

**Scheme of Studies for
B.Sc. (Hons.) Degree Programs in
Plant Breeding and Molecular Genetics**

| Course No. | Title | Credit Hours |
|--|---|------------------------|
| PBMG 211 | Introductory Genetics | 3(2-1) |
| PBMG 221 | Introductory Plant Breeding | 3(2-1) |
| 5th Semester Courses | | |
| PBMG 311 | Principles of Genetics | 3(2-1) |
| PBMG 312 | Breeding Field Crops | 3(2-1) |
| PBMG 313 | Cytogenetics | 3(2-1) |
| PBMG 314 | Fundamentals of Plant Biometry | 3(2-1) |
| PBMG 315 | Modern Techniques in Plant Breeding | 3(2-1) |
| | | <hr/> Total= 15 |
| 6th Semester Courses | | |
| PBMG 321 | Breeding Fibre Crops | 3(2-1) |
| PBMG 322 | Breeding Sugar Crops | 3(2-1) |
| PBMG 323 | Breeding Maize and Millets | 3(2-1) |
| PBMG 324 | Biodiversity and Plant Genetic Resources | 3(3-0) |
| PBMG 325 | Molecular Genetics | 3(2-1) |
| | | <hr/> Total= 15 |
| 7th Semester Courses | | |
| PBMG 411 | Breeding Oilseed Crops | 3(2-1) |
| PBMG 412 | Breeding Pulse Crops | 3(2-1) |
| PBMG 413 | Breeding Vegetable Crops | 3(2-1) |
| PBMG 414 | Breeding Cereal Crops | 3(2-1) |
| PBMG 415 | Experimentation in Plant Breeding | 3(2-1) |
| | | <hr/> Total= 15 |
| 8th Semester Courses | | |
| PBMG 421 | Breeding Fodder and Forage Crops | 3(2-1) |
| PBMG 422 | Fundamentals of Research & Scientific Writing | 3(2-1) |
| PBMG 423 | Genomics in Agriculture | 3(2-1) |
| PBMG 424 | Breeding Medicinal Plants | 3(2-1) |
| PBMG 425 | Internship or Research Project | 3(0-3) |
| | | <hr/> Total= 15 |

Objectives

To enable the students to understand:

- Basic concepts of genetics
- Mechanism of heredity
- Chemical and molecular nature of nucleic acids

Theory

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

Practical

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

Books recommended

1. Singh, B.D. 2004. Genetics. Kalyani Publishers, New Delhi, India.
2. Klug, W.S. and M. R. Cummings. 2003. Concepts of Genetics. (7th ed.), Pearson Education, Singapore.
3. Singh, P. 2003. Elements of Genetics. (2nd ed.) Kalyani Publishers, Delhi, India.
4. Stansfield, W.D. 1988 Theory and Problems of Genetics. 4th Ed. McGraw Hill Book Co, NY.
5. Khan I.A. F.M. Azhar, Z. Ali and A.A. Khan. 2008. Solving Numerical Genetic Problems. Dept. Plant Breed. Genet. Uni. Agri. Faisalabad.

World Wide Web

1. <http://anthro.palomar.edu/mendel/mendel1.htm>

Objectives

To enable the students to understand:

- Basis of plant breeding
- Reproductive mechanisms in major crops
- Application of genetic principles in crop improvement
- Breeding methods in self and cross pollinated crops

Theory

Introduction to plant breeding and its role in crop improvement. Reproductive systems in major crop plants. Genetic variation and its exploitation, creation of variation through genetic recombination, mutation and heteroploidy. Breeding self-pollinated crops: introduction, mass selection, pure line selection, hybridization, pedigree method, bulk method and backcross techniques. Breeding cross-pollinated crops: introduction, mass selection, recurrent selection, development and evaluation of inbred lines, development of hybrids, synthetic and composite populations. New trends in plant breeding.

