

Post-Graduate Degree Programme
COURSE CATALOGUE



Horticultural Sciences

Fruit Science
Vegetable Science
Floriculture & Land Scape Architecture
Plantation, Spices, Medicinal & Aromatic Crops

**SRI KONDA LAXMAN TELANGANA
STATE HORTICULTURAL UNIVERSITY**

Mulugu, Siddipet, Telangana - 502 279.

ORGANIZATION OF COURSE CONTENTS & CREDIT REQUIREMENTS

Code Numbers

- All courses are divided into two series: 500-series courses pertain to Master's level, and 600-series to Doctoral level. A Ph. D. student must take a minimum of two 600 series courses, but may also take 500-series courses if not studied during Master's programme.
- Credit seminar for Master's level is designated by code no. 591, and the two seminars for Doctoral level are coded as 691 and 692, respectively.
- Similarly, 599 and 699 codes have been given for Master's research and Doctoral research, respectively.

Course Contents

The contents of each course have been organized into:

- Objective – to elucidate the basic purpose.
- Theory units – to facilitate uniform coverage of syllabus for paper setting.
- Suggested Readings – to recommend some standard books as reference material. This does not unequivocally exclude other such reference material that may be recommended according to the advancements and local requirements.
- A list of journals pertaining to the discipline is provided at the end which may be useful a study material for 600-series courses as well as research topics.
- E-Resources - for quick update on specific topics/events pertaining to the subject.
- Broad research topics provided at the end would facilitate the advisors for appropriate research directions to the PG students.

Minimum Credit Requirements

Subject	Master's programme	Doctoral programme
Major	20	15
Minor	09	08
Supporting	05	05
Seminar	01	02
Research	20	45
Total Credits	55	75
Compulsory Non Credit Courses	See relevant section	

Major subject: The subject (department) in which the students takes admission

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.

Minor subject: The subject closely related to students major subject (e.g., if the major subject is Entomology, the appropriate minor subjects should be Plant Pathology & Nematology).

Non-Credit Compulsory Courses: Please see the relevant section for details. Six courses (PGS 501-PGS 506) are of general nature and are compulsory for Master's programme. Ph. D. students may be exempted from these courses if already studied during Master's degree.



MAJOR DEPARTMENT COURSES

FRUIT SCIENCE

Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
FSC 501*	TROPICAL AND DRY LAND FRUIT PRODUCTION	2+1
FSC 502*	SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION	2+1
FSC 503*	BIODIVERSITY AND CONSERVATION OF FRUIT CROPS	2+1
FSC 504	CANOPY MANAGEMENT IN FRUIT CROPS	1+1
FSC 505	PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS	2+1
FSC 506*	BREEDING OF FRUIT CROPS	2+1
FSC 507	POST HARVEST TECHNOLOGY FOR FRUIT CROPS	2+1
FSC 508	GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS	2+1
FSC 509	BIOTECHNOLOGY OF HORTICULTURAL CROPS	2+1
FSC 510	ORGANIC HORTICULTURE	1+1
FSC 511	PROTECTED FRUIT CULTURE	2+1
FSC 512	GAP FOR HORTICULTURAL CROPS	1+0
FSC 513	CLIMATE MANAGEMENT IN HORTICULTURAL PRODUCTION	1+0
FSC 591	MASTER'S SEMINAR	1+0
FSC 599	MASTER'S RESEARCH	20
FSC 601**	ADVANCES IN BREEDING OF FRUIT CROPS	2+1
FSC 602**	ADVANCES IN PRODUCTION OF FRUIT CROPS	2+1
FSC 603	ADVANCES IN GROWTH REGULATION OF FRUIT CROPS	2+1
FSC 604	GENOMICS AND BIOINFORMATICS IN HORTICULTURE	2+1
FSC 605	BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS	2+1
FSC 691	DOCTORAL SEMINAR I	1+0
FSC 692	DOCTORAL SEMINAR II	1+0
FSC 699	DOCTORAL RESEARCH	45

*Compulsory for Master's programme; ** Compulsory for Doctoral programme

VEGETABLE SCIENCE

Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
VSC 501*	PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS	2+1
VSC 502*	PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS	2+1
VSC 503*	BREEDING OF VEGETABLE CROPS	2+1
VSC 504*	GROWTH AND DEVELOPMENT OF VEGETABLE CROPS	2+1
VSC 505	SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS	2+1
VSC 506	SYSTEMATICS OF VEGETABLE CROPS	1+1
VSC 507	PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS	2+1
VSC 508	ORGANIC VEGETABLE PRODUCTION TECHNOLOGY	1+1
VSC 509	FUNDAMENTALS OF PROCESSING OF VEGETABLES	2+1
VSC 591	MASTER'S SEMINAR	1+0
VSC 599	MASTER'S RESEARCH	20
VSC 601**	ADVANCES IN VEGETABLE PRODUCTION	2+1
VSC 602**	ADVANCES IN BREEDING OF VEGETABLE CROPS	2+1
VSC 603**	PROTECTED CULTIVATION OF VEGETABLE CROPS	1+1
VSC 604**	BIOTECHNOLOGY OF VEGETABLE CROPS	2+1
VSC 605	SEED CERTIFICATION, PROCESSING AND STORAGE OF VEGETABLE CROPS	2+1
VSC 606	ABIOTIC STRESS MANAGEMENT IN VEGETABLE CROPS	2+1
VSC 691	DOCTORAL SEMINAR I	1+0
VSC 692	DOCTORAL SEMINAR II	1+0
VSC 699	DOCTORAL RESEARCH	45

* Compulsory for Master's programme; **Compulsory for Doctoral programme

FLORICULTURE AND LANDSCAPE ARCHITECTURE

Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
FLA.501*	BREEDING OF FLOWER CROPS AND ORNAMENTAL PLANTS	2+1
FLA.502*	PRODUCTION TECHNOLOGY OF CUT FLOWERS	2+1
FLA.503*	PRODUCTION TECHNOLOGY OF LOOSE FLOWERS	2+1
FLA.504*	LANDSCAPING AND ORNAMENTAL GARDENING	2+1
FLA.505	PROTECTED FLORICULTURE	2+1
FLA.506	VALUE ADDITION IN FLOWERS	2+1
FLA.507*	TURFING AND TURF MANAGEMENT	2+1
FLA.508	CAD FOR OUTDOOR AND INDOOR SCAPING	2+1
FLA 591	MASTER'S SEMINAR	1+0
FLA 599	MASTER'S RESEARCH	20
FLA 601**	ADVANCES IN BREEDING OF FLOWER CROPS	2+1
FLA 602**	ADVANCES IN FLOWER PRODUCTION TECHNOLOGY	2+1
FLA 603	ADVANCES IN PROTECTED AND PRECISION FLORICULTURE	1+1
FLA 604**	ADVANCES IN LANDSCAPE ARCHITECTURE	1+2
FLA 605	ADVANCES IN BIOCHEMISTRY AND BIOTECHNOLOGY OF FLOWERS	2+1
FLA 691	DOCTORAL SEMINAR I	1+0
FLA 692	DOCTORAL SEMINAR II	1+0
FLA 699	DOCTORAL RESEARCH	45

* Compulsory for Master's programme; **Compulsory for Doctoral programme

PLANTATION, SPICES, MEDICINAL & AROMATIC CROPS

Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
PSMA 501*	PRODUCTION TECHNOLOGY OF PLANTATION CROPS	2+1
PSMA 502*	PRODUCTION TECHNOLOGY OF SPICE CROPS	2+1
PSMA 503*	PRODUCTION TECHNOLOGY OF MEDICINAL AND AROMATIC CROPS	2+1
PSMA 504*	BREEDING OF PLANTATION CROPS AND SPICES	2+1
PSMA 505*	BREEDING OF MEDICINAL AND AROMATIC CROPS	2+1
PSMA 506*	PROCESSING OF PLANTATION CROPS, SPICES, MEDICINAL AND AROMATIC CROPS	2+1
PSMA 507	ORGANIC SPICE AND PLANTATION CROP PRODUCTION TECHNOLOGY	2+1
PSMA 508	UNDEREXPLOITED MEDICINAL AND AROMATIC PLANTS	1+1
PSMA 591	MASTER'S SEMINAR	1+0
PSMA 599	MASTER'S RESEARCH	20
PSMA 601**	ADVANCES IN PRODUCTION OF PLANTATION CROPS	2+1
PSMA 602**	ADVANCES IN SPICE PRODUCTION	2+1
PSMA 603**	ADVANCES IN MEDICINAL AND AROMATIC CROP PRODUCTION TECHNOLOGY	2+1
PSMA 604**	ADVANCES IN BREEDING OF PLANTATION CROPS AND SPICES	2+1
PSMA 605	ADVANCES IN BREEDING OF MEDICINAL AND AROMATIC CROPS	2+1
PSMA 606	BIOTECHNOLOGY IN PLANTATION CROPS AND SPICES	1+1
PSMA 607	POST HARVEST PROCESSING AND EXTRACTION IN MEDICINAL AND AROMATIC CROPS	2+1
PSMA 608	ENVIRONMENTAL HORTICULTURE	2+1
PSMA 691	DOCTORAL SEMINAR I	1+0
PSMA 692	DOCTORAL SEMINAR II	1+0
PSMA 699	DOCTORAL RESEARCH	45

* Compulsory for M. Sc. Programme; ** Compulsory for Doctoral programme

MINOR DEPARTMENT COURSES

Course Structure – at a Glance BIOCHEMISTRY

CODE	COURSE TITLE	CREDITS
BIOCHEM 501	BASIC BIOCHEMISTRY	2+1
BIOCHEM 504	MOLECULAR BIOLOGY	2+1
BIOCHEM 607	ADVANCED TECHNIQUES IN BIOCHEMISTRY	0+2

PLANT PHYSIOLOGY

CODE	COURSE TITLE	CREDITS
PP 501	PRINCIPLES OF PLANT PHYSIOLOGY	2+1
PP 504	HORMONAL REGULATION OF PLANT GROWTH AND DEVELOPMENT	2+1
PP 511	MINERAL NUTRITION	2+1
PP 604	TECHNIQUES IN PLANT PHYSIOLOGY	1+2
PP 606	POST HARVEST PHYSIOLOGY	1+1
PP 607	WEED PHYSIOLOGY AND HERBICIDE ACTION	1+1

AGRONOMY

CODE	COURSE TITLE	CREDITS
AGRON 504	PRINCIPLES AND PRACTICES OF WATER MANAGEMENT	2+1
AGRON 505	AGROMETEOROLOGY AND CROP WEATHER FORECASTING	2+1
AGRON 511	CROPPING SYSTEMS	2+0
AGRON 513	PRINCIPLES AND PRACTICES OF ORGANIC FARMING	2+1
AGRON 605	IRRIGATION MANAGEMENT	2+1
AGRON 606	ADVANCES IN WEED MANAGEMENT	2+0
AGRON 607	INTEGRATED FARMING SYSTEMS	2+0
AGRON 608	SOIL CONSERVATION AND WATERSHED MANAGEMENT	2+1

SOIL SCIENCE

CODE	COURSE TITLE	CREDITS
SOILS 510	REMOTE SENSING AND GIS TECHNIQUES FOR SOIL AND CROP STUDIES	2+1
SOILS 511	ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS	0+2
SOILS 513	MANAGEMENT OF PROBLEM SOILS AND WATERS	2+1
SOILS 514	FERTILIZER TECHNOLOGY	1+0
SOILS 515	LAND DEGRADATION AND RESTORATION	1+0
SOILS 602	ADVANCES IN SOIL FERTILITY	2+0
SOILS 606	LAND USE PLANNING AND WATERSHED MANAGEMENT	2+0

GENETICS AND PLANT BREEDING

CODE	COURSE TITLE	CREDITS
GP 504	PRINCIPLES OF QUANTITATIVE GENETICS	2+1
GP 507	HETEROSIS BREEDING	2+1
GP 509	BIOTECHNOLOGY FOR CROP IMPROVEMENT	2+1
GP 510	BREEDING FOR BIOTIC AND ABIOTIC STRESS RESISTANCE	2+1

SUPPORTING DEPARTMENT COURSES

Course Structure – at a Glance

AGRICULTURAL STATISTICS

CODE	COURSE TITLE	CREDITS
STAT 511	STATISTICAL METHODS FOR APPLIED SCIENCES	2+1
STAT 512	EXPERIMENTAL DESIGNS	2+1
STAT 531	DATA ANALYSIS USING STATISTICAL PACKAGES	2+1

COMPULSORY NON-CREDIT COURSES

(Compulsory for Master's programme in all disciplines; Optional for Ph.D. scholars)

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	0+1
PGS 503 (e-Course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-Course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-Course)	DISASTER MANAGEMENT	1+0

MAJOR DEPARTMENT COURSES

FRUIT SCIENCE

Course Contents

FSC 501 TROPICAL AND DRY LAND FRUIT PRODUCTION 2+1

Objective

To impart basic knowledge about the importance and scientific management of tropical and dry land fruits grown in India.

Theory

Commercial varieties of regional, national and international Importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports.

Principles of dryland horticulture, geographical distribution of dry lands in India, edaphic factors. Crops suitable for dry lands. Water management – farm ponds, other agricultural practices to conserve water. Value added products for dryland fruit crops.

Crops

- UNIT I : Mango and Banana
UNIT II : Citrus and Papaya
UNIT III : Guava, Sapota and Jackfruit
UNIT IV : Pineapple, Annonas and Avocado
UNIT V : Aonla, Pomegranate, Phalsa and Ber, minor fruits of tropics ie. Karonda, Jamun, Tamarind and fig.

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical and arid zone orchards, Project preparation for establishing commercial orchards.

Suggested Readings

- Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits - Horticulture*. Allied Publ.
Bose TK, Mitra SK & Sanyal D. 2001. (Eds.). *Fruits –Tropical And Subtropical*. Naya Udyog.
Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vols. IIIIV. Malhotra Publ. House.

Nakasone HY & Paul RE. 1998. *Tropical Fruits*. CABI.

Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency. Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008.

Management of Horticultural Crops. Parts I, II. New India Publ. Agency. Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Singh HP, Negi JP & Samuel JC. (Eds.). 2002. *Approaches for Sustainable Development of Horticulture*. National Horticultural Board.

Singh HP, Singh G, Samuel JC & Pathak RK. (Eds.). 2003. *Precision Farming in Horticulture*. NCPAH, DAC/PFDC, CISH, Lucknow.

Objective

To impart basic knowledge about the importance and scientific approaches for production and post harvest management of subtropical and temperate fruits grown in India.

Theory

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones(AEZ) and industrial support.

Crops

UNIT I	:	Apple, pear, quince, grapes
UNIT II	:	Plums, peach, apricot, cherries, hazlenut
UNIT III	:	Litchi, loquat, persimmon, kiwifruit, strawberry
UNIT IV	:	Nuts- walnut, almond, pistachio, pecan
UNIT V	:	Minor fruits- mangosteen, carambola, bael, wood apple, fig, Jamun, Rambutan, pomegranate

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical, subtropical, humid tropical and temperate orchards, Project preparation for establishing commercial orchards.

Suggested Readings

- Bose TK, Mitra SK & Sanyol D. (Ed.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.
- Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House.
- Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.
- Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons.
- Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
- Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagminder Book Agency.

Objective

Understanding the principles of biodiversity and strategies in germplasm conservation of fruit crops.

Theory

UNIT I

Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.

UNIT II

Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ*.

UNIT III

Germplasm conservation- problem of recalcitrancy - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.

UNIT IV

Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core groupmolecular marker based biodiversity conservation of fruit crops

UNIT V

GIS and documentation of local biodiversity, Geographical indication.

Crops

Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard, apple, ber, aonla, malus, *Prunus* sp, litchi, nuts, coffee, tea, rubber, cashew, coconut, cocoa, palmyrah, arecanut, oil palm and betelvine.

Practical

Documentation of germplasm – maintenance of passport data and other records of accessions; field exploration trips, exercise on *ex situ* conservation – cold storage, pollen/seed storage, cryopreservation, visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

Suggested Readings

Frankel OH & Hawkes JG. 1975. *Crop Genetic Resources for Today and Tomorrow*. Cambridge University Press.

Peter KV & Abraham Z. 2007. *Biodiversity in Horticultural Crops*. Vol. I. Daya Publ. House.

Peter KV. 2008. *Biodiversity of Horticultural Crops*. Vol. II. Daya Publ. House.

Objective

To impart knowledge about the principles and practices in canopy management of fruit crops.

Theory

UNIT I

Canopy management - importance and advantages; factors affecting canopy development.

UNIT II

Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies.

UNIT III

Spacing and utilization of land area - Canopy classification; Canopy management through rootstock and scion.

UNIT IV

Canopy management through plant growth inhibitors, training and pruning and management practices.

UNIT V

Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, passion fruits, mango, sapota, guava, citrus and ber.

Practical

Study of different types of canopies, training of plants for different canopy types, canopy development through pruning, use of plant growth inhibitors, geometry of planting; study on effect of different canopy types on production and quality of fruits.

Suggested Readings

Chadha KL & Shikhamany SD. 1999. *The Grape, Improvement, Production and Post Harvest Management*. Malhotra Publ. House.

Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. New India Publ. Agency.

Objective

Familiarization with principles and practices of propagation and nursery management for fruit crops.

Theory

UNIT I

Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.

UNIT II

Seed quality, treatment, packing, storage, certification, testing. Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

UNIT III

Budding and grafting – selection of elite mother plants, methods. Establishment of bud wood bank, stock, scion and inter stock, relationship – Incompatibility. Rejuvenation through top working – Progeny orchard and scion bank.

UNIT IV

Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques - *in vitro* clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules.

UNIT V

Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

Practical

Anatomical studies in rooting of cutting and graft union, construction of propagation structures, study of media and PGR. Hardening – case studies, micropropagation, explant preparation, media preparation, culturing – *in vitro* clonal propagation, meristem culture, shoot tip culture, axillary bud culture, direct organogenesis, direct and indirect embryogenesis, micro grafting, hardening. Visit to TC labs and nurseries.

Suggested Readings

Hartmann HT & Kester DE. 1989. *Plant Propagation – Principles and Practices*. Prentice Hall of India.

Bose TK, Mitra SK & Sadhu MK. 1991. *Propagation of Tropical and Subtropical Horticultural Crops*. Naya Prokash.

Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency. Singh SP. 1989 *Mist Propagation*. Metropolitan Book Co.

Rajan S & Baby LM. 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Objective

To impart comprehensive knowledge about the principles and practices of breeding of fruit crops.

Theory

Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, , approaches for crop improvement - introduction, selection, hybridization, ideotype breeding mutation breeding, polyploidy breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses-traditional methods and molecular methods , biotechnological interventions, achievements and future thrust in the following selected fruit crops.

Crops

- UNIT I : Mango, banana and pineapple
- UNIT II : Citrus, grapes, guava and sapota
- UNIT III : Jackfruit, papaya, custard apple, aonla, avocado and ber
- UNIT IV : Mangosteen, litchi, jamun, phalsa, mulberry, raspberry, kokam and nuts
- UNIT V : Apple, pear, plums, peach, apricot, cherries and strawberry

Practical

Characterization of germplasm, blossom biology, study of anthesis, estimating fertility status, studying heritability of characters , practices in hybridization, ploidy breeding,mutation breeding, evaluation of biometrical traits and quality traits,screening for resistance to biotic and abiotic stresses , developing breeding programme for specific traits, visit to research stations working on tropical, subtropical and temperate fruit improvement

Suggested Readings

- Bose TK, Mitra SK & Sanyol D. (Eds.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.
- Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House.
- Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.
- Janick J& Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons. Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
- Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

Objective

To facilitate deeper understanding on principles and practices of post harvest management of fruit crops.

Theory

UNIT I

Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration.

UNIT II

Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

UNIT III

Treatments prior to shipment, viz., chlorination, waxing, chemicals, Bio control agents and natural plant products. Methods of storage ventilated, refrigerated, MAS, CA storage, physical injuries and disorders.

UNIT IV

Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies.

UNIT V

Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Practical

Analyzing maturity stages of commercially important horticultural crops, improved packing and storage of important horticultural commodities, physiological loss in weight of fruits and vegetables, estimation of transpiration, respiration rate, ethylene release and study of vase life extension in cut flower using chemicals, estimation of quality characteristics in stored fruits and vegetables, cold chain management - visit to cold storage and CA storage units, visit to fruit and vegetable processing units, project preparation, evaluation of processed horticultural products.

Suggested Readings

Bhutani RC. 2003. *Fruit and Vegetable Preservation*. Biotech Books.

Chadha KL & Pareek OP. (Eds.). 1996 *Advances in Horticulture*. Vol. IV. Malhotra Publ. House.

Haid NF & Salunkhe SK. 1997. *Post Harvest Physiology and Handling of Fruits and Vegetables*. Grenada Publ.

Mitra SK. 1997. *Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits*. CABI.

Ranganna S. 1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.

Sudheer KP & Indira V. 2007. *Post Harvest Technology of Horticultural Crops*. New India Publ. Agency.

