

# 18 Plant Genetic Resources

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## TRIMESTER WISE DISTRIBUTION OF COURSES

### I TRIMESTER

	L	P
<b>PGR 500</b> BIODIVERSITY AND PLANT GENETIC RESOURCES	2	0
<b>PGR 507</b> INFORMATION MANAGEMENT IN PLANT GENETIC RESOURCES	2	1
<b>PGR 508</b> PLANT TAXONOMY	2	1
<b>PGR 509</b> PLANT BIOSECURITY	2	0
<b>PGR 600</b> ADVANCES IN EXPLORATION AND GERMPLASM COLLECTING	2	1
<b>PGR 608</b> ADVANCED ECONOMIC BOTANY	2	1
<b>PGR 607/</b> REGULATORY MECHANISMS AND INTELLECTUAL <b>GP 607</b> PROPERTY RIGHTS	3	1
<b>PGR 691</b> SEMINAR	1	0

### II TRIMESTER

<b>PGR 501</b> EXPLORATION AND GERMPLASM COLLECTING	2	1
<b>PGR 504</b> PRINCIPLES AND PRACTICES OF GERMPLASM REGENERATION AND EVALUATION	2	1
<b>PGR 506</b> ECONOMIC BOTANY	2	1
<b>PGR 601</b> ADVANCES IN SEED PHYSIOLOGY IN RELATION TO GERMPLASM CONSERVATION	2	1
<b>PGR 602</b> <i>IN VITRO</i> CONSERVATION AND CRYOPRESERVATION	2	2
<b>PGR 603</b> <i>IN SITU</i> CONSERVATION OF PLANT BIODIVERSITY	2	1
<b>PGR 605</b> PRINCIPLES AND METHODS IN ANALYSES OF MOLECULAR DIVERSITY	2	2
<b>PGR 691</b> SEMINAR	1	0

### III TRIMESTER

<b>AGR 013</b> ECONOMIC BOTANY AND PLANT GENETIC RESOURCES	1	1
<b>PGR 502</b> GERMPLASM EXCHANGE AND PLANT QUARANTINE	3	2
<b>PGR 503</b> PRINCIPLES AND METHODS OF GERMPLASM CONSERVATION	2	1
<b>PGR 505</b> BIOTECHNOLOGY IN PLANT GENETIC RESOURCE MANAGEMENT	3	2
<b>PGR 604</b> ADVANCES IN GERMPLASM EVALUATION AND UTILIZATION	2	1

<b>PGR 606</b> ECOLOGY AND BIODIVERSITY	2	1
<b>PGR 609</b> ADVANCED PLANT TAXONOMY	2	1
<b>PGR 691</b> SEMINAR	1	0

**Core Courses:**

**M.Sc.:** PGR 500, PGR 501, PGR 502, PGR 503, PGR 504, PGR 505, PGR 506, PGR 508, PGR 509  
 GP 500, GP 520, AS 501, PGS 503

# PLANT GENETIC RESOURCES

**Major Field** : Plant Genetic Resources

**Minor Fields** : Ph.D. student shall take two minors (9 credits of course work in each) from any of the other fields outside his/her own.

M.Sc. student shall take one minor (9 credits of course work) from any of the other fields outside his/her own.

## DESCRIPTION OF COURSES

### AGR 013 ECONOMIC BOTANY AND PLANT GENETIC RESOURCES

(1L+1P) III

#### Objective

This course is aimed at understanding the economic uses on plant species and potential of plant species as a natural resource or raw material for use in crop improvement.

#### Theory

##### UNIT I

Origin and history of agriculture; dynamics of domestication; centres of plant origin and diversity.

##### UNIT II

Patterns of variation; classification of cultivated plants; concept of gene pool; geographical distribution of crops of Indian origin.

##### UNIT III

Principles of PGR exploration and collection; introduction, acclimatization and utilization; principles of plant quarantine; principles and strategies for germplasm conservation; *ex situ* and *in situ* methods.

##### UNIT IV

Components of genebank: seed genebank, field genebank, *in vitro* repository, cryo genebank; DNA libraries, herbarium.

##### UNIT V

Policy issues: assessing economic values, conflict over ownership, management and use; data documentation.

#### Practicals

Preparation of herbarium; recording the data for characterization and evaluation of genetic resources in the field; Processing of samples of genetic resources for long-term conservation: testing the viability and seedling vigour, testing of moisture content, equilibration of moisture content, packaging of sample for long-term conservation in Seed Genebank; *in vitro* conservation of genetic resources: preparation of culture medium, sterilization and inoculation of explants, maintenance of cultures in the In vitro Genebank; data documentation, demonstration of database on plant genetic resources.

## Suggested Readings

- Dhillon, B.S., Tyagi, R.K., Lal, A. and Saxena, S. (eds.). 2004. *Plant Genetic Resource Management*. Narosa Publishing House, New Delhi.
- Frankel, O.H., Brown, A.D. and Burdon, J.J. 1995. *The Conservation of plant Biodiversity*. Camb. Univ. Press.
- Harlan, J.R. 1992. *Crops and Man* (American Society of Agronomy, Crop science Society of America).
- Hawks, J.G. 1983. *The Diversity of Crop Plants* Harvard Univ. Press, Cambridge, Mass London.
- Paroda, R.S., Arora, R.K. and Chandel, K.P.S. 1987. *Plant genetic resources: Indian perspective*. NBPGR, New Delhi.
- Rana, R.S., Saxena, R.K., Tyagi, R.K., Saxena, S. and Mitter, V. 1994. *Ex-situ Conservation of PGR*. NBPGR, New Delhi.

## PGR 500 BIODIVERSITY AND PLANT GENETIC RESOURCES

(2L+0P) I

### Objective

To provide an overview of global biodiversity, agrobiodiversity and agricultural intensification, and an understanding of basic science and management issues related to plant genetic resources including policy.

### Theory

#### UNIT I

Biodiversity-an overview; genetic, species and ecosystem diversity; determinants of biodiversity.

#### UNIT II

Higher plant diversity, species richness and endemism.

#### UNIT III

Biodiversity and agricultural intensification: agriculture as friend and foe of biodiversity, harmonizing biodiversity conservation and agricultural development, policy considerations along the interface between biodiversity and agriculture.

#### UNIT IV

Agro-biodiversity and plant genetic resources; origin and history of agriculture; dynamics of domestication; centers of crop plant origin and diversity; geographical distribution of crops of Indian origin.

#### UNIT V

An overview of plant genetic resources management (importance and usefulness of germplasm, germplasm conservation, threat of genetic vulnerability, global concerns etc.).

#### UNIT VI

Managing plant genetic resources: Basic science issues (genetic vulnerability and crop diversity, crop diversity-institutional responses, *in situ* conservation of genetic resources, the science of collecting genetic resources, the science of managing genetic resources, using genetic resources, biotechnology and germplasm conservation etc.).

## UNIT VII

Managing plant genetic resources: policy issues (exchange of genetic resources: quarantine, IPR; genetic resources: assessing economic value; conflicts over ownership, management and use; national and international treaties/legislations: CBD, IT-PGRFA, GPA, PVP&FR Act, Biodiversity Act etc.).