Practical

Descriptive study of floral biology, scientific names, chromosome number and ploidy level of important field crops. Selfing and crossing techniques in major crops. List of approved varieties in major field crops.

Books recommended

1. Sleper, D. A. and J.M. Poehlman. 2006. Breeding Field Crops. 5th ed. Iowa State University Press, Ames, USA.
2. Chahal, G.S. and S.S. Gosal. 2003. Principles and Procedures of Plant Breeding. Narosa Publishing House New Delhi India.
3. Singh, B. D. 2003. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi, India.
4. Singh, P. 2003. Essentials of Plant Breeding. Kalyani Publishers, New Delhi, India. Khan, M.A (Editor). 1994. Plant Breeding. National Book Foundation, Islamabad.
5. Acquaah, G. 2009. Principles of Plant Genetics and Breeding. John Wiley & Sons, UK.

Objectives

To enable students to understand:

- Expansion of Mendelian inheritance
- Chemical nature of genetic material
- Genetic control of protein synthesis
- Molecular basis of gene
- Mutation and its types

Theory

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

Practical

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

Books recommended

1. Klug, W.S. and M.R. Cummings. 2010. Concepts of Genetics. Dorling Kindersley, Pvt. (Ltd.) New Delhi, India.
2. Brooker, R.J. 2005. Genetics: Analysis and Principles. 2nd ed., McGraw-Hill Company, New York, USA.
3. Griffiths, A.J.F., J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart. 2005. An Introduction to Genetic Analysis. W.H. Freeman and Company, New York, USA.
4. Singh, B.D. 2004. Genetics. Kalyani Publishers, New Delhi, India.
5. Stansfield, W.D. 1988 Theory and Problems of Genetics. 4th Ed. McGraw Hill Book Co, NY.
6. Khan, I.A. F.M. Azhar, Z. Ali and A.A. Khan. 2008. Solving Numerical Genetic Problems. Dept. Plant Breed. Genet. Uni. Agri. Faisalabad.

Objectives

To enable students to understand:

- Achievements made in plant breeding
- Strategies of plant breeding
- Various breeding methods in self and cross pollinated crops

Theory

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

Practical

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

Books recommended

1. Singh, B.D. 2007. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi, India.
2. Sleper, D.A. and J.M. Poehlman. 2006. Breeding Field Crops. 5th Ed. Iowa State University Press Ames, USA.
3. Singh, P. 2004. Essentials of Plant Breeding. Kalyani Publishers, New Delhi, India.
4. Chahal, G.S. and S.S. Gosal. 2002. Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches. Alpha Science International Ltd., Oxford, UK.
5. Khan, M.A. (Editor). 1994. Plant Breeding. National Book Foundation, Islamabad, Pakistan.
6. Acquaah, G. 2009. Principles of Plant Genetics and Breeding. John Wiley & Sons, UK.

Objectives

To enable students to understand:

- Structure and functions of cell organelles
- Chromosomal structure, functions and their abnormalities

Theory

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.

Practical

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

Books recommended

1. Singh, R.J. 2003. Plant Cytogenetics. CRC Press, Baton Rudge, USA.
2. Ravindranath, N.H. 2002. Elements of Modern Cytology, Genetics and Evolution. Kalyani Publishers, New Delhi, India.
3. Clark, M.S. and W.J. Wall. 1996. Chromosomes: The Complex Code. Chapman and Hall Ltd., London, UK.
4. Jahier, J., A.M. Chevre, R. Delourme, F. Eber, and A.M. Tanguy. 1996. Techniques of Plant Cytogenetics. Science Publishers Inc, New York, USA.

World Wide Web

1. www.molecularcytogenetics.org/

Objectives

To enable students to understand

- Application of biometrical techniques in genetics and breeding
- Recording and analyzing qualitative and quantitative data
- Various statistical techniques used in plant breeding

Theory

Concept of quantitative, qualitative traits and their analysis. Chi-square test. Variance and covariance: components of variance and covariance. Regression and correlation. Heritability types, selection pressure, selection differential, response to selection and genetic advance. Heterosis, hetero-beltiosis, potence ratio and combing ability. Introduction to different genetic models.