Willis R, Mc Glassen WB, Graham D & Joyce D. 1998. *Post Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals*. CABI.

Objective

To develop understanding of growth and development of horticultural crops which have implications in their management

Theory

UNIT I

Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis.

UNIT II

Annual, semi-perennial and perennial horticultural crops, environmental impact on growth and development, effect of light, photosynthesis and photoperiodism vernalisation, effect of temperature, heat units, thermoperiodism.

UNIT III

Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscissic acid, ethylene, brassinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors.

UNIT IV

Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.

UNIT V

Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

Practical

Understanding dormancy mechanisms in seeds, tubers and bulbs and stratification of seeds, tubers and bulbs, visit to arid, subtropical and temperate horticultural zones to identify growth and development patterns, techniques of growth analysis, evaluation of photosynthetic efficiency under different environments, study of growth regulator functions, hormone assays, understanding ripening phenomenon in fruits and vegetables, study of impact of physical manipulations on growth and development, study of chemical manipulations on growth and development, understanding stress impact on growth and development.

Suggested Readings

Buchanan B, Gruissem W & Jones R. 2002. *Biochemistry & Molecular Biology of Plants*. John Wiley & Sons.

Epstein E. 1972. *Mineral Nutrition of Plants: Principles and Perspectives*. Wiley.

Fosket DE. 1994. *Plant Growth and Development: a Molecular Approach*. Academic Press.

Leopold AC & Kriedermann PE. 1985. *Plant Growth and Development*. 3rd Ed. Mc Graw-Hill.

Peter KV. 2008. (Ed.) *Basics of Horticulture*. New India Publ. Agency.

Roberts J, Downs S & Parker P. 2002. Plant Growth Development. In: *Plants* (I. Ridge, Ed.), pp. 221-274, Oxford University Press.

Salisbury FB & Ross CW. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ.

Objective

Understanding the principles, theoretical aspects and developing skills in biotechnology of horticultural crops.

Theory

UNIT I

Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.

UNIT II

Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis.

UNIT III

Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, ex vitro techniques- production of synthetic/artificial seeds , establishment of tissue cultured plants.

UNIT IV

Physiology of hardening - hardening and field transfer, organ culture –meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion.

UNIT V

Construction and identification of somatic hybrids and cybrids, wide hybridization, *in vitro* pollination and fertilization, haploids, *in vitro* mutation, , cryopreservation, rapid clonal propagation, genetic engineering in horticulture crops, use of molecular markers. *In vitro* selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

Practical

An exposure to low cost, commercial and homestead tissue culture laboratories, media preparation, inoculation of explants for clonal propagation, callus induction and culture, regeneration of plantlets from callus, sub-culturing, techniques on anther, ovule, embryo culture, somaclonal variation, *in vitro* mutant selection against abiotic stress, protoplast culture, fusion technique, development of protocols for mass multiplication, project development for establishment of commercial tissue culture laboratory-protocol of producing tissue culture plants in banana.

Suggested Readings

Bajaj YPS. (Ed.).1989. *Biotechnology in Agriculture and Forestry*. Vol. V, *Fruits*. Springer. Brown TA. 2001. *Gene Cloning and DNA Analysis and Introduction*. Blackwell Publ.

Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology – Concepts, Methods and Applications*. Oxford & IBH. Gordon H & Rubsell S. 1960. *Hormones and Cell Culture*. AB Book Publ. Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene Transfer*. Orient & Longman (Universal Press). Keshavachandran R, Nazeem PA, Girija D, John PS & Peter KV. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. Vols. I, II. New India Publ. Agency. Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash. Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ. Skoog F & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Culture in vitro*. *Symp. Soc. Exp. Biol.* 11: 118-131 Vasil TK, Vasi M, While DNR & Bery HR. 1979. *Somatic Hybridization and Genetic Manipulation in Plants*. *Plant Regulation and World Agriculture*. Planum Press. Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V. Academic Press.

Objective

To develop understanding of organic horticulture production system including GAP.

Theory

UNIT I

Organic horticulture – definition, synonyms and misnomers, principles, methods, merits and demerits.

UNIT II

Organic farming systems, components of organic horticultural systems, different organic inputs, their role in organic horticulture, role of biofertilizers, biodynamics and the recent developments.

UNIT III

EM technology and its impact in organic horticulture, indigenous practices of organic farming, sustainable soil fertility management, weed management practices in organic farming, biological/natural control of pests and diseases, organic horticulture in quality improvement.

UNIT IV

GAP - Principles and management, HACCP exercise, certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies.

UNIT V

Constraints in certification, organic horticulture and export, IFOAM and global scenario of organic movement, post-harvest management of organic produce.

Practical

Features of organic orchards, working out conversion plan, Input analysis manures, nutrient status assessment of manures, biocomposting, biofertilizers and their application, panchagavya preparation and other organic nutrients application, methods of preparation of compost, vermicompost, green manuring, preparation of neem products and application, BD preparations and their role, EM technology and products, biological/natural control of pests and diseases, soil solarization, frame work for GAP, case studies, HACCP analysis, residue analysis in organic products, documentation for certification, visit to fields cultivated under organic practices

Suggested Readings

Claude A, Vandana S, Sultan I, Vijaya L, Korah M & Bernard D. 2000. *The Organic Farming Reader*. Other Indian Press, Goa.

Gaur AC, Neblakantan S & Dargan KS. 1984 *Organic Manures*. ICAR. Lampkin N & Ipswich. 1990. *Organic Farming*. Farming Press. London.

Lampkin NH & Padel S. 1992. *The Economics of Organic Farming – An International Perspective*. CABI.

Palaniappan & Annadurai. 2008. *Organic Farming- Theory and Practise*. Scientific Publ.

Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency. New Delhi.

Rao S. 1977. *Soil Microorganism and Plant Growth*. Oxford & IBH.

Objective

Understanding the principles, theoretical aspects and developing skills in protected cultivation of fruit crops.

Theory

UNIT I

Greenhouse – World scenario, Indian situation: present and future, Different agro-climatic zones in India, Environmental factors and their effects on plant growth.

UNIT II

Basics of greenhouse design, different types of structures – glasshouse, shade net, poly tunnels - Design and development of low cost greenhouse structures.

UNIT III

Interaction of light, temperature, humidity, CO₂, water on crop regulation -Greenhouse heating, cooling, ventilation and shading.

UNIT IV

Types of ventilation- Forced cooling techniques - Glazing materials – Micro irrigation and Fertigation.

UNIT V

Automated greenhouses, microcontrollers, waste water recycling, Management of pest and diseases – IPM.

Practical

Designs of greenhouse, low cost poly tunnels, nethouse- Regulation of light, temperature, humidity in greenhouses, media, greenhouse cooling systems, ventilation systems, fertigation systems, special management practices, project preparation for greenhouses, visit to greenhouses.

Suggested Readings

Aldrich RA & Bartok JW. 1994. *Green House Engineering*. NRAES, Riley, RobbHall, Cornell University, Ithaca, New York.

Bhattacharjee BS. 1959. *Rose Growing in Tropics*. Thackarpink & Co. Laurie A, Kiplingr DD & Nelson KS. 1968. *Commercial Flower Forcing*. McGraw-Hill.

Mears DR, Kim MK & Roberts WJ. 1971. *Structural Analysis at an Experimental Cable-supported Air Inflated Green Houses*. Trans. ASAE. Pant V Nelson. 1991. *Green House Operation and Management*. Bali Publ. Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2007. *Management of Horticultural Crops*. Parts I, II. New India Publ.Agency.

Objective

To impart comprehensive knowledge about the principles and practices of Good Agricultural Practises (GAP) for horticultural crops.

Theory

UNIT I

Genesis of GAP – definition/description, components listed by FAO, frame work.

UNIT II

Management of site history and soil, crop and fodder production, IPM, INM, IWM, irrigation water, crop production and protection. Identification of ways of improving the productivity profitability, and resource efficiency. harvest and post-harvest handling.

UNIT III

Animal production, product certification, animal waste management, animal health and welfare, harvest.

UNIT IV

On farm processing, storage, energy and waste management, human health, welfare, safety, wild life benefits.

UNIT V

Institutions involved in GAP certification. Indian agencies, EUREPGAP (European Retail Producers Group- Good Agricultural Practices), EUREP etc.

Suggested Readings

Peter KV. 2008. *Basics in Horticulture*. New India Publ. Agency.

Objective

To develop understanding about the impact and management of climate in horticultural production.

Theory

UNIT I

Introduction to climate change. Factors directly connected to climate change, average temperature, change in rainfall amount and patterns, rising atmospheric concentrations of CO₂, pollution levels such as tropospheric ozone, change in climatic variability and extreme events like receding of glaciers in Himalayas.

UNIT II

Sensors for climate registration and crop monitoring, phytomonitoring and biosensors, plants response to the climate changes, premature bloom, marginally overwintering or inadequate winter chilling hours, insect pests, longer growing seasons and shifts in plant hardiness for perennial fruit crops, flowering plants and other plant species.

UNIT III

Impact of climate changes on invasive insect, disease, weed, pests, horticulture yield, quality and sustainability, climate management in field production – mulching - use of plastic-windbreak- spectral changes- frost protection. Climate management in greenhouse- heating - vents - CO₂ injection - screens - artificial light.

UNIT IV

Climate management for control of pests, diseases, quality, elongation of growth and other plant processes- closed production systems around the world. Special protected cultivation now and in the future, growth chambers, production in space, biosphere, future aspects of closed production, future greenhouse, use of LED as artificial light, future sensor types etc. clean development mechanism, role of tropical trees.

Suggested Readings

Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency. Rao GSLHV, Rao GGSN, Rao VUM & Ramakrishnan YS. 2008.

Climate Change and Agriculture over India. ICAR.

Rao GSLHV. 2008. *Agricultural Meteorology*. Prentice Hall.

Objective

To update knowledge on the recent research trends in the field of breeding of fruit crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

Evolutionary mechanisms, adaptation and domestication, Genetic resources, cytogenetics, cytomorphology, chemotaxonomy, genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits, recent advances in crop improvement efforts- introduction and selection, chimeras, apomixis, clonal selections, intergeneric, interspecific and intervarietal hybridization, mutation and polyploid breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, molecular and transgenic approaches in improvement of selected fruit crops.

Crops

- UNIT I : Mango and banana
- UNIT II : Papaya, grapes and citrus
- UNIT III : Guava and sapota
- UNIT IV : Pineapple and avocado
- UNIT V : Apple, pear, plums, peaches, apricot, cherries and Strawberry.

Practical

Description and cataloguing of germplasm, use of minimal descriptors, pollen viability tests, pollen Germination-isozyme techniques-survey and clonal selection, observations on pest, disease and stress reactions in inbreds and hybrids, use of mutagens and colchicine for inducing mutation and ploidy changes, practices in different methods of breeding fruit crops and in-vitro breeding techniques.

Suggested Readings

- Bose TK, Mitra SK & Sanyal D. (Ed.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.
- Chadha KL & Pareek OP. (Eds.). 1996. *Advances in Horticulture*. Vol. I. Malhotra Publ. House.
- Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.
- Gowen S. 1996. *Banana and Plantains*. Chapman & Hall.
- Janick J & Moore JN. 1996. *Fruit Breeding*. Vols. I-III. John Wiley & Sons. Nijjar GS. (Ed.). 1977. *Fruit Breeding in India*. Oxford & IBH.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
- Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagminder Book Agency.
- Stover RH & Simmonds NW. 1991. *Bananas*. Longman.

Objective

To keep abreast with latest developments and trends in production technology of fruit crops.

Theory

National and International scenario in fruit production, Recent advances in propagation - root stock influence, planting systems, High density planting, crop modeling , Precision farming, decision support systems - aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, , Total quality management(TQM) - Current topics.

Crops

- UNIT I : Mango and banana
- UNIT II : Papaya, grapes and citrus
- UNIT III : Guava, sapota, pomegranate and aonla
- UNIT IV : Pineapple, avocado, jack fruit and fig
- UNIT V : Apple, pear, plums, strawberry, peach, apricot, cherries and nut crops

Practical

Survey of existing fruit cropping systems and development of a model cropping system, Estimating nutrient deficiency- estimation of water use efficiency, soil test-crop response correlations, practices in plant growth regulation, studying physiological and biochemical responses, quality analysis.

Suggested Readings

- Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits –Horticulture*. Allied Publ.
- Bose TK, Mitra SK & Sanyal D. (Eds.). 2001. *Fruits -Tropical andSubtropical*. Naya Udyog.
- Bose TK, Mitra SK, Farooqi AA & Sadhu MK. 1999. *Tropical Horticulture*. Vol. I. Naya Prokash.
- Chadha KL & Pareek OP. (Eds.).1996. *Advances in Horticulture*. Vols. IIIIV. Malhotra Publishing House.
- Chadha KL. 2001. *Handbook of Horticulture*. ICAR.
- Nakasone HY & Paull RE. 1998. *Tropical Fruits*. CABI.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Objective

Appraisal on the advances in growth regulation of fruit crops.

Theory

UNIT I

Ecophysiological influences on growth and development of fruit crops flowering, fruit set- Crop load and assimilate partitioning and distribution.

UNIT II

Root and canopy regulation, study of plant growth regulators in fruitculture- structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants.

UNIT III

Absorption, translocation and degradation of phytohormones – internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, canopy management for fertigated orchards.

UNIT IV

Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production.

UNIT V

Flower drop and thinning, fruitset and development, fruit drop, parthenocarpy, fruit maturity and ripening and storage, molecular approaches in crop growth regulation- current topics.

Practical

Root- shoot studies, quantifying the physiological and biochemical effects of physical and chemical growth regulation, bioassay and isolation through chromatographic analysis for auxins, gibberellins, experiments on growth regulation during propagation, dormancy, flowering, fruitset and fruit development stages.

Suggested Readings

- Buchanan B, Gruissem W & Jones R. 2002. *Biochemistry & Molecular Biology of Plants*. John Wiley & Sons.
- Epstein E. 1972. *Mineral Nutrition of Plants: Principles and Perspectives*. Wiley.
- Fosket DE. 1994. *Plant Growth and Development: A Molecular Approach*. Academic Press.
- Leopold AC & Kriedemann PE. 1985. *Plant Growth and Development*. 3rd Ed. McGraw-Hill.
- Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
- Roberts J, Downs S & Parker P. 2002. Plant Growth Development. In: *Plants* (I. Ridge, Ed.), pp. 221-274, Oxford University Press.
- Salisbury FB & Ross CW. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ.

Objective

Studies on the fundamentals and application of genomics and bioinformatics in horticulture.

Theory

UNIT I

Primer on bioinformatics and computational genomics, database fundamentals – biological databases, horticultural genome and protein databases, functional genomics.

UNIT II

Dynamic Programming Sequence Alignment, BLAST search engine, FASTA search engine, Microarrays- Microarray Clustering and Classification, Terminologies and Ontologies - EcoCYC knowledge base of E. Coli metabolism - Description of UMLS Semantic Network.

UNIT III

Multiple Sequence Alignment, MSA algorithm descriptions, ClustalW, 1D Motifs, Algorithms and Databases, methods for sequence weighting, BLOCKS database, Making BLOCK motifs, PROSITE database, 3D structure alignment, SCOP, DALI, LOCK, MUSTA algorithm for geometric hashing and multiple alignment.

UNIT IV

Hidden Markov models , Molecular energetics and dynamics , Protein structure prediction, Genetic networks - Modeling and Simulation of Genetic Regulatory Systems- KEGG database of genes and gene pathways/networks - EcoCYC database of metabolic pathways in E. Coli - EGF-signal pathway modeling, Gene finding algorithms – Genome Annotation Assessment Project for Arabidopsis, Comparative genomics algorithms, Genome Alignment.

UNIT V

3D structure computations, NMR, Xtallography, NMR Structure Determination, X-ray Crystallography Structure Determination, Distance Geometry Description, RNA secondary structure, Molecular Modeling and Drug discovery programs.

UNIT VI

Phylogenetic algorithms - Treebase database of phylogenetic information for plants mostly, Tree of Life Page, Samples from the Tree of Life, Ribosomal Database Project, Natural Language Processing , Proteomics, 3D Motifs, Applications and Integration with Horticulture, Final Thoughts. proteomics, metabolomics and genomics of banana, mango, peach and plum

Practical

Computers, Operating systems and Programming languages, Internet Resources, Horticultural Genome and Protein Databases, BLAST/RNA Structure, Sequence Alignment, Microarray Data Analysis, Ontology, MSA, HMMs, Identification of Functional Sites in Structures, Protein Structure Prediction - Phylogenetics - Gene Finding - Molecular Modeling and Drug Discovery Software – Assignments.

Suggested Readings

- Attwood TK & Parry Smith DJ. 2006. *Introduction to Bioinformatics*. Pearson Edu. Baxevanis AD. 2005. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. 3rd Ed. Wiley.
- Bourne PE & Weissig H. (Eds.). 2004. *Structural Bioinformatics*. John Wiley & Sons. Durbin R, Eddy SR, Krogh A & Mitchison G. 1999. *Biological Sequence Analysis: Probabilistic Model of Proteins and Nucleic Acids*. Cambridge Univ. Press.
- Keshavachandran R, Nazeem PA, Girija D, John PS & Peter KV. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. Vols. I, II. New India Publ. Agency. Kohane IS, Kho A & Butte AJ. 2002. *Microarrays for an Integrative Genomics*. MIT Press. Mount DW. 2001. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbour Laboratory Press.

Objective

To update knowledge on the recent research trends in the field of biotic and abiotic stress management in horticultural crops.

Theory

UNIT I

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.).

UNIT II

Pollution - increased level of CO₂, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations.

UNIT III

Crop modeling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stress and their impact on crop growth and productivity.

UNIT IV

Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers.

UNIT V

Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices.

Practical

Seed treatment /hardening practices, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP), analysis of plant stress factors, RWC, chlorophyll fluorescence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, economics of stress management, visit to orchards and water shed locations.

Suggested Readings

Blumm A. 1988. *Plant Breeding for Stress Environments*. CRC.

Christiansen MN & Lewis CF. 1982. *Breeding Plants for Less Favourable Environments*. Wiley Inter. Science.

Gupta US. 1990. *Physiological Aspects of Dry Farming*.

Hsiao TC. 1973. Plant Responses to Water Stress. *Ann. Rev. Plant Physiology* 24: 519-570.

Kramer PJ. 1980. Drought Stress and the Origin of Adaptation. In: *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons.

- Levitt J. 1972. *Response of Plants to Environmental Stresses*. Academic Press.
- Maloo SR. 2003. *Abiotic Stress and Crop Productivity*. Agrotech Publ. Academy. Mussell H & Staples R. 1979. *Stress Physiology in Crop Plants*. Wiley Inter. Science.
- Nickell LG. 1983. *Plant Growth Regulating Chemicals*. CRC.
- Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency.
- Turener NC & Kramer PJ. 1980. *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons.

FRUIT SCIENCE

List of Journals & Magazines

- ✓ Acta Horticulture
- ✓ Haryana Journal of Horticulture Science
- ✓ Horticulture Reviews
- ✓ HortScience
- ✓ Indian Horticulture
- ✓ Indian Journal of Arid Horticulture
- ✓ Indian Journal of Horticulture
- ✓ Journal of American Society of Horticultural Sciences
- ✓ Journal of Applied Horticulture
- ✓ Journal of Horticultural Sciences
- ✓ Journal of Horticultural Sciences & Biotechnology
- ✓ Journal of Japanese Society for Horticulture Science
- ✓ Journal of Korean Society for Horticulture Science
- ✓ Scientia Horticulture
- ✓ South Indian Horticulture

Suggested Broad Topics for Master's and Doctoral Research

- ✓ Micro-propagation of fruit crops
- ✓ Application of genetic engineering in fruit crops
- ✓ Use of molecular markers in fruit crops
- ✓ Fruit crop improvement
- ✓ Crop selection for biotic and abiotic stresses
- ✓ Diagnostic and recommended integrated system in cultivation of fruit crops
- ✓ Precision farming in fruit crops
- ✓ Protected cultivation of fruit crops
- ✓ Root distribution studies in fruit crops
- ✓ Canopy management in fruit crops
- ✓ Organic fruit cultivation
- ✓ Post harvest management of fruit crops
- ✓ Value addition in fruit crops
- ✓ Rejuvenation of orchards
- ✓ Replant problems in perennial fruit crops
- ✓ Research on burning problems in horticulture crops like mango malformation, citrus decline, guava wilt, alternate bearing, etc.

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VEGETABLE SCIENCE

Course Contents

VSC 501 PRODUCTION TECHNOLOGY OF COOL SEASON 2+1
VEGETABLE CROPS

Objective

To educate production technology of cool season vegetables.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

UNIT I

Potato

UNIT II

Cole crops: cabbage, cauliflower, knoll kohl, sprouting broccoli, Brussels sprout

UNIT III

Root crops: carrot, radish, turnip and beetroot

UNIT IV

Bulb crops: onion and garlic

UNIT V

Peas and broad bean, green leafy cool season vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economics; Experiments to demonstrate the role of mineral elements, plant growth substances and herbicides; study of physiological disorders; preparation of cropping scheme for commercial farms; visit to commercial greenhouse/ polyhouse.

