviations
6. Preparing preliminary draft, editing, and evaluating the final draft
7. Preparation of PC forms
8. Plagiarism, its types and testing methods
9. Policy of HEC on Plagiarism

Practical

1. Exercise of scientific writing and research proposal
2. Exercise of collecting material from different sources on assigned topics and oral presentations
3. Use of reference manager, endnote and Turnitin software

Recommended Texts

1. Anderson, J., Durston, B.H., & Poole, M. (1992). *Thesis and Assignment Writing*. New Delhi, India: Wiley Eastern.
2. Andrew, C.O. (1993). *Applied Agricultural Research: Foundations and Methodology*. Colorado: West view Press.

Suggested Readings

1. Gatner, E.S. M., & Cordasco, F. (1959). *Research and Report Writing*. New York, USA: Barnes and Noble.
2. Gopen, G.D., & Swan, J.A. (1990). *The Science of Scientific Writing.* American Scientist, 78: 550-558.

3. Ghafoor, A. (2007). *Manual for Synopsis and Thesis Preparation.* Faisalabad: University of Agriculture.

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 knowhow 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 prior to 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 prior to 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*, (10th ed.). New Jersey: Prentice Hall.
2. Salvatore, D. (2007). *International economics*. (9th ed.). New York: 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.

PLBG-6219 Breeding Fodder and Forage Crops 3(2+1)

This is a graduate level course of plant breeding and genetics. At the end of the course, students will be able to understand significance of fodder and forages in livestock sector, genetic and cytoplasmic basis of reproductive systems in forages, and breeding methods in fodder and forages. Students will learn handling of apomictic, self and cross-pollinated fodder species. The course discusses floral morphology of fodder crops and alternative methods of creation of variation in fodder crops. It is also about comparative advantage of Rabi and kharif fodders in terms of fodder quality traits such as protein content. It includes brief introduction regarding the processed fodders such as hay and silage; Reproductive systems in fodder and forage crops; Apomixis and its role in fodder and forage crops; Male sterility and self-incompatibility: genetic and cytoplasmic basis. Breeding objectives for fodder crop improvement and the interspecific fodders with multi-cut as well as multi tillering attributes are also part of this course.

Contents

1. Introduction to major fodder and forage crops
2. Genetic resources and classification of fodder and forage crops
3. Reproductive systems in fodder and forage crops
4. Apomixis and its role in fodder and forage crops
5. Male sterility and self-incompatibility: genetic and cytoplasmic basis
6. Breeding objectives and methods for improvement
7. Quality components in fodder and forage crops, anti-quality agents and remedies
8. Application of biotechnology in fodder and forage crops

Practical

1. Floral morphology, pollination, fertilization and seed setting in fodder and forage crops
2. Handling of apomictic, self and cross-pollinated fodder and forage species
3. Hay and silage production techniques
4. Mixed fodder cropping
5. Determination of nutritive quality and nutritive value
6. Visit to research organizations, livestock farms and feed industry

Recommended Texts

1. Sleper, D.A. & Poehlman, J.M. (2006). *Breeding Field Crops.* Ames, Iowa, USA: Iowa State University Press.
2. Chatterjee, B.N, (1989). *Forage Crop Production: Principles and Practices.* New Delhi, India: Oxford and IBH Publishing.

Suggested Readings

1. Rognli, O.A., Solberg, E.T., & Schjelderup, I. (1994). *Breeding Fodder Crops for Marginal Conditions. Series: Developments in Plant Breeding*. USA: Springer.
2. Sleper, D.A., Asay K.H., & Pedersen, J.F. (1989). *Contributions from Breeding Forage and Turf Grasses*. Madison, Wisconsin, USA: CSSA Special Publication 15, Amer. Soc. Agron.
3. Boller, B., Posselt U.K., & Veronesi, F. (2010) *Fodder Crops and Amenity Grasses*. New York: Springer.

PLBG-6220 Breeding Minor Crops 2(1+1)

This is a graduate level course of plant breeding and genetics. It focuses on breeding of minor crops such as guar, tobacco, sesame, linseed, groundnut. These are the crops which are neglected and farmers do not want to grow due to competition among high cash crops. These crops are grown only in those areas where other cash crop not perform well or poorly performed. Therefore, there is a dire need to improve the breeding and genetics of these minor crops so that these crops can perform well in better as well as on marginal lands. This course also includes the concept of processing and value addition of different products of these crops. Therefore, main objective of this course is to enable the students to understand significance and status of minor crops, breeding objectives, methodologies and selection procedures, recurrent selection, general and specific combining ability of minor crops and breeding methods in minor crops.

Contents

1. Introduction and importance of minor crops: tea, guar, sesame, linseed, groundnut, tobacco and other local crops
2. Breeding objectives, methodologies and selection procedures; recurrent selection, general and specific combining ability
3. Breeding for biotic and abiotic stresses
4. Genotype x environment interactions and stability analysis
5. Processing and value addition in minor crops

Practical

1. Selfing and crossing techniques
2. Layout of experiments, recording and analysis of data on various plant parameters
3. Screening of germplasm for biotic and abiotic stresses
4. Visit to research Institutes and industry

Recommended Texts

1. Singh, B.D. (2007). *Plant Breeding: Principles and Methods*. New Delhi, India: Kalyani Publishers.
2. Douglas, C.A. (2005). *Evaluation of Guar Cultivars in Central and Southern Queensland.* Australia: RIRDC Publications.

Suggested Readings

1. Ozturk M., Hakeem, K.R., & Ashraf. (Eds) (2011). *Global Perspectives on Underutilized Crops.* New York: Springer.
2. Goodman, J. (Ed.) (2004). *Tobacco in History and Culture: An Encyclopedia.* New York: Charles Scribner's Sons.
3. Ram, H.H., & Singh, H.J. (2003). *Crop Breeding and Genetics.* New Delhi, India: Kalyani Publishers.

PLBG-6221 Crop Variety Registration and Intellectual Property Rights 2(2+0)

This is a graduate level course of plant breeding and genetics. Intellectual property is a category of property that includes intangible creations of the human intellect. Intellectual property in divided into two categories: Industrial property (includes patents for inventions, trademarks, industrial design, and geographical indications). Copy right (includes literary work such as novels, poems and plays, films, musical works, artistic works such as drawings, paintings, photographs and architectural designs). Intellectual property rights are any other property rights that allow the creator, or owner of a patent, trademark, or copyright to benefit from his or her own work or investment. It sets forth the right to benefit from the protection of moral and material interest resulting from authorship of any scientific, literary, or artistic production. It will enable students to understand: registration of crop varieties and its approval, seed certification, different categories of seeds their production and labelling, intellectual property rights, international harmonization of patent laws and concerns of Plant Variety Protection (PVP) and farmers rights in world and Plant Breeders Rights Act in Pakistan, its background, advantages and disadvantages. The course also provides an overview of World Trade Organization, World Intellectual Property Organization, Paris Convention, Biological Diversity Act, TRIPS and seed industry in Pakistan.

Contents

1. Intellectual Property Rights (IPR): introduction
2. Need and implementation of IPR, Issues and challenges
3. Strategies to maximize benefits from IPR
4. Plant Breeder's Rights Act: background, requirements; advantages and disadvantages
5. Plant Variety Protection (PVP) and farmer's rights
6. Patenting biological material
7. International harmonization of patent laws
8. Plant variety registration and approval
9. Production of various classes of seeds and certification procedures
10. Proforma of Federal Seed Certification Department for crop variety registration
11. An overview of "WTO, Biological Diversity Act, TRIPS and seed industry in Pakistan"

Recommended Texts

1. Helfer, L.R. (2004). *Intellectual Property Rights in Plant Varieties: International legal regimes and policy options for national governments.* Rome, Italy: FAO Legislative Study 85, Food and Agriculture Organization.
2. Erbisch, F.U., & K.M.(eds). (2003). *Intellectual Property Rights in Agricultural Biotechnology.* USA: CABI Publishing Company.

