Fifth Semester

PBG-301 Principles of Genetics 3(2-1)

Objectives

To enable students to understand the principles of genetics

Genetic improvement of the crop plants.

Application of innovative techniques in plant breeding and genetics.

Theory

Genetic concepts; Metabolic pathways and genic interactions; Sex linked inheritance; Holandric genes; Extra chromosomal inheritance; Linkage and crossing over; Three-point and multipoint tests; Chemical nature of genetic material; Protein synthesis and gene regulation; Genetic coding; Mutations and their implications; Hardy Weinberg Law and its implications; DNA repair mechanism; Epigenetics.

Practical

Solving genetic problems: monogenic and multigenic traits; Chi-square test; Probability; Non-allelic interactions; Metabolic pathway interactions; Sex inheritance; Multiple alleles; Linkage and crossing over analysis; Hardy-Weinberg Law.

Suggested Readings

1. Brooker, R.J. 2005. Genetics: Analysis and Principles. (2nd ed) McGraw-Hill, USA.
2. Jones, R.N. and G.K. Richards. 1991. Practical Genetics. Open University Press, Milton Keynes, Philadelphia, USA.
3. Rothwell, N.V. 1993. Understanding Genetics: A Molecular Approach. Wiley Publishers, USA.
4. Singh, B.D. 2003. Genetics. Ist ed. Kalyani Publishers, New Delhi, India.

Strickberger, M.W. 1990. Genetics. 3rd ed. McMillan Publishing Company, New York, USA.

PBG-303 Breeding Field Crops 3(2-1)

Objectives

To enable students to understand the breeding field crops

Genetic improvement of the crop plants.

Application of new innovative techniques that useful for breeding field crops

Theory

Plant breeding: genesis, role in increasing crop productivity and quality, objectives, strategies, consequences; Inheritance of qualitative and quantitative characters; Variation and its assessment; Components of variance; Heritability and factors affecting it's estimates; Selection differential and response to selection; Methods of breeding varieties of self pollinated crops: mass selection, pure line selection, pedigree selection, bulk method, back cross method, multi line breeding, development of double haploids and single seed decent method. Methods of breeding cross pollinated crops; population improvement principle, recurrent selection and its various types, development of hybrids, composite and synthetics. Methods of breeding vegetatively propagated crops. Special approaches of breeding crops. Release of new varieties and production of quality seeds.

Practical

Selfing and crossing techniques in major crops. Assessment of variability for different plant characters. Planting breeding material following CRD, RCBD and Factorial designs and data analyses.

Suggested Readings

1. Chahal, G.S. and S.S. Gosal. 2002. Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches. Alpha Science International Ltd., UK.
2. Khan, M.A. 2008. Plant Breeding. National Book Foundation, Islamabad.
3. Sleper, D.A. and J.M. Poehlman, 2006. Breeding Field Crops. 5th ed. Blackwell Publishing Company, USA.
4. Simmonds, N.W. and J. Smartt. 1999. Principles of Crop Improvement. Blackwell Science. London, UK.
5. Singh, B.D. 2009. Plant Breeding: Principles and Methods. 8th ed. Kalyani Publishers, New Delhi.

Singh, P. 2004. Essentials of Plant Breeding. Kalyani Publishers, New Delhi, India.

PBG 305 Modern Techniques in Plant Breeding 3(2-1)

Objectives

To enable students to understand:

Modern breeding tools and techniques in crop improvement.

Application of new techniques in plant breeding.

Theory

Introduction to genetic engineering and plant biotechnology. In vitro culture techniques : callus culture, cell suspension culture, protoplast culture, embryo rescue, soma clonal variations. Basics of molecular biology, DNA amplification, Polymerase Chain Reaction, DNA fingerprinting, molecular markers and marker assisted selection in plant breeding. Biotechnological approaches to drought tolerance, salt tolerance and protein quality in various field crops. Scope of transgenic plants in plant breeding.