Suggested Readings

Bose TK & Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash. Bose TK, Som G & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.

Bose TK, Som MG & Kabir J. (Eds.). 1993. *Vegetable Crops*. Naya Prokash. Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.

Chadha KL & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture* Vols. V-X. Malhotra Publ. House.

Chadha KL. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.

Chauhan DVS. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad & Sons. Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.

- Edmond JB, Musser AM & Andrews FS. 1951. *Fundamentals of Horticulture*. Blakiston Co.
- Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
- Gopalakrishanan TR. 2007. *Vegetable Crops*. New India Publ. Agency.
- Hazra P & Som MG. (Eds.). 1999. *Technology for Vegetable Production and Improvement*. Naya Prokash.
- Rana MK. 2008. *Olericulture in India*. Kalyani Publ.
- Rana MK. 2008. *Scientific Cultivation of Vegetables*. Kalyani Publ.
- Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall.
- Saini GS. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ. House.
- Salunkhe DK & Kadam SS. (Ed.). 1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
- Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.
- Singh DK. 2007. *Modern Vegetable Varieties and Production Technology*. International Book Distributing Co.
- Singh SP. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre.
- Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*. ICAR.
- Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata McGraw-Hill.

VSC 502 PRODUCTION TECHNOLOGY OF WARM SEASON 2+1
VEGETABLE CROPS

Objective

To teach production technology of warm season vegetables.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures, economics of crop production and seed production of:

UNIT I

Tomato, eggplant, hot and sweet peppers

UNIT II

Okra, beans, cowpea and clusterbean

UNIT III

Cucurbitaceous crops

UNIT IV

Tapioca and sweet potato

UNIT V

Green leafy warm season vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of summer vegetable crops and their economics; study of physiological disorders and deficiency of mineral elements, preparation of cropping schemes for commercial farms; experiments to demonstrate the role of mineral elements, physiological disorders; plant growth substances and herbicides; seed extraction techniques; identification of important pests and diseases and their control; maturity standards; economics of warm season vegetable crops.

Suggested Readings

- Bose TK & Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash. Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.
- Bose TK, Som MG & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash. Brown HD & Hutchison CS. *Vegetable Science*. JB Lippincott Co. Chadha KL & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture*. Vols. V-X. Malhotra Publ. House.
- Chadha KL. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.
- Chauhan DVS. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad & Sons.
- Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.
- Edmond JB, Musser AM & Andrews FS. 1964. *Fundamentals of Horticulture*. Blakiston Co
- Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.

Gopalakrishanan TR. 2007. *Vegetable Crops*. New India Publ. Agency. Hazra P & Som MG. (Eds.). 1999. *Technology for Vegetable Production and Improvement*. Naya Prokash.

Kaloo G & Singh K (Ed.). 2000. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ.

House. Nayer NM & More TA 1998. *Cucurbits*. Oxford & IBH Publ. Palaniswamy & Peter KV. 2007. *Tuber Crops*. New India Publ. Agency. Pandey AK & Mudranalay V. (Eds.). *Vegetable Production in India: Important Varieties and Development Techniques*.

Rana MK. 2008. *Olericulture in India*. Kalyani.

Rana MK. 2008. *Scientific Cultivation of Vegetables*. Kalyani.

Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall. Saini GS. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ.

House. Salunkhe DK & Kadam SS. (Ed.). 1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.

Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.

Objective

To educate principles and practices adopted for breeding of vegetable crops.

Theory

Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, pedigree, back cross, bulk method, mutation, synthetics), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPV&FR act.

UNIT I

Potato and tomato

UNIT II

Eggplant, hot pepper, sweet pepper and okra

UNIT III

Peas and beans, amaranth, chenopods and lettuce

UNIT IV

Gourds, melons, pumpkins and squashes

UNIT V

Cabbage, cauliflower, carrot, beetroot, radish, sweet potato and tapioca

Practical

Selection of desirable plants from breeding populations, observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations; induction of flowering, palanological studies, selfing and crossing techniques in vegetable crops; hybrid seed production of vegetable crops in bulk. screening techniques for insect-pests, disease abiotic stress resistance in above mentioned crops, demonstration of sib-mating and mixed population; stability analysis, molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques. Visit to breeding blocks.

Suggested Readings

Allard RW. 1999. *Principles of Plant Breeding*. John Wiley & Sons.

Basset MJ. (Ed.). 1986. *Breeding Vegetable Crops*. AVI Publ.

Dhillon BS, Tyagi RK, Saxena S. & Randhawa GJ. 2005. *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. House.

Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani.

Gardner EJ. 1975. *Principles of Genetics*. John Wiley & Sons.

Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill.

- Hayward MD, Bosemark NO & Romagosa I. (Eds.). 1993. *Plant Breeding- Principles and Prospects*. Chapman & Hall.
- Kaloo G. 1988. *Vegetable Breeding*. Vols. I-III. CRC Press.
- Kaloo G. 1998. *Vegetable Breeding*. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.
- Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.
- Paroda RS & Kaloo G. (Eds.). 1995. *Vegetable Research with Special Reference to Hybrid Technology in Asia-Pacific Region*. FAO.
- Peter KV & Pradeepkumar T. 2008. *Genetics and Breeding of Vegetables*. Revised, ICAR.
- Rai N & Rai M. 2006. *Heterosis Breeding in Vegetable Crops*. New India Publ. Agency.
- Ram HH. 1998. *Vegetable Breeding: Principles and Practices*. Kalyani. Simmonds NW. 1978. *Principles of Crop Improvement*. Longman. Singh BD. 1983. *Plant Breeding*. Kalyani.
- Singh PK, Dasgupta SK & Tripathi SK. 2004. *Hybrid Vegetable Development*. International Book Distributing Co.
- Swarup V. 1976. *Breeding Procedure for Cross-pollinated Vegetable Crops*. ICAR.

Objective

To teach the physiology of growth and development of vegetable crops.

Theory

UNIT I

Cellular structures and their functions; definition of growth and development, growth analysis and its importance in vegetable production.

UNIT II

Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellins, cytokinins and abscisic acid; Application of synthetic hormones, plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production.

UNIT III

Role of light, temperature and photoperiod on growth, development of underground parts, flowering and sex expression in vegetable crops; apical dominance.

UNIT IV

Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening.

UNIT V

Plant growth regulators in relation to vegetable production; morphogenesis and tissue culture techniques in vegetable crops.

Practical

Preparation of solutions of plant growth substances and their application; experiments in breaking and induction of dormancy by chemicals; induction of parthenocarpy and fruit ripening; application of plant growth substances for improving flower initiation, changing sex expression in cucurbits and checking flower and fruit drops and improving fruit set in solanaceous vegetables; growth analysis techniques in vegetable crops.

Suggested Readings

Bleasdale JKA. 1984. *Plant Physiology in Relation to Horticulture*. 2nd Ed. MacMillan.

Gupta US. (Ed.). 1978. *Crop Physiology*. Oxford & IBH.

Krishnamoorti HN. 1981. *Application Plant Growth Substances and Their Uses in Agriculture*. Tata-McGraw Hill.

Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency. Saini RS, Sharma KD, Dhankhar OP & Kaushik RA. (Eds.). 2001.

Laboratory Manual of Analytical Techniques in Horticulture. Agrobios. Wien HC. (Ed.). 1997.
The Physiology of Vegetable Crops. CABI.

Objective

To educate principles and methods of quality seed and planting material production in vegetable crops.

Theory

UNIT I

Definition of seed and its quality, new seed policies; NDUS test, scope of vegetable seed industry in India.

UNIT II

Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behaviour, seed development and maturation; methods of hybrid seed production, manual, male sterility and self incompatibility based hybrid seed production.

UNIT III

Categories of seed; maintenance of nucleus, foundation and certified seed in self and cross pollinated vegetables; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control.

UNIT VI

Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology.

UNIT V

Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.

Practical

Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, physical purity) and seed health testing; testing, releasing and notification procedures of varieties; floral biology; rouging of off-type; methods of hybrid seed production in important vegetable and spice crops; seed extraction techniques; handling of seed processing and seed testing equipments; seed sampling; testing of vegetable seeds for seed purity, germination, vigour and health; visit to seed processing units, seed testing laboratory and seed production farms.

Suggested Readings

Agrawal PK & Dadlani M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ.

Agrawal RL. (Ed.). 1997. *Seed Technology*. Oxford & IBH.

Bendell PE. (Ed.). 1998. *Seed Science and Technology: Indian Forestry Species*. Allied Publ.

Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani.

George RAT. 1999. *Vegetable Seed Production*. 2nd Ed. CABI.

Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.

More TA, Kale PB & Khule BW. 1996. *Vegetable Seed production Technology*. Maharashtra State Seed Corp.

Rajan S & Baby L Markose. 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.

Singh NP, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distributing Co.

Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.

Objective

To teach morphological, cytological and molecular taxonomy of vegetable crops.

Theory

UNIT I

Principles of classification; different methods of classification; salient features of international code of nomenclature of vegetable crops.

UNIT II

Origin, history, evolution and distribution of vegetable crops, botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables.

UNIT III

Cytological studies of various vegetable crops; descriptive keys for important vegetables.

UNIT IV

Importance of molecular markers in evolution of vegetable crops; molecular markers as an aid in characterization and taxonomy of vegetable crops.

Practical

Identification, description, classification and maintenance of vegetable species and varieties; survey, collection of allied species and genera locally available; preparation of keys to the species and varieties; methods of preparation of herbarium and specimens.

Suggested Readings

Chopra GL. 1968. *Angiosperms - Systematics and Life Cycle*. S. Nagin Dutta AC. 1986. *A Class Book of Botany*. Oxford Univ. Press.

Pandey BP. 1999. *Taxonomy of Angiosperm*. S. Chand & Co.

Peter KV & Pradeepkumar T. 2008. *Genetics and Breeding of Vegetables*. (Revised), ICAR.

Soule J. 1985. *Glossary for Horticultural Crops*. John Wiley & Sons.

Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS.

2001. *Minimal Descriptors of Agri-Horticultural Crops*. Part-II: *Vegetable Crops*. NBPGR, New Delhi.

Vasistha. 1998. *Taxonomy of Angiosperm*. Kalyani.

Vincent ER & Yamaguchi M. 1997. *World Vegetables*. 2nd Ed. Chapman & Hall.

VSC 507 PRODUCTION TECHNOLOGY OF UNDER EXPLOITED VEGETABLE CROPS 2+1

Objective

To educate production technology of underutilized vegetable crops.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed production of:

UNIT I

Asparagus, artichoke and leek

UNIT II

Brussels's sprout, Chinese cabbage, broccoli, kale and artichoke.

UNIT III

Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella, bathu (chenopods) and chekurmanis.

UNIT IV

Elephant foot yam, lima bean, winged bean, vegetable pigeon pea, jack bean and sword bean.

UNIT V

Sweet gourd, spine gourd, pointed gourd, Oriental pickling melon and little gourd (kundru).

Practical

Identification of seeds; botanical description of plants; layout and planting; cultural practices; short-term experiments of underexploited vegetables.

Suggested Readings

Bhat KL. 2001. *Minor Vegetables - Untapped Potential*. Kalyani.

Indira P & Peter KV. 1984. *Unexploited Tropical Vegetables*. Kerala Agricultural University, Kerala.

Peter KV. (Ed.). 2007-08. *Underutilized and Underexploited Horticultural Crops*. Vols. I-IV. New India Publ. Agency.

Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall

Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS. 2001.

Minimal Descriptors of Agri-Horticultural Crops. Part-II: *Vegetable Crops*. NBPGR, New Delhi.

Objective

To educate principles, concepts and production of organic farming in vegetable crops.

Theory

UNIT I

Importance, principles, perspective, concept and component of organic production of vegetable crops.

UNIT II

Organic production of vegetables crops, viz., solanaceous crops, cucurbits, cole crops, root and tuber crops.

UNIT III

Managing soil fertility, pests and diseases and weed problems in organic farming system; crop rotation in organic horticulture; processing and quality control for organic foods.

UNIT IV

Methods for enhancing soil fertility, mulching, raising green manure crops. Indigenous methods of compost, Panchagavya, Biodynamics, preparation etc Pest and disease management in organic farming; ITK's in organic farming. Role of botanicals and bio-control agents.

UNIT V

GAP and GMP- Certification of organic products; organic production and export - opportunity and challenges.

Practical

Method of preparation of compost, vermicomposting, biofertilizers, soil solarization, bio pesticides in horticulture, green manuring, mycorrhizae and organic crop production, waste management, organic soil amendment for root disease, weed management in organic horticulture. Visit to organic fields and marketing centers.

Suggested Readings

- Dahama AK. 2005. *Organic Farming for Sustainable Agriculture*. 2nd Ed. Agrobios. Gehlot G. 2005. *Organic Farming; Standards, Accreditation Certification and Inspection*. Agrobios. Palaniappan SP & Annadorai K. 2003. *Organic Farming, Theory and Practice*. Scientific Publ. Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. New India Publ. Agency. Shivashankar K. 1997. *Food Security in Harmony with Nature*. 3rd IFOAMASIA, Scientific Conf.. 1- 4 December, 1997, UAS, Bangalore

Objective

To educate principles and practices of processing of vegetable crops.

Theory

UNIT I

History of food preservation. Present status and future prospects of vegetable preservation industry in India.

UNIT II

Spoilage of fresh and processed horticultural produce; biochemical changes and enzymes associated with spoilage of horticultural produce; principal spoilage organisms, food poisoning and their control measures. Role of microorganisms in food preservation.

UNIT III

Raw materials for processing. Primary and minimal processing; processing equipments; Layout and establishment of processing industry, FPO licence. Importance of hygiene; Plant sanitation.

UNIT IV

Quality assurance and quality control, TQM, GMP. Food standards – FPO, PFA, etc. Food laws and regulations.

UNIT V

Food safety – Hazard analysis and critical control points (HACCP). Labeling and labeling act, nutrition labeling.

UNIT VI

Major value added products from vegetables. Utilization of byproducts of vegetable processing industry; Management of waste from processing factory.

UNIT VII

Investment analysis. Principles and methods of sensory evaluation of fresh and processed vegetables.

Practical

Study of machinery and equipments used in processing of horticultural produce; Chemical analysis for nutritive value of fresh and processed vegetables; Study of different types of spoilages in fresh as well as processed horticultural produce; Classification and identification of spoilage organisms; Study of biochemical changes and enzymes associated with spoilage; Laboratory examination of vegetable products; Sensory evaluation of fresh and processed vegetables; Study of food standards – National, international, CODEX Alimentarius; Visit to processing units to study the layout, equipments, hygiene, sanitation and residual / waste management.

Suggested Readings

- Arthey D & Dennis C. 1996. *Vegetable Processing*. Blackie/Springer- Verlag. Chadha DS. 2006. *The Prevention of Food Adulteration Act*. Confed. of Indian Industry. Desrosier NW. 1977. *Elements and Technology*. AVI Publ. Co. FAO. 1997. *Fruit and Vegetable Processing*. FAO. FAO. *CODEX Alimentarius: Joint FAO/WHO Food Standards Programme*. 2nd Ed. Vol. VB. *Tropical Fresh Fruits and Vegetables*. FAO. FAO. *Food Quality and Safety Systems – Training Manual on Food Hygiene and HACCP*. FAO.
- Fellow's P. 1988. *Food Processing Technology*. Ellis Horwood International. Frazier WC & Westhoff DC. 1995. *Food Microbiology*. 4th Ed. Tata McGraw Hill. Giridharilal GS, Siddappa & Tandon GL. 1986. *Preservation of Fruits and Vegetables*. ICAR.
- Gisela J. 1985. *Sensory Evaluation of Food – Theory and Practices*. Ellis Horwood.
- Graham HD. 1980. *Safety of Foods*. AVI Publ. Co.
- Hildegrade H & Lawless HT. 1997. *Sensory Evaluation of Food*. CBS.
- Joslyn M & Heid. *Food Processing Operations*. AVI Publ. Co. Mahindru SN. 2004. *Food Safety: Concepts and Reality*. APH Publ. Corp. Ranganna S. 1986. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw Hill.
- Shapiro R. 1995. *Nutrition Labeling Handbook*. Marcel Dekker.
- Srivastava RP & Kumar S. 2003. *Fruit and Vegetable Preservation: Principles and Practices*. 3rd Ed. International Book Distri. Co.
- Tressler & Joslyn MA. 1971. *Fruit and Vegetable Juice Processing Technology*. AVI Publ. Co.
- Verma LR & Joshi VK. 2000. *Post-harvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management*. Indus Publ. Co

Objective

To keep abreast with latest developments and trends in production technology of vegetable crops.

Theory

Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing of:

UNIT I

Tomato, brinjal, chilli, sweet pepper and potato

UNIT II

Cucurbits, cabbage, cauliflower and knol-khol

UNIT III

Bhendi, onion, peas and beans, amaranthus and drumstick

UNIT IV

Carrot, beet root and radish

UNIT V

Sweet potato, tapioca, elephant foot yam and taro

Practical

Seed hardening treatments; practices in indeterminate and determinate vegetable growing and organic gardening; portraits and ball culture; diagnosis of nutritional and physiological disorders; analysis of physiological factors like anatomy; photosynthesis; light intensity in different cropping situation; assessing nutrient status, use of plant growth regulators; practices in herbicide application; estimating water requirements in relation to crop growth stages, maturity indices; dryland techniques for rainfed vegetable production; production constraints; analysis of different cropping system in various situation like cold and hot set; vegetable waste recycling management; quality analysis ;marketing survey of the above crops; visit to vegetable and fruit malls and packing houses.

Suggested Readings

Bose TK & Som NG. 1986. *Vegetable Crops of India*. Naya Prokash. Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog. Brewster JL. 1994. *Onions and other Vegetable Alliums*. CABI. FFTC. *Improved Vegetable Production in Asia*. Book Series No. 36.

Ghosh SP, Ramanujam T, Jos JS, Moorthy SN & Nair RG. 1988. *Tuber Crops*. Oxford & IBH.

Gopalakrishnan TR. 2007. *Vegetable Crops*. New India Publishing Agency.

Kallo G & Singh K. (Ed.). 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.

Kurup GT, Palanisami MS, Potty VP, Padmaja G, Kabeerathuma S & Pallai SV. 1996. *Tropical Tuber Crops, Problems, Prospects and Future Strategies*. Oxford & IBH.

Sin MT & Onwueme IC. 1978. *The Tropical Tuber Crops*. John Wiley & Sons.

Singh NP, Bhardwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distr. Co.

Singh PK, Dasgupta SK & Tripathi SK. 2006. *Hybrid Vegetable Development*. International Book Distr. Co.

Objective

To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance of:

UNIT I

Tomato, brinjal, chilli, sweet pepper and potato

UNIT II

Cucurbits, Cabbage, cauliflower and knol-khol

UNIT III

Bhendi, onion, peas and beans, amaranthus and drumstick

UNIT IV

Carrot, beet root and radish

UNIT V

Sweetpotato, tapioca, elephant foot yam and taro

Practical

Designing of breeding experiments, screening techniques for abiotic stresses, screening and rating for pest, disease and nematode resistance, estimation of quality and processing characters, screening for quality improvement, estimation of heritability, heterosis and combining ability, induction and identification of mutants and polyploids, distant hybridization and embryo rescue techniques.

Suggested Readings

Acta Horticulture. Conference on Recent Advance in Vegetable Crops. Vol. 127. Chadha KL, Ravindran PN & Sahijram L. 2000. *Biotechnology in Horticultural and Plantation Crops*. Malhotra Publ. House. Chadha KL. 2001. *Hand Book of Horticulture*. ICAR.
Dhillon BS, Tyagi RK, Saxena S & Randhawa GJ. 2005. *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. House. Janick JJ. 1986. *Horticultural Science*. 4th Ed. WH Freeman & Co. Kaloo G & Singh K. 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals and Book Publ. House.
Kaloo G. 1994. *Vegetable Breeding*. Vols. I-III. Vedams eBooks. Peter KV & Pradeep Kumar T. 2008. *Genetics and Breeding of Vegetables*. (Revised Ed.). ICAR. Ram HH. 2001. *Vegetable Breeding*. Kalyani.

Objective

To impart latest knowledge in growing of vegetable crops under protected environmental condition.

Theory

Crops: Tomato, capsicum, cucumber, melons and lettuce

UNIT I

Importance and scope of protected cultivation of vegetable crops; principles used in protected cultivation, energy management, low cost structures; training methods; engineering aspects.

UNIT II

Regulatory structures used in protected structures; types of greenhouse/polyhouse/nethouse, hot beds, cold frames, effect of environmental factors, viz. temperature, light, CO₂ and humidity on growth of different vegetables, manipulation of CO₂, light and temperature for vegetable production, fertigation.