Suggested Readings

1. Helfer, L.R. (2002). Intellectual Property Rights in Plant Varieties: an overview with options for national governments. *FAO Legal Papers,* Online #31. Rome, Italy: Food and Agriculture Organization.
2. Evenson, R.E. (1999). *Intellectual Property Rights; access to plant germplasm and crop production scenarios in 2020*. Crop Sci., 39:1630-1635.
3. Sleper, D.A., & Poehlman, J.M. (2006). *Breeding Field Crops* (5th ed.). Ames, USA: Iowa State University Press.

PLBG-6222 Genomics in Agriculture 2(1+1)

This is a graduate level course of plant breeding and genetics. Genomics is providing powerful tools to address the need to develop crop strains and livestock breeds that can support increased food production while resisting pests and disease and reducing the environmental footprint, in terms of toxic chemicals and carbon emissions, of traditional farming. Genomics can be used on a personal level to decrease transplant rejection, predict genetic diseases that a person may have inherited, determine the risks of genetic diseases for an individual's children. Genomics is the study of whole genomes of organisms, and incorporates elements from genetics. Genomics uses a combination of recombinant DNA, DNA sequencing methods, and bioinformatics to sequence, assemble, and analyze the structure and function of genomes. It focuses on emerging trends of genomics in relation to Agriculture and Crops Breeding. At the end of the course, students will be able to understand construction of DNA libraries, transcriptome analysis and applications of genomics in forward and reverse genetics.

Contents

1. Genomics: Introduction, scope and application in agriculture
2. Genome organization and structure
3. Methods of DNA sequencing
4. Construction of DNA libraries, gene identification in a genome sequence
5. Transcriptome analysis: Microarray and DNA chip, genomic variation analysis
6. Application of genomics in forward and reverse genetics
7. Metabolomics, phylogenomics, and proteomics

Practical

1. Exploring the database for gene/protein sequences and retrieval
2. Primer designing
3. Translation tools
4. Construction of a phylogenetic tree
5. Sequence annotation tools
6. Submitting a gene/protein sequence in Gene banks

Recommended Texts

1. Brown, T.A. (2006). *Gene Cloning and DNA Analysis, and Introduction*. (5th ed.). UK: Blackwell Science.
2. Slater, A., Scott, N., & Fowler. M. (2004). *Plant Biotechnology: The Genetic Manipulation of Plants*. USA: Oxford University Press.

Suggested Readings

1. Brown, T.A. (1989). *Genetics: A Molecular Approach*. London: Van Nostrand Reinhold International.
2. Evans, D.E., Coleman J.O.D., & Kearns. A. (2003). *Plant Cell Culture*. USA: BIOS Scientific Publishers.
3. Gardner, E. J., Simmons M. J., & Snustad, D. P. (1991). *Principles of Genetics* (8th ed.). New York, USA: John Wiley and Sons.

PLBG-6223 Research Project/Internship 4(0+4)

This is an important course to nurture the insights of germplasm conservation in Field/Lab, Plant breeding and Genetics techniques being employed in leading research institutes of different crops and zones. The students will be attached singly or in groups with the faculty members. In addition, the students will pay study visits to various agricultural research stations and leading research projects in the province/country with special reference to Plant Breeding and Genetics techniques. The field crop production and protection techniques will be applied for climate smart agriculture, precision agriculture and seed production farms. The students will be familiarized with manures/chemical fertilizers intelligent use for the best response by crops. Every student will be asked to write a comprehensive Internship/ Project report based on his/her field work/experiences. This course will enable students to understand importance of planning and conducting research project, data collection, analyzing, interpretation and logical presentation of results.

Contents

1. Students will be required to undertake internship at various agricultural research organizations, private companies, extension/adaptive/private farms
2. To undertake a research project at university fields/laboratories
3. Practical training
4. Planning, layout and execution of experiment
5. Collection, analysis, and interpretation of data
6. Upon completion of internship/research project, students are required to submit a report
7. Presentation of internship/research experiment

Recommended Texts

1. Khalil, S.K., & P. Shah. (2007). *Scientific Writing and Presentation*. Islamabad, Pakistan: Higher Education Commission.
2. Gardner, E. J., Simmons M. J., & Snustad, D. P. (1991). *Principles of Genetics* (8th ed.). New York, USA: John Wiley and Sons.

Suggested Readings

1. Mauch, J.E., & Park, N. (2003). *Guide to the Successful Thesis and Dissertation: A Handbook for Students and Faculty* (5th ed.). New York, USA: Marcel Dekker.
2. Kirub, A. (2015). *Agricultural Research Proposal Writing, Addressing Familiar Questions.* Ethiopia: Ethiopian Institute of Agricultural Research.

MSc
(Hons)
PLANT BREEDING & GENETICS

PLBG-7101 **Principles of Plant Breeding** **3(2+1)**

Plant breeding improves the characteristics of the plant to make them more desirable agronomically and economically. Main objectives include increased production, resistant to lodging, resistance to pests and diseases, improved quality and crop plants suited to specific soils and climates. This is accomplished by selecting plants found to be economically or aesthetically desirable, first by controlling the mating of selected individuals, and then by selecting certain individuals among the progeny. The genetic principles are useful to improve the heredity of plants. It focuses on the variability and its exploitation, creation of variations, breeding objectives and breeding methods. At the end of the course, students will be able to understand development of inbred lines and hybrid seed production, seed certification and MAS in plant breeding.

Contents

1. Role of Plant Breeding in crop improvement; Variability in populations and its exploitation
2. Creation of genetic variation using conventional and non-conventional techniques
3. Specific objectives in various self, and cross-pollinated crops
4. Breeding methods in self- pollinated crops and in cross pollinated crops
5. Heterosis and its exploitation in crop improvement
6. Development, evaluation and improvement of inbred lines
7. A, B and R lines in hybrid seed production; Variety evaluation committee
8. Novelty and DUS characteristics in varietal registration
9. Seed certification; Seed production system of approved, pure line and hybrid varieties
10. Reverse breeding; Marker assisted selection in plant breeding

Practical

1. Hybridization techniques in self-pollinated and cross-pollinated crops
2. Handling of segregating and inbred generations
3. Layout of experiments and collection of experimental data, its tabulation and interpretation
4. Estimating effective population and sample size

Recommended Texts

1. Sleper, D. A., & Poehlman, J. M. (2006). *Breeding field crops* (5th ed.). UK: Blackwell publishing.
2. Singh, B. D. (2006). *Plant Breeding: Principles and Methods*. New Delhi, India: Kalyani.

Suggested Readings

1. Khan, M.A., Bashir, E & Bantel, R. (Editors). (1994). *Plant Breeding*. Islamabad: National Book Foundation.
2. Fehr, W. (1991). *Principles of cultivar development: theory and technique*. New York: Macmillan Publishing Company.
3. Allard, R. W. (1999). *Principles of plant breeding*. New York: John Wiley & Sons.

PLBG-7102 **Advanced Genetics** **3(3+0)**

This is the postgraduate level course of Plant Breeding and Genetics. It explores genetics as both a science and toolbox of experimental approaches to study diverse biological processes. The goals of the course are to familiarize students with: genetics as the science of heredity, gene expression, developmental programs, and diseases, the rationale and methodologies used in modern genetic analyses, understanding the fundamental topics of genetics, the history of major discoveries in genetics, and relationships of genetics to other areas of the Biological Sciences (e.g. biochemistry, genomics, physiology, developmental biology). Also understanding about gene manipulation techniques: epigenetics and gene cloning, role of cytoplasmic inheritance its origin and biological implications. Understanding genetics of killer traits. and how DNA sequencing techniques have revolutionized the field of genetics.