Practical

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

Books recommended

1. Singh, R.K. and B.D. Chaudhary. 2004. Biometrical Methods in Quantitative Genetics Analysis. Kalyani Publishers, New Delhi, India.
2. Kang, M.S. and M. Kang (ed). 2003. Handbook of Formulae and Software for Plant Geneticists and Breeders. Harworth Press Inc, Los Angelus, USA.
3. Singh, P. 2000. Biometrical Techniques in Plant Breeding. 2nd ed., Kalyani Publishers, New Delhi, India.
4. Baker, W.A. 1992. Manual of Quantitative Genetics. 5th ed. Academic enterprises, Pullman, USA.
5. Ali, Z. 2010. Analyzing and Understanding Genetic Problems: Classical and conventional approach. VDM, Germany.

Objectives

To enable students to understand:

- Modern breeding tools in crop improvement.
- Application of new techniques in plant breeding.

Theory

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

Practical

Safety measures in the biotech laboratory. Orientation to various lab equipments. 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 micro-propagation.

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, USA.
6. Brown, T.A. 2010. Gene cloning and DNA analysis: An introduction. Willy-Blackwell, UK.

World Wide Web.

1. www.accessexcellence.org/LC/ST/st2bgplant.html -

Objectives

To enable students to understand:

- Developmental history of various fibre crops
- Breeding fibre crops for yield and quality characteristics
- Breeding methods for incorporating resistance against biotic and abiotic stresses

Theory

Introduction to fibre crops. Role of fibre crops in national and international economy. Current breeding work on cotton and other fibre crops in Pakistan. Cotton genetic resources: species grown in Pakistan. Objectives of breeding fibre crops. Breeding methods. Concepts of ideotype breeding in cotton. Coloured and organic cotton. Genetics of host-plant resistance. Fibre quality attributes and their relationship with morphological traits. Development of hybrid and transgenic cotton. Scope and perspective of *Bt* cotton in Pakistan.

Practical

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

Books recommended

1. Sleper, D.A. and J.M. Poehlman. 2006. Breeding Field Crops. 5th Ed. Iowa State University Press Ames, USA.
2. Shiron, J. (Editor). 2004. Transgenic Cotton. Science Press, 16 Donghuangchenggen North Street Beijing, China.
3. Singh, P. 2004. Cotton Breeding. Kalyani Publishers. New Delhi. India.
4. Johnie, N.J. and S. Saha. 2001. Genetic improvement of Cotton-emerging techniques. Oxford and IBH Publishing Co., New Delhi, India.
5. Mauney, J.R. 1984. Cotton. ASA, CSSA and SSSA. Agronomy Monograph. Amer. Soc. Agron., Madison, Wisconsin, USA.

Objectives

To enable students to understand:

- Breeding methods in sugar crops
- Constraints in sugarcane breeding
- Different genetic systems in sugar crops

Theory

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

Practical

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

Books recommended

1. Henry, R.J. and C. Kole. 2010. Genetics, Genomics and Breeding of Sugarcane. Taylor and Francis, London, UK.
2. Malik, K.B. 2009. Cane and Sugar Production. Punjab Agriculture Research Board, Lahore, Pakistan.
3. Draycott, A.P. 2006. Sugar beet. Blackwell Publishing Ltd., Oxford, UK.
4. Sleper, D.A. and J.M. Poehlman. 2006. Breeding Field Crops. 5th ed. Iowa State University Press, Ames, Iowa, USA.
5. James, G. 2004. Sugarcane. Blackwell Publishing Co., Ames, Iowa, USA.