UNIT III

Nursery raising in protected structures like poly-tunnels, types of benches and containers, different media for growing nursery under cover.

UNIT IV

Regulation of flowering and fruiting in vegetable crops, technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, training and staking in protected crops, varieties and hybrids for growing vegetables in protected structures.

UNIT V

Problem of growing vegetables in protected structures and their remedies, insect and disease management in protected structures; soil-less culture, use of protected structures for seed production.

Practical

Study of various types of structures, methods to control temperature, CO₂ light, media, training and pruning, maintenance of parental lines and hybrid seed production of vegetables, fertigation and nutrient management, control of insect-pests and disease in greenhouse; economics of protected cultivation, visit to established green/polyhouse/net house/shade house in the region.

Suggested Readings

Anonymous 2003. *Proc. All India Seminar on Potential and Prospects for Protective Cultivation*. Organised by Institute of Engineers, Ahmednagar. Dec.12-13, 2003.

Chandra S & SomV. 2000. *Cultivating Vegetables in Green House*. *Indian Horticulture* 45: 17-18.

Prasad S & Kumar U. 2005. *Greenhouse Management for Horticultural Crops*. 2nd Ed. Agrobios.

Tiwari GN. 2003. *Green House Technology for Controlled Environment*. Narosa Publ. House.

Objective

To impart knowledge about advances in biotechnology for improvement of vegetable crops.

Theory

Crops: Tomato, eggplant, hot and sweet pepper, potato, cabbage, cauliflower, tapioca, onion, cucurbits.

UNIT I

In vitro culture methods and molecular approaches for crop improvement in vegetables, production of haploids, disease elimination in horticultural crops, micro grafting, somoclones and identification of somaclonal variants, *in vitro* techniques to overcome fertilization barriers, *in vitro* production of secondary metabolites.

UNIT II

Protoplast culture and fusion; construction, identification and characterization of somatic hybrids and cybrids, wide hybridization, embryo rescue of recalcitrant species, *in vitro* conservation.

UNIT III

In vitro mutation for biotic and abiotic stresses, recombinant DNA methodology, gene transfer methods, tools, methods, applications of DNA technology.

UNIT IV

Quality improvement, improvement for biotic and abiotic stresses, transgenic plants.

UNIT V

Role of molecular markers in characterization of transgenic crops, fingerprinting of cultivars etc., achievements, problems and future thrusts in horticultural biotechnology. Transgenic tomatoes, pea, cabbage, genomics of tomato, chilli and potato (solonomics)

Practical

Establishment of axenic explants, callus initiation and multiplication, production of suspension culture, cell and protoplast culture, fusion, regeneration and identification of somatic hybrids and cybrids; Identification of embryonic and non-embryonic calli, development of cell lines; *in vitro* mutant selection for biotic and abiotic stresses, *In vitro* production and characterization of secondary metabolites, isolated microspore culture, isolation and amplification of DNA, gene transfer methods, molecular characterization of transgenic plants.

Suggested Readings

Bajaj YPS. (Ed.). 1987. *Biotechnology in Agriculture and Forestry*. Vol.XIX. *Hitech and Micropropagation*. Springer. Chadha KL, Ravindran PN & Sahijram L. (Eds.). 2000. *Biotechnology of Horticulture and Plantation Crops*. Malhotra Publ. House.

Debnath M. 2005. *Tools and Techniques of Biotechnology*. Pointer Publ. Glover MD. 1984. *Gene Cloning: The Mechanics of DNA Manipulation*. Chapman & Hall.

Gorden H & Rubsell S. 1960. *Hormones and Cell Culture*. AB Book Publ. Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene Transfer*. Orient & Longman (Universal Press). Keshavachandran R et al. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. New India Publ. Agency. Panopoulos NJ. (Ed.). 1981. *Genetic Engineering in Plant Sciences*. Praeger Publ. Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash. Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ. Prasad S. 1999. *Impact of Plant Biotechnology on Horticulture*. 2nd Ed. Agro Botanica. Sharma R. 2000. *Plant Tissue Culture*. Campus Books. Singh BD. 2001. *Biotechnology*. Kalyani. Skoog Y & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Cultured in vitro*. Attidel. II Symp. On Biotechnology Action of Growth Substance. Vasil TK, Vasi M, While DNR & Bery HR. 1979. *Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture*. Planum Press. Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V.

**VSC 605 SEED CERTIFICATION, PROCESSING AND STORAGE 2+1
OF VEGETABLE CROPS**

Objective

To educate the recent trends in the certification, processing and storage of vegetable crops.

Theory

UNIT I

Seed certification, objectives, organization of seed certification, Indian minimum seed certification standards of vegetable crops, field inspection, specification for certification. CVRC – SVRC - farmers' rights, seed law enforcement, seed act and seed policy.

UNIT II

Seed processing, study of seed processing equipments seed cleaning and upgrading, Seed packing and handling, equipment used for packaging of seeds, procedures for allocating lot number.

UNIT III

Pre-conditioning, seed treatment, benefits, types and products, general principles of seed storage, advances in methods of storage, quality control in storage, storage containers, seed longevity and deterioration, sanitation, temperature and relative humidity control.

UNIT IV

Seed testing; ISTA rules for testing, moisture, purity germination, vigor test, seed sampling, determination of genuineness of varieties, seed viability, seed health testing; seed dormancy and types of dormancy, factors responsible for dormancy.

UNIT V

Seed marketing, demand forecast, marketing organization, economics of seed production;

Practical

Seed sampling, purity, germination testing, moisture testing, seed viability, seed vigor tests, seed health testing, Grow out test, seed cleaning, grading and packaging; handling of seed testing equipment and processing machines; seed treatment methods, seed priming and pelleting; field and seed inspection, practices in rouging, seed storage, isolation distances, biochemical tests, visit to seed testing laboratories and processing plants, mixing and dividing instruments, visit to seed processing unit and warehouse visit and sanitation standards.

Suggested Readings

- Agrawal PK & Dadlani M. 1992. *Techniques in Seed Science and Technology*. South Asian Publ.
- Singh N, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distr. Co.
- Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.
- Tanwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, GOI, New Delhi.
- Rajan S & Baby L Markose 2007. *Propagation of Horticultural Crops*. New India Publ. Agency.

Objective

To update knowledge on the recent research trends in the field of breeding of vegetable crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

UNIT I

Environmental stress and its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stress; root stock, use of wild species, use of antitranspirants.

UNIT II

Mechanism and measurements of tolerance to drought, water logging, soil salinity, frost and heat stress in vegetable crops.

UNIT III

Soil-plant-water relations under different stress conditions in vegetable crops production and their management practices.

UNIT IV

Techniques of vegetable growing under water deficit, water logging, salinity and sodicity.

UNIT V

Techniques of vegetable growing under high and low temperature conditions, use of chemicals in alleviation of different stresses.

Practical

Identification of susceptibility and tolerance symptoms to various types of stress in vegetable crops, measurement of tolerance to various stresses in vegetable crops, short term experiments on growing vegetable under water deficit, water-logging, salinity and sodicity, high and low temperature conditions, and use of chemicals for alleviation of different stresses.

Suggested Readings

- Dwivedi P & Dwivedi RS. 2005. *Physiology of Abiotic stress in Plants*. Agrobios.
Lerner HR (Ed.). 1999. *Plant Responses to Environmental Stresses*. Marcel Decker.
Maloo SR. 2003. *Abiotic Stresses and Crop Productivity*. Agrotech Publ. Academy.

VEGETABLE SCIENCE

List of Journals

- ✓ American Journal of Horticultural Sciences
- ✓ American Potato Growers
- ✓ American Scientist
- ✓ Annals of Agricultural Research
- ✓ Annual Review of Plant Physiology
- ✓ California Agriculture
- ✓ Haryana Journal of Horticultural Sciences
- ✓ HAU Journal of Research
- ✓ Horticulture Research
- ✓ HortScience
- ✓ IIVR Bulletins
- ✓ Indian Horticulture
- ✓ Indian Journal of Agricultural Sciences
- ✓ Indian Journal of Horticulture
- ✓ Indian Journal of Plant Physiology
- ✓ Journal of American Society for Horticultural Sciences
- ✓ Journal of Arecanut and Spice Crop
- ✓ Journal of Food Science and Technology
- ✓ Journal of Plant Physiology
- ✓ Journal of Post-harvest Biology and Technology
- ✓ Post-harvest Biology and Technology
- ✓ Scientia Horticulturae
- ✓ Seed Research
- ✓ Seed Science
- ✓ South Indian Horticulture
- ✓ Vegetable Grower
- ✓ Vegetable Science
- ✓

Suggested Broad Topics for Master's and Doctoral Research

- ✓ Organic farming in vegetable crops
- ✓ Application of molecular markers in genetic improvement of
 - vegetable crops
- ✓ Development of transgenic vegetables
- ✓ Growing vegetables under protected conditions
- ✓ Mulching in vegetable crops
- ✓ Micronutrients in vegetable crops
- ✓ Screening of vegetable s against abiotic stress
- ✓ Hi-tech methods for raising nursery of vegetable crops
- ✓ Dry land and coastal farming

- ✓ Drip/micro irrigation in vegetable crops
- ✓ Fertigation in vegetable crops
- ✓ Research on physiological disorders in vegetable crops
- ✓ Breeding for quality improvement
- ✓ Breeding for insect-pest and disease resistance
- ✓ Breeding for extending shelf life of vegetable crops
- ✓ Minimal processing of vegetables
- ✓ Concept of quality control in vegetable seed production
- ✓ Integrated nutrients management in vegetable crops
- ✓ Breeding for industrial and processing of vegetable crops
- ✓ Research on water management in vegetable crops
- ✓ Research on home storage of vegetable crops
- ✓ Hi-tech home gardening

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FLORICULTURE AND LANDSCAPE ARCHITECTURE

Course Contents

FLA 501 BREEDING OF FLOWER CROPS AND ORNAMENTAL PLANTS 2+1

Objective

To impart comprehensive knowledge about the principles and practices of breeding of flower crops and ornamental plants.

Theory

UNIT I

Principles -- Evolution of varieties, origin, distribution, genetic resources, genetic divergence- Patents and Plant Variety Protection in India.

UNIT II

Genetic inheritance -- of flower colour, doubleness, flower size, fragrance, post harvest life.

UNIT III

Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants-- introduction, selection, domestication, polyploid and mutation breeding for varietal development, Role of heterosis, Production of hybrids, Male sterility, incompatibility problems, seed production of flower crops.

UNIT IV

Breeding constraints and achievements made in commercial flowers - rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, dahlia, gerbera, gladioli, orchids, anthurium, aster, heliconia, liliiums, nerium.

UNIT V

Breeding constraints and achievements made in ornamental plants – petunia, hibiscus, bougainvillea, Flowering annuals (zinnia, cosmos, dianthus, snap dragon, pansy) and ornamental foliages– Introduction and selection of plants for waterscaping and xeriscaping.

Practical

Description of botanical features– Cataloguing of cultivars, varieties and species in flowers, floral biology, selfing and crossing, evaluation of hybrid progenies, seed production- Induction of mutants through physical and chemical mutagens, induction of polyploidy, screening of plants for biotic, abiotic stresses in flower crops and ornamental plants.

Suggested Readings

- Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
- Bose TK & Yadav LP. 1989. *Commercial Flowers*. Naya Prokash. Chadha KL & Choudhury B.1992. *Ornamental Horticulture in India*.
- ICAR. Chadha KL. 1995. *Advances in Horticulture*. Vol. XII. Malhotra Publ. House.
- Chaudhary RC. 1993. *Introduction to Plant Breeding*. Oxford & IBH. Singh BD. 1990. *Plant Breeding*. Kalyani.

Objective

To impart basic knowledge about the importance and production technology of cut flowers grown in India.

Theory

UNIT I

Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India- Patent rights, nursery management, media for nursery, special nursery practices.

UNIT II

Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO₂ on growth and flowering.

UNIT III

Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.

UNIT IV

Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

UNIT V

Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.

Crops:

Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliams, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers.

Practical

Botanical description of varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, cold chain, project preparation for regionally important cut flowers, visit to commercial cut flower units and case study.

Suggested Readings

- Arora JS. 2006. *Introductory Ornamental horticulture*. Kalyani.
- Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
- Bose TK & Yadav LP. 1989. *Commercial Flowers*. Naya Prokash.
- Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping*. Naya Prokash.
- Chadha KL & Chaudhury B. 1992. *Ornamental Horticulture in India*. ICAR.
- Chadha KL. 1995. *Advances in Horticulture*. Vol. XII. Malhotra Publ.
- House. Lauria A & Ries VH. 2001. *Floriculture – Fundamentals and Practices*. Agrobios.
- Prasad S & Kumar U. 2003. *Commercial Floriculture*. Agrobios. Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
- Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture*. Indian Society of Ornamental Horticulture, New Delhi.

Objective

To impart basic knowledge about the importance and management of loose flowers grown in India.

Theory

UNIT I

Scope of loose flower trade, Significance in the domestic market/export, Varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers, nursery management, pro-tray nursery under shadenets, transplanting techniques

UNIT II

Soil and climate requirements, field preparation, systems of planting, precision farming techniques.

UNIT III

Water and nutrient management, weed management, rationing, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM.

UNIT IV

Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation.

UNIT V

Harvest indices, harvesting techniques, post-harvest handling and grading, pre-cooling, packing and storage, value addition, concrete and essential oil extraction, transportation and marketing, export potential, institutional support, Agri Export Zones.

Crops:

Jasmine, scented rose, chrysanthemum, marigold, tuberose, crossandra, nerium, hibiscus, barleria, celosia, gomphrena, non-traditional flowers (Nyctanthes, Tabernaemontana, ixora, lotus, lilies, tecoma, champaka, pandanus).

Practical

Botanical description of species and varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, storage and cold chain, project preparation for regionally important commercial loose flowers, visits to fields, essential oil extraction units and markets.

Suggested Readings

Arora JS. 2006. *Introductory Ornamental Horticulture*. Kalyani. Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers*. Naya Prokash.

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping*. Naya Prokash.

Chadha KL & Chaudhury B. 1992. *Ornamental Horticulture in India*. ICAR.

- Chadha KL. 1995. *Advances in Horticulture*. Vol. XII. Malhotra Publ. House.
- Lauria A & Ries VH. 2001. *Floriculture – Fundamentals and Practices*. Agrobios.
- Prasad S & Kumar U. 2003. *Commercial Floriculture*. Agrobios.
- Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ. Sheela VL. 2007. *Flowers in Trade*. New India Publ. Agency.
- Valsalakumari PK, Rajeevan PK, Sudhadevi PK & Geetha CK. 2008. *Flowering Trees*. New India Publ. Agency.

Objective

Familiarization with principles and practices of landscaping and ornamental gardening.

Theory

UNIT I

Landscape designs, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams, Buddha garden; Styles of garden, formal, informal and free style gardens.

UNIT II

Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates.

UNIT III

Garden plant components, arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, bamboo groves; Production technology for selected ornamental plants.

UNIT IV

Lawns, Establishment and maintenance, special types of gardens, vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, colour wheels, temple garden, sacred groves.

UNIT V

Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping.

Practical

Selection of ornamental plants, practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates, avenue planting, practices in planning and planting of special types of gardens, burlapping, lawn making, planting herbaceous and shrubbery borders, project preparation on landscaping for different situations, visit to parks and botanical gardens, case study on commercial landscape gardens.

Suggested Readings

- Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping*. Naya Prokash. Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios. Nambisan KMP. 1992. *Design Elements of Landscape Gardening*. Oxford & IBH. Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ. Sabina GT & Peter KV. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency.
- Valsalakumari et al. 2008. *Flowering Trees*. New India Publ. Agency.
- Woodrow MG. 1999. *Gardening in India*. Biotech Books.

Objective

Understanding the principles, theoretical aspects and developing skills in protected cultivation of flower crops.

Theory

UNIT I

Prospects of protected floriculture in India; Types of protected structures – Greenhouses, polyhouses, shade houses, rain shelters etc., Designing and erection of protected structures; Low cost/Medium cost/High cost structures – economics of cultivation; Location specific designs; Structural components; Suitable flower crops for protected cultivation.

UNIT II

Environment control – management and manipulation of temperature, light, humidity, air and CO₂; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation.

UNIT III

Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and IDM.

UNIT IV

Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation.

UNIT V

Harvest indices, harvesting techniques, post-harvest handling techniques, Precooling, sorting, grading, packing, storage, quality standards.

Practical

Study of various protected structures, practices in design, layout and erection of different types of structures, practices in preparatory operations, soil decontamination techniques, practices in environmental control systems, practices in drip and fertigation techniques, special horticultural practices, determination of harvest indices and harvesting methods, post harvest handling, packing methods, project preparation, visit to commercial greenhouses.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. *Commercial Flowers*. Naya Prokash.

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping*. Naya Prokash.

Chadha KL. 1995. *Advances in Horticulture*. Vol. XII. Malhotra Publ. House. Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.

Nelson PV. 1978. *Green House Operation and Management*. Reston Publ. Co. Prasad S & Kumar U. 2003. *Commercial Floriculture*. Agrobios. Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied

Publ. Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture*. Indian Society of Ornamental Horticulture, New Delhi.

Objective

To develop understanding of the scope and ways of value addition in flowers.

Theory

UNIT I

Prospects of value addition, National and global scenario, production and exports, Women empowerment through value added products making, supply chain management.

UNIT II

Types of value added products, value addition in loose flowers, garlands, veni, floats, floral decorations, value addition in cut flowers, flower arrangement, styles, Ikebana, morebana, free style, bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands, etc.; Selection of containers and accessories for floral products and decorations.

UNIT III

Dry flowers– Identification and selection of flowers and plant parts; Raw material procurement, preservation and storage; Techniques in dry flower making – Drying, bleaching, dyeing, embedding, pressing; Accessories; Designing and arrangement – dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths; Packing and storage.

UNIT IV

Concrete and essential oils; Selection of species and varieties (including non-conventional species), extraction methods, Packing and storage, Selection of species and varieties, Types of pigments, carotenoids, anthocyanin, chlorophyll, betalains; Significance of natural pigments, Extraction methods; Applications.

Practical

Practices in preparation of bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands with fresh flowers; Techniques in flower arrangement; Techniques in floral decoration; Identification of plants for dry flower making; Practices in dry flower making; Preparation of dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths, etc.; Visit to dry flower units, concrete and essential oil extraction units.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ. Chadha KL.1995. *Advances in Horticulture*. Vol.XII. Malhotra Publ. House.

Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.

Prasad S & Kumar U. 2003. *Commercial Floriculture*. Agrobios.

Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture*. Indian Society of Ornamental Horticulture, New Delhi

Objective

To develop understanding of the principles and management of turfing

Theory

UNIT I

Prospects of landscape industry; History of landscape gardening, site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment.

UNIT II

Turf grasses - Types, species, varieties, hybrids; Selection of grasses for different locations; Grouping according to climatic requirement- Adaptation; Turfing for roof gardens.

UNIT III

Preparatory operations; Growing media used for turf grasses – Turf establishment methods, seeding, sprigging/dibbling, plugging, sodding/turfing, turf plastering, hydro-seeding, astro-turfing.

UNIT IV

Turf management – Irrigation, nutrition, special practices, aerating, rolling, soil top dressing, use of turf growth regulators (TGRs) and micronutrients, Turf mowing -- mowing equipments, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs.

UNIT V

Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, tennis, rugby, etc.

Practical

Identification of turf grasses, Preparatory operations in turf making, Practices in turf establishment, Layout of macro and micro irrigation systems, Water and nutrient management; Special practices – mowing, raking, rolling, soil top dressing, weed management; Biotic and abiotic stress management; Project preparation for turf establishment, visit to IT parks, model cricket and golf grounds, airports, corporates, Govt. organizations; Renovation of lawns; Turf economics.

Suggested Readings

Nick-Christians 2004. *Fundamentals of Turfgrass Management*. www.amazon.com

Objective

To impart basic knowledge about the operation of Computer Aided Designing (CAD) in landscape garden designing.

Theory

UNIT I

Exposure to CAD (Computer Aided Designing) – Applications of CAD in landscape garden designing, 2D drawing by AUTOCAD, 3D drawing by ARCHICAD, 3D drawing by 3D MAX software, Creating legends for plant and non-plant components, Basics of Photoshop software in garden designing.

UNIT II

2D drawing methods, AUTOCAD Basics, Coordinate systems in AUTOCAD LT 2007, Point picking methods, Toolbars and Icons, File handling functions, Modifying tools, Modifying comments, Isometric drawings, Drafting objects.

UNIT III

Using patterns in AUTOCAD drawing, Dimension concepts, Hyperlinking, Script making, Using productivity tools, e-transmit file, making sample drawing for outdoor and indoor garden by AUTOCAD 2D Drawing techniques, Drawing web format design, Making layout.

UNIT IV

3D drawing methods, ARCHICAD file system, Tools and Infobox, modification tools, structural elements, GDL objects (Grid Dimensional Linking), Creation of garden components through ARCHICAD.