Contents

1. Classical and modern concepts of gene
2. Genetic material: a brief review: structure, function, organization, replication and properties of genetic material
3. Gene, genetic code, Wobble hypothesis and one gene-one polypeptide concept
4. Gene expression and regulation in prokaryotes and eukaryotes
5. Genetic recombination. Gene interaction: control, basis and importance
6. Mutation: classification, biochemical basis, factors affecting the rate of mutation and repair mechanism
7. Transposable genetic elements. Cytoplasmic inheritance: Origin and biological implications, genetics of killer traits
8. Introduction to non-conventional gene manipulation techniques: epigenetics and gene cloning
9. DNA sequencing techniques

Recommended Texts

1. Klug, W.S., & M.R. Cummings. (2010). *Concepts of Genetics*. New Delhi, India: Dorling Kindersley.
2. Snustad, D.P., & Simmons, M.J. (2009). *Principles of Genetics.* New York, USA: John Wiley and Sons.

Suggested Readings

1. Hartl, D.L. (2005). *Genetic Analysis of Genes and Genomes.* (6th ed.). New York, USA: John and Bartlett Publishers.
2. Lewin, B. (2004). *Genes VIII*. New York, USA: John Wiley and Sons.
3. Reece, R. J. (2004). *Analysis of genes and genomes* (pp. 88-95). Hoboken, New Jersey: John Wiley & Sons.

PLBG-7103 Molecular Plant Breeding 3(2+1)

This is a postgraduate level course of Plant Breeding and Genetics. The use of DNA markers in plant breeding has opened a new realm in agriculture called molecular breeding and molecular marker is a DNA sequence that is readily detected and whose inheritance can easily be removed. This course focuses on quantitative genetics, introduction of molecular breeding, genotype x environmental interaction (BEI) and its molecular dissection, use of molecular markers for crop improvement, Types of molecular markers, division of molecular markers, molecular dissection of complex traits, concept of molecular maps and types of mapping, concept of quantitative trait loci (QTL), multiple QTLs, problems and possible solutions in QTL analysis and linkage analysis, use of marker assisted selection in molecular breeding, primer designing. At the end of the course, students will be able to learn mapping, DNA extraction, primer designing, and in silico mapping and their applications in crop improvements.

Contents

1. Introduction to molecular breeding. Quantitative genetics and plant improvement
2. Genotype x environment interaction (GEI), Molecular dissection of GEI
3. Applications of molecular markers, development of mapping populations
4. Molecular dissection of complex traits, molecular maps and types of mapping
5. Introduction to quantitative trait loci, QTL mapping, Multiple QTLs
6. genetic architecture of quantitative traits
7. Bayesian and linkage disequilibrium mapping. Linkage analysis, experimental design and testing marker segregating patterns. Assumptions of different map functions
8. Problems and possible solutions in QTL analysis
9. Construction of molecular linkage map – a case study from cereals
10. Fine mapping of QTL and map-based cloning. Markers assisted selection
11. Marker assisted gene introgression, selection for QTLs
12. Future prospects in molecular plant breeding.
13. Genotyping by sequencing

Practical

1. DNA extraction, Primer designing, PCR, gel scoring, phenotypic and genotypic data collection, Software based data analysis to develop QTLs
2. *In silico* mapping–physical position of a marker- a case study in completely sequenced plant genome. Analysis of upstream and downstream genes of a marker
3. Genome browsing of sequenced plant genomes, Promoter analysis

Recommended Texts

1. Camp, N. J., & Cox, A. (Eds.). (2002). *Quantitative trait loci: methods and protocols* (Vol. 195). Springer Science & Business Media.
2. Kang, M. S. (Ed.). (2002). *Quantitative genetics, genomics, and plant breeding*. CABI.

Suggested Readings

1. Kole, C. 2007. *Genome Mapping and Molecular Breeding in Plants*. New York: Springer.
2. Wu, R., Ma, C., & Casella, G. (2007). *Statistical genetics of quantitative traits: linkage, maps and QTL*. Berlin, Germany: Springer Science & Business Media.
3. Xu, Y. (2010). *Molecular Plant Breeding*. Wallingford, United Kingdom: CABI.

PLBG-7104 Cytogenetics of Crop Plants 3(2+1)

This is a postgraduate level course of Plant Breeding and Genetics. It focuses on the use of cytogenetics tools for the crop improvement. Students will learn about the basic concepts about ultra-fine structure of cells and component of cells along with various phases of cell cycle, chromosomal aberrations and evidences of crossing over. Students will be taught to give understanding about the utilization of various types of aneuploidy in genetic studies, their role in evolution of complex genetics of traits and contribution in evolution of homoploid. Main focus of this course is how to handle hetro-polyploidy in practical plant breeding. It will enable students to understand cytological basis of crossing over, cytology of heteroploidy and role of translocations and inversions in crop improvement. Students will be given hands-on training to use microscopy in cytological studies, slide preparation for mitotic and meiotic cell division, and karyotype analysis of various crop species.

Contents

1. Cytogenetics and its importance in crop improvement
2. Ultra-fine structure of cell and its organelles
3. Overview of cell cycle
4. Cytological evidences of crossing over
5. Chromosomal aberrations; deficiencies and duplications, their phenotypic effects, genetic and cytological tests
6. Use of translocations and inversions in genetic studies and evolution
7. Methods of locating break points
8. Genetic studies in translocations and inversions in different crops
9. Heteroploidy, genetic and cytological behavior

Practical

1. Use of various microscopes in cytological studies
2. Slide preparation of mitotic and meiotic cell divisions from different plant material
3. Karyotype study of different crop plants
4. Banding techniques (ISH, FISH & GISH)

Recommended Texts

1. Bass, H.W., & Brichler J.A. (2010). *Plant Cytogenetics: Genome Structure and Chromosome Function.* New York, USA: Springer Publishers.
2. Gupta, R.K. (1999). *Cytogenetics*. Meerut, India: Rastogi Publishers.

Suggested Readings

1. Singh, R.J. (2003). *Plant Cytogenetics*. London, UK: CRC Press.
2. Prasad, G. (1998). *Introduction to Cytogenetics*. New Delhi, India: Kalyani Publishers.
3. Sinha, U, & Sinha, S. (1998). *Cytogenetics, Plant Breeding and Evolution*. New Delhi, India: Vikas Publishing House.

PLBG-7105 Breeding and Genetics of Fodder Crops 3(2+1)

This is a postgraduate level course of Plant Breeding and Genetics. Students will learn about various reproductive systems prevailing in fodder species such as sexual reproduction, apomixes, clonal propagation. Students will be familiarizing with the mating designs and breeding cycles for the development and improvement of various populations in forage species. Breeding objectives of specific crop species such as sorghum, rye grass, alfalfa, berseem, oat, maize etc. will be discussed. Students will be taught regarding the role of wide crossing for sustainable and durable supply of fodder in current scenario of global climate change. Students will be given hands-on training regarding the evaluation of forage populations for various forage yield components and quality contributing traits which may be helpful as a part of training in development of high yielding forage varieties. At the end of the course, students will be able to understand evaluation of quality parameters of fodder crops, development of hybrids and synthetic variety.

Contents

1. Reproductive mechanisms in various fodder crops
2. Male sterility and self-incompatibility factors and their consequences
3. Genetic systems in fodder crops
4. Breeding objectives in fodders
5. Genetics of high productivity and quality parameters
6. Breeding procedures and techniques, introduction, selection and evolution of new varieties/species
7. Testing of inbred lines; production of hybrid fodder
8. Interspecific and intergeneric crosses in fodder species such as sorghum-sudangrass hybrid, bajra-napier hybrid
9. Use of polycross methods in fodders
10. Developing synthetic varieties
11. Evaluation for quality; proteins, carbohydrates and digestibility
12. Breeding for greater seedling vigour, persistence of stand and disease and insect resistance

Practical

1. Classification of various *rabi* and *kharif* fodders
2. Study of floral structure in different fodder crops
3. Selfing and crossing techniques for various fodders; handling breeding material and its evaluation

Recommended Texts

1. Sleper, D. A., & Poehlman, J. M. (2006). *Breeding field crops* (5th ed.). Oxford, UK: Blackwell publishing.
2. Bhatti, M. B., & Khan, S. (1996). *Fodder production in Pakistan.* Islamabad: PARC/ FAO.