World Wide Web

1. <http://sugarcane-breeding.tn.nic.in/>
2. <http://khbreeding97.webs.com/sugarcropsresinst.htm>

Objectives

To enable students to understand:

- Evolutionary pathways of maize and millet
- Breeding methods in maize and millet
- Hybrid maize production and its scope

Theory

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

Practical

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

Books recommended

1. Dana. S. 2001. Plant Breeding. Partha Sankar Basu Publishing Co. Kolkata, India.
2. Sprague, G. F. and J. V. Dudley (ed.). 1988. Corn and Corn Improvement. 3rd ed. ASA, CSSA and SSSA. Agronomy Monograph 18, Amer-Soc. Agron., Madison, Wisconsin, USA.
3. Chaudhry, A.R. 1983. Maize in Pakistan. Punjab Agric. Res. Coordination Board, Univ. of Agric., Faisalabad, Pakistan.
4. Hallauer, A.R. and J.B. Miranda. 1988. Quantitative Genetics in Maize Breeding. 1st ed. Iowa State University Press, Ames, Iowa.
5. FAO. 1980. Improvement and production of Maize, Sorghum and Millet. Vol. 2, Food and Agric. Org. of the United Nations, Home, Italy.

Objectives

To enable students to understand:

- Importance of biodiversity in plant breeding
- Strategies of germplasm collection and conservation
- Role of novel techniques in germplasm identification and preservation

Theory

Importance of plant biodiversity, characteristics of wild and domesticated plant species. Origin and distribution patterns of crop species. Centres of origin and genetic diversity. Wild relatives of crops, Exploration of genetic resources. Principles and strategies of germplasm collection. Seed bank and its role in biodiversity conservation. Mechanism of gene banking: maintenance, evaluation and conservation (*In situ* and *ex situ*). Utilization of genetic resources in crop research and plant breeding. Introduction to national and international germplasm centers. Visit to gene banks.

Books recommended

1. Sleper, D.A. and J.M. Poehlman. 2006. Breeding Field Crops. 5th Ed., Iowa State University Press, Ames, USA.
2. Dhillon, B.S., R.K. Tyagi and A. Lal. 2004. Plant Genetic Resource Management. Narosa, New Delhi, India.
3. Brown, A.H.D., O.H. Frankel, D.R. Marshall and J.T. Williams. 1989. The Use of Plant Genetic Resources. Cambridge University Press, Cambridge, UK.

Objectives

To enable students to understand:

- Concept of genetic codes and gene function
- Basics of genetic engineering and biotechnology

Theory

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. Transposable elements. Gene cloning techniques in crop plants. Gene mapping. Marker assisted analysis and QTL mapping.

Practical

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

Books recommended

1. Klug, W.S. and M.R. Cummings. 2010. Concepts of Genetics. Dorling Kindersley, Pvt.(Ltd.) New Delhi, India.
2. Rothwell, V.N. 1993. Understanding Genetics: A Molecular Approach. 2nd ed., John Wiley and Sons New York, USA.
3. Bilgrami, K.S. and A.K. Pandey. 1992. Introduction of Biotechnology. CBS Publishers & Distributors, New Delhi, India.
4. Maniatis, T., E.F. Fritsch and J. Sambrook, 1989. Molecular Cloning. A Laboratory Manual. Cold Spring Harbor, USA.

Objectives

To enable students to understand:

- Status of oilseeds in Pakistan
- Significance of conventional and non-conventional oilseed crops
- Breeding methods in oilseed crops

Theory

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

Practical

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

Books recommended

1. Nagata, T. and S. Tabata (ed).2003. Brassica and Legumes: From Genome Structure to Breeding. Springer Verlag, New York, USA.
2. Verma, D.P.S. 1996. Soybean: Genetics, Molecular Biology and Biotechnology. Biotechnology in Agriculture Series, No 14. CABI Publishing Co. USA.
3. Kimber, D. and D.I. McGregor. 1995. Brassica Oilseeds: Production and Utilization. Cambridge, UK.
4. Robbelen, G. and R.K. Downey. 1990. Oil Crops of the World: their Breeding and Utilization, McGraw-Hill Publishing Company, New York, USA.