UNIT V

ARCHICAD organization tools, Dimensioning and detailing of designs, Attribute settings of components, Visualization tools for landscape preview, Data management, plotting and accessories for designing, Inserting picture using photoshop, Making sample drawing for outdoor and indoor gardens.

Practical

Practices in point picking methods, Using tool bars and icons, Using modifying tools and modifying comments, Isometric drawings, Using productivity tools, Drawing designs by AUTOCAD for home garden, institutional garden and special types of garden, Using tools and info-box for 3D drawing, Creation of garden components with ARCHICAD, Organization, dimensioning, detailing and visualization tools with ARCHICAD, Using Photoshop package for 3D picture insertion, Drawing designs with ARCHICAD for home garden, interior garden designing, IT parks, Corporates, Theme parks and Ecotourism spots

Suggested Readings

Christine Wein-Ping Yu 1987. *Computer-aided Design: Application to Conceptual Thinking in Landscape Architecture*. amazon.com

Objective

To update knowledge on the recent research trends in the field of breeding of flower crops with special emphasis on crops grown in India.

Theory

UNIT I

Origin and evolution of varieties, distribution, Genetic resources, genetic divergence, Plant introduction, selection and domestication, Inheritance of important characters, Genetic mechanisms associated with flower colour and flower size, doubleness, fragrance and post-harvest life, farmers rights and Plant Variety Protection Act.

UNIT II

Specific objectives of breeding in flower crops, Methods of breeding suited to seed and vegetatively propagated flower crops, Introduction, selection, polyploidy and mutation breeding in the evolution of new varieties, Exploitation of heterosis, utilization of male sterility-Incompatibility problems, *In Vtro* breeding - achievements.

UNIT III

Breeding for resistance to pests, diseases, nematodes and other biotic and abiotic stresses in flower crops.

UNIT IV

Specific breeding problems and achievements made in rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, gerbera, gladioli, orchids and anthurium.

UNIT V

Specific breeding problems and achievements made in aster, petunia, liliams, heliconia, bird of paradise, hibiscus and bougainvillea.

Practical

Description of crops and cultivars; Cataloguing of species and cultivars, floral biology, selfing and crossing, evaluation of hybrid progenies; Induction of mutants; Physical and chemical mutagens; Induction of polyploidy; Screening of plants for biotic and abiotic stresses in flower crops.

Suggested Readings

Arora JS. 2006. *Introductory Ornamental Horticulture*. Kalyani. Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ. Choudhary RC.1993. *Introduction to Plant Breeding*. Oxford & IBH. Singh BD.1990. *Plant Breeding*. Kalyani.

Objective

To keep abreast with latest developments and trends in production technology of flower crops.

Theory

UNIT I

Commercial flower production; Scope and importance; Global Scenario in cut flower production and trade, varietal wealth and diversity; Soil and Environment; Special characteristics and requirements; cut flower, loose flowers, dry flowers and floral oil trade.

UNIT II

Propagation and multiplication; IPR issues related to propagation of materials; Greenhouse management; Soil/media decontamination techniques; Microirrigation; nutrition and fertigation; slow release fertilizers and biofertilizers; influence of environmental parameters, light, temperature, moisture, humidity and CO₂ on growth and flowering; regulation for quality flowers.

UNIT III

Flower forcing and year-round flowering through physiological interventions; Chemical regulation; Environmental manipulation; Harvest indices; Harvesting techniques; Post-harvest handling; Precooling, pulsing, packing, marketing; Export potential; Agri Export Zones.

UNIT IV

Crop specific practices – rose, anthurium, orchids, carnation, gladioli, gerbera, liliums, heliconia, bird of paradise, *Jasminum* sp., marigold, tuberose, crossandra.

UNIT V

Floral oil industry, floral concrete production, extraction methods, recent advances.

Practical

Varietal wealth in flower crops; Greenhouse management; Soil decontamination techniques; Microirrigation; Nutrition and fertigation. Special practices- Pinching, netting, disbudding, defoliation and chemical pruning; Photoperiodic and chemical induction of flowering; Assessing harvest indices; Post-harvest handling; Tissue analysis; Preparation of floral decoratives; Extraction of floral concrete and oils; case studies; visit to commercial cut flower units.

Suggested Readings

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping*. Naya Prokash. Chadha KL & Choudhury B. 1992. *Ornamental Horticulture in India*. ICAR.

George S & Peter KV. 2008. *Plants in a Garden*. New India Publ. Agency.

Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices*. Agrobios. Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Reddy S, Janakiram B, Balaji T, Kulkarni. S & Misra RL. 2007. *Hightech Floriculture*. Indian Society of Ornamental Horticulture, New Delhi.

Objective

Appraisal on advances in protected and precision farming of flower crops.

Theory

UNIT I

Prospects of protected floriculture in India, growing structures, basic considerations in establishment and operation of green houses, functioning and maintenance.

UNIT II

Environmental control systems in greenhouse, containers, substrate culture, soil decontamination techniques.

UNIT III

Water and nutrient management, crop regulation, special horticultural practices under protected cultivation of rose, chrysanthemum, carnation, orchids, anthurium, gerbera, liliiums, cut foliage; Harvest indices – harvesting, PH handling, marketing, export.

UNIT IV

Precision floriculture, Principles and concepts, Enabling technologies of precision farming, GPS, GIS, Remote sensing, sensors.

UNIT V

Variability management in precision farming, mapping, variable rate technology, precision equipments, computers and robotics in precision farming, post-harvest process management in floriculture using precision farming.

Practical

Growing structures, basic considerations in establishment and operation of greenhouses, Environmental control systems in greenhouse, containers, substrate culture, soil decontamination techniques, Crop regulation, special horticultural practices under protected cultivation, precision equipments, computers and robotics in precision farming, post-harvest process management in floriculture using precision farming.

Suggested Readings

Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping*. Naya Prokash.

Reddy S, Janakiram B, Balaji T, Kulkarni S, & Misra RL. 2007. *Hightech Floriculture*. Indian Society of Ornamental Horticulture, New Delhi.

Objective

To update knowledge on the recent trends in the field of landscape architecture and developing practical skills.

Theory

UNIT I

Commercial landscape gardening- History, Plant identification and ecology, Materials of garden design, Design making by different garden styles and types.

UNIT II

Expenses to model landscaping units of all category, Creativity and communication skills for landscape architect, Way of designing a commercial landscape project.

UNIT III

Assessing site and plants adaptability for different locations, Landscape engineering (Topographical) survey and designing concept), special techniques in garden landscaping (Burlaping, waterscaping, hardscaping, lawn making, topiary styles specializing, bioaesthetic planning).

UNIT IV

Preparation and drawing of site plan, Learning the basics in computer aided design (CAD) for developing a garden landscape plan, Handling soft landscape materials (AUTOCAD & ARCHICAD), GIS as a tool for spatial designing.

UNIT V

Contemporary landscaping, Environmental landscaping, Industrial and institutional landscaping, Public and private garden making, play ground landscaping, Case study with the successful landscapist, Budget / Project cost estimating, Execution strategies, Assessing a successful design in site.

Practical

Commercial landscaping, Plant identification, Materials of garden design, Design making by different garden styles and types. Way of designing a commercial landscape project, visit to model ornamental nursery. Assessing site and plants adaptability for different locations, Landscape engineering (Topographical survey and designing concept), special techniques in garden landscaping (Burlaping, waterscaping, hardscaping, lawn making, topiary styles specializing, bioaesthetic planning). Preparation and drawing of site plan, Learning the basics in computer aided design (CAD) for developing a garden landscape plan, Handling soft landscape materials (AUTOCAD & ARCHICAD), GIS as a tool for spatial designing. Contemporary landscaping, Environmental landscaping, Industrial and institutional landscaping, Public and private garden making, play ground landscaping, Case study with the successful landscapist, Budget/Project cost estimating, Execution.

Suggested Readings

Bose TK, Maiti RG, Dhua RS & Das, P. 1999. *Floriculture and Landscaping*. Naya Prokash.
Nambisan KMP. 1992. *Design Elements of Landscape Gardening*. Oxford & IBH.

FLA 605 ADVANCES IN BIOCHEMISTRY AND BIOTECHNOLOGY 2+1 OF FLOWERS

Objective

Appraisal on the advances in biochemistry of flowers and application of biotechnology in flower crops.

Theory

UNIT I

Biochemistry of flowers: Principle involved in the formation of pigments – chlorophyll, xanthophyll, carotenoids, flavonoids and anthocyanins. Chemistry and importance of secondary metabolites in rose, jasmine, marigold, tuberose, carnation, orchids, liliams and bougainvillea. Biochemistry and utilization commercial products (select items).

UNIT II

Recent trends- Extraction of biocolours and their value addition, uses in food and textile industries. Biochemistry of post harvest management of cut flowers.

UNIT III

Biotechnology – tools, techniques and role in floriculture industry, physical factors and chemical factors influencing the growth and development of plant cell, tissue and organs, cytodifferentiation, organogenesis, somatic embryogenesis.

UNIT IV

In vitro techniques for biotic and abiotic stress – Meristem culture for disease elimination, production of haploids through anther and pollen culture – embryo and ovule culture, micrografting, wide hybridization and embryo rescue techniques, construction of somatic hybrids and cybrids, regeneration and characterization of hybrids and cybrids, *in vitro* pollination and fertilization, hardening, techniques and establishment of tissue culture plants in the primary and secondary nursery.

UNIT V

Somoclonal variation and its applications – variability induction through *in vitro* mutation, development of cell suspension cultures, types and techniques, *in vitro* production of secondary metabolites, role of bioreactors in production of secondary metabolites, quantification and quality analysis of secondary metabolites using HPLC, *in vitro* conservation and cryo-preservation techniques.

UNIT VI

Gene cloning, genetic engineering: vectors and methods of transformation – electroporation, particle bombardment, *Agrobacterium* mediated, transgenic plants in flower crops isolation of DNA, RNA, quantification, Polymerase Chain Reaction for amplification; AGE & PAGE techniques; identification of molecular markers.

UNIT VII

Construction of c- DNA library, DNA fingerprinting technique in economic flower crop varieties, molecular approaches to control ethylene response, improving shelf life, improving resistance for biotic and abiotic stress, approaches to improve flower development, pigment production, secondary metabolite production, post harvest biotechnology of flowers, ornamental plants, achievements of bio-technology in flower crops.

Practical

Extraction of flower pigments – xanthophylls, carotenoids and anthocyanins. Plant nutrient stock- growth regulators- media preparation and sterilization- *In vitro* seed germination- callus culture and organ culture- Cell suspension culture – cell plating and regeneration- clonal propagation through Meristem culture, induction of multiple shoots- Anther- Pollen- Ovule and Embryo culture- Synthetic seed production, *in vitro* mutation induction, *in vitro* rooting – hardening at primary and secondary nurseries, Project preparation for establishment of low, medium and high cost tissue culture laboratories, DNA isolation from economic flower crop varieties – Quantification and amplification, DNA and Protein profiling – molecular markers for economic flower crops, restriction enzymes, vectors for cloning and particle bombardment, DNA fingerprinting of flower crop varieties .

Suggested Readings

Chopra VL & Nasim. 1990. *Genetic Engineering and Biotechnology – Concepts, Methods and Applications*. Oxford & IBH.

Debnath M. 2005. *Tools and Techniques of Biotechnology*. Pointer Publ. Dey PM & Harborne JB. 1997. *Plant Biochemistry*. 2nd Ed. Academic Press.

Glover MD. 1984. *Gene Cloning: The Mechanics of DNA Manipulation*. Chapman & Hall. Goodwin TW & Mercer EI. 2003. *Introduction to Plant Biochemistry*. CBS. Gordon H & Rubsell S. 1960. *Hormones and Cell Culture*. AB Book Publ. Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Methods in Tissue Culture and Gene Transfer*. Orient & Longman (Universal Press).

Keshavachandran R, Nazeem PA, Girija D, John PS & Peter KV. (Eds.). 2007. *Recent Trends in Horticultural Biotechnology*. Vols. I, II. New India Publishing Agency.

Panopoulos NJ. (Ed.). 1981. *Genetic Engineering in Plant Sciences*. Praeger Publ. Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. NayaProkash.

Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ. Prasad S. 1999. *Impact of Plant Biotechnology on Horticulture*. 2nd Ed. Agro Botanica. Sharma R. 2000. *Plant Tissue Culture*. Campus Books International. Singh BD. 2001. *Biotechnology*. Kalyani.

Skoog Y & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Culture in vitro*. Symp. Soc. Exp. Biol. 11: 118-131.

Vasil TK, Vasi M, While DNR & Bery HR. 1979. *Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture*. Planum Press.

Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V. www.amazon.com

FLORICULTURE AND LANDSCAPE ARCHITECTURE

List of List of Journals & Magazines

- ✓ Acta Horticulture
- ✓ Floriculture Today
- ✓ Haryana Journal of Horticulture Science
- ✓ Horticulture Reviews
- ✓ HortScience
- ✓ Indian Horticulture
- ✓ Indian Journal of Arid Horticulture
- ✓ Indian Journal of Horticulture
- ✓ Journal of American Society of Horticultural Sciences
- ✓ Journal of Applied Horticulture
- ✓ Journal of Horticultural Sciences
- ✓ Journal of Horticultural Sciences & Biotechnology
- ✓ Journal of Japanese Society for Horticulture Science
- ✓ Journal of Korean Society for Horticulture Science
- ✓ Journal of Landscape architecture
- ✓ Journal of Ornamental Horticulture
- ✓ Scientia Horticulture

Suggested Broad Topics for Master's and Doctoral Research

- ✓ Micro-propagation of major flower crops
- ✓ Application of genetic engineering in flower crops
- ✓ Use of molecular markers in flower crops
- ✓ Flower crops improvement
- ✓ Crop selection for biotic and abiotic stresses
- ✓ Diagnostic and recommended integrated system in floriculture
- ✓ Precision farming in floriculture
- ✓ Protected cultivation of flower crops
- ✓ Post-harvest management of flower crops
- ✓ Nutritional and water requirements of flower crops

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PLANTATION, SPICES, MEDICINAL & AROMATIC CROPS

Course Contents

PSMA 501 PRODUCTION TECHNOLOGY OF PLANTATION CROPS 2+1

Objective

To impart basic knowledge about the importance and production technology of plantation crops grown in India.

Theory

Role of plantation crops in national economy, export potential, IPR issues, clean development mechanism, classification and varietal wealth. Plant multiplication including *in vitro* multiplication, systems of cultivation, multitier cropping, photosynthetic efficiencies of crops at different tiers, rainfall, humidity, temperature, light and soil pH on crop growth and productivity, high density planting, nutritional requirements, physiological disorders, role of growth regulators and macro and micro nutrients, water requirements, fertigation, moisture conservation, shade regulation, weed management, training and pruning, crop regulation, maturity indices, harvesting. Cost benefit analysis, organic farming, management of drought, precision farming.

Crops

UNIT I	:	Coffee and tea
UNIT II	:	Cashew and cocoa
UNIT III	:	Rubber, palmyrah and oil palm
UNIT IV	:	Coconut and arecanut
UNIT V	:	Wattlenut, date palm and betel vine

Practical

Description of botanical and varietal features, selection of mother palms and seedlings in coconut and arecanut, soil test crop response studies and manuring practices, pruning and training, maturity standards, harvesting, Project preparation for establishing plantations, Visit to plantations.

Suggested Readings

- Anonymous, 1985. *Rubber and its Cultivation*. The Rubber Board of India. Chopra VL & Peter KV. 2005. *Handbook of Industrial Crops*. Panima. Harler CR. 1963. *The Culture and Marketing of Tea*. Oxford Univ. Press. Kurian A & Peter KV. 2007. *Commercial Crops Technology*. New India Publ. Agency.
- Nair MK, Bhaskara Rao EVV, Nambiar KKN & Nambiar MC. 1979. *Cashew*. CPCRI, Kasaragod.
- Peter KV. 2002. *Plantation Crops*. National Book Trust. Pradeep Kumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008.
- Management of Horticultural Crops*. Part I, II. New India Publ. Agency. Rai PS & Vidyachandram B. 1981. *Review of Work Done on Cashew*. UAS, Research Series No.6, Bangalore.
- Ranganathan V. 1979. *Hand Book of Tea Cultivation*. UPASI, Tea Res. Stn. Cinchona.
- Srivastava HC, Vatsaya B & Menon KKG. 1986. *Plantation Crops – Opportunities and Constraints*. Oxford & IBH. Thampan PK. 1981. *Hand Book of Coconut Palm*. Oxford & IBH.

Objective

To impart basic knowledge about the importance and production technology of spices grown in India.

Theory

Introduction, importance of spice crops-historical accent, present status - national and international, future prospects, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, site selection, layout, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed planting material and micro-propagation, precision farming, organic resource management, organic certification, quality control, pharmaceutical significance and protected cultivation of:

UNIT I

Black pepper, cardamom

UNIT II

Clove, cinnamon and nutmeg, allspice

UNIT III

Turmeric, ginger and garlic

UNIT IV

Coriander, fenugreek, cumin, fennel, ajowain, dill, celery

UNIT V

Tamarind, garcinia and vanilla

Practical

Identification of seeds and plants, botanical description of plant; preparation of herbarium, propagation, nursery raising, field layout and method of planting, cultural practices, harvesting, drying, storage, packaging and processing, value addition; short term experiments on spice crops

Suggested Readings

Agarwal S, Sastry EVD & Sharma RK. 2001. *Seed Spices: Production, Quality, Export*.

Pointer Publ. Arya PS. 2003. *Spice Crops of India*. Kalyani.

Bhattacharjee SK. 2000. *Hand Book of Aromatic Plants*. Pointer Publ. Bose TK, Mitra SK,

Farooqi SK & Sadhu MK (Eds.). 1999. *Tropical Horticulture*. Vol.I. Naya Prokash.

Chadha KL & Rethinam P. (Eds.). 1993. *Advances in Horticulture*. Vols. IX-X. *Plantation Crops and Spices*. Malhotra Publ. House.

Gupta S. (Ed.). *Hand Book of Spices and Packaging with Formulae*. Engineers India Research Institute, New Delhi.

- Kumar NA, Khader P, Rangaswami & Irulappan I. 2000. *Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants*. Oxford & IBH. Nybe EV, Miniraj N & Peter KV. 2007. *Spices*. New India Publ. Agency.
- Parthasarthy VA, Kandiannan V & Srinivasan V. 2008. *Organic Spices*. New India Publ. Agency.
- Peter KV. 2001. *Hand Book of Herbs and Spices*. Vols. I-III. Woodhead Publ. Co. UK and CRC USA
- Pruthi JS. (Ed.). 1998. *Spices and Condiments*. National Book Trust Pruthi JS. 2001. *Minor Spices and Condiments- Crop Management and Post Harvest Technology*. ICAR.
- Purseglove JW, Brown EG, Green CL & Robbins SRJ. (Eds.). 1981. *Spices*. Vols. I, II. Longman.
- Shanmugavelu KG, Kumar N & Peter KV. 2002. *Production Technology of Spices and Plantation Crops*. Agrobios.
- Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*. ICAR.
- Tiwari RS & Agarwal A. 2004. *Production Technology of Spices*. International Book Distr. Co. Varmudy V. 2001. *Marketing of Spices*. Daya Publ. House.

PSMA 503 PRODUCTION TECHNOLOGY FOR MEDICINAL 2+1
AND AROMATIC CROPS

Objective

To impart comprehensive knowledge about the production technology of medicinal and aromatic crops.

Theory

UNIT I

Herbal industry, WTO scenario, Export and import status, Indian system of medicine, Indigenous Traditional Knowledge, IPR issues, Classification of medicinal crops, Systems of cultivation, Organic production, Role of institutions and NGO's in production, GAP in medicinal crop production.

UNIT II

Production technology for Senna, Periwinkle, Coleus, Aswagandha, Glory lily, Sarpagandha, *Dioscorea* sp., *Aloe vera*, *Phyllanthus amarus*, *Andrographis paniculata*.

UNIT III

Production technology for Medicinal solanum, Isabgol, Poppy, Safed musli, *Stevia rebaudiana*, *Mucuna pruriens*, *Ocimum* sp.

UNIT IV

Post harvest handling – Drying, Processing, Grading, Packing and Storage, processing and value addition; GMP and Quality standards in herbal products.

UNIT V

Influence of biotic and abiotic factors on the production of secondary metabolites, Regulations for herbal raw materials, Phytochemical extraction techniques.

UNIT VI

Aromatic industry, WTO scenario, Export and import status, Indian perfumery industry, History, Advancements in perfume industry.

UNIT VII

Production technology for palmarosa, lemongrass, citronella, vetiver, geranium, artemisia, mentha, ocimum, eucalyptus, rosemary, thyme, patchouli, lavender, marjoram, oreganum.

UNIT VIII

Post-harvest handling, Distillation methods, advanced methods, Solvent extraction process, steam distillation, Perfumes from non-traditional plants, Quality analysis, Value addition, Aroma chemicals, quality standards and regulations.