Suggested Readings

1. Poehlman, J. M. (1995). *Breeding Field Crops*. Ames, Iowa, USA: Iowa State University Press.
2. Rognli, O.A., Solberg, E.T., & Schjelderup, I. (eds.). (1994). *Breeding Fodder Crops for Marginal Conditions. Series: Developments in Plant Breeding*. USA: Springer.

PLBG-7106 Mutation Breeding 3(2+1)

This is a postgraduate level course of Plant Breeding and Genetics. Mutations are heritable changes in the phenotypes of organisms. This course focuses on importance, history and achievements of mutation in plant breeding, general properties of mutation, concepts of point and chromosomal mutation in plant cells, spontaneous and induced mutation, macro and micro mutation, molecular basis of mutation: the nucleus, chromosomes and DNA, use of mutagens and their mode of action, use of different chemical and physical mutagens to create mutation in plant cells and tissues, determination of LD 50 dose for mutation, method of determination of mutants in population, utilization of induced mutation in plant breeding, concept of gamma garden, procedure of mutation breeding, handling of the mutated populations in the case of seed propagated and clonally propagated species, use of TILLING–a reverse genetics technique to improve the trait of crop plants. At the end of the course, students will be able to understand LD50, gamma garden, TILLING, and cytological analysis of mutants.

Contents

1. Mutation: importance and achievements in plant breeding
2. Classes of mutagens
3. Induction of mutation, detection, evaluation and utilization of induced mutants
4. Factors modifying the effectiveness of irradiation in seed treatment
5. Determination of LD50
6. Effectiveness and efficiency for inducing cytological changes
7. Gamma garden. Induced mutations through transposable elements
8. Molecular basis of Mutation: Targeting Induced Local Lesions in Genomes (TILLING); making Kill Curve, development and handling of TILLING populations, high throughput screening of point mutations
9. Observations in M1 and procedure for selection in later generations
10. Use of mutants in hybridization program
11. Improvement of specific characters through induced mutation
12. Mutation breeding research in some vegetatively propagated crops
13. Bio-safety concerns

Practical

1. Radiation treatment techniques
2. Radio sensitivity of field crops
3. Cytological analysis of mutants
4. Field observations and selection procedure of mutagenic material
5. Visit to various mutation research facilities

Recommended Texts

1. Purohit, S.S. (2010). *Mutation Breeding*. India: Agrobios.
2. Datta, S.K. (2005). *Role of Classical Mutation Breeding in Crop Improvement*. New Delhi, India: Daya Publishers.

Suggested Readings

1. Van Harten, A. M. (1998). *Mutation breeding. Theory and Practical Applications*. Cambridge, UK: Cambridge University Press.
2. Amir, M., & Borstel, R.C. (1985). *Basic and Applied Mutagens*. New York, USA: Plenum Press.

3. Singh, B.D. (2004). *Plant Breeding, Principles and Methods*. New Delhi, India: Kalyani Publishers.

PLBG-7107 Cotton Genetics and Breeding 3(2+1)

This is a postgraduate level course of Plant Breeding and Genetics. It focuses on cotton crop, its importance in the economy of Pakistan, an over view of cotton research work being done by research institutes/organization in Pakistan, history and evolution of cotton, classification and taxonomy of cotton crop, important cultivated cotton species and their botanical description, breeding methods to develop new cotton genotypes, use of biotechnology to develop Bt cotton, advantages and disadvantages of Bt cotton, genomics of cotton, development of CLCV resistant cotton varieties. The objectives of the course include measurement of fiber quality traits and strategies to improve fiber quality and breeding cotton for stress environment by utilizing wild relatives and marker assisted selection (MAS). At the end of the course, students will be able to understand ideotype breeding in cotton, fiber quality attributes, use of DNA markers for various traits and breeding methods for incorporating resistance against biotic and abiotic stresses.

Contents

1. Importance of cotton in national and global economy
2. Description of various species of cotton
3. Evolutionary history and cultivated species of cotton
4. Cotton genomics, Transgenic Cotton, Contemporary issues in transgenic cotton production and CLCuD susceptibility
5. Breeding Cotton for Stress Environments
6. Organic and colored cotton
7. Introduction to genome organization and sources of resistance/tolerance (gene families) against CLCuD and other stresses
8. Utilization of wild species of Gossypium in breeding programs
9. Components of genetic defense umbrella, R gene mediated resistance
10. Cotton fibre quality traits, cotton fiber developmental stages, control of fiber elongation and maturity. Strategies to improve cotton fiber quality

Practical

1. Methods of measuring cotton fiber strength, fineness and maturity
2. Cladogram construction of various gene families involved in fiber development
3. Exploring cotton fiber EST databases, DNA markers for various traits
4. Data recording on plant and fiber characters and genetic analyses

Recommended Texts

1. Sleper, D.A., & Poehlman, J.M. (2006). *Breeding Field Crops*. (5th ed.). Oxford, UK: Blackwell publishing.
2. Rafiq, M. (2004). *Cotton: An Introduction.* Washington DC, USA: ICAC.

Suggested Readings

1. Shiron, J. (Ed.) (2004). *Transgenic Cotton*. Beijing, China: Science press.
2. Singh, P. (2004). *Cotton Breeding*. New Delhi. India: Kalyani Publishers.
3. Johnie, N.J., & Saha, S. (2001). *Genetic improvement of Cotton-emerging techniques*. New Delhi, India: Oxford and IBH Publishing.

PLBG-7108 Genetics and Breeding of Sugar Crops 3(2+1)

This is a postgraduate level course of Plant Breeding and Genetics. It focuses on: Evolutionary history of sugarcane and sugar beet; Understanding the genetic barriers in sugarcane flowering and their possible solutions; Management of fuzz production and germination; Understanding the role of polyploidy in sugar crops breeding; Genetic determination of quality parameters and their utilization; Understanding the genetic relationship between cane yield and sugar recovery and role of biotechnology in sugar crop improvement; Understanding process and purposes of about inheritance of genetic traits; To solve various genetics problems, making calculated and accurate predictions; Chemical and molecular nature of gene and its expression in sugar crops; Understanding the concept of sugar importance in sugar crops and its recovery. It will enable students to understand the breeding strategies for genetic improvement in sugar crops. The course will also aid the students to estimate the Brix value of sugarcane using Refractometer and collection of data for various plant traits in sugar crops and their statistical analysis.

Contents

1. Evolutionary history of sugarcane and sugar beet
2. Genetic barriers in sugarcane flowering and their possible solutions
3. Management of fuzz production and germination
4. Genetic determination of quality parameters and their utilization
5. Genetics of different parameters in sugarcane and sugar beet
6. Role of polyploidy in sugar crops
7. Genetic relationship between cane yield and sugar recovery
8. Strategies for genetic improvement in sugar crops
9. Role of biotechnology in sugar crops improvement

Practical

1. Estimation of Brix value of sugarcane
2. Collection of data for various plant traits in sugar crops and their statistical analysis
3. Visit to research institutes and sugar industries

Recommended Texts

1. Henry, R.J., & Kole, C. (2010). *Genetics, Genomics and Breeding of Sugarcane*. London, UK: Taylor and Francis.
2. Malik, K.B. (2009). *Cane and Sugar Production*. Lahore, Pakistan: Punjab Agriculture Research Board.

Suggested Readings

1. Draycott, A.P. (2006). *Sugar beet.* Oxford, UK: Blackwell Publishing.
2. Sleper, D.A., & Poehlman, J.M. (2006). *Breeding Field Crops* (5th ed.). Ames, Iowa, USA: Iowa State University Press.

PLBG-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 directed assignment and collect information and material related to current research interest. 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 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 special problem assigned to students are to enhance the knowledge of a subject, develop writing skills, enhance time management and organizing skills. The special problem makes you do your work by prioritizing the needs and time frames completing all your tasks peacefully avoiding panic. Special problem writing work provides students a lot of scope to improve themselves.