World Wide Web

1. <http://www.parc.gov.pk/1SubDivisions/NARCCSI/CSI/rapeseed.html>
2. http://archive.idrc.ca/library/document/091017/chap3_e.html

Objectives

To enable students to understand:

- Significance and status of pulses
- Constraints in pulse breeding
- Breeding methods for biotic and abiotic stresses

Theory

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

Practical

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

Books recommended

1. Sleper, D.A. and J.M. Poehlman. 2006. Breeding Field Crops. Iowa State University Press, Ames, Iowa, USA.
2. Ali, M. 2006. Drought Management Strategies for Pulse crops. Agrotech. Publishing Academy, Udaipur, India.
3. Nagata, T. and S. Tabata (ed). 2003. Brassica and Legumes - From Genome Structure to Breeding. Springer Verlag, New York, USA.
4. Singh, D.P. (ed). 2001. Genetics and Breeding of Pulse Crops. Kalyani Publishers New Delhi, India.
5. Persley, G.J. (ed.). 1984. Tropical Legume Improvement. Biotech Anutech Pvt. Ltd., Canberra, Australia.

Objectives

To enable students to understand:

- Significance and classification of vegetables
- Reproductive mechanisms in various vegetables
- Role of innovative tools in vegetable improvement

Theory

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

Practical

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

Books recommended

1. Arya, P.S. 2003. Vegetable Breeding, Production and Seed Production. Kalyani Publisher, New Delhi, India.
2. Kalloo, G. and B.O. Bergh. (Eds) 1999. Genetic Improvement of Vegetable Crops. Pergoman Press, New York. USA.
3. Swiader, J.M., G.W. Ware and J.M. McCollum. 1992. Producing Vegetable Crops. 4th ed. Interstate Publisher Inc., Danville, Illinois, U.S.A.
4. Bassett, M.J. (ed.) 1986. Breeding Vegetable Crops. Avi Publishing Co., Inc. Westport, Connecticut, U.S.A.

Objectives

To enable students to understand:

- Application of genetic principles in cereal breeding
- Various reproductive systems in cereals
- Variety development and release procedures

Theory

Importance of cereals; wheat, rice, barley, oats and triticale. Status of cereals; global and local perspective. Evolution, origin, and phenology of cereal crops. Breeding techniques and objectives in cereals. Yield and quality parameters in cereals. Breeding for biotic and abiotic stresses. Procedure for variety development. Preliminary and multi-location yield trials (NUYT, DUS test). Genetic improvement using novel techniques. Development of commercial hybrids, exploitation of male sterility systems for hybrid development in cereals.

Practical

Development of genetic material using appropriate mating techniques. Assessment of various phenological stages in cereal crops. Handling of segregating populations. Data recording of various plant attributes using descriptors.

Books recommended

1. Sleper, D.A. and J.M. Poehlman. 2006. Breeding Field Crops. 5th Ed., Iowa State University Press, Ames, USA.
2. Morris, P.C. and J.H. Bryce. (ed.). 2000. Cereal Biotechnology. Woodhead, New York, USA.
3. Nanda, J.S. 2000. Rice Breeding and Genetics: Research Priorities and Challenges. Pak Book Corporation, Lahore, Pakistan.
4. Heyne, E.G. (ed.). 1987. Wheat and Wheat Improvement. 2nd ed., ASA, CSSA and SSSA. Agronomy Monograph 13, Amer. Soc. Agron., Madison, Wisconsin, USA.
5. Fehr, W.R. 1987. Principles of Cultivar Development, Vol. 2: Crop Species. Macmillan Pub Co., NY, USA.