UNIT IX

Institutional support and international promotion of essential oil and perfumery products.

Practical

Botanical description, Propagation techniques, Maturity standards, Digital documentation, Extraction of secondary metabolites, Project preparation for commercially important medicinal crops, Visit to medicinal crop fields, Visit to herbal extraction units. Extraction of Essential oils, Project preparation for commercially important Aromatic crops, Visit to distillation and value addition units – Visit to CIMAP.

Suggested Readings

Atal CK & Kapur BM. 1982. *Cultivation and Utilization of Aromatic Plants*. RRL, CSIR, Jammu.

Atal CK & Kapur BM. 1982. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR, Jammu.

Farooqi AA & Sriram AH. 2000. *Cultivation Practices for Medicinal and Aromatic Crops*. Orient Longman Publ.

Farooqi AA, Khan MM & Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops*. Natural Remedies Pvt. Ltd. Hota D. 2007. *Bio Active Medicinal Plants*. Gene Tech Books.

Jain SK. 2000. *Medicinal Plants*. National Book Trust.

Khan IA & Khanum A. *Role of Bio Technology in Medicinal and Aromatic Plants*. Vol. IX. Vkaaz Publ.

Kurian A & Asha Sankar M. 2007. *Medicinal Plants*. Horticulture Science Series, New India Publ. Agency.

Panda H. 2002. *Medicinal Plants Cultivation and their Uses*. Asia Pacific Business Press.

Prajapati SS, Paero H, Sharma AK & Kumar T. 2006. *A Hand book of Medicinal Plants*. Agro Bios.

Ramawat KG & Merillon JM. 2003. *BioTechnology-Secondary Metabolites*. Oxford & IBH.

Skaria P Baby, Samuel Mathew, Gracy Mathew, Ancy Joseph, Ragina Joseph. 2007. *Aromatic Plants*. New India Publ. Agency.

Objective

To impart comprehensive knowledge about the principles and practices of breeding of plantation crops and spices.

Theory

Species and cultivars, cytogenetics, conservation and evaluation, blossom biology, breeding objectives, approaches for crop improvement, introduction, selection, hybridization, mutation breeding, polyploid breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, molecular aided breeding and biotechnological approaches, marker-assisted selection IPR issues, achievements and future thrusts.

Crops

UNIT I	:	Coffee and tea
UNIT II	:	Cashew and cocoa
UNIT III	:	Rubber, palmyrah and oil palm
UNIT IV	:	Coconut and arecanut
UNIT V	:	Black pepper and cardamom
UNIT VI	:	Ginger and turmeric
UNIT VII	:	Fenugreek, coriander, fennel, celery and ajwain
UNIT VIII	:	Nutmeg, cinnamon, clove and all spice

Practical

Characterization and evaluation of germplasm accessions, survey, collection of germplasm, Blossom biology, studies on pollen behaviour, practices in hybridization, ploidy breeding, mutation breeding, evaluation of biometrical traits and quality traits, screening for biotic and abiotic stresses, haploid culture, protoplast culture and fusion- induction of somaclonal variation and screening the variants. Identification and familiarization of spices; floral biology anthesis; fruit set; selfing and crossing techniques; description of varieties. Salient features of improved varieties and cultivars from public and private sector, bioinformatics, visit to radiotracer laboratory, national institutes for plantation crops and plant genetic resource centers, genetic transformation in plantation crops for resistance to biotic stress/quality improvement etc.

Suggested Readings

Anonymous 1985. *Rubber and its Cultivation*. The Rubber Board of India. Chadha KL & Rethinam P. (Eds.).1993. *Advances in Horticulture*. Vol. IX. *Plantation Crops and Spices*. Part-I. Malhotra Publ. House. Chadha KL, Ravindran PN & Sahijram L. 2000. *Biotechnology in Horticultural and Plantation Crops*. Malhotra Publ. House. Chadha KL. 1998. *Advances in Horticulture*. Vol. IX. *Plantation and Spices Crops*. Malhotra Publishing House, New Delhi. Chopra VL & Peter KV. *Handbook of Industrial Crops*. Haworth Press. Panama International Publishers, New Delhi (Indian Ed.). Damodaran VK, Vilaschandran T & Valsalakumari PK. 1979. *Research on Cashew in India*. KAU, Trichur.

Ferwerden FP & Wit F. (Ed.). 1969. *Outlines of Perennial Crop Breeding in the Tropics*. H. Veenman & Zonen.

Harver AE. 1962. *Modern Coffee Production*. Leonard Hoff.

Raj PS & Vidyachandra B. 1981. *Review of Work Done on Cashew*. UAS Research Series No.6, Bangalore.

Thampan PK 1981. *Hand Book of Coconut Palm*. Oxford & IBH.

Objective

To impart comprehensive knowledge about the principles and practices of breeding of medicinal and aromatic crops.

Theory

UNIT I

crop bio-diversity, conservation of germplasm, IPR issues, Major objectives of breeding of Medicinal and Aromatic Crops, Scope for introduction; cytogenetic background of important Medicinal and Aromatic Crops; Scope for improvement of Medicinal and Aromatic Crops through selection, intra and interspecific hybridization, induced autotetraploidy, mutation breeding and biotechnological approaches. Constraints in breeding of MAP.

UNIT II

Breeding for yield and quality improvement in medicinal plants, Breeding for high herbage yield, essential oil and quality components, secondary metabolites in medicinal and aromatic crops; Genetics of active principles and assay techniques useful in evaluation of breeder's material. Breeding problems in seed and vegetatively propagated medicinal and aromatic crops.

UNIT III

Achievements and prospects in breeding of medicinal crops, viz. *Cassia angustifolia*, *Catharanthus roseus*, *Gloriosa superba*, *Coleus forskohlii*, *Stevia*, *Withania somnifera*, *Papaver somniferum*, *Plantago ovata*, *Dioscorea* sp.

UNIT IV

Prospects and achievements in breeding of medicinal crops, viz. *Chlorophytum* sp, *Rauwolfia serpentina*, *Aloe vera*, *Ocimum* sp, *Phyllanthus amarus*, *Solanum* sp.

UNIT V

Prospects in breeding of aromatic crops viz., *Geranium*, *vettiver*, *Lemon grass*, *Palmarosa*, *citronella*, *Rosemary*, *Patchouli*, *Eucalyptus*, *Artemisia* and *Mint*.

Practical

Description of Botanical features, Cataloguing of cultivars, varieties and species in medicinal and aromatic crops, Floral Biology, Selfing and crossing, Evaluation of hybrid progenies, Induction of economic mutants, High alkaloid and high essential oil mutants, evolution of mutants through physical and chemical mutagens, Introduction of polyploidy, Screening of plants for biotic and abiotic stress, *in-vitro* breeding in medicinal and aromatic crops.

Suggested Readings

Atal CK & Kapur BM. 1982. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR, Jammu.

Chadha KL & Gupta R. 1995. *Advances in Horticulture*. Vol. XI. Malhotra Publ. House.

Farooqi AA, Khan MM & Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops*. Natural Remedies Pvt. Ltd.

Jain SK. 2000. *Medicinal Plants*. National Book Trust.

Julia F & Charters MC. 1997. *Major Medicinal Plants – Botany, Cultures and Uses*. Thomas Publ.

Kurian A & Asha Sankar, M. 2007. *Medicinal Plants*. Horticulture Science Series, New India Publ. Agency.

Prajapati ND, Paero Hit SS, Sharma AK, Kumar T. 2006. *A Hand book of Medicinal Plants*. Agro Bios (India).

Skaria P Babu. 2007. *Aromatic Plants*. New India Publ. Agency.

Thakur RS, Pauri HS & Hussain A. 1989. *Major Medicinal Plants of India*. CSIR.

Objective

To facilitate deeper understanding on principles and practices of post harvest technology of plantation crops, spices, medicinal and aromatic crops.

Theory

UNIT I

Commercial uses of spices and plantation crops. Processing of major spices - cardamom, black pepper, ginger, turmeric, chilli and paprika, vanilla, cinnamon, clove, nutmeg, allspice, coriander, fenugreek, curry leaf. Extraction of oleoresin and essential oils.

UNIT II

Processing of produce from plantation crops, viz. coconut, arecanut, cashewnut, oil palm, palmyrah, date palm, cocoa, tea, coffee, rubber etc.

UNIT III

Processing of medicinal plants– dioscorea, gloriosa, stevia, coleus, ashwagandha, tulsi, isabgol, safed musli, senna, aloe, catharanthus, etc. Different methods of drying and storage. Microbial contamination of stored product. Influence of temperature and time combination on active principles.

UNIT IV

Extraction and analysis of active principles using TLC / HPLC / GC. Distillation, solvent extraction from aromatic plants– davana, mint, rosemary, rose, citronella, lavender, jasmine, geranium etc. Study of aroma compounds and value addition. Nano-processing technology in medicinal and aromatic plants.

Practical

Study of processing of different spices and plantation crops. Study of processing of medicinal plants, their drying and storage. Extraction of active ingredients from different spices and herbs using TLC, HPLC, GC/MS technology. Distillation, solvent extraction from aromatic plants – davana, mint, rosemary, citronella, lavender, jasmine, etc. Identification of different odoriferous factors in essential oil with GLC/GCMS. Physico-chemical and sensory evaluation of oils and oleoresin. Value added products from spices and plantation crops.

Suggested Readings

Chadha KL et al. (Eds.). 1993-95. *Advances in Horticulture*. Vol. IX. *Plantation Crops and Spices*. Malhotra Publishing House, New Delhi. Fellows PJ. 1988. *Food Processing Technology*. Ellis Horwood International. Switzerland.

Fennema OR. 1985. *Food Chemistry*. Marcel Dekker. Kumar N, Abdul Khader ML, Rangaswamy P & Ikrulappan I. 1994. *Spices, Plantation Crops, Medicinal and Aromatic Plants*. Rajalakshmi

Publ. Mandal RC. 1996. *Coconut Production and Processing Technology*. Agro. Bot. Mandal RC. 1997. *Cashew: Production and Processing Technology*. Agro. Bot. Masada Y. 1986. *Analysis of Essential Oil by Gas Chromatograph and Mass Spectrometry*. John Wiley & Sons.

Paine FA. 1987. *Modern Processing, Packaging and Distributions Systems for Food*. AVI Publ.

Peter KV. (Ed.). 2001. *Handbook of Herbs and Spices*. Vols.I-III. Wood Head Publishing Co., UK & CRC, USA.

Sudheer KP & Indira V. 2008. *Post-Harvest Technology of Horticultural Crops*. Horticulture Science Series. New India Publ. Agency.

Thampan PK. 1981. *Handbook of Coconut Palm*. Oxford & IBH.

PSMA 507 ORGANIC SPICE AND PLANTATION CROP PRODUCTION 2+1
TECHNOLOGY

Objective

To educate principles, concepts and production of organic farming in spice and plantation crops.

Theory

UNIT I

Importance, principles, perspective, concept and component of organic production of spice and plantation crops.

UNIT II

Organic production of spice crops and plantation crops, viz. pepper, cardamom, turmeric, ginger, cumin, vanilla, coconut, coffea, cocoa, tea, arecanut.

UNIT III

Managing soil fertility, pests and diseases and weed problems in organic farming system; crop rotation in organic horticulture; processing and quality control for organic foods.

UNIT IV

Methods for enhancing soil fertility, mulching, raising green manure crops. Indigenous methods of compost, Panchagavya, Biodynamics, preparation etc.; Pest and disease management in organic farming; ITK's in organic farming. Role of botanicals and bio-control agents.

UNIT V

GAP and GMP- Certification of organic products; organic production and export - opportunity and challenges

Practical

Method of preparation of compost, vermicomposting, biofertilizers, soil solarization, bio pesticides in horticulture, green manuring, mycorrhizae and organic crop production, waster management, organic soil amendment for root disease, weed management in organic horticulture. Visit to organic fields and marketing centers.

Suggested Readings

- Dahama AK. 2005. *Organic Farming for Sustainable Agriculture*. 2nd Ed. Agrobios.
- Gehlot G. 2005. *Organic Farming: Standards, Accreditation, Certification and Inspection*. Agrobios.
- Palaniappan SP & Annadorai K. 2003. *Organic Farming: Theory and Practice*. Scientific Publ.
- Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. New India Publ. Agency.
- Shivashankar K. 1997. *Food Security in Harmony with Nature*. 3rd IFOAMASIA, Scientific Conference. 1-4 Dec., 1997, UAS, Bangalore.

Objective

To facilitate understanding on the importance, conservation and cultivation of medicinal and aromatic crops.

Theory

UNIT I

Introduction, importance, present status and future prospects, origin, distribution, species, varieties, economic parts and their uses in different diseases, Biodiversity and conservation, RET (Rare, Endangered and Threatened) and MPCAs (Medicinal Plants Conservation Areas).

UNIT II

Underutilized species – importance, traditional usage, ISM, TCM, Functional foods.

UNIT III

Production technology of underutilized medicinal crops– *Morinda citrifolia*, *Caesalpinia sappan*, *Caralluma*, *Terminalia chebula*, *Strychnos nuxvomica*, *Solanum trilobatum*, *Physalis*, *Aegle marmelos*, *Alpinia* sp., *Anthocephalus kadamba*, *Costus*.

UNIT IV

Production technology of underutilized aromatic crops– *Curcuma aromatica*, *C. caesia*, *Coleus aromaticus*, *Ocimum kilimanjaricum*, *Bursera*.

UNIT V

National and international conservation network, IPR issues, Promotion of underutilized species, Processing and value addition, Marketing.

Practical

Case studies.

Suggested Readings

Atal CK & Kapur BM. 1982. Cultivation and Utilization of Aromatic Plants. RRL, CSIR, Jammu.

Atal CK & Kapur BM. 1982. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR, Jammu.

Chadha KL Gupta. R. 1995. *Advance in Horticulture*. Vol. XI. *Medicinal & Aromatic Plants*. Malhotra Publ. House.

CSIR. 1971. *The Wealth of India*. Vols. A-Z. CSIR.

Farooqui AA, Khan MM & Sreeramu BS. 1997. *Cultivation of Medicinal and Aromatic Crops in India*. Naya Prokash.

Guenther E. 1975. *The Essential Oils*. Robert K. Krieger Publ. Co. Jain SK. 1979. *Medicinal Plants*. National Book Trust.

Kurian A & Asha Sankar M. 2007. *Medicinal Plants*. Horticulture Science Series, New India Publ. Agency.

Peter KV. (Ed.). 2007-08. *Underexploited and Underutilized Horticultural Crops*. Vols.I-IV. New India Publ. Agency.

Sivarajan VV & Balachandran I. 1994. *Ayurvedic Drugs and their Plant Sources*. Oxford & IBH.

Objective

To keep abreast with latest developments and trends in production technology of plantation crops.

Theory

Plantation crops – area and production, export potential - varietal wealth and appraisal on the crop improvement in plantation crops. Mass multiplication techniques, High density planting, systems of cultivation, multitier cropping, companion cropping, studies of on canopy and root management, photosynthetic efficiencies of crops at different tiers, Biotic and abiotic factors on growth and productivity, nutritional requirements, role of macro and micro nutrients, Nutrient deficiency symptoms, growth regulators, water requirement, fertigation, soil and moisture conservation practices, Drought management, permanent vegetation management, Basin management, training and pruning, maturity indices, harvesting, curing, processing and value addition, grading, packing and storage, role of commodity boards in plantation crop development, Production of plantation crops through GAP, GMP, HACCP.

Crops

UNIT I	:	Coffee and tea
UNIT II	:	Cashew and cocoa
UNIT III	:	Rubber, palmyrah and oil palm
UNIT IV	:	Coconut and arecanut
UNIT V	:	Wattlenut, date palm and betelvine

Practical

Description of botanical and varietal features-selection of mother palms and elite clones, Clonal fidelity testing, nursery techniques and propagation methods, High density planting, training and pruning practices, fertigation and foliar nutrition, shade regulation, maturity standards, harvesting, curing, processing and grading, project preparation for establishing new plantations, visit to plantation gardens, commodity boards and plantation based industries.

Suggested Readings

- Anonymous 1985. *Rubber and its Cultivation*. The Rubber Board of India. Grimwood BE. 1975. *Coconut Palm Products*. FAO.
- Kurian A & Peter KV. 2007. *Commercial Crops Technology*. New India Publ. Agency.
- Nair MK, Bhaskara Rao EVV, Nambiar KKN & Nambiar MC. 1979. *Cashew*. CPCRI, Kasaragod.
- Patel JS. 1938. *The Coconut – A Monograph*. Govt. Press, Madras. Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2007.
- Management of Horticultural Crops*. Parts I, II. New India Publ. Agency.
- Rai PS & Vidyachandram B. 1981. *Review of Work Done on Cashew*. UAS Research Series No.6, Bangalore.
- Ranganathan V. 1979. *Hand Book of Tea Cultivation*. UPASI, Tea Res.Stn. Cinchona.
- Srivastava HC, Vatsaya B & Menon KKG. 1986. *Plantation Crops – Opportunities and Constraints*. Oxford & IBH.
- Thampan PK. 1981. *Hand Book of Coconut Palm*. Oxford & IBH.

Objective

To educate advances in production technology of spice crops.

Theory

Spices- current status on area and production, state, national and global scenario of spices, global trade, problems encountered in spices productivity, systems of cultivation, varieties, soil and climate, propagation techniques and nursery management, planting systems and methods, cropping pattern, permanent floor management concepts in mulching and weed management, canopy and root studies under different spice-based cropping systems, shade and basin management, INM practices, irrigation and fertigation techniques, chemical regulation of crop productivity, IPM, clean cultivation strategies, harvesting, Post-harvest and quality management for value added spices, quality standards, GAP and GMP for spices production, quality control and certification. Protected cultivation of high value spice crops. Value addition and byproduct utilization. Precision farming and organic farming in spice crops. Commodity Boards in spices development

UNIT I	:	Pepper and cardamom
UNIT II	:	Nutmeg, clove, cinnamon and allspice
UNIT III	:	Turmeric, ginger, garcinia, tamarind and garlic
UNIT IV	:	Coriander, fenugreek, fennel, cumin and vanilla
UNIT V	:	Paprika and important herbal spices

Suggested Readings

- Chadha KL. 2001. *Hand book of Horticulture*. ICAR
- George CK. (Ed.). 1989. *Proceedings of First National Seminar on Seed Spices*. Spices Board, Ministry of Commerce, Govt. of India, Kochi.
- Marsh AC, Moss MK & Murphy EW. 1977. *Composition of Food Spices and Herbs, Raw, Processed and Prepared*. Agric. Res. Serv. Hand Book 8-2. Washinton DC. Parry JW. 1969. *Spices and Condiments*. Pitman.
- Peter KV. 2001. *Hand Book of Herbs and Spices*. Vols. I-III. Woodhead Publ. Co., UK & CRC, USA. Purseglove JW. 1968. *Tropical Crops – Dicotyledons*. Longman.
- Purseglove JW, Brown EG, Green CL & Robbins SRJ. 1984. *Spices*. Vols. I, II. Longman.
- Ridley HM. 1972. *Spices*. Mac Millan.
- Rosengarten F Jr. 1969. *The Book of Spices*. Wynnewood; Livingston Publ. Co. Ravindran PN. 2001. *Monograph on Black Pepper*. CRC Press. Ravindran PN & Madhusoodanan KJ. 2002. *Cardamom, The Genus Elettaria*. Series - *Medicinal and Aromatic Plants - Industrial Profiles*. Routledge, UK. Agarwal S, Divkara Sastry EV & Sharma RK. 2001. *Seed Spices, Production, Quality and Export*. Pointer Publ.
- Shanmugavelu KG, Kumar N & Peter KV. 2002. *Production Technology of Spices and Plantation Crops*. Agrobios.
- Winton AL & Winton KB. 1931. *The Structure and Composition of Food*. John Wiley & Sons.
- Yagna Narayan Ayer AK. 1960. *Cultivation of Cloves in India*. ICAR. Nybe EV, Mini Raj N & Peter KV. 2007. *Spices*. New India Publ. Agency. Varmudy V. 2001. *Marketing of Spices*. Daya Publ. House.

Objective

To keep abreast with latest developments and trends in production technology of medicinal and aromatic crops.

Theory

UNIT I

Genetic biodiversity of medicinal plants, Conservation networks, Global initiatives on medicinal plants conservation and development, World history on usage of medicinal plants, Preference to natural products, Advanced research in biomedicines, Nutraceuticals and natural drugs, American, European and Asian legislations on plant drugs, Intellectual Property Rights, Patents.

UNIT II

Indian traditional wisdom and Heritage- Indian herbal wealth, Documentations, Databases, Scientific validation, Production Problems of Medicinal and Aromatic plants, Export and import status. WTO scenario - Principles and guidelines for GAP, GCP and GMP in medicinal crops.