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

The seminar is intended to instruct students, proper techniques for presentation of scientific material. Each student is expected to prepare and present a scientific seminar and to submit supporting/ supplemental material. A seminar is a form of academic instruction, either at an academic institution or offered by a commercial or professional organization. It is a formal academic gathering with function to brainstorming, focusing each time on some particular subject, in which everyone i.e. students as well as faculty is invited 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 precise information and modern skills in a stipulated period. It also creates a sense of friendship associated with the seminar attendance, presentation, followed by question & answer session. Attending a seminar also gives the updates of latest research and development in respective fields as well as it improves communication skills of both presenter and audiences.

PLBG-7111 Genetic Engineering in Plants 3(2+1)

Genetic engineering in an emerging science and utilizes novel ways for the improvement of crop species. This course is designed to familiarize students with current applications of genetic engineering. It focuses on the molecular approaches for gene manipulation in plants, gene cloning, DNA probing, blotting techniques, and bioinformatics. There will be stepwise lectures on exploitation of recombinant DNA technology and gene delivery systems for genetic improvement of crop species. Recombinant technology is based on use of biological scissors (restriction enzymes) and glues (ligases) to integrate DNA from two different sources, and introduction in host cell on vehicles such as plasmids and virus. Importance of *Agrobacterium tumefacians* or bolistic guns for gene delivery will also be part of lectures. Issues related to release of transgenic crop varieties and their possible impact on ecosystem and environment will be considered and will be discussed in lectures. Students will be given hands-on training to enhance their capabilities to run PCR, extract DNA synthesis, genetic transformation, and development of transgenic plants.

Contents

1. Molecular approaches of gene manipulation in plants
2. Techniques for locating genes. Importance of gene cloning in industry
3. Restriction endonucleases and ligases
4. Cloning vehicles. DNA probing and blotting techniques
5. Types of PCR, cDNA synthesis and expression analysis
6. Genetic transformation and its types
7. Selection for recombinants: identification and selection of cloned gene
8. Development of transgenic plants. Benefits and problems related with transgenic plants
9. Bioinformatics

Practical

1. Extraction and purification of plasmid, genomic DNA and RNA
2. Restriction mapping. PCR and electrophoresis
3. Genetic transformation of bacteria and plants
4. Visit to National Institutions working in Genetic Engineering and Biotechnology

Recommended Texts

1. Slater, A., Scott, N.W., & Fowler, M.R. (2008). *Plant Biotechnology: the Genetic Manipulation of Plants*. Oxford, UK: Oxford University Press.
2. Liang, G.H., & Skinner, D.Z. (2005). *Transgenic Crops*. New York, USA: Haworth Press.

Suggested Readings

1. Chawla, H.S. (2004). *Introduction to Plant Biotechnology*. New Hampshire, USA: Science Publishers.
2. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., & Losick, R. (2004). *Molecular Biology of the Gene*. London, UK: Pearson Education.
3. Jackson, J,F., & Linskens. (Ed.) (2002). Testing for Genetic Manipulation in plants. *Molecular Methods of Plant Analysis* (Vol. 22). Berlin, Germany: Springer-Verlag.

PLBG-7112 Genetics of Plant Disease and Insect Resistance 3(2+1)

This course focuses on the genetics of insect and disease resistance. Disease resistance is often defined as reduction of pathogen growth on or in the plant. It denotes less disease development in a genotype than that in the susceptible variety and is a relative attribute. Plant disease resistance protects plants from pathogens in two ways: by pre-formed structures and chemicals, and by infection-induced responses of the immune system. Insect resistance refers to crops that either naturally or through genetic engineering are able to resist insect damage. Insect-resistant crops generally produce compounds that are toxic to insects that attempt to eat the resistant plants. Plant breeding for disease and insect resistance has two advantages: (i) It enhances the production of food by reducing dosses due to insects and diseases (ii) Reduces the dependence on pesticides, fungicides and bactericides. It will enable students to understand nature of parasitism, pathogenicity and expression of disease resistance, nature and mechanisms of resistance, and transfer of genetic resistance. Students will learn disease inoculation techniques and measurement of resistance.

Contents

1. Nature of parasitism, pathogenicity and expression of disease resistance
2. Mendelian, quantitative and cytoplasmic resistance in host
3. Genetics of host-pathogen interaction and various models
4. Horizontal and vertical resistance
5. Identification of disease resistance sources
6. Host/non-host resistance, Nature and genetic mechanism of resistance
7. Transfer of genetic resistance, Pyramiding genes for resistance
8. Evaluation of plant resistance to insect and diseases
9. Molecular approaches to insect and disease resistance

Practical

1. Inoculation techniques for various plant diseases
2. Study of differentiation among disease susceptibility, disease escape, tolerance, resistance and immunity
3. Measurement of resistance by using different scoring scales and their statistical analysis
4. Visit to specialized research institutes

Recommended Texts

1. Agrios, G.N. (2005). *Plant Pathology*. Burlington, USA: Elsevier Academic Press.
2. Singh, D.P., & Singh, A. (2005). *Disease and Insect Resistance in Plants*. New Hampshire, USA: Science Publishers.

Suggested Readings

1. Sadasivam, S., & Thayumanavan, B. (Ed). (2003). *Molecular Host Plant Resistance to Pests*. New York, USA: Marcel Dekker.
2. Kranz, J. (Ed.) (2002). *Comparative Epidemiology of Plant Diseases*. New York, USA: Springer.
3. Gunasekaran, M., & Weber, D.J. (Ed.) (1995). *Molecular Biology of the Biological Control of Pests and Diseases of Plants*. Provo, Utah: Department of Botany and Range Science, Brigham Young University.

PLBG-7113 Development of Hybrid and Seed Production 3(2+1)

This is a postgraduate level course of Plant Breeding and Genetics. It focuses on the importance and production of hybrid seed as the demand of hybrid seed is increasing day by day. Most of the research institutes and private companies also shifted their attention from synthetic to hybrids and producing hybrid seeds for farmers. So, this course highlighted different components of the hybrid seed production like development of inbred lines, different types of hybrids, evaluation of inbred lines. Heterosis and its different types and how heterosis can be exploited also important components of hybrid seed production. As all of these procedures are done under the field condition so there must be some field standard which are also covered in this course. At the end of the course, students will be able to understand the development of inbred lines, estimation of GCA and SCA, and mechanisms of hybrid seed production.

Contents

1. Principles for hybrid seed production
2. Heterosis, classification and its genetic basis
3. Hybrid types. Two and three-line systems of hybrid development
4. Development and maintenance of parental lines (A, B and R lines)
5. Evaluation of inbred lines for general and specific combining ability
6. Production technology for hybrid seed in field crops and vegetables
7. Isolation (temporal and spatial), planting ratios and synchronization of male and female parents.
8. Commercial use of hybrid vigor
9. Field standards, genetic purity, harvesting and handling of hybrid seed
10. Economic aspects of hybrid seed production

Practical

1. Development of inbred lines
2. Estimation of GCA and SCA
3. Selection and maintenance of A, B and R lines under field conditions
4. Use of gametocytes, induction of male sterility and evaluation of hybrids
5. Visit to private and public research institutes engaged in commercial hybrid seed production

Recommended Texts

1. Sleper D.A., & Poehlman, J.M. (2006). *Breeding Field Crops*. Ames, USA: Blackwell Publishers.
2. Singal, W.C. (2004). *Hybrid Seed Production.* New Delhi, India: Kalyani Publishers.

Suggested Readings

1. Basra, A.S. (2000). *Hybrid Seed Production in Vegetables: Rationale and Methods in Selected Crops*. New York, USA: Food Product Press.
2. Feistritzer, W.P., & Kelly, A.F. (Eds.) (1987). Hybrid Seed Production of Selected Cereal, Oil and Vegetable Crops. *FAO Plant Production and Protection Paper 82*. Rome, Italy: FAO.