### Suggested Readings

Brown, A.H.D., Clegg, M.T., Kahler, A.L. and Weir, B.S. (eds.)1990. *Plant population genetics, breeding, and genetic resources* , Sinauer Associates, USA.

Brown, A.H.D., Frankel, O.H., Marshall, D.R. and Williams, J.T. 1989. *The use of plant genetic resources* , Cambridge Univ. Press

Chapman & Hall 1992. Global biodiversity: Status of the Earth's living resources, World Conservation Monitoring Centre, London. xx + 594 pp.

Frankel, O.H. and Michael, E.S. 1987. *Conservation and evolution*, Cambridge Univ. Press.

Harlan, J.R. 1992. *Crops & Man* (Second Edition) , American Society of Agronomy Inc., Crop Science Society of America Inc., Madison, Wisconsin, USA.

Holden, J.H.N. and Williams, J.T. 1984. *Crop genetic resources: conservation and evaluation*, IBPGR.

Plucknett, D.L., Smith, N.J.H. and Williams, J.T. 1987. *Genebanks & the world's food*, Princeton Univ. Press.

Primack, R.B. 1993. *Essentials of conservation biology* , Sinauer Associates Inc., USA.

## PGR 501 EXPLORATION AND GERMPLASM COLLECTING

(2L+1P) II

### Objective

To provide information about science of germplasm collecting.

### Theory

#### UNIT I

History and importance of germplasm exploration; distribution and extent of prevalent genetic diversity; phyto-geographical regions/ecological zones and associated diversity; mapping eco-geographic distribution of diversity, threatened habitats, use of flora.

#### UNIT II

Concept of population and gene pool, variations in population and their classification, gene frequencies in populations, rare and common alleles, gene pool sampling in self- and cross-pollinated and vegetatively propagated species, non-selective, random and selective sampling strategies.

#### UNIT III

Strategies and logistics of plant exploration and collection, coarse and fine grid surveys, practical problems in plant exploration, use of *in vitro* methods in germplasm collection.

#### UNIT IV

Ethnobotanical aspects of PGR, crop botany, farming systems, collecting wild relatives of crop plants.

#### UNIT V

Post-exploration handling of germplasm collections, collection and preservation of specimens, importance and use of herbaria and preparation of herbarium specimens.

## UNIT VI

Present status and future strategies in collecting of major crops of Indian origin such as rice, maize, sorghum, sesame, brassica, okra, eggplant, cotton, mango, etc.

### Practicals

Plant exploration and germplasm collecting; documenting passport data; use of flora and maps; collecting vegetatively propagated species; local field visit for recording of ethnobotanical information/notes; post exploration handling of germplasm accessions; collecting wild relatives of crop plants; preparation, maintenance and use of herbarium; local field visit for herbarium collection; report writing on germplasm collecting missions.

### Suggested Readings

Falk, D.A. and Holsinger, K.E. 1991. *Genetics and conservation of rare plants*, Oxford University Press, New York, USA.

Frankel, O.H. and Bennett, E. 1970. *Genetic Resources in Plants - Their Exploration and Conservation*, Oxford: Blackwell Scientific.

Frankel, O.H. and Hawks, J.G. 1975. *Crop genetic resources for today and tomorrow*, Cambridge Univ. Press.

Guriano, L., Ramanatha Rao, V. and Reid, R. 1995. *Collecting plant genetic diversity- Technical Guidelines*, CAB International, Wallingford, U.K.

Other relevant books/ serials and IPGRI publication etc. and original papers

## PGR 502 GERmplasm EXCHANGE AND PLANT QUARANTINE

(3L+2P) III

### Objective

To provide information about germplasm exchange and plant quarantine including exchange of genetically modified plants.

### Theory

#### UNIT I

History, principles, objectives and importance of plant introduction; Prerequisites, conventions, national and international legislations and policies on germplasm collection and exchange.

#### UNIT II

Plant quarantine- introduction, history, principles, objectives and relevance; Regulations and plant quarantine set up in India; Pest risk analysis, pest and pathogen information database; Quarantine in relation to integrated pest management; Economic significance of seed-borne pests (insects, mites, non-insect pests, nematodes, fungi, bacteria, viruses, phytoplasma etc.).

#### UNIT III

Detection and identification of pests including use of recent techniques like ELISA, PCR etc., Symptoms of pest damage, salvaging techniques for infested/infected germplasm, post-entry quarantine operation, seed treatment and other prophylactic treatments and facilities.

#### UNIT IV

Domestic quarantine; seed certification; International linkages in plant quarantine; weaknesses and future thrust.

## UNIT V

Genetically modified organisms (GMOs) or genetically engineered plants (GEPs), Concepts of biosafety, risk analysis and consequences of spread of GE crops on the environment; Treaties and multilateral agreements governing trans-boundary movement of GEPs or GMOs, Indian regulatory system for biosafety.

### Practicals

Inventory of IQ/ EQ samples; joint inspection for pest detection; history, principles, objectives and relevance of Plant Quarantine; seed –borne pests of quarantine significance; quarantine in relation to integrated pest management; salvaging of infested germplasm; seed treatment and other prophylactic treatments and facilities; domestic quarantine; seed-health certification.

### Suggested Readings

Anonymous. 1985. *Plant Quarantine Treatment Manual*, USDA.

Dent, David 1991. *Insect Pest Management*. C.A.B. International Publication 604 p.

Khetarpal, R.K., Varaprasad, K.S., Lal, A., Agarwal, P.C. and Lal, B. 2001. *Plant Quarantine of Germplasm under Exchange*. pp. 99-115. In : National Bureau of Plant Genetic Resources: A Compendium of Achievements- Dhillon BS, Varaprasad KS, Srinivasan K, Singh M, Archak S, Srivastava U and Sharma GD (Eds.). NBPGR Publication, New Delhi 329 p.

Neergard, P. 1979. *Seed Pathology*, Vol. I&II, Macmillan Press Ltd., London, U.K. 1191 p.

Richards, O.W. and Davies, R.G. 1973. *A general textbook of Entomology*. Butler and Tanner Ltd. Frome and London. 886 p.

Richardson, M.J. 1990. *An Annotated list of seed-borne diseases* (Fourth Edition). International Seed Testing Association, P.O. Box 412. CH 8046 Zurich, Switzerland.

William, B. Hewitt and Luigi, Chiarappa 1977. *Plant Health and Quarantine in International Transfer of Genetic Resources*. CRC Press, Inc., Ohio Publication 345p.

## PGR 503 PRINCIPLES AND METHODS OF GERMPLASM CONSERVATION (2L+1P) III

### Objective

To impart knowledge on crop germplasm conservation with particular emphasis on seed genebanks.

### Theory

#### UNIT I

*In situ* and *ex situ* conservation: concept of biosphere reserves, gene sanctuaries, on-farm conservation, field genebanks, botanical gardens, herbal gardens, *in vitro* repositories and cryobanks.