UNIT III

Climate, Soil and substrate culture, Improved varieties, Organic production, Nutrition and irrigation requirements, inter culture, mulching, Weed control, Maturity indices and Harvesting, Post-harvest handling, Drying, Processing, Grading, Packing and Storage, Quality standards in medicinal plants, Biotechnological approaches for advances in phytochemical extraction technologies, Separation of Bio-molecules, Distillation methods, Essential oil extraction and value addition in aromatic plants, Phytochemicals and drug development.

UNIT IV

Medicinal crops : *Coleus forskohlii*, Glory lily, Senna, Periwinkle, *Stevia rebaudiana*, Aswagandha, Sarpagandha, *Aloe vera*, *Dioscorea* sp, *Phyllanthus amarus*, *Andrographis paniculata*, Medicinal solanum, Isabgol, *Poppy*, *Digitalis* sp, *Commiphora* sp, *Ipecac*, *Henbane*, *Ocimum* sp., *Centella*, *Bacopa*, *Saraca indica* and *Bael*.

UNIT V

Aromatic crops: Palmarosa, Lemongrass, citronella, vetiver, Geranium, Artemisia, Mentha, *Ocimum*, Eucalyptus, Rosemary, Thyme, patchouli.

Practical

Identification and documentation- propagation in medicinal crops, Maturity standards, Harvesting and Drying techniques, Processing and grading, Analysis of bio-molecules, Extraction of secondary metabolites, identification and characterization of - secondary metabolites, Essential oils, Visit to commercial medicinal plants field, Visit to GMP phytochemical extraction and value addition unit.

Suggested Readings

Dharamvir H. 2007. *Bioactive Medicinal Plants*. Gene Tech Books.

Farooqi AA, Khan MM & Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops*. Natural Remedies Pvt. Ltd.

Farooqi.AA & Sriram AH. 2000. *Cultivation Practices for Medicinal and Aromatic Crops*. Orient Longman Publ.Jain SK. 2000. *Medicinal Plants*. National Book Trust.

Khan IA & Khanum A. 2001 *Role of Biotechnology in Medicinal and Aromatic Plants*. Vol. IX. Vikaaz Publ.

Panda H. 2002. *Medicinal Plants Cultivation and their Uses*. Asia Pacific Business Press.

Prajapati ND, Paero Hit SS, Sharma AK & Kumar T. 2006. *A Hand Book of Medicinal Plants*. Agro Bios.

Ramawat KG & Merillon JM. 2003. *BioTechnology – Secondary Metabolites*. Oxford & IBH.

Objective

To update knowledge on the recent research trends in the field of breeding of plantation crops and spices.

Theory

Evolutionary mechanisms, adaptation and domestication, genetic resources, genetic divergence, cytogenetics, variations and natural selection, types of pollination and fertilization mechanisms, sterility and incompatibility system, recent advances in crop improvement efforts, introduction and selection, chimeras, clonal selections, intergeneric, interspecific and intervarietal hybridization, heterosis breeding, mutation and polyploidy breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, genetics of important traits and their inheritance pattern, molecular and transgenic approaches and other biotechnological tools in improvement of selected spice and plantation crops.

Crops

UNIT I	:	Coffee and tea
UNIT II	:	Cashew and cocoa
UNIT III	:	Rubber, palmyrah and oil palm
UNIT IV	:	Coconut and arecanut
UNIT V	:	Pepper and cardamom
UNIT VI	:	Nutmeg, clove, cinnamon and allspice
UNIT VII	:	Turmeric, ginger, garcinia, tamarind and garlic
UNIT VIII	:	Coriander, fenugreek, fennel, cumin and vanilla

Practical

Description and cataloguing of germplasm, pollen viability tests, pollen germination, survey and clonal selection, screening techniques for abiotic stresses, screening and rating for pest, disease and stress resistance in inbreds and hybrids, estimation of quality and processing characters for quality improvement, use of mutagenes and colchicine for inducing mutation and ploidy changes, practices in different methods of breeding and *in vitro* breeding techniques.

Suggested Readings

Chadha KL. 1998. *Advances in Horticulture*. Vol. IX, X. *Plantation and Spices Crops*. Malhotra Publ. House.

Chadha KL, Ravindran PN & Sahijram L. 2000. *Biotechnology in Horticultural and Plantation Crops*. Malhotra Publ. House.

Chadha KL. 2001. *Hand book of Horticulture*. ICAR.

Chopra VL & Peter KV. 2002. *Handbook of Industrial Crops*. Haworth Press, USA &. Panama International Publ. (Indian Ed.).

Damodaran VK, Vilaschandran T & Valsalakumari PK.1979. *Research on Cashew in India*. KAU, Trichur.

George CK. (Ed.). 1989. *Proceedings of First National Seminar on Seed Spices*. Spices Board, Ministry of Commerce, Govt. of India, Kochi. Harver AE. 1962. *Modern Coffee Production*. Leonard Hoff (Book) Ltd. Purselove JW. 1968. *Tropical Crops – Dicotyledons*. Longman. Purselove JW, Brown EG, Green CL & Robbins SRJ. 1984. *Spices*. Vols. I, II. Longman. Peter KV. 2001-04. *Handbook of Herbs and Spices*. Vols. I-III. Woodhead Publ. Co., UK & CRC, USA. Raj PS & Vidyachandra B. 1981. *Review of Work Done on Cashew*. UAS Research Series No.6, Bangalore. Ravindran PN. 2001. *Monograph on Black Pepper*. CRC Press. Ravindran PN & Madhusoodanan KJ. 2002. *Cardamom, The Genus Elettaria Series on Medicinal and Aromatic Plants – Industrial Profiles*. Routledge, UK Rosengarten F Jr. 1969. *The Book of Spices*. Wynnewood; Livingston Publ. Co. Shanmugavelu KG, Kumar N & Peter KV. 2002. *Production Technology of Spices and Plantation Crops*. Agrobios.

Objective

To update knowledge on the recent research trends in the field of breeding of medicinal and aromatic crops with special emphasis on tropical, subtropical and temperate crops grown in India.

Theory

UNIT I

Origin and evolution of varieties, distribution- Genetic resources, Plant introduction, selection and domestication - Inheritance of important characters, Genetic mechanisms associated with alkaloids and secondary metabolites. Constraints and Achievements in breeding of MAP.

UNIT II

Methods of breeding of seed and vegetative propagated MAP crops. Polyploidy and mutation breeding in the evolution of new varieties, Exploitation of heterosis, utilization of male sterility and self incompatibility. Breeding for resistance to pests, diseases, nematodes in medicinal and aromatic crops.

UNIT III

Specific breeding objectives in medicinal and aromatic crops, genetic resources , Breeding problems and improvements in Senna, Periwinkle, Aswagandha, Isabgol, Sarpagandha, Poppy, Glory lily, *Coleus*, *Mucuna* and *Ocimum*, Centella, Bacopa, Dioscorea, Solanum, Andrographis, *Aloe vera*, Phyllanthus, Eucalyptus, Bael, Cinchona.

UNIT IV

Specific breeding objectives in medicinal and aromatic crops, genetic resources , Breeding problems and improvements in Henbane aromatic grasses, Geranium, Patchouli, Artemisia, Rosemary, Thyme, Sage, Marjoram, Fever few.

UNIT V

Biotechnological (tissue culture and biotechnological) approaches for crop improvement of medicinal and aromatic crops.

Practical

Description of crops and cultivars, Cataloguing of species and cultivars, floral biology, selfing and crossing, evaluation of hybrid progenies, Induction of economic, colour mutants, Increased alkaloid content in medicinal crops, high essential oil content in aromatic plants, Physical and chemical mutagens, Induction of polyploidy, Screening of plants for biotic and abiotic stresses and environmental pollution, *in-vitro* breeding in flower crops, medicinal and aromatic crops.

Suggested Readings

Atal C & Kapoor V. 1992. *Cultivation and Utilization of Medicinal and Aromatic Crops*. CSIR.

Chadha KL & Gupta R. 1995. *Advances in Horticulture*. Vol.XI. Malhotra Publ. House.

Farooqi AA, Khan MM & Vasundhara M. 2001. *Production Technology of Medicinal and Aromatic Crops*. Natural Remedies Pvt. Ltd. Handa SS & Kaul MK. 1982. *Cultivation and Utilization of Medicinal Plants*. NISC, CSIR.

Jain SK. 2000. *Medicinal Plants*. National Book Trust. Julia F & Charters MC. 1997. *Major Medicinal Plants – Botany, Cultures and Uses*. Thomas Publ. Prajapati ND, Purohit SS, Sharma AK & Kumar T. 2006. *A Hand book of Medicinal Plants*. Agro Bios.

Thakur RS, Pauri HS & Hussain A. 1989. *Major Medicinal Plants of India*. CSIR.

Objective

To teach advances in biotechnology for improvement of plantation crops and spices.

Theory

Crops:

Coconut, oil palm, coffee, tea, cocoa, pepper, cardamom, turmeric, ginger, vanilla

UNIT I

In vitro culture methods and molecular approaches for crop improvement in plantation crops and spices, production of haploids, disease elimination in horticultural crops, micro grafting; somoclones and identification of somaclonal variants, *in vitro* techniques to overcome fertilization barriers, *in vitro* production of secondary metabolites.

UNIT II

Protoplast culture and fusion, construction, identification and characterization of somatic hybrids and cybrids, wide hybridization, embryo rescue of recalcitrant species, *in vitro* conservation of spices and plantation crops.

UNIT III

In vitro mutation for biotic and abiotic stresses, recombinant DNA methodology, gene transfer methods, tools, methods, applications of rDNA technology.

UNIT IV

Quality improvement; improvement for biotic and abiotic stress resistance; transgenic plants- achievements in medicinal and aromatic crops.

UNIT V

Role of molecular markers in characterization of transgenic crops, fingerprinting of cultivars etc., achievements, problems and future thrusts in plantation and spice crop biotechnology.

Practical

Establishment of axenic explants, callus initiation and multiplication; production of suspension culture, cell and protoplast culture, fusion, regeneration and identification of somatic hybrids and cybrids, Identification of embryonic and non-embryonic calli, development of cell lines; *in vitro* mutant selection for biotic and abiotic stress resistance, *In vitro* production and characterization of secondary metabolites, isolated microspore culture, isolation and amplification of DNA, gene transfer methods; molecular characterization of transgenic plants

Suggested Readings

Bajaj YPS. (Ed.). 1987. *Biotechnology in Agriculture and Forestry*.

Springer. Chadha KL, Ravindran PN & Sahijram L. (Eds.). 2000. *Biotechnology of Horticulture and Plantation Crops*. Malhotra Publ. House. Debnath M. 2005. *Tools and Techniques of Biotechnology*. Pointer Publ.

Glover MD. 1984. *Gene Cloning: The Mechanics of DNA Manipulation*. Chapman & Hall.

- Gorden H & Rubsell S. 1960. *Harmones and Cell Culture*. AB Book Publ. Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene Transfer*. Orient & Longman (Universal Press).
- Keshavachandran R, Nazim PA, Girija D. & Peter KV 2007. *Recent Trends in Biotechnology of Horticultural Crops*. New India Publ.
- Agency. Panopoulos NJ. (Ed.). 1981. *Genetic Engineering in Plant Sciences*. Praeger Publ.
- Parthasarathy VA., Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash.
- Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ. Prasad S. 1999. *Impact of Plant Biotechnology on Horticulture*. 2nd Ed. Agro Botanica.
- Sharma R. 2000. *Plant Tissue Culture*. Campus Books, International. Singh BD. 2001. *Biotechnology*. Kalyani.
- Skoog F & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Culture in vitro*. Symp. Soc. Exp. Biol. 11: 118-131.
- Vasil TK, Vasi M, White DNR & Bery HR. 1979. *Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture*. Plenum Press. Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V. Academic Press.

**PSMA 607 POST-HARVEST PROCESSING AND EXTRACTION 2+1
IN MEDICINAL AND AROMATIC PLANTS**

Objective

To teach advances in post harvest processing and extraction of economically important medicinal and aromatic crops.

Theory

UNIT I

Post-harvest handling of plant material, preparation of plant material for packaging and extraction. Methods of extraction of secondary metabolites from medicinal crops like sarpagandha, steroid-bearing solanums, ashwagandha, henbane, periwinkle, senna, costus, coleus, etc.

UNIT II

Procedures and equipments used for extraction of active principles. Principles and practices of different types of chromatographs - paper, thinlayer, column, gas and high performance liquid chromatography and mass spectroscopy. Preservation of plant extracts and their trade mechanisms.

UNIT III

Harvesting, drying, handling and preparation of different aromatic crops - jasmine, tuberose, oil-bearing rose, scented geranium, patchouli, davana, mints, basils, etc., for essential oil extraction.

UNIT IV

Principles and practices of different types of extraction - distillation, solvent extraction, supercritical fluid extraction, etc. Fine flavour and perfume extraction. Qualitative determination of essential oils. *In vitro* production of biomass and organic extraction of oils. Quality analysis and characterization through chromatographs.

UNIT V

Commercial uses of essential oils, aromatherapy, etc. Commercial utilization of spent material. Storage of essential oils.

Practical

Identification of different economic parts of medicinal and aromatic crops. Preparation of plant material for extraction. Study of different extraction methods. Study of solvents used in extraction of concrete and absolutes. Extraction of crude drugs and essential oils from different medicinal and aromatic crops respectively. Handling of different chromatographs. Quality analysis of essential oils - both physical and chemical, determination of phenol values, acid values, alcohol values, etc. Sensory evaluation of essential oils. Storage studies in essential oils. Visit to commercial extraction and product development units.

Suggested Readings

Bhattacharjee SK. *Amenity Horticulture, Biotechnology and Post-harvest Technology*. Vol. V. International Book Periodicals Supply Services. Chadha KL (Ed.). 1993-95. *Advances in Horticulture*. Vols. I-XIII. Malhotra Publ. House.

- Kumar N, Abdul Khader ML, Rangaswamy P & Ikrulappan I. 1994. *Spices, Plantation Crops, Medicinal and Aromatic Plants*. Rajalakshmi
Publ. Leo ML Nollet. 1995. *Food Analysis by HPLC*. Marcel Dekker.
- Masada Y. 1986. *Analysis of Essential Oil by Gas Chromatograph and Mass Spectrometry*. John Wiley & Sons.
- Sadasivam S & Manickam A. 1996. *Biochemical Methods*. 2nd Ed. New Age International Pvt. Ltd., Bangalore and TNAU; Scientific Publishers (India), Jodhpur.
- Teranishi R, Hornstein I, Issenberg P & Wick EL. 1971. *Flavour Research: Principles and Techniques*. Marcel Dekker.
- WHO. 1998. *Quality Control Methods for Medicinal Plants Materials*. WHO.

Objective

To teach advances in environmental management of horticultural crops.

Theory

UNIT I

Environmental complex, interaction of ecological factors in horticultural crop production, interaction of physiographic factors in horticultural crop production. Geo-chemical and hydrological cycles and their impact on ecosystems.

UNIT II

Global warming- carbon trading role of green house gases, elevated CO₂ and its impact on productivity of horticultural systems. Habitat ecology, changes in habitats and its impact on horticultural production, Habitat analysis, conservation biology, domestication. Forest ecosystem and its evolution to a hort-ecosystem.

UNIT III

Phytogeography. changes in land use pattern and its impact on horticultural crop production. Natural resource management in hortisystems. Subsistence farming systems of the world, threat and challenges.

UNIT IV

Environmental pollution in horti systems, chemicals, fertilizers, etc. Waste management in processing industry, phytoremediation. Alternate farming systems, horticultural therapy Environmental policy & legislation in India, International treatise and Summit, Biodiversity Board, Act, etc.

Practical

Phyto-sociological analysis, assessment of plant associations in natural and domestic systems, productivity assessment of various ecosystems, analysis and assessment of various phytogeographic zones, assessment of land use changes and its impact on horticultural systems, assessment of biodiversity, pesticide residue analysis in horticultural produce.

Suggested Readings

- Ashby M. 1973. *Introduction to Plant Ecology*. MacMillan Press. CSIR. 1971. *The Wealth of India*. Vols. A-Z. CSIR.
- Daubenmire RF. 1959. *Plants and Environment*. Wiley Eastern. Fall. 2001. *Tolerance of Landscape Plants to Recycle Water Irrigation*. UC and ANR Publ.
- Mathew IP & Karikari SK. 1990 *Horticulture Principles and Practices*. MacMillan Intermediate Agricultural Series.
- Prasad S & Kumar U. 2003. *Principles of Horticulture*. Agrobios.
- Sasikumar B, Krishna Murthy B, Rama.J, Ravindran PN & Peter KV. (Eds.). 1999. *Biodiversity Conservation and Utilization of Spices, Medicinal and Aromatic Plants*. IISR, Calicut. Singh PP. 2006. *Perspectives in Plant Ecology and Environmental Biology*. Scientific Publ.

PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS

List of Journals & Magazines

- ✓ Acta Horticulture
- ✓ Haryana Journal of Horticulture Science
- ✓ Horticulture Reviews
- ✓ HortScience
- ✓ Indian Horticulture
- ✓ Indian Journal of Arid Horticulture
- ✓ Indian Journal of Horticulture
- ✓ Indian Spice
- ✓ Journal of American Society of Horticultural Sciences
- ✓ Journal of Applied Horticulture
- ✓ Journal of Horticultural Sciences
- ✓ Journal of Horticultural Sciences & Biotechnology
- ✓ Journal of Japanese Society for Horticulture Science
- ✓ Journal of Korean Society for Horticulture Science
- ✓ Journal of Plantation Crops
- ✓ Journal of Spices and Aromatic Crops
- ✓ Scientia Horticulture
- ✓ South Indian Horticulture
- ✓ Spice India

Suggested Broad Topics for Master's and Doctoral Research

- ✓ Micro-propagation of plantation crops and spices
- ✓ Application of genetic engineering in plantation crops, spices, medicinal and aromatic crops
- ✓ Use of molecular markers in plantation crops, spices, medicinal and aromatic crops
- ✓ Plantation crops, spices, medicinal and aromatic crop improvement
- ✓ Crop selection for biotic and abiotic stresses
- ✓ Diagnostic and recommended integrated system in cultivation of plantation crops, spices, medicinal and aromatic crops
- ✓ Precision farming in plantation crops, spices, medicinal and aromatic crops
- ✓ Root distribution studies in plantation crops, spices, medicinal and aromatic crops
- ✓ Organic production of plantation crops, spices, medicinal and aromatic crops
- ✓ Post harvest management of plantation crops, spices, medicinal and aromatic crops
- ✓ Value addition in plantation crops, spices, medicinal and aromatic crops
- ✓ Rejuvenation of plantations and spice garden
- ✓ Research on burning problems in plantation crops, spices, medicinal and aromatic crops like root wilt of coconut, yellowing of areacanut, foot rot of black pepper, katte disease of cardamom etc.

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Minor Department Courses

BIOCHEMISTRY

Course Contents

BIOCHEM 501

BASIC BIOCHEMISTRY

2+1

Objective

To provide elementary knowledge/overview of structure and functions and metabolism of biomolecules.

Theory

UNIT I

Scope and importance of biochemistry in agriculture; Fundamental principles governing life; structure of water; acid base concept and buffers; pH; hydrogen bonding; hydrophobic, electrostatic and Van der Waals forces; General introduction to physical techniques for determination of structure of biopolymers.

UNIT II

Classification, structure and function of carbohydrates, lipids and biomembranes, amino acids, proteins, and nucleic acids.

UNIT III

Structure and biological functions of vitamins, enzymes classification and mechanism of action; regulation, factors affecting enzyme action. Hormones animal plants and insects, Fundamentals of thermodynamic principles applicable to biological processes, Bioenergetics.

UNIT IV

Metabolism of carbohydrates, photosynthesis and respiration, oxidative phosphorylation, lipids, proteins and nucleic acids. DNA replication, transcription and translation; recombinant DNA technology.

Practical

Preparation of standard and buffer solutions, Extraction and estimation of sugars, Amino acids, Estimation of Proteins by Lowry's method, Estimation of DNA and RNA by diphenylamine and orcinol methods, Estimation of Ascorbic acid, Separation of biomolecules by TLC and Paper chromatography.

Suggested Readings

Conn EE & Stumpf PK. 1987. *Outlines of Biochemistry*. John Wiley.

Metzler DE. 2006. *Biochemistry*. Vols. I, II. Wiley International.

Nelson DL & Cox MM. 2004. *Lehninger Principles of Biochemistry*. 4th Ed. MacMillan.

Voet D, Voet JG & Pratt CW. 2007. *Fundamentals of Biochemistry*. John Wiley.

Objective

To provide knowledge regarding genes, their functions, expression, regulation and transfer in heterologous systems.

TheoryUNIT I

Historical development of molecular biology, nucleic acids as genetic material, chemistry and structure of DNA and RNA, Genome organization in prokaryotes and eukaryotes, chromatin structure and function.

UNIT II

DNA replication, DNA polymerases, topoisomerases, DNA ligase, reverse transcriptase, repetitive and non-repetitive DNA, satellite DNA; transcription process, RNA editing, RNA processing.