PLBG-7114 Biometrical Techniques in Plant Breeding 3(2+1)

Biometrical or quantitative genetics is the area of genetics concerned with the inheritance of characters for which the genotype is, but poorly identified from the phenotype. Characters such as: height, yield and quality in crop plants exhibits no clear discontinuity between the phenotypes; the range of appearance of one genotype often overlaps that of others, so extensively, as to give the impression of a continuous distribution. Traits for which the variation shows such properties are referred to as quantitative, metrical or continuously varying traits to distinguish them from the qualitative traits. Quantitative traits are those controlled by naturally occurring allelic variation at several to many genes, poly-genes, together with the relatively major influences of environment. Knowledge of such traits can enable breeders to plant improvement programs. This is a postgraduate level course of Plant Breeding and Genetics. It focuses on the biometrical techniques used in plant breeding and its importance. At the end of the course students will be able to understand various advance data analysis tools such as principal component analysis and biplot analysis and software for biometrical analysis.

Contents

1. Importance of biometry in plant improvement
2. Selection indices. Diallel cross system
3. Genetic analysis of additive-dominance model, adequacy tests, limitations and assumptions for additive-dominance model, combining ability analysis, line x tester analysis and generation mean analysis
4. Regression and correlation analysis
5. Genotypic and phenotypic correlation analysis
6. Path coefficient analysis. Heritability and its role in selection
7. Multivariate analysis. Principal Component and Bi-plot Analysis

Practical

1. Numerical examples regarding genetic analysis
2. Assessment of genotypic and phenotypic correlations, and partitioning of genotypic correlation into direct and indirect path ways
3. Use of software for biometrical analysis

Recommended Texts

1. Singh, R.K., & Chaudhary, B.D. (2004). *Biometrical Methods in Quantitative Genetic Analysis*. New Delhi, India: Kalyani Publishers.
2. Mead, R., Curnow, R.N., & Hasted, A.M. (2003). *Statistical Methods in Agriculture and Experimental Biology*. London, UK: Chapman and Hall.

Suggested Readings

1. Townend, J. (2002). *Practical Statistics for Environmental and Biological Statistics*. New York, USA: John Wiley.
2. Becker, W.L. (1993). *Manual of Quantitative Genetics*. Pullman, Washington, USA: Washington State University Press.
3. Mead, R. (1995). *The Design of Experiments.* Cambridge, UK: Cambridge University Press.

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

This course designed for MSc (Hons)/MPhil programs of agriculture sciences provides the applied statistics background for 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 plays an important role in experimentation. While many scientific problems could be solved by different statistical procedures like Selection of statistical tools based on scale of measurements. Furthermore, some statistical softwares 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, Inverse Gaussian 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: John Wiley & Sons.
2. Rao, G. N. (2007). *Statistics for agricultural sciences* (2nd ed.). Hyderabad, India: BS Publication.

Suggested Readings

1. Lawal, B. (2014). *Applied statistical methods in agriculture, health and life sciences*. USA: Springer.
2. Sahu, P. K. (2016). *Applied statistics for agriculture, veterinary, fishery, dairy and allied fields.* USA: 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*. USA: Soil Science Society of America.

PhD

PLANT BREEDING & GENETICS

PLBG-8101 Breeding for Stress Environment 3(2+1)

This course focuses on the impact of abiotic and biotic stress on yield potential and quality aspects of different crops. Understanding the mechanism of Resistance breeding focuses on the use of genetic resources for improving plant defense against stress factors, defense mechanisms and strategies that protect host plants against pests and pathogens, inheritance of resistance genes, and durable effectiveness of resistance genes. Understanding the breeding for abiotic stress resistance and tolerance to such factors addresses concepts such as adaptability and stability of crop plants, mechanisms of stress tolerance and phenotyping for selection, genotype by environment interaction and selection in multi-environment trials. Enabling the students about screening and micro-screening techniques; breeding and selection strategies for stress tolerance in perspectives of climatic changes. At the end of the course, students will be able to understand concept of resistance and tolerance, genetic variability for stress tolerance, and genetic analysis for tolerance related traits.

Contents

1. Definition and types of stresses: environmental, soil and physiological
2. Importance of stress breeding in local and global scenarios
3. Response of crop plants to environmental stresses
4. Concepts of resistance and tolerance
5. Genetic variability for stress tolerance and its evaluation for improvement
6. Selection indices under various stresses: salinity, water and temperature shocks
7. Induction of stress tolerance, adaptive mechanisms
8. Identification of genetic resources for tolerant genes and their transfer to indigenous varieties
9. Screening and micro-screening techniques; breeding and selection strategies for stress tolerance in perspectives of climatic changes. Molecular basis of stress tolerance

Practical

1. Field and laboratory study of stress parameters
2. Screening under simulated stress conditions
3. Genetic analysis of tolerance related traits

Recommended Texts

1. Goyal, S.S., Sharma, S.K., & Rains, D.W. (eds.) (2003). *Crop Production in Saline Environments: Global and Integrative Perspectives.* London, UK: Haworth Press.
2. Hall, A.E. (2001). *Crop Responses to Environment*. Boca Raton, Florida, UK: CRC Press.

Suggested Readings

1. Gupta, U.S. (1997). *Crop Improvement Vol. 2 Stress Tolerance.* New Delhi, India: Oxford and IBH Publishing.
2. Pessarakli, M. (Ed.) (1994). *Handbook of Plant and Crop Stress.* New York, USA: Marcel Dekker.
3. Mooney, H.A., Winner, W.E., & Pell, E.J. (1991). *Response of Plants to Multiple Stresses*. San Diego, California, USA: Academic Press.

PLBG-8102 Population Genetics 3(3+0)

Population genetics is very important postgraduate level course of Plant Breeding and Genetics. Population genetics is a subfield of genetic. dealing with genetic differences among population. It is the branch of biology used to understand the pattern of evolutionary changes that occurred among population. It also discusses the role of genetic variation within populations, its effects, way to check and balance as well as modelling of all changes in the frequencies of genes and alleles. In natural populations, the genetic structure/genetic constitution may change over time within individual or populations from generation to generation, or the changes occurred among populations are the ultimate result of evolutionary processes. This course may help to understand the phenomena, how and why the frequencies of alleles and genotypes change over time within and between the populations. It will enable students to understand allelic frequency and polymorphism, genetic diversity, Hardy-Weinberg equilibrium, population models, shifting balance and consequences of genetic erosion.

Contents

1. Definition and scope of population genetics; Allelic frequency and polymorphism
2. Organization of genetic diversity
3. Hardy-Weinberg law and factors affecting population structure
4. Mating systems: random, assortative and dis-assortative
5. Population models: consequences of genetic drift
6. Genetic differentiation of populations
7. Inbreeding in small populations, effective population size
8. Wahlund's Principle, patterns of migration; natural selection; over-dominance, heterozygote inferiority
9. Mutation, selection and shifting balance
10. Genetic erosion: consequences and gene conservation

Recommended Texts

1. Hamilton, M. B. (2009). *Population Genetics.* Sussex, UK: Wiley and Blackwell.
2. Harrl, D.L. (2007). *Principles of Population Genetics.* Sunderland, Massachusetts, USA: Sinauer Associates.

Suggested Readings

1. Neal, D. (2003). *Introduction to Population Biology*. Cambridge, UK: Cambridge University Press.
2. Falconer, D.S., & Mackay, T.E.C. (1996). *Introduction to Quantitative Genetics*. London: Longman.
3. Brown, A.G.D., Clegg, M.T., Kahler, A.L.& Weir, B.S. (1990). *Population Genetics, Breeding and Genetic Resources*. Sunderland, Massachusetts, USA: Sinauer Associates.

PLBG-8103 Cereal Genetics and Breeding 3(2+1)

A cereal is considered as any grass cultivated for the production of edible grain or components of its grain, that is the amalgamation of endosperm, germ, and bran. Cereals were the foundation of human civilization. The cereal genetics and breeding science laid the foundation of cereal crop improvement, its domestication and climate proofing. Today cereals have passed a series of genetic manipulation, re-arrangement of genetic architecture, polyploidization to compete against, all biotic and abiotic stresses, particularly diseases, water stress, winter hardiness, salinity, frost, mineral toxicity etc. This is the postgraduate level course of Plant Breeding and Genetics, having maximum interpretation to enhance the research skills among students to compete the changing world, focusing on cereal crops and its byproducts, its prime role in human diet, breeding objectives-based strategies. At the end of the course, students will be able to understand the genetics and breeding behavior of cereal crops and its estimation.