#### UNIT II

Short-, medium- and long-term conservation, concept of base, active and working collections, seed structure and function, physiological and genetic changes during storage, theories of aging, viability equations, predicting storage life of seeds, dormancy and germination.

#### UNIT III

Genebank management: acquisition, accessioning and processing of germplasm samples for storage, genebank standards for various crops, ISTA, AOSA, IPGRI guidelines, monitoring and regeneration of plant germplasm.

#### UNIT IV

Design of storage facilities, maintenance and operation of storage modules.

#### UNIT IV

Information management in genebanks, strategies for revival and rescue of rare genetic material.

### Practicals

Seed structure and morphology; seed germination and seedling evaluation; seed viability test, seed sampling and purity analysis, seed dormancy and dormancy breaking treatments, moisture testing methods, vigour testing methods and seed leachate analysis, accelerated aging of seeds and their assessment, seed processing and storage in Gene Bank.

### Suggested Readings

Bewley, J.D. and Black, M. 1994. *Seeds Physiology of Development and Germination*. Second Edition. Plenum Press, New York and London.

Bonner, F.T. 1990. *Storage of seeds*. Potential and limitation of germplasm conservation. Forest Ecol. and Manage.

Ellis, R.H., Hong, T.D. and Roberts, E.H. 1985a. *Handbook of Seed Technology for Genebank*. Volume II. Principles and Methodology. International Board for Plant Genetic Resources, Rome.

Ellis, R.H., Hong, T.D. and Roberts, E.H. 1985b. *Handbook of Seed Technology for Genebank*. Compendium of Specific Germination Information and Test Recommendations. International Board for Plant Genetic Resources, Rome.

Hong, T.D. and Ellis, R.H. 1996. *A protocol to determine seed storage behaviour*. International Plant Genetic Resources Institute IPGRI Technical Bulletin No. 1, Rome.

Roberts, E.H. 1972. *Viability of Seeds*, Chapman and Hall, London.

Thomson, J.R. 1979. *An Introduction to seed Technology*.

## **PGR 504 PRINCIPLES AND PRACTICES OF GERMPLASM REGENERATION AND EVALUATION (2L+1P) II**

### Objective

To educate students about science of managing genetic resources including principles involved in maintaining genetic integrity during regeneration, germplasm characterization and evaluation.

### Theory

#### UNIT I

Germplasm management systems: global scenario; genetic variation in crop plants and management of germplasm collections.

#### UNIT II

Principles and practices of germplasm regeneration and maintenance, breeding systems and mode of reproduction; maintaining sufficiently large populations for effective conservation of farmer landraces.

#### UNIT III

Germplasm characterization/evaluation procedures; evaluation of germplasm for specific traits; key issues for the improvement of characterization, evaluation and use of plant genetic resources; concept of core collection.



#### UNIT IV

Measuring diversity using agromorphological data; gene markers and their use in PGR management.

#### UNIT V

Evaluation and maintenance of wild relatives of crop plants; genetic enhancement/pre-breeding and use of alien/unadapted genetic resources in crop improvement.

### Practicals

Field layout and experimental designs, recording field data on germplasm evaluation in different agri-horticultural crops, biochemical and phyto-chemical evaluation of crop germplasm, data processing, documentation, analysis of diversity and cataloguing.

### Suggested Readings

Brown, A.H.D., Clegg, M.T., Kahler, A.L., Weir, B.S. (eds.) 1990. *Plant population genetics, breeding, and genetic resources*, Sinauer Associates, USA.

Brown, A.H.D., Frankel, O.H., Marshall, D.R. and Williams, J.T. 1989. *The use of plant genetic resources*, Cambridge Univ. Press.

Frankel, R. and Galun, E. 1977. *Pollination mechanisms, reproduction and plant breeding*.

Hayward, M.D., Bosemak, N.O. and Romagosa, I. 1993. *Plant Breeding: Principles & Practices*, Chapman & Hall.

Holden, J.H.N. and Williams, J.T. 1984. *Crop genetic resources: conservation and evaluation*, IBPGR.

Paroda, R.S. and Arora, R.K. (eds.) 1991. *Plant genetic resources: conservation and management*, NBPGR.

*Regeneration of accessions in seed collections: a decision guide* 1997. by IPGRI: Handbook for genebanks No. 5.

Stoskopf, N.C. 1993. *Plant Breeding: Theory & Practice*, Westview Press.

## PGR 505 BIOTECHNOLOGY IN PLANT GENETIC RESOURCE MANAGEMENT (3L+2P) III

### Objective

To provide information on use of biotechnology in germplasm conservation including molecular characterization and conservation technologies.

### Theory

#### UNIT I

Tissue culture and PGR conservation, Tissue culture media, Sterilization techniques, *In vitro* clonal multiplication, Somatic embryogenesis, Meristem culture and virus elimination, *In vitro* conservation –Introduction and principle, Strategies for *in vitro* short- and medium-term conservation, *In vitro* collection, *in vitro* exchange of germplasm.

#### UNIT II

Plant Cryopreservation-Introduction, Principle of cryotolerance, Techniques of cryopreservation: slow cooling, desiccation, pregrowth, encapsulation-dehydration, vitrification, droplet freezing, Cryoprotectants, Cryopreservation of seeds and pollen, Cryopreservation of *in vitro* cultures, Application of *in vitro* cryopreservation techniques in monocots and dicots - case studies,

Management of *in vitro* and cryobanks, Genetic stability of *in vitro* conserved and cryopreserved germplasm, Importance of database for *in vitro* and cryopreserved germplasm.

### UNIT III

The need for plant germplasm characterization; introduction to different techniques for plant germplasm characterization; biochemical and molecular marker techniques for germplasm characterization and evaluation; recent advances in molecular genetic diversity analysis –use of SNPs and microarrays; data handling and statistical analysis; analysis of genetic diversity; marker assisted evaluation of core collections; conservation of genomic resources; molecular markers for gene bank management; detection of adventitious transgenics.

### Practicals

- Preparation of stock solutions; media preparation; preparation of explants and culture initiation in monocots and dicots; meristem isolation and culture establishment; subculture of shoots in monocots and dicots, hardening and field establishment of plantlets; preparation of cryoprotectant solutions and regrowth media; cryopreservation of *in vitro* cultures- isolation of explants and pretreatment.
- Encapsulation-dehydration technique; encapsulation-vitrification technique; assessing genetic stability of *in vitro* conserved and cryopreserved germplasm.
- Basic techniques in molecular biology; isolation of Genomic DNA from leaves; purification of DNA Quantification of DNA; PCR; RAPD, ISSR, demonstration of RFLP, AFLP, STMS; data Handling and Statistical Analysis.