Practical

Safety measures in the biotech laboratory. Introduction to aseptic techniques, autoclaving, sterilization, use of laminar flow and fume hoods. Storage and weighing of chemicals, preparation of stock-solutions, adjusting pH, making dilutions. Media preparation. Callus formation and regeneration from plant material. Isolation, handling and quantification of DNA.

Books recommended

1. Loodish, H. 2004. Molecular Cell Biology. 5th Ed., John Wiley and Sons, New York, USA.
2. Paul, C and K. Harry. 2004. Handbook of Plant Biotechnology. John Willy and Sons, New York, USA.
3. Muglani, G. S. 2003. Advanced Genetics. Narosa Publishing House, New Delhi, India.
4. Razdan, M. K. (Ed) 2003. Introduction to Plant Tissue Culture. 2nd Ed., Intercept, New York, USA.
5. Brown, T. A. 2000. Essential Molecular Biology: A Practical Approach. Oxford University Press, New York.

PBG 307 Breeding for Climate Change Resilient Crops 3(2-1)

Objectives

This course aims to familiarize the students about the impact of climate change on crop production and climate-smart crop management practices to improve the climate resilient crops.

Course contents

Introduction to abiotic stresses, impact of climate change on agriculture and food production, introduction to climate-smart crop production, climate-smart crop production practices and technologies, climate-smart crop production systems in practice, creation of an enabling environment for climate-smart crop production, breeding of crops for climate change adaptation, Biotechnology- a toolkit for climate resilient agriculture, genome editing for sustainable agriculture, speed breeding.

Books Recommended

Bakala, H. S., Singh, G., & Srivastava, P. (2020). Smart Breeding for Climate Resilient Agriculture. In (Ed.), Plant Breeding - Current and Future Views. Intech Open. https://doi.org/10.5772/intechopen.94847

Kole C, (2013). Genomics and Breeding for Climate-Resilient Crops, Springer Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-37045-8

PBG 309 Molecular Plant breeding 3(2-1)

Objective:

The course goal is to familiarize students with the application of molecular information to plant breeding. By the end of the semester students should be able to describe current methods for mapping quantitative trait loci (QTL), Genome-wide association (GWAS), marker-assisted selection (MAS), and Genomic Selection (GS). The course will also review the applications of biotechnology to breeding programs**.**

Theory:

Introduction to Methods in Plant Breeding. Introduction to Molecular Markers and their type. Introduction to molecular mapping using molecular markers. Types of mapping: Linkage Mapping. Quantitative Trait Loci (QTL) mapping. Genome-Wide mapping and Analysis, QTL mapping and analysis. Marker-Assisted Selection (MAS), Genomic Selection (GS). Genetic Engineering in Plant Breeding: Traditional Methods, Genetic Engineering in Plant Breeding: Gene-Editing tools. Application of marker assisted breeding

Practical:

DNA extraction, PCR and its basic requirements, gel electrophoresis, Primer design and use of different software for primer designing, Functional marker development.

Books Recommended

- Garcia, M & Mather DE 2014 ‘From genes to markers: exploiting gene sequence information to develop tools for plant breeding’, In Fleury, D & Whitford, R (eds.) Crop Breeding: Methods and Protocols. Methods in Molecular Biology vol. 1145, Springer Science+Business Media, New York.

- Rex Bernardo. 2014. “Essentials of plant breeding”. Stemma press. Woodbury, Minnesota, USA. ISBN 978-0- 9720724-2-7
- Broman, K W. 2001. “Review of Statistical Methods for QTL Mapping in Experimental Crosses.” Lab Animal 30 (7): 44–52. doi:11469113.
- Collard, B. C Y, M. Z Z Jahufer, J. B. Brouwer, and E. C K Pang. 2005. “An Introduction to Markers, Quantitative Trait Loci (QTL) Mapping and Marker-Assisted Selection for Crop Improvement: The Basic Concepts.” Euphytica 142 (1–2): 169–96. doi:10.1007/s10681-005-1681-5.