Contents

1. Role of cereals in human food
2. Genomic relationship among various species of cereal crops: wheat, rice, maize, barley, oats and triticale
3. Genetics of morphological, physiological and grain quality characters in cereal crops
4. Genetics of disease and insect resistance
5. Genetic basis of resistance/tolerance against abiotic stresses
6. Strategies for improvement of cereal crops for specific traits

Practical

1. Problems relating to genetic analysis in wheat, rice, maize and barley
2. Estimation of grain quality
3. Identification and scoring of cereal diseases, screening of cereal cultivars for drought resistance and salt tolerance in lab and field conditions
4. Visit to various cereal research institutes

Recommended Texts

1. Datta, S.K. (2008). *Rice Improvement in the Genomics* Era. CRC Press, New York, USA.
2. Sleper D.A., & Poehlman, J.M.. (2006). *Breeding Field Crops*. Ames, USA: Blackwell Publishers; Iowa State University Press.

Suggested Readings

1. Nevo, E., Korol, A.B., Beilesand, A., & Fahima, T. (2002). *Evolution of Wild Emmer and Wheat Improvement.* Germany: Springer-Verlag.
2. Slafer, G.A., Molina-Cano, J.L. Araus, J.L., & Romagosa, I. (eds.). (2002). *Barley Science: Recent Advances from Molecular Biology to Agronomy of Yield*. New York, USA: Food Product Press.
3. Hallauer, A.R. (Ed.) (2001). *Specialty Corns*. Florida, USA: CRC Press.

PLBG-8104 Genetics and Breeding of Oilseed Crops 3(2+1)

This course is designed to enable students to learn about the importance and breeding oil seed crops with special reference to agro-climatic condition of Pakistan. Course will build understanding about the status of oilseeds in Pakistan, significance of conventional and non-conventional oilseed crops. Lectures will be delivered to understand various cyto-genetical aspects of oilseeds. Students will learn the importance of various components of gene pool, its collection, maintenance and utilization, cytological relationship among cultivated and wild germplasm of various oilseed. Genetical and anatomical aspects of traits related to the oil contents, fatty acids. Students will learn the use of various genetics tools for the improvement of oil contents in crop species, modification of fatty acids and enhancement of nutritional values of oilseed crops for multiple uses. Breeding methods in oilseed crops and innovative tools in oilseed breeding. Students will learn the oil extraction, estimation of oil quality by fatty acid profiling and genetic evaluation of fatty acids in oilseeds.

Contents

1. Significance of edible oil in the economy of Pakistan
2. Major issues of oilseed crops: conventional and non-conventional
3. Genetic relationship among different Brassica species
4. Genetic resources and their exploitation in oilseed crops
5. Genetic basis of qualitative, quantitative and oil quality traits
6. Genetics of double low traits and its utilization
7. Genetics of male sterility and its use in sunflower and canola hybrid seed production
8. Strategies for genetic improvement of oilseeds. Progress in oilseed crops genomics
9. Exploitation of innovative tools in oilseed crops breeding
10. New trends in long chain fatty acids

Practical

1. Specification and characteristics of edible oil, oil content, fatty acid, iodine number, acid value, hydrogenation and saponification
2. Methods and equipment used for oil extraction and analysis
3. Fatty acid profile of various edible and industrial oils
4. Genetic evaluation of different fatty acids in oilseeds

Recommended Texts

1. Ramanath, T. (2004). *Applied Genetics of Oilseed Crops*. New Delhi, India: Daya Publishers.
2. Nagata, T., & Tabata, S. (ed). (2003). *Brassica and Legumes: From Genome Structure to Breeding.* New York, USA: Springer Verlag.

Suggested Readings

1. Kimber, D. S., McGregor, D. I., & C.A.B. International. (1995). *Brassica oilseeds: Production and utilization*. Wallingford, Oxon, UK: CAB International.
2. Verma, D.P.S. (1996). Soybean: Genetics, Molecular Biology and Biotechnology. *Biotechnology in Agriculture Series No 14.* USA: CABI Publishing.
3. Robbelen, G., & Downey, R.K. (1990). *Oil Crops of the World: Their Breeding and Utilization,* New York, USA: McGraw-Hill Publishing.

PLBG-8105 Evolution in Field Crops 3(3+0)

The processes- Gene recombination, polyploidy and mutation- are not new innovations. These extend the natural forces by which present cultivated crop species have evolved and reached the forms in which we know them today. In fact, crop evolution – genetic change in crop populations – is probably at least as rapid now as ever it has been and, some crops, much more rapid. Plant breeders are applied evolutionists. One might call this the continuum view of crop evolution. Evolution of crop plants has been acclaimed as uniquely comprehensive and authoritative work on the subject of evolution of man's crops. It presents in a concise way a synoptic view of crop history, linking studies of origin and early evolution with recent and even possibly future trends in breeding to meet the changing demands of world agriculture. This is a postgraduate level course of Plant Breeding and Genetics. It focuses on the theories of evolution, phylo-genetic history of evolution and modes of speciation. It will enable students to understand evolution of major field crops, evolution of genes and genomes of field crops, and software for phylo-genetic studies.

Contents

1. Theories of evolution
2. Co-evolution, phylo-genetic history of evolution
3. Concept of species, isolating mechanisms, different types/modes of speciation
4. Various sources of variation, role of genetic polymorphism, migration, mutation, hybridization and polyploidy in evolution
5. Natural selection, patterns of selection
6. Wide crosses and species re-synthesis in crops
7. Evolution and species relationship in important field crops
8. Evolutionary trends in crops, important plant adaptations in climatic vagaries
9. Evolution of genes and genomes of field crops
10. Introduction of various software for phylo-genetic relationships

Recommended Texts

1. Hancock, J. (2004). *Plant Evolution and the Origin of Crop Species*. (2nd ed.). USA: Oxford University Press.
2. Willis, K.J., & McElwain, J.C. (2002). *Evolution of Plants*. Oxford, UK: Oxford University Press.

Suggested Readings

1. Strickberger, M.W. (2000). *Evolution.* New York, USA: Jones and Bartlett.
2. Ladizinsky, G. (1998). *Plant Evolution Under Domestication*. New York, USA: Kluwer Academic Publishers.
3. Smartt, J., & Simmonds, N.W. (Eds.) (1995). *Evolution of Crop Plants*. (2nd ed.). Essex, England: Longman Scientific and Technical.

PLBG-8106 **Advanced Cytogenetics** **3(3+0)**

The main focus of this course is to build understanding about the advanced tools and concepts of cytogenetics among plant breeding and genetics students. Lectures will be delivered about the modern concept and theories of the evolution of the cell and its components. Course will cover concepts about the polyploidy, aneuploidy and its different types. The focus of lectures will be to differentiate the polysomic, disomic, trisomic, monosomic and nullisomic organisms with respect to their origin, and cyto-genetical aspects. Cyto-genetical aspects includes the pairing of homologous or homologous chromosome, stability of polyploid plants, genetics of autopolyploidy. Students will learn the utility of plants with abnormal chromosome number in understanding the genetic control of various morphological traits. It will focus on advanced cytogenetics by describing heteroploidy, use of substitution lines in crop improvement, cytogenetics of apomixes, FISH and GISH. Students will be able to learn production of polyploid, haploids and dihaploids, and aneuploid analysis.