### Suggested readings

- Ashmore, S.E. 1997. *Status Report on the Development and Application of In Vitro Techniques for the Conservation and Use of Plant Genetic Resources*. IPGRI, Rome.
- Benson, E.E. (ed.) 1999. *Plant Conservation Biotechnology*. Taylor & Francis Ltd. London.
- Bhojwani, S.S. and Razdan, M.K. 1983. *Plant Tissue Culture: Theory and Practice*. Elsevier Science Publishing Co.Inc. New York.
- Dodds, J.H. (eds.) 1991. *In Vitro Methods for Conservation of Plant Genetic Resources*. Chapman and Hall, London.
- Dodds, J.H. and Robberts, L.W. 1985. *Experiments in Plant Tissue Culture*, 2nd Ed., Cambridge University Press, Cambridge, London.
- Engelmann, F. and Takagi, H. (eds) 2000. *Cryopreservation of Tropical Plant Germplasm - Current Research Progress and Application*, IPGRI, Rome/JIRCAS/Japan.
- Ford-Lloyd, B.V., Newbury, J.H. and Callow, J.A. (eds.) 1998. *Biotechnology and Plant Genetic Resources: Conservation and Use*. CABI, Wellingford.
- Griffin, H.G. and Griffin, A.M. 1994. *PCR Technology: Current Innovations*. CRC Press, London.
- Henry, R.J. (Editor) *Plant Genotyping: The DNA Fingerprinting of Plants*, Publisher: CABI Publishing.
- Karp, A., Isaac, P.G. and Ingram, D.S. 1998. *Molecular Tools for Screening Biodiversity – Plants and Animals*. Chapman and Hall, London.
- Kartha, K.K. (ed) 1995. *Cryopreservation of Plant Cells and Organs*. CRC Press, Boca Raton, Florida.
- Sambrook, J., MacCallum, P., Russell, D.(eds.) 2001. *Molecular Cloning: A Laboratory Manual (Third Edition)*, CSHL Press.

**Objective**

To study the relationship between people and plants including anthropology, botany and environmental conservation.

**Theory**

## UNIT I

Origin and history of agriculture, domestication and adaptations of cultivated plants.

## UNIT II

Taxonomy, reproductive systems and breeding behaviour of crop plants.

## UNIT III

Origin, evolution, botany, cultivation, use, genetic resource activities and utilization of genetic diversity of important crops, *viz.*, cereals, millets, legumes, forage and fodder crops, medicinal and aromatic plants, beverages, oil yielding plants, spices and condiments, wood and timber yielding taxa, fumitory and masticatory plants, vegetable crops, sugar, starch and cellulose yielding plants, rubber yielding plants, insecticidal and herbicidal plants, fruits and nuts, flowering agents, gums and resins, fiber yielding plants, under-utilized and under-exploited plants, new crops, pseudo-cereals, important taxa in agro-forestry, horticulture and floriculture, processing and use of crop residues.

**Practicals**

Botanical microtechniques for the study of structure, development and biochemical status of plant parts; structure of economic important plant parts; case studies on adaptations during domestication-*Solanum* species; histochemical localization of chemical constituents in economically important plant parts; identification and status of economically important plant parts in different groups of plants.

**Suggested readings**

- An Introduction to Modern Economic Botany. By Maiti RK and Singh VP, 2006 Eastern Book Corporation, Delhi
- Economic Botany: Plants in Our World. By Beryl Brintnall Simpson, Molly Ogorzaly, Simpson Beryl. 2001. Mcgraw-hill Science/engineering/math.
- Economic Botany in the Tropics. By Kochhar (Third edition), Macmillan Publishers, India
- A text book of Economic Botany. By Beryl B. Simpson, 1991, Univ. of Texas.
- The Economic Botany of the Himalayas. Atkinson, E.T., 1980.
- Plants for Human Consumption. G. Kunkel.* Koeltz Scientific Books, West Germany. 1984, 393 pp.
- Plant that feed and serve us. By Hvass, Else, Blandford Press, London, 1973.
- Plant genetic resources: conservation and management (1991) By R.S. Paroda & R.K. Arora (eds.), NBPGR .
- Economic Botany: A Textbook of Useful Plants and Plant Products. By Albert F. Hill, 1952, Second Edition, New York Toronto London McGraw-hill Book Company, Inc.

**PGR 507 INFORMATION MANAGEMENT IN PLANT GENETIC RESOURCES (2L+1P) I**

**Objective**

To train the students in germplasm data base management using modern tools and softwares.

**Theory**

UNIT I

Statistical techniques in management of germplasm, developing core collection, estimation of sample size during plant explorations, impact of sampling on population structure.

UNIT II

Sequential sampling for viability estimation, introduction of binomial, normal and negative cumulative normal, use of Probit scales, viability equations and nomograms, estimation of sample size for storage and viability testing.

UNIT III

Germplasm documentation; basics of computer and operating systems, database management system, use of statistical softwares, pictorial and graphical representation of data; Introduction to communication network.

**Practicals**

Experimental designs and data analysis; viability equations, sampling strategies, data documentation, cataloguing.

**Suggested Readings**

Painting, K.A., Perry, M.C., Denning, R.A. and Ayad, W.G. 1993. *Guide Book for Genetic Resources Documentation*. IPGRI, Rome, Italy.

Puzone, L. and Th. Hazekamp 1996. *Characterization and Documentation of Genetic Resources Utilizing Multimedia Database*. NBPGR, New Delhi.

Rana, R.S., Sapra, R.L., Agrawal, R.C. and Gambhir, R. 1991. *Plant Genetic Resources, Documentation and Information Management*. NBPGR, New Delhi.

**PGR 508 PLANT TAXONOMY (2L+1P) I**

**Objective**

To educate about the relationships between plants and their evolution, especially at the higher levels and actual handling of plant specimens.

**Theory**

UNIT I

Classical and modern species concepts, differentiation and evolution of species and biosystematics: Classical & modern species concepts, variation within species, population genetics, phenotypic plasticity, environmental effects on populations, differentiation and evolution of species, biosystematics; Modern evidences: Morphology and Anatomy; Modern evidences: Embryology and Palynology; Modern evidences: Biogeography and Cytotaxonomy; Modern evidences: Comparative studies on phytochemistry, Chemotaxonomy; Modern evidences: Molecular taxonomy

methods; Numerical methods in taxonomy; Biosystematic approaches in plant taxonomy- some Indian case studies.

#### UNIT II

Taxonomy of cultivated plants: Taxonomy of cultivated plants with particular emphasis on Indian groups: Hybrids, domesticated species, wild-cultivated continuum; Tools of taxonomy for identification of plant species and variation patterns therein; Field and herbarium methods; Floristic and monographic works; Systematic and evolutionary studies.

#### UNIT III

Taxonomic databases: Taxonomic databases and documentation methods.