Objectives

To enable students to understand:

- Concepts of Biostatistics
- Various experimental layout and designs
- Statistical softwares

Theory:

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

Practical:

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

Books recommended

1. Gomez, K.A. and A.A. Gomez. 1984. Statistical Procedures for Agricultural Research. 1984. 2nd Ed. John Wiley & Sons.
2. Singh, R.K. and B.D. Chaudhary. 2004. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, N. Delhi, India

Objectives

To enable students to understand:

- Significance of fodder and forages in livestock sector
- Genetic and cytoplasmic basis of reproductive systems in forages
- Breeding methods in fodder and forages

Theory

Introduction to major fodder and forage crops. Genetic resources and classification of fodder and forage crops. 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 and methods for improvement. Quality components in fodder and forage crops, anti-quality agents and remedies. Application of biotechnology in fodder and forage crops.

Practical

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

Books recommended

1. Sleper, D.A. and J.M. Poehlman. 2006. Breeding Field Crops. Iowa State University Press, Ames, Iowa, USA.
2. Rognli, O.A., E.T. Solberg, I. Schjelderup.(eds.). 1994. Breeding Fodder Crops for Marginal Conditions. Series: Developments in Plant Breeding, SpringerLink, USA.
3. Chatterjee, B.N, 1989. Forage Crop Production: Principles and Practices. Oxford and IBH Publishing Co. Ltd., New Delhi, India.
4. Sleper, D.A., K.H. Asay and J.F. Pedersen, (eds.) 1989. Contributions from Breeding Forage and Turf Grasses. CSSA Special Publication 15, Amer. Soc. Agron., Madison, Wisconsin, USA.
5. Boller, B., U.K Posselt, and F. Veronesi. (eds) 2010 Fodder Crops and amenity grasses. Springer.

Objectives

To enable students to understand:

- Different types of research and scientific reports.

Theory

Introduction of concept of science and scientific method. The concept, purpose and kinds of research project and Scientific Reports. Collection and organizing source materials: reviewing the literature and preparing bibliography. The techniques of composition: rules of scientific writing, word usage in scientific writing, style for composing scientific writing. 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. Preparing preliminary draft, editing, and evaluating the final draft. Preparation of PC forms. Plagiarism, its types and testing methods. Policy of HEC on Plagiarism.

Practical

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

Books recommended

1. Anderson, J., B.H. Durston and M. Poole. 1992. Thesis and Assignment Writing. Wiley Eastern Ltd. New Delhi, India
2. Andrew, C.O. 1993. Applied Agricultural Research: Foundations and Methodology. West view Press
3. Everything You Wanted to Know About Making Tables and Figures. <http://abacus.bates.edu/~ganderso/biology/resources/writing/HTWtablefigs.html>
4. Gatner, E.S. M. and F. Cordasco. 1959. Research and Report Writing. Barnes and Noble, Inc., New York, USA
5. Gopen, G.D. and J. A. Swan. 1990. The Science of Scientific Writing. American Scientist, 78: 550-558.
6. Ghafoor, A. 2007. Manual for synopsis and thesis preparation. University of Agriculture, Faisalabad.
7. Ghafoor, A., G. Murtaza, and S.I. Hussain. 2006. Fundamentals of Scientific Communications and Presentations. Allied Book Centre, Lahore.
8. Guidelines for Writing Scientific Papers. <http://www.bms.bc.ca/library/Guidelines>
9. Handbook of postgraduate Research students. UHI Millennium Institute, Perth College, Scotland, UK. WWW.PERTH.AC.UK.
10. McGranaghan, M. Guidelines on writing a research. <http://www2.hawaii.edu/~matt/proposal.html>, <http://www.imechanica.org/node/588>
11. Plagiarism policy. 2007. HEC booklet.
12. Tischler, M.E. Scientific Writing Booklet. Dept. of Biochemistry and Biophysics, University of Arizona. www.biochem.arizona.edu/marc/Sci-Writing.pdf
13. William R.L. 2001. Fine-Tuning Your Writing. Wise Owl Publishing Co., Madison, USA

Objectives

To enable students to understand:

- Emerging trends of genomics in relation to Agriculture and Crops Breeding

Theory

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

Practical

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

Books recommended

1. Brown, T.A. 2006. Gene cloning and DNA analysis, and introduction. Fifth edition. Blackwell Science Ltd. UK.
2. Brown, T.A. 1989. Genetics: A molecular approach, Van Nostrand Reinhold (International) Co. Ltd. London.
3. Evans, D.E., J.O.D. Coleman and A. Kearns. 2003. Plant cell culture, BIOS Scientific Publishers, USA.
4. Gardner, E. J., M. J. Simmons and D. P. Snustad. 1991. Principles of Genetics. 8th ed. John Wiley and Sons, Inc., New York, USA.
5. Lesk, A.M. 2000. Introduction to Bioinformatics. Oxford University Press, Inc. New York, USA.
6. Orengo, C., Jones, D. and Thornton, J. 2003. Bioinformatics: genes, proteins and computers. BIOS Scientific Publishers Limited. Cornwall Press, Trowbridge, UK.
7. Singh, B.D. 2004. Plant Breeding: principals and methods, Kalyani Publishers, India.
8. Slater, A., N. Scott, and M. Fowler. 2004. Plant biotechnology: The genetic manipulation of plants, Oxford University Press Inc., USA.

Articles

1. Hodges, E., Z. Xuan¹, V. Balija, M. Kramer, M. N. Molla, S. W. Smith, C. M. Middle, M. J. Rodesch, T. J. Albert, G. J. Hannon and W. R. McCombie. 2007. Genome-wide in situ exon capture for selective resequencing. Nature Genetics, 39:1522 – 1527
2. Ronaghi, M. 2001. Pyrosequencing sheds light on DNA sequencing. Genome Res., 11:3-11
3. Shendure J., R. D.Mitra, C. Varma and G.M. Church. 2004. Advanced sequencing technologies: Methods and Goals. Nature Genetics, 5: 335-344

Websites

1. www.expasy.ch
2. www.justbio.com
- www.ncbi.nlm.nih.gov/entrez/index.html

Objectives

To enable students to understand:

- Significance of medicinal plants in national and international perspectives
- Role of conventional and molecular tools for improvement of medicinal plants

Theory

History of uses of medicinal plants. Present status of commercially grown medicinal plants. Germplasm collection, evaluation, and diversity among medicinal plants; *ex situ* and *in situ* conservation. Objectives and problems in breeding medicinal plants. Breeding methods, use of mutation, and modern techniques for improvement of medicinal plants. Marker assisted selection for medicinal value related traits.

Practical

Identification of medicinal plants. Reproductive biology, selfing and artificial hybridization techniques in medicinal plants. Handling of segregation generations. Measurement of economic yield and medicinal value related traits.

Books recommended

1. Heywood, V. 1991. Conservation of Medicinal Plants: International Consultation Papers. World Conservation Union, World Health Organization, World Wide Fund for Nature. Cambridge University Press, UK.
2. Johnson, C.B. and C. Franz. 2002. Breeding Research on Aromatic and Medicinal Plants. The Haworth Press Inc. USA
3. Yaniv, Z. and U. Bachrach. 2005. Handbook of Medicinal Plants. The Haworth Press Inc. USA.

Objectives

To enable students to understand:

- Importance of planning and conducting research project
- Data collection, analysing and interpretation
- Logical presentation of results

Practical

Students will be required to undertake internship at various agricultural research organizations, private companies, extension/adaptive/private farms.

OR

To undertake a research project at university fields/laboratories aimed at their practical training. Planning, layout and execution of experiment. Collection, analysis, and interpretation of data.

Upon completion of internship/research project, students are required to submit a report and give presentation of internship/research experiment.

Books recommended

1. Khalil, S.K. and P. Shah. 2007. Scientific Writing and Presentation. Higher Education Commission, Islamabad, Pakistan.