Contents

1. Endosymbiotic theory of evolution of organelles
2. Heteroploidy
3. Autopolyploidy: occurrence and general characteristics
4. Haploids vs monoploids, artificial production of haploids and dihaploids
5. Theoretical genetic ratios for single gene locus, genetic data, linkages in autopolyploids.
6. Allopolyploidy: origin, evidences of homology between chromosomes
7. Aneuploidy: trisomics, monosomics, nullisomics, their transmission and factors influencing transmission
8. Substitution lines and their use in crop improvement
9. Cytogenetics of apomixes
10. Introduction to florescent and genomic *in situ* hybridization techniques

Recommended Texts

1. Puertas, M.J., & Naranjo, T. (2005). *Plant Cytogenetics: Cytogenetic and Genome Research.* Berlin, Germany: Karger Publishers.
2. Schulz-Schaeffer, J. (1981). *Cytogenetics: Plants, Animal, Humans.* New York, USA: Springer-Verlag.

Suggested Readings

1. Singh, R. J. (2005). *Plant Cytogenetics*. Florida, USA: CRC Press.
2. Swanson, C.P., Merz, T. & Young, W.J. (1981). *Cytogenetics* (2nd ed.). Englewood Cliff, New Jersey, USA: Prentice Hall international.

PLBG-8107 **Plant Genomics** **3(2+1)**

Students will be enabled to learn the concepts of genomics and functional genomics. Lectures will be scheduled to provide key concepts about the genome annotation, gene mining, sequencing, origin and evolution of various organellar genomes. Students will be taught about the nuclear, cytoplasmic organization of eukaryotic genome, and epigenetic changes affecting the genome expression in nucleus. Students will be given hands-on training about various genomic tools and software to learn genomic homology, phylogenetic relationship with respect to nucleotide homology and alignment. Integration of genomic sequencing data for whole genome association mapping to identify genes and single nucleotide polymorphism associated with the traits of breeding interest. It focuses on introduction and structure of plant genomics, physical mapping of plant chromosomes, MMS for gene mapping and gene discovery. At the end of the course, students will learn the construction of cDNA libraries, genomic DNA libraries, gene discovery from sequence data and TILLING.

Contents

1. Introduction to plant genomics
2. The structure of plant genomes
3. Origin and evolution of plant nuclear, mitochondrial and plastid genomes
4. Physical organization and gene contents of cytoplasmic genomes
5. Organization of DNA into chromosomes
6. Construction of genomic DNA libraries; Physical mapping of plant chromosomes
7. Molecular marker systems for gene mapping
8. DNA based markers. Genome sequencing strategies
9. Gene discovery from sequence data; ESTs and full-length cDNA libraries
10. Transposable elements and transcription factors
11. Identification of genes by mutagenesis – forward and reverse genetic approaches. T-DNA mutagenesis, RNAi, TILLING, delete a gene and combinatorial gene silencing
12. Comparative genomics – case study of cereal genomes
13. Epigenomics and its applications in crop plants
14. Current prospectus and future scenario of plant genomics

Practical

1. Taxonomic and molecular identification of various crop progenitors in the field
2. Analysis of gene family evolution
3. *In silico* expression profiling of genes. Analysis of *cis* and *trans* acting elements

Recommended Texts

1. Cullis C.A. (2004). *Plant Genomics and Proteomics*: New York: Wiley Liss.
2. Daniell, H., & Chase, C. (2004). *Molecular biology and biotechnology of plant organelles: Chloroplasts and mitochondria*. Dordrecht, the Netherlands: Springer.

Suggested Readings

1. Leister, D. (2005). *Plant Functional Genomics*: USA: CRC Press.
2. Somers, D.J., Langridge, P., & Gustafson, J.P. (2009). *Plant Genomics Methods and Protocols; Series: Methods in Molecular Biology* (Vol. 513). Totowa, New Jersey: Humana Press.

PLBG-8108 Advanced Methods in Plant Breeding 3(2+1)

Traditional plant breeding procedures are based on manipulation of genes and chromosomes through sexual reproduction in whole plants. The procedures were developed from Mendelian Genetic principles, and were expanded with the developments in cytology, polyploidy, mutation induction, quantitative genetics, heterosis, male sterility and related areas. In recent years, a technology for genetic manipulation at the cellular level has emerged, which has a unique potential for supplementing traditional plant breeding procedures. This is the postgraduate level course of Plant Breeding and Genetics. This provides a good deal of information on various biometrical techniques, that are useful in assessment of variability, selection of elite genotypes from diverse genetic populations, choice of desire of parents and breeding procedures, varietal adaptability and role of computer in plant breeding. This type of genetical information obtainable from above biometrical techniques and the manner in which the information is useful in plant breeding programs has been dealt with. This course will enable students to understand ideotype concept, participatory plant breeding, stability analysis, marker assisted selection and its applications. Students will learn the application of various mating designs and computer software.

Contents

1. Ideotype concept; its genetic basis, identification and development of an ideotype
2. Current scenario and future concerns. Participatory plant breeding
3. Components of variation, estimation of additive and non-additive variances
4. Heritability and its role in selection
5. Testing G × E; Stability analysis; Enhancement of genetic gain in plant breeding
6. Mating designs: Diallel, North Carolina design I, II and III
7. Selection indices and their uses. Significance and utilization of wide crosses
8. Marker assisted selection and its application in plant breeding

Practical

1. Expected mean squares and their use in plant breeding
2. Response to selection, Estimation of variance and heritability from the mating designs
3. Application of various mating designs and selection indices

Recommended Texts

1. Singh, R.K. & Chaudhary, B.D. (2004). *Biometrical Methods in Quantitative Genetic Analysis.* New Delhi, India: Kalyani Publishers.
2. Falconer, D.S. (2003). *Introduction to Quantitative Genetics*. London, UK: Textbook Publisher.

Suggested Readings

1. Kang, M.S. (ed). (2003). *Handbook of Formulas and Software for Plant Geneticists and Breeders*. LA, USA: Harworth Press.
2. Kang, M.S. (Ed.) (2002). *Quantitative Genetics, Genomics and Plant Breeding*. Sussex, UK: CABI.

3. Kang, M.S., & Gauch, H.G. (1996). *Genotype by Environment Interaction.* New York, USA: CRC Press.

PLBG-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 assignment and collect information and material related to current research interest. 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 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 special problem assigned to students are to enhance the knowledge of a subject, develop writing skills, enhance time management and organizing skills. The special problem makes you do your work by prioritizing the needs and time frames completing all your tasks peacefully avoiding panic. Special problem writing work provides students a lot of scope to improve themselves.

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

The seminar is intended to instruct students, proper techniques for presentation of scientific material. Each student is expected to prepare and present a scientific seminar and to submit supporting/ supplemental material. A seminar is a form of academic instruction, either at an academic institution or offered by a commercial or professional organization. It is a formal academic gathering with function to brainstorming, focusing each time on some particular subject, in which everyone i.e. students as well as faculty is invited 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 precise information and modern skills in a stipulated period. It also creates a sense of friendship associated with the seminar attendance, presentation, followed by question & answer session. Attending a seminar also provides updates of latest research and development in respective fields as well as it improves communication skills of both presenter and audience.

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

Modern agricultural production is characterized by various activities that require 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. Data in agriculture is of numerical character accompanied with variability of data. Statistics can be used as a tool for agricultural research. It can help research workers to design his experiments and to evaluate objectively the resulting numerical data. This course focus on advanced design of experiment tools which will be helpful to find out the factors of output related to agriculture experiments. Moreover, students will learn some statistical software's like Minitab, R, and Design Expert 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
6. Effect of violation of assumptions of underlying ANOVA
7. Factorial Experiments, 2^n, 3^n… P^n
8. Mixed levels factorial experiments
9. Confounding and its types. Fractional replication. Application and construction of contrasts
10. Response surface methodology
11. Introduction of multivariate analysis
12. Principle component analysis
13. Factor analysis
14. Cluster Analysis
15. Correspondence analysis

Recommended Texts

1. Muhammad, F. (2000). *Statistical methods and data analysis*. Pakistan: Ilmi Kitab Khana.
2. Montgomery, D. C. (2017). *Design and analysis of experiments* (9th ed.). New York: John Wiley & Sons.

Suggested Readings

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