### Practicals

- Classical and modern species concepts and biosystematics - Morphology and anatomy; Comparative studies on phytochemistry, Chemotaxonomy; Field and herbarium methods; Floristic and monographic work; Practical methods for elucidating and proving hypotheses relating to plant speciation; Numerical taxonomy-practice and procedures; Biosystematic studies and their role in improving plant taxonomies; Intraspecific categories in relation to population biology
- Taxonomic databases- Taxonomic databases and documentation methods in relation to plant genetic resources
- Taxonomy of crop plants- Taxonomy of cultivated species, domesticated species, wild-cultivated continuum; problems and their resolution; newer methods of analysis and interpretation

### Suggested Readings

- Davis, P.H. and Heywood, V.H. 1963. *Principles of Angiosperm Taxonomy*. Oliver and Boyd, UK. 556 p.
- Greuter, W., Barrie, F.R., Burdet, H.M., Chaloner, W.G., Demoulin, V., Hawksworth, D.L., Jorgenson, P.M., Nicolson, D.H., Silva, P.C., Trehane, P. and McNeill, J. 1994. International Code of Botanical Nomenclature, Regnum Veg. 131, Koeltz. Sci. Books, Konigstein, Germany. 389 p.
- Jain, S.K. and Rao, R.R. 1976. *A Handbook of Field and Herbarium Methods*. Today & Tomorrow's Printers & Publishers, New Delhi, India. 157 p.
- Lawrence, G.H.M. 1951. *Taxonomy of Vascular Plants*. Indian ed., 1964, Oxford and IBM Publishing Co., Calcutta, India. 323 p.
- Maheshwari, J.K. 1963. *The Flora of Delhi*. Publications and Information Directorate, CSIR, New Delhi. 447 p.
- Porter, C.L. 1959. *Taxonomy of Flowering Plants*. W. H. Freeman and Co. Inc., USA. 452 p.

### PGR 509 PLANT BIOSECURITY

(2L+0P) I

#### Objective

To educate about protecting the economy, environment and plant health from pests and disease including preventing new pests and diseases from arriving, and helping to control outbreaks when they do occur.

## Theory

### UNIT I

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/ resurgence of pests and diseases.

### UNIT II

National Regulatory Mechanism and International Agreements/ Conventions viz. Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/ World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/ disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

### UNIT III

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

## Suggested Readings

Original articles and websites

## **PGR 600 ADVANCES IN EXPLORATION AND GERMPLASM COLLECTING (2L+1P) I**

### Objective

To provide information on ecogeographic surveys, sampling strategies and legal issues involved in germplasm collecting.

### Theory

#### UNIT I

Genetic diversity of PGR, genetic principles of diversity and its distribution.

#### UNIT II

Indicators of diversity, assessing the threats of genetic erosion; eco-geographic surveys: planning, collection and analysis of eco-geographic data, outputs of eco-geographic surveys.

#### UNIT III

Germplasm collecting legal issues and the FAO code of conduct, participatory approaches to collecting including indigenous knowledge.

#### UNIT IV

Sampling strategies theory and practice, strategies for wild species.

### Practicals

- Collecting ecogeographic data, use of GIS in biodiversity mapping and collecting; analysis of ecogeographic data
- Exposure to use of flora/maps, study of wild/weedy species aids to taxonomic identification
- Genetic diversity analysis: morphological / physiological characterization, biochemical/ molecular characterization

## Suggested Readings

- Falk, D.A. and Holsinger, K.E. 1991. *Genetics and conservation of rare plants*, Oxford University Press, New York, USA.
- Frankel, O.H. and Bennett, E. 1970. *Genetic Resources in Plants - Their Exploration and Conservation*, Oxford: Blackwell Scientific.
- Frankel, O.H. and Hawks, J.G. 1975. *Crop genetic resources for today and tomorrow*, Cambridge Univ. Press.
- Guriano, L., Ramanatha Rao, V. and Reid, R. 1995. *Collecting plant genetic diversity- Technical Guidelines*, CAB International, Wallingford, U.K.
- Other relevant books/ serials and IPGRI publication etc. and original papers

## PGR 601 ADVANCES IN SEED PHYSIOLOGY IN RELATION TO GERMPLASM CONSERVATION (2L+1P) II

### Objective

To provide an insight into physiological processes governing seed quality and its survival in relation to germplasm conservation and seed science and technology.

### Theory

#### UNIT I

Seed as genetic material for conservation; seed structure, development and physiological maturity; seed germination and growth; mobilization of reserves and their control processes.

#### UNIT II

Seed storage behaviour and their importance in conservation; post-collection care, seed processing for short, medium and long-term storage

#### UNIT III

Seed germination, viability and vigour; concept and testing methods for assessment of vigour and longevity; seed dormancy and methods for breaking dormancy; mid-storage treatments; invigoration techniques and seed hardening.

#### UNIT IV

Seed storage for long-term conservation and factors affecting seed longevity; seed moisture content, storage temperature and their influence on storability; artificial aging and controlled deterioration test; ultra-desiccation techniques for germplasm conservation.

#### UNIT V

Physiological, biochemical and genetic indices of seed deterioration, seed conservation and exchange.

### Practicals

Identification of seeds based on seed morphology and structure; Testing seed viability and vigour; Seed Longevity and accelerated ageing test in different types of seeds; Determining causes for dormancy, hard seededness and physiological immaturity; Developing short and medium-term conservation strategies for difficult-to-store seeds; Seed quality enhancement through seed priming; Ultra-desiccation of seeds in relation to seed longevity; Biochemical manifestation of seed deterioration.

## Suggested Reading

- Bewley, J.D. and Black, M. 1994. *Seeds Physiology of Development and Germination*. Second Edition. Pleenum Press, New York and London.
- Cromarty, A. 1984. *Techniques of drying seeds*. pp 88-125 in *Seed Management Techniques for Genebank* (JB Dicke, S Linington and JT Williams, eds). International Board on Plant Genetic Resources, Rome.
- Cromarty, A., Ellis, R.H. and Robert, E.H. 1982. *The design of seed storage facilities for Genetic Conservation*. Revised 1985. International Board on Plant Genetic Resources, Rome.
- Ellis, R.H. 1987. Monitoring the viability of seed accessions. *Plant Genet. Resour. Newsl.* 71: 16-21.
- Ellis, R.H. 1988. The viability equation, seed viability monographs, and practical advice on seed storage. *Seed Sci. and Technol.* 16: 29-50.
- Ellis, R.H., Hong, T.D. and Roberts, E.H. 1985a. *Handbook of Seed Technology for Genebank*. Volume II. Principles and Methodology. International Board for Plant Genetic Resources, Rome.
- Ellis, R.H., Hong, T.D. and Roberts, E.H. 1985b. *Handbook of Seed Technology for Genebank*. Compendium of Specific Germination Information and Test Recommendations. International Board for Plant Genetic Resources, Rome.
- Hong, T.D. and Ellis, R.H. 1996. *A protocol to determine seed storage behaviour*. International Plant Genetic Resources Institute IPGRI Technical Bulletin No. 1, Rome.
- Roberts, E.H. 1972. *Viability of Seeds*, Chapman and Hall, London.

## PGR 602 *IN VITRO* CONSERVATION AND CRYOPRESERVATION

(2L+2P) II

### Objective

To equip students with skills in using tissue culture and cryopreservation techniques for conservation and management of PGR.

### Theory

#### UNIT I

*In vitro* techniques in PGR management; *in vitro* clonal propagation for germplasm conservation; somaclonal variation and its implication in PGR conservation; *in vitro* collecting; meristem culture, virus indexing and elimination, *in vitro* exchange and its international guidelines.

#### UNIT II

Techniques of *in vitro* conservation of tropical and temperate crops under slow/normal growing conditions; tissue culture in circumventing crossability barriers embryo rescue technique, rescue and survival of rare and endangered species; management of large *in vitro* collections; concept of active and base *in vitro* genebanks.

#### UNIT III

History of plant cryopreservation; structural, physiological and biochemical basis of desiccation and freezing sensitivity of plant cells, tissues and organs; cryoprotectants and their mode of action, factors affecting cryoprotection.



#### UNIT IV

Methods of cryopreservation – conventional slow cooling and vitrification-based methods; factors influencing success in cryopreservation importance of pre-treatments, pre-conditioning of explant donor plants, regrowth media and culture conditions; advances in cryogenic protocols; status of application of cryopreservation in PGR conservation, application in pharmaceutical industry, forest breeding and production of transgenics.

#### UNIT V

Monitoring genetic stability of *in vitro*-conserved and cryopreserved germplasm.

#### Practicals

- Preparation of stock solutions; media preparations; preparation of explants and culture initiation in monocots and dicots; meristem isolation and culture establishment; subculture of shoots in monocots and dicots, hardening and field establishment of plantlets; preparation of cryoprotectant solutions and regrowth media; cryopreservation of *in vitro* cultures- isolation of explants and pretreatment.
- Encapsulation-dehydration technique; encapsulation-vitrification technique; assessing genetic stability of *in vitro* conserved and cryopreserved germplasm.
- Cryobanking of germplasm, effect of duration and temperature of cryoprotectant treatment on shoot tips, effect of cold hardening - isolation of shoot tips in dicot, cryopreservation-vitrification technique, effect of thawing treatment on regrowth.
- Demonstration of embryo rescue technique/ virus indexing.
- Assessing genetic stability of *in vitro* conserved and cryopreserved germplasm.
- Case studies related to monitoring genetic stability of in-vitro conserved/ cryopreserved germplasm.

#### Suggested Readings

- Ashmore, S.E. 1997. *Status Report on the Development and Application of In Vitro Techniques for the Conservation and Use of Plant Genetic Resources*. IPGRI, Rome.
- Benson, E.E. (ed.) 1999. *Plant Conservation Biotechnology*. Taylor & Francis Ltd. London.
- Bhojwani, S.S. and Razdan, M.K. 1983. *Plant Tissue Culture: Theory and Practice*. Elsevier Science Publishing Co.Inc. New York.
- Dodds, J.H. (eds.) 1991. *In Vitro Methods for Conservation of Plant Genetic Resources*. Chapman and Hall, London.
- Dodds, J.H. and Robberts, L.W. 1985. *Experiments in Plant Tissue Culture*, 2nd Ed., Cambridge University Press, Cambridge, London.
- Engelmann, F. and Takagi, H. (eds) 2000. *Cryopreservation of Tropical Plant Germplasm - Current Research Progress and Application*, IPGRI, Rome/JIRCAS/Japan.
- Ford-Lloyd, B.V., Newbury, J.H. and Callow, J.A. (eds.) 1998. *Biotechnology and Plant Genetic Resources: Conservation and Use*. CABI, Wellingford.
- Kartha, K.K. (ed) 1995. *Cryopreservation of Plant Cells and Organs*. CRC Press, Boca Raton, Florida.
- Razdan, M.K. and Cocking, E.C. (eds) 1997. *Conservation of Plant Genetic Resources In Vitro*, Vol. 1: General Aspects. Science Publishers, Inc. USA.

Razdan, M.K. and Cocking, E.C. (eds.) 2000. *Conservation of Plant Genetic Resources In vitro*, Vol. 2: Applications and Limitations. Science Publishers, Inc. USA.

Withers, L.A. and Alderson, P.G. 1986. *Plant Tissue Culture and its Agricultural Applications*. Butterworth, London.

## **PGR 603 IN SITU CONSERVATION OF PLANT BIODIVERSITY**

**(2L+1P) II**

### **Objective**

To impart knowledge about in situ/on-farm conservation of crop diversity and type of information necessary for such interventions.

### **Theory**

#### UNIT I

Complementary strategies for plant biodiversity conservation.

#### UNIT II

*In situ* conservation of wild species in nature reserves, *in situ* conservation components, factors influencing conservation value, national plan for *in situ* conservation.

#### UNIT III

*In situ* conservation of agro-biodiversity on-farm: importance of on-farm conservation initiatives, overview of the types of information necessary in the design of an on-farm conservation programme.

#### UNIT IV

Practical design and implementation aspects of on-farm conservation.

### **Practicals**

- Ecogeographical surveys and inventory.
- Estimation of genetic diversity in traditional agroecosystems on farm, matrix ranking of farmer selection criteria.
- Factors influencing conservation value.

### **Suggested Readings**

Brush, S.B. 1999. *Genes in the field: On-farm Conservation of Crop Diversity*. Lewis Publishers, Boca Raton, Florida, USA.

Engels, J.M.M. 1995. *In situ conservation and sustainable use of plant genetic resources for food and agriculture in developing countries*. IPGRI/DSE.

Jarvis, D., Staphit, B. and Sears, L. 2000. *Conserving agricultural biodiversity in situ: a scientific basis for sustainable agriculture*. IPGRI, Rome, Italy.

Maxted, N., Ford-Lloyd, B.V. and Hawkes, J.G. 1997. *Plant Genetic Conservation: The In Situ Approach*. Chapman & Hall, London.

McNeely, J.A. 1988. *Economic and biological diversity: developing and using economic incentives to conserve biological resources*. International Union for Conservation of Nature and Natural Resources, Gland.

Wood, D. and Lenne, J. 1999. *Agrobiodiversity: Characterisation, Utilization and Management*. CAB International, Wallingford.

**Objective**

To impart theoretical and practical knowledge on recent advances in crop germplasm evaluation and use.

**Theory**

## UNIT I

Limitation in use of germplasm: Limitations in use of germplasm collections and necessity of germplasm evaluation, advances in methodology of germplasm evaluation and predictive methods for identification of useful germplasm.

## UNIT II

Evaluation of crop germplasm for value addition: Evaluation of germplasm against biotic/abiotic stresses; quality attributes and other value addition traits.

## UNIT III

Management and utilization of crop germplasm: Concept of core collection; Molecular markers and their use in characterization and use of genetic resources; Germplasm enhancement/pre-breeding and use of wild relatives in crop improvements, Molecular tagging of QTLs and its role in utilization of germplasm resources.

## UNIT IV

Harmonising agro-biodiversity conservation and agricultural development: New crops of the future; PGR management: complementarity in *ex situ-in situ* (on-farm) approaches and participatory plant breeding.

**Practicals**

- Management and utilization of crop germplasm: Exercise for developing core set
- Evaluation of crop germplasm for value addition
- Evaluation of crop germplasm against biotic/abiotic stresses
- Evaluation of germplasm for quality traits
- Biochemical/molecular characterisation of germplasm
- Experiments on wide hybridization

**Suggested Readings**

- Brown, A.H.D., Clegg, M.T., Kahler, A.L. and Weir, B.S. (eds.) 1990. *Plant population genetics, breeding, and genetic resources*, Sinauer Associates, USA.
- Brown, A.H.D., Frankel, O.H., Marshall, D.R. and Williams, J.T. 1989. *The use of plant genetic resources*, Cambridge Univ. Press
- Frankel, O.H. and Hawks, J.G. 1975. *Crop genetic resources for today and tomorrow*, Cambridge Univ. Press.
- Frankel, O.H. and Michaele, E.S. 1987. *Conservation and evolution*, Cambridge Univ. Press.
- Frankel, R. and Galun, E. 1977. *Pollination mechanisms, reproduction and plant breeding*.
- Harlan, J.R. 1992. *Crops & Man* (Second Edition), American Society of Agronomy Inc., Crop Science Society of America Inc., Madison, Wisconsin, USA

Hayward, M.D., Bosemak, N.O. and Romagosa, I. 1993. *Plant Breeding: Principles & Practices*, Chapman & Hall.

Holden, J.H.N. and Williams, J.T. 1984. *Crop genetic resources: conservation and evaluation*, IBPGR. *Regeneration of accessions in seed collections: a decision guide* (1997) by IPGRI: Handbook for genebanks No. 5.

Stoskopf, N.C. 1993. *Plant Breeding: theory & practice*, Westview Press.

## **PGR 605 PRINCIPLES AND METHODS IN ANALYSES OF MOLECULAR DIVERSITY**

**(2L+2P) II**

### **Objective**

To provide insight into organization and structure of genetic variation in plant populations and practical skills in molecular diversity analysis.

### **Theory**

#### UNIT I

Organization and structure of genetic variation in natural populations, organization and evolution of eukaryotic genome.

#### UNIT II

Molecular verses other conventional methods for assessing genetic variation; sampling for molecular analyses, functional polymorphism, uses and applications of molecular markers in PGR - analysis of genetic diversity, identification of gaps in collection, evaluation and characterization etc.

#### UNIT III

Biochemical and molecular markers, molecular cytology, principles of RFLPs, PCR based techniques, AFLPs, SNPs and DNA sequencing; statistical treatment of the molecular data and interpretation; recent advances: emerging techniques, their applicability and uses.

### **Practicals**

- The Hardy-Weinberg principle and estimating allele frequencies in populations; Inbreeding and self-fertilization
- Testing for departures from Hardy-Weinberg proportions
- The Wahlund Effect and Wright's F-statistics
- Analyzing the genetic structure of populations; Quantitative genetics ; Introduction to Linkage disequilibrium and association analysis
- Molecular evolution
- The neutral theory of molecular evolution
- Detecting selection on nucleotide polymorphisms
- Patterns of selection on nucleotide polymorphisms
- Tajima's D, Fay and Wu's H, and Zeng et al.'s E
- Evolution in multigene families
- Phylogeography
- Methods in numerical taxonomy
- Cladistics

## Suggested Readings

- Griffin, H.G. and Griffin, A.M. 1994. *PCR Technology: Current Innovations*. CRC Press, London.
- Hillis, D. and Moritz, C. 1990. *Molecular Systematics*. Sinauer Associates, USA.
- Karp A., Isaac, P.G. and Ingram, D.S. 1998. *Molecular Tools for Screening Biodiversity – Plants and Animals*. Chapman and Hall, London.
- Lynch, M. and Walsh, B. 1998. *Genetics and analysis of quantitative traits*. Sinauer Associates, Massachusetts, USA.
- Tanksley, S.D. and Orton, T.J. 1983. *Isozymes in Plant Genetics and Breeding, Part A & B*. Elsevier Science Publication, Amsterdam.
- Weir, B.S. 1996. *Genetic Data Analysis II: methods for Discrete Population Genetic Data*. Sinauer Associates, Massachusetts, USA.

## PGR 606 ECOLOGY AND BIODIVERSITY

(2L+2P) III

### Objective

To educate students about interdisciplinary **scientific** study of the distributions, abundance and relations of **organisms** and their interactions with the environment, and the study of **ecosystems**.

### Theory

#### UNIT I

Origin and diversity of life, adaptations, basic elements of plant ecology, ecological components, population ecology- populations and life history, growth and limits.

#### UNIT II

Community ecology- species interactions, role of behaviour, interactions and structure.

#### UNIT III

Ecosystems- concept of ecosystems, ecological balance, vegetation dynamics, productivity and nutrient cycling.

#### UNIT IV

Conservation ecology, seed ecology, nature conservation and environmental management, ecosystem restoration, biogeography and evolution.

#### UNIT V

Biodiversity functioning- genetic adaptations, population irruptions/crisis in nature, community change and ecosystem regulation.

#### UNIT VI

Biodiversity conservation-geographical patterns in biodiversity, habitat fragmentation and conservation areas.

#### UNIT VII

Biodiversity management and exploitation-biodiversity resources and their harvesting, impact of physical and biotic factors on sustainability- case studies, impact of biotic and climatic factors on biomes and biodiversity- pollution and over-exploitation.

## Practicals

- Adaptations in plants, ecological components, survey of local biodiversity (field study), ecological status of various species (field study)
- Population and community patterns- case studies on local flora
- Identification of alien species and their impact assessment, study of protected areas restoration of threatened species
- Bioresources and their harvesting, impact assessment of pollution and over-exploitation on targeted taxa

## Suggested Readings

Bioresource ecology by Ananthakrishnan, Published in 1989, Oxford & IBH Pub. Co. (New Delhi).

Principle of general ecology by Angus M. Woodbury. Blakiston, New York, 1954.

Ecology: a text book by Remmert Hermann, Publisher: Springer (1980)

Taxonomy and Ecology by Heywood, Academic Press London, 1973.

Modern concepts of ecology by H.D. Kumar, Vikas Pub. House (New Delhi), 1992.

Principles of conservation Biology, 2<sup>nd</sup> edition by Meffe and Carroll, Publisher: Sinauer Associates, 1997.

Conservation Biology : Research priorities for the next Decade, edited by Soule and Orians (2001)

Plant genetic resources: conservation and management (1991) By R.S. Paroda & R.K. Arora (eds.), NBPGR

Biodiversity: implication for global food security (1992) By M.S. Swaminathan & S. Jana (eds.), McMillan Press

Crops & Man (Second Edition) (1992). By J.R. Harlan, American Society of Agronomy Inc., Crop Science Society of America Inc., Madison, Wisconsin, USA

Plant genetic resources of India: their diversity and conservation (1982). By K.L. Mehra and Arora, R.K.

## PGR 607 REGULATORY MECHANISMS AND INTELLECTUAL PROPERTY RIGHTS

(3L+1P) I

### Objective

To educate students about concepts and instruments of intellectual property rights, plant breeder's rights, farmer's rights, access and benefit sharing, international treaties and national legislation related to plant genetic resources.

### Theory

#### UNIT I

Concept of intellectual property, need for IP protection, Dimensions and nature of IPR, conflicting community interest with private right. Forms of IPR, patents, copyright, trademark, design, trade secret/ confidential information, GI registration. Process of obtaining an IPR, World Intellectual Property Organization, patent cooperation treaty (PCT).

## UNIT II

Plant breeder's rights, protection of plant varieties, UPOV; registration of plant varieties and essentially derived varieties, duration and effect of registration; traditional knowledge systems, farmer's rights, folklore, code of conduct, access and benefit sharing; compulsory license; plant varieties protection appellate tribunal; finance, accounts and audit; infringement, offenses, penalties and procedure.

## UNIT III

International instruments concerning agro-biodiversity, Agenda 21, convention on biological diversity (CBD), FAO and global system of PGR, the international treaty on plant genetic resources for food and agriculture (ITPGR), Global Plan of Action, TRIPS agreement and IPR protection of life forms, geographical appellations.

## UNIT IV

Multilateral agreement on trade in goods - relevance to agriculture, agreement on agriculture (AOA); agreement on application of sanitary and phytosanitary measures (SPS), international plant protection convention, agreement on technical barriers to trade (TBT). Plant quarantine, biosafety related issues.

## UNIT V

National legislations related to biodiversity conservation and IPR protection.

### **Practicals**

- Patent Information Search
- Patent Drafting
- Opinion on Patentability
- Patent Infringement

### **Suggested readings**

Valuation and Conservation of Biodiversity: Interdisciplinary Perspectives on the Convention on Biological Diversity by Michael Markussen et al. Springer 2005.

Use of Biodiversity: Access to Genetic Resources and Benefit Sharing by Kerry Ten Kate and Sarah A Laird; Earthscan 2002.

Providing Protection For Plant Genetic Resources: Patents, Sui Generis Systems And Biopartnerships; Publisher : Kluwer Academic Press, ISBN : 9041188754; Distributer : Landmark Ltd.

e-reading: [www.icar.org.in/files/reports/other-reports/icar-ipmttcguide.pdf](http://www.icar.org.in/files/reports/other-reports/icar-ipmttcguide.pdf)

### **Websites**

[www.wto.org](http://www.wto.org) [www.geographicindications.com](http://www.geographicindications.com)

[www.cbd.int](http://www.cbd.int) [www.patentoffice.nic.in](http://www.patentoffice.nic.in)

[www.uspto.gov](http://www.uspto.gov)

[www.wipo.int](http://www.wipo.int)

[www.nif.org.in](http://www.nif.org.in)

[plantauthority.gov.in](http://plantauthority.gov.in)

[nbaindia.org](http://nbaindia.org)

**Objective**

To apprise students about economic uses of plants including fields such as **ethnopharmacology** as well as potential new commercial crops.

**Theory**

UNIT I

Structure, development and chemical constituents of plant parts- cereals, pulses and oilseeds, vegetables, fruits, nuts.

UNIT II

Origin, evolution and interrelations of crop taxa- cereals, pulses and oilseeds, vegetables, fruits, nuts, ornamental plants, underutilized plants.

UNIT III

Economic uses and commercial importance of crop plants- cereals, pulses and oilseeds, vegetables, fruits, nuts, ornamental plants, underutilized plants.

UNIT IV

Importance of plants with respect to society and environment- Social and religious significance of plants in environmental amelioration.

**Practicals**

Structure, development and chemical constituents of plant parts-cereals, pulses and oilseeds, vegetables, fruits, nuts, ornamental plants, underutilized plants.

**Suggested Readings**

Crop genetic resources for today and tomorrow (1975). By O.H. Frankel & J.G. Hawks, Cambridge Univ. Press

Tropical Crops. Dicotyledons. The English Language Book Society and Longman. Purseglove, W. 1981.

Tropical Crops. Monocotyledons. The English Language Book Society and Longman. Purseglove, W. 1981.

Plants for human consumption. By Kunel, G

Plants and human affairs. By Schultes, RE

The use of plant genetic resources (1989). By A.H.D. Brown, O.H. Frankel, D.R. Marshall & J.T. Williams, Cambridge Univ. Press

Biodiversity: implication for global food security (1992) By M.S. Swaminathan & S. Jana (eds.), McMillan Press

Crops & Man (Second Edition) (1992). By J.R. Harlan, American Society of Agronomy Inc., Crop Science Society of America Inc., Madison, Wisconsin, USA

**Objective**

To apprise students about the identification and classification of plants including taxonomic databases and documentation systems.



## Theory

### UNIT I

Classical and modern species concepts, differentiation and evolution of species and biosystematics: Classical & modern species concepts, variation within species, population genetics, phenotypic plasticity, environmental effects on populations, differentiation and evolution of species, biosystematics; Modern evidences: Morphology and Anatomy; Modern evidences: Embryology and Palynology; Modern evidences: Biogeography and Cytotaxonomy; Modern evidences: Comparative studies on phytochemistry, Chemotaxonomy; Modern evidences: Molecular taxonomy methods; Numerical methods in taxonomy; Biosystematic approaches in plant taxonomy- some Indian case studies.

### UNIT II

Taxonomy of cultivated plants: Taxonomy of cultivated plants with particular emphasis on Indian groups: Hybrids, domesticated species, wild-cultivated continuum; Tools of taxonomy for identification of plant species and variation patterns therein; Field and herbarium methods; Floristic and monographic works; Systematic and evolutionary studies.

### UNIT III

Taxonomic databases: Taxonomic databases and documentation methods.

## Practicals

- Classical and modern species concepts and biosystematics - Morphology and anatomy; Comparative studies on phytochemistry, Chemotaxonomy; Field and herbarium methods; Floristic and monographic work; Practical methods for elucidating and proving hypotheses relating to plant speciation; Numerical taxonomy-practice and procedures; Biosystematic studies and their role in improving plant taxonomies; Intraspecific categories in relation to population biology.
- Taxonomic databases- Taxonomic databases and documentation methods in relation to plant genetic resources.
- Taxonomy of crop plants- Taxonomy of cultivated species, domesticated species, wild-cultivated continuum; problems and their resolution; newer methods of analysis and interpretation.

## Suggested Readings

- Brummitt, R.K. and Powell, C.E. 1992. Authors of Plant Names. Royal Botanic Gardens, Kew, London, UK. 732 p.
- Hollingsworth, P.M., Bateman, R.M. and Gornall, R.J. (eds.) 1999. Molecular Systematics and Plant Evolution. Taylor and Francis, London and New York. 485 p.
- Trehane, P., Bricknell, C.D., Baum, B.R., Hettterscheid, W.L.A., Leslie, A.C., McNeill, J., Spongberg, S.A. and Vrugtman, F. 1995. The International Code of Nomenclature for Cultivated Plants- Regnum Veg. 133. Quarterjack Publishing, Wimborne, UK. 175 p.
- Vavilov, N.I. 1887-1943. Origin and Geography of Cultivated Plants. English ed.: Translated by Love, D. 1992. Camb. University Press, Cambridge, UK. 498 p.
- Watt, G. 1889-1896. A Dictionary of Economic Products of India. 7 vols., Repr. 1972. Calcutta, India.