UNIT III

Ribosomes structure and function, organization of ribosomal proteins and RNA genes, genetic code, aminoacyl tRNA synthetases' inhibitors of replication, transcription and translation; translation and Post translational modification; nucleases and restriction enzymes, regulation of gene expression in prokaryotes and eukaryotes, molecular mechanism of mutation.

UNIT IV

DNA sequencing, recombinant DNA technology, vectors, isolation of genes, recombinants vector, selection of recombinants, PCR; general features of replication, transcription, site directed mutagenesis and translation in eukaryotes.

Practical

Isolation and purification of DNA and RNA from different sources, check of purity of isolated DNA and RNA, restriction fragmentation and separation of oligos by agarose electrophoresis, RAPD analysis of DNA, cDNA synthesis using PCR, Southern and Northern blotting experiments

Suggested Readings

- Adams RLP, Knowler JT & Leader DP. 1992. *The Biochemistry of the Nucleic Acids*. 11th Ed. Chapman & Hall.
- Alberts B, Bray D, Lewis J, Raff M, Roberts K & Watson JD 2006. *Molecular Biology of the Cell*. 6th Ed. Garland Publ.
- Blackburn GM & Gait MJ. 1996. *Nucleic Acids in Chemistry and Biology*. 2nd Ed. Oxford University Press.
- Freifelder D & Malacinski GM. 1996. *Essentials of Molecular Biology*. 3rd Ed. Panima.
- Glick BR & Pasternak JJ. 1994. *Molecular Biology: Principles and Applications of Recombinant DNA Technology*. ASM Press.
- Lewin B. 2007. *Genes IX*. Oxford University Press.
- Lodish H, Berk A, Zipursky SA, Matsudaira P, Baltimore D & Darnell J. 1999. *Molecular Cell Biology*. WH Freeman.
- Old RW & Primrose SB. 1989. *Principles of Gene Manipulation: An Introduction to Genetic Engineering*. 4th Ed. Blackwell Scientific Publ.
- Sambrook J & Russel DW. 2001. *Molecular Cloning: A Laboratory Manual*. Vols. I-III. Cold Spring Harbor.

Objective

To impart students a hands on training of techniques of biochemistry and molecular biology.

Theory

UNIT I

Isolation and purification of protein from microbial/plant/animal source. Electrophoretic separation of protein. Determination of molecular weight of protein using PAGE/ gel filtration method.

UNIT II

Experiments on DNA: Isolation, agarose gel electrophoresis and restriction analysis of DNA.

UNIT III

Isolation of chloroplast and mitochondria by differential centrifugation and their purification by density gradient centrifugation.

UNIT IV

Isolation and purification of enzymes, isozymic analysis and enzyme immobilization

Suggested Readings

Kolowick NP & Kaplan NP. *Methods in Enzymology*. Academic Press (Series).

Plummer DT. 1998. *An Introduction to Practical Biochemistry*. 3rd Ed. Tata McGraw Hill.

Rickwood D. (Ed.). 1984. *Practical Approaches in Biochemistry*. 2nd Ed. IRL Press, Washington DC.

Wilson K & Goulding KH. 1992. *A Biologist's Guide to Principles and Techniques of Practical Biochemistry*. 3rd Ed. Cambridge Univ. Press.

Wilson K & Walker J. 2000. *Principles and Techniques of Practical Biochemistry*. 5th Ed. Cambridge Univ. Press.

BIOCHEMISTRY

List of Journals

- ✓ Annual Review of Biochemistry
- ✓ Annual Review of Genetics
- ✓ Annual Review of Plant Physiology and Plant Molecular Biology
- ✓ Biochemical and Biophysical Research Communication
- ✓ Biochemical Journal
- ✓ Biochim. Biophysic Acta
- ✓ Cell
- ✓ Current Science
- ✓ Federation of European Biochemical Society
- ✓ Indian Journal of Experimental Biology
- ✓ Journal of Biological Chemistry
- ✓ Journal of Immunology
- ✓ Journal of Molecular Modeling
- ✓ Journal of Plant Biochemistry and Biotechnology
- ✓ Nature
- ✓ Physiologia Plantarum
- ✓ Plant Physiology
- ✓ Plant Science
- ✓ Planta
- ✓ Proceedings of National Academy of Sciences, USA
- ✓ Protein Science
- ✓ RNA
- ✓ Science
- ✓ Scientific American
- ✓ Trends in Biochemical Sciences
- ✓ Trends in Biotechnology
- ✓ Trends in Plant Sciences

e-Resources

- www.unixl.com/dir/molecular_sciences/biochemistry/biochemistry_jobs/
- www.unixl.com/dir/medical_sciences/
- <http://www.ncbi.nlm.nih.gov/>
- <http://us.expasy.org>
- <http://us.expasy.org/spdbv/>
- <http://www.brenda.uni-koeln.de/>
- <http://www.worthington-biochem.com>
- <http://www.cefotaxime.net>
- <http://home.123india.com/nbsc/>
- <http://www.biochemist.org>
- <http://www.gwu.edu/~mpb>

Suggested Broad Topics for Master's and Doctoral Research

- Immobilization of industrially important enzymes
- Manipulation of metabolic pathways for reserve biosynthesis and utilization.
- Biochemistry and molecular biology of biotic and abiotic stresses in plants.
- Biochemistry of fruits and vegetables during ripening and post ripening.
- Manipulation of metabolic pathways at molecular level to increase shelf life of fruits and to increase contents of alkaloids, flavones and isoflavones, PUFA etc
- Use of molecular markers for identification and improvement of crop plants.
- Enzyme engineering and functional genomics/proteomics.
- Biochemical and molecular evaluation of varieties for quality improvement.
- Use of biomolecules as biosensors.
- Study of metabolome and elucidation of metabolic pathway of secondary metabolites.

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PLANT PHYSIOLOGY

Course Contents

PP 501

PRINCIPLES OF PLANT PHYSIOLOGY

2+1

Objective

To acquaint the students with the basic concepts of plant physiology and their application in agriculture.

Theory

UNIT I

Cell organelles and their physiological functions, structure and physiological functions of cell wall, cell inclusions; cell membrane structure and functions.

UNIT II

Soil and plant water relations, water and its role in plants, properties and functions of water in the cell water relations-cell water terminology, water potential of plant cells.

UNIT III

Mechanism of water uptake by roots-transport in roots, aquaporins, movement of water in plants – Mycorrhizal association on water uptake.

UNIT IV

Water loss from plants-Energy balance-Solar energy input-energy dissipation at crop canopy level- evapotranspiration transpiration –Driving force for transpiration, plant factors influencing transpiration rate.

UNIT V

Stomata structure and function – mechanism of stomatal movement, antitranspirants.

UNIT VI

Physiology of water stress in plants: Influence of water stress at cell, organ, plant and canopy levels. Indices for assessment of drought resistance.

UNIT VII

The role of mineral nutrients in plant metabolism: Essential elements, classification based on function of elements in plants.

UNIT VIII

Uptake of mineral elements in plants –Mechanisms of uptake-translocation of minerals in plants.

UNIT IX

Physiological and metabolic functions of mineral elements, critical levels, deficiency symptoms, nutrient deficiency and toxicity. Foliar nutrition.

UNIT X

Photosynthesis and its importance in bio productivity. Photochemical process, photochemical reactions, CO₂ reduction in Calvin cycle, supplementary pathway of C fixation in C₄ and CAM plants and its significance.

UNIT XI

Photorespiration and its relevance. Photosynthesis as a diffusive process effect of environmental factors on photosynthetic rates. Synthesis of sucrose, starch, oligo and polysaccharides (composition of cell wall). Translocation of photosynthates and its importance in sink growth.

UNIT XII

Mitochondrial respiration, growth and maintenance respiration, cyanide resistant respiration and its significance.

UNIT XIII

Nitrogen metabolism: Inorganic nitrogen species (N_2 , NO_3 and NH_3) and their reduction to aminoacids, protein synthesis and nucleic acids.

Unit XIV

Lipid metabolism- Storage, protective and structural lipids. Biosynthesis of fattyacids, diacyl and triacyl glycerol, fatty acids of storage lipids. Secondary metabolites and their significance in plant defence mechanism.

UNIT XV

Growth and differentiation. Hormonal concept of growth and differentiation, plant growth hormones and their physiological role synthetic growth regulators, growth retardants., Apical dominance, senescence, fruit growth, abscission.

UNIT XVI

Photo morphogenesis: Photo receptors, phytochrome, cryptochrome, physiology of flowering- Photoperiodism and Vernalisation.

Practical

Measurement of soil water status: Theory and principle of pressure plate apparatus, neutron probe, Measurement of plant water status: Relative water content, water saturation deficits Chardakov's test. Theory and principle of pressure bomb, psychrometer and osmometer, Measurement of transpiration rate. Measurement of vapour pressure deficits, theory and principle of porometry, diffusion potometer and Steady state potometer, Stomatal physiology, influence of ABA on stomatal closing. Mineral nutrients: Demonstration of energy requirement for ion uptake. Deficiency of chlorophylls, O_2 evolution during photosynthesis, Measurement of gas exchange parameters, conductance, photosynthetic rate, photorespiration, Respiration rates, Estimation of reducing sugars, starch. Estimation of NO_3 , free aminoacids in the xylem exudates, quantification of soluble proteins. Bioassays for different growth hormones- Auxins, Gibberellins, Cytokinins, ABA and ethylene. Demonstration of photoperiodic response of plants in terms of flowering.

Suggested Readings

Hopkins WG & Huner NPA. 2004. *Introduction to Plant Physiology*. John Wiley & Sons.
Salisbury FB & Ross C. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ. Taiz L & Zeiger E. 2006. *Plant Physiology*. 4th Ed. Sinauer Associates

PP 504 HORMONAL REGULATION OF PLANT GROWTH AND DEVELOPMENT 2+1

Objective

To apprise the students about structure function of plant growth regulator on growth and development of plant.

Theory

UNIT I

Definition and classification of plant growth regulators- Hormones, endogenous growth substances and synthetic chemicals, Endogenous growth regulating substances other than hormones. triconanol, Phenols – polyamines, jasmonates, concept of death hormone.

UNIT II

Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth development of individual group of hormones- Auxins, Gibberellins, cytokinins, Abscisic acid and Ethylene Brassinosteroids.

UNIT III

Hormone mutants and transgenic plants in understanding role of hormones.

UNIT IV

Signal perception.transduction, and effect at functional gene level of different hormones- Auxins- cell elongation, Gibberellins -, germination of dormant seeds, cytokinins- cell division. Retardation of senescence of plant parts, Abscisic acid-Stomatal closure and induction of drought resistance, Ethylene- fruit ripening.

UNIT V

Interaction of hormones in regulation of plant growth and development processes. Rooting of cuttings-Flowering. Apical dominance, molecular aspects of control of reproductive growth and development.

UNIT VI

Synthetic growth regulators- Classification, their effect on plant growth and development. Practical utility in agriculture and horticulture.

Practical

Quantification of Hormones- Principles of bioassays, physico chemical techniques and immunoassay, Extraction of hormones from plant tissue. Auxins- bioassays- auxins effect on rooting of cuttings, abscission, apical dominance, Gibberellins- bioassays-GA effect on germination of dormant seeds, cytokinin- bioassays- estimation using immunoassay technique cytokinin effect on apical dormance and senescence, ABA bioassay estimation using immunoassay technique. ABA effect on somatal movement, Ethylene bioassays, estimation using physico chemical techniques- effect on breaking dormancy in sunflower and groundnut.

Suggested Readings

Hopkins WG & Huner NPA. 2004. *Introduction to Plant Physiology*. John Wiley & Sons.
Salisbury FB & Ross C. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ. Taiz L & Zeiger E. 2006. *Plant Physiology*. 4th Ed. Sinauer Associates.

Objective

To impart knowledge about physiological and molecular aspects of carbon reduction cycle and nitrogen assimilation

Theory

UNIT I

Overview of essential mineral elements, kinetics of nutrient uptake by plants. Biological actions influencing nutrient availability near the root system.

UNIT II

Nutrient uptake by root cells, long distance transport in plants and movement into developing grains. Nutrient transport from vegetative to reproductive organs during reproductive stage of growth and maturity.

UNIT III

Molecular mechanism of ion uptake, ion transporters, specific examples of transporters for Nitrate, Phosphate, Potassium and other nutrients. Multiple transporters for a single ion and their functional regulation.

UNIT IV

Molecular physiology of micronutrient acquisition. Examples of genes encoding mineral ion transporters. Strategies plants adopt to acquire and transport minerals under deficient levels.

UNIT V

Physiological and molecular mechanisms underlying differential nutrient efficiency in crop genotypes, Examples of Phosphorous, Iron and Zinc efficient crop varieties.

UNIT VI

Breeding crop varieties for improved nutrient efficiency. Plant responses to mineral toxicity.

Practical

Physiological and biochemical changes in plants under nutrient sufficiency and deficiency levels. Quantification of pigment levels, enzyme activities.

Suggested Readings

- Barker AB & Pilbeam DJ. 2007. Handbook of Plant Nutrition. CRC
Epstein E. 2007. Mineral Nutrition of Plants. John Wiley & Sons.
Marschner H. 1995. Mineral Nutrition of Higher Plants. Academic Press.

Objective

To impart recent practical training to study various physiological processes in plants.

Theory

UNIT I

Recent experimental techniques to study various physiological processes, Photosynthetic gas exchange measurements, light and CO₂ response curves-determination of relative limitations to photosynthesis; chlorophyll fluorescence measurements.

UNIT II

Estimation of water use efficiency at whole plant and single leaf level. Use of stable isotopes to understand physiological processes.

UNIT III

Radio isotopes in plant biology.

UNIT IV

Tools and techniques (molecular and biochemical) to study physiological processes and to screen & assess stress responses in plants, such as (a) DNA & RNA isolation, cDNA synthesis & library construction, semiquantitative & quantitative RT-PCR, northern blot, immunoassays; (b) techniques for defined physiological processes.

UNIT V

Methods to phenotype germplasm for specific physiological traits.

UNIT VI

Quantification of mineral nutrients using advanced instruments like AAS, & ICP.

UNIT VII

Techniques in plant transformation & analysis of transgenic plants

UNIT VIII

Molecular markers- genetic distance and mapping population concept of linkage maps and identification of QTLs.

UNIT IX

Instrumentation: Acquaintance of the operation of specific instruments important in physiological research like Mass spec., phosphor-imager, DNA sequencer, spectro-fluorometer, oxygen electrode, etc.

Practical

Photosynthetic gas exchange measurements, light and CO₂ response curves-determination of relative limitations to photosynthesis; chlorophyll fluorescence measurements. Estimation of water use efficiency at whole plant and single leaf level. Use of stable and radioactive isotopes to understand physiological processes. DNA & RNA isolation, cDNA synthesis & library construction, semiquantitative & quantitative RT-PCR, northern blot, immunoassays; techniques for defined physiological processes, Quantification of mineral nutrients using advanced instruments like AAS.

Suggested Readings

Dhopte MA & Manuael Livera M. 1986. *Useful Techniques for Plant Scientists*. Forum for Plant Physiologists, R. D. G., Aloka.

Objective

To impart knowledge about physiological changes during senescence and ripening.

Theory

UNIT I

Environmental factors influencing senescence, ripening and post harvest life of flowers, vegetables and seeds.

UNIT II

Molecular mechanism of senescence and ageing. Physiological, biochemical and molecular aspects of senescence and fruit ripening.

UNIT III

Senescence associated genes and gene products.

UNIT IV

Functional and ultrastructural changes in chloroplast membranes, mitochondria and cell wall during senescence and ripening.

UNIT V

Regulatory role of ethylene in senescence and ripening, ethylene biosynthesis, perception and molecular mechanism of action.

UNIT VI

Post harvest changes in seed and tubers biochemical constituent's quality parameters. Effect of environmental factors on post harvest changes in seed and tubers.

UNIT VII

Biotechnological approaches to manipulate ethylene biosynthesis and action.

UNIT VIII

Alternate post harvest methodology and quality attributes. Scope for genetic modification of post harvest life of flowers and fruits.

UNIT IX

Uses of GM crops and ecological risk assessment.

Practical

Physiological and biochemical changes during senescence and ripening, Estimation of ethylene during senescence and ripening, determination of Reactive Oxygen Species and scavenging enzymes, Measurement of dark and alternate respiration rates during senescence and ripening. Estimation of ripening related enzyme activity, Cellulases pectin methyl esterases, polygalacturonase etc.

Suggested Readings

Jeffrey K Brecht & Weichmann J. 2003. *Post Harvest Physiology and Pathology of Vegetables*. CRC Press.

Objective

To apprise students regarding weed and crop competition, and physiological and molecular aspects of herbicides.

Theory

UNIT I

Weed biology, ecology and physiology. Weed and crop competition, allelochemicals, their nature and impact. Weed-seed physiology.

UNIT II

Classification of herbicides and selectivity. Recent concepts on entry, uptake, translocation and metabolism of soil and foliar applied herbicides. Environmental and plant factors influencing entry, uptake and translocation of herbicides.

UNIT III

Classification and chemistry of common herbicides. Physiological, biochemical and molecular mechanism of action of different groups of herbicides; ACC synthase inhibitors, ALS inhibitors, Mitotic inhibitors, Cellulose biosynthesis inhibitors, Inhibitors of fatty acid biosynthesis, inhibitors of Photosynthesis, Auxinic Herbicides, New herbicides,

UNIT IV

Metabolic pathway of herbicide degradation in plants and soil. Herbicide adjuvants and their classification.

UNIT V

Molecular mechanism of action of herbicide synergists and antagonists.

UNIT VI

Physiological and molecular mechanism of herbicide selectivity.

UNIT VII

Herbicide resistant crops; transgenic & tissue culture approaches to develop herbicide tolerant varieties.

Practical

Adjuvants and their effect on spray droplets, chemical entry and transport. Determination of physiological and biochemical processes like photosynthesis, respiration, cell division, Protein & fatty acid synthesis, membrane permeability as affected by herbicides. Quantification of pigment levels in leaves, specific enzyme activities affected by herbicides. Demonstration of translocating type of herbicides by radio labeling studies.

Suggested Readings

Devine MD, Duke SO & Fedtake C. 1993. *Physiology of Herbicide Action*. Prentice Hall.
Monaco TJ, Weller SC & Ashton FM. 2002. *Weed Science - Principles and Practices*. Wiley.com Publ.

PLANT PHYSIOLOGY

List of Journals

- ✓ American Journal of Botany
- ✓ Annals of Arid Zone
- ✓ Annual Review of Plant Physiology and Plant Molecular Biology
- ✓ Australian Journal of Agricultural Research
- ✓ Australian Journal of Biological Sciences
- ✓ Australian Journal of Botany
- ✓ Australian Journal of Plant Physiology
- ✓ Biochemie und Physiologie der Pflanzen
- ✓ Biologia Plantarum
- ✓ Botanical Gazette
- ✓ Botanical Review
- ✓ Canadian Journal of Agricultural Research
- ✓ Canadian Journal of Botany
- ✓ Canadian Journal of Plant Science
- ✓ Communications in Soil Science and Plant Analysis
- ✓ Current Science
- ✓ Environmental and Experimental Botany
- ✓ Euphytica
- ✓ Experimental Agriculture
- ✓ Experimental Cell Biology
- ✓ Functional Plant Biology
- ✓ Indian Journal of Agriculture
- ✓ Indian Journal of Experimental Biology
- ✓ Indian Journal of Plant Physiology
- ✓ International Journal of Botany
- ✓ Japanese Journal of Crop Science
- ✓ Journal of Agricultural and Scientific Research
- ✓ Journal of Agricultural Science
- ✓ Journal of Arid Environment
- ✓ Journal of Experimental Botany
- ✓ Journal of Plant Biology
- ✓ Journal of Plant Nutrition
- ✓ Nature
- ✓ New Physiologist
- ✓ Physiologia Plantarum
- ✓ Physiology and Molecular Biology of Plants
- ✓ Plant and Cell Physiology
- ✓ Plant and Soils
- ✓ Plant Cell, Tissue and Organ Culture
- ✓ Plant Growth Regulator abstracts
- ✓ Plant Physiology and Biochemistry
- ✓ Plant Science

- ✓ Plant Science (India)
- ✓ Science Journal
- ✓ Seed Science and Technology
- ✓ Seed Science Research
- ✓ Soil Science and Plant Nutrition
- ✓ Soviet Plant Physiology
- ✓ Trends in Plant Science
- ✓ Tropical Agriculture

e-Resources

- [www.Bioone Online Journals The Arabiopsis Book.](#)
- [www. Botany on line:](#)
- [www.Ingenta Connect Physiologia Plantarum](#)
- [www.new.phytologist.org.](#)
- [www.plant physiol.org.](#)
- [www.mpiz-Kolen.mpg.de.](#)
- [www.Science Direct.](#)
- [www.Scientia Agricolo.](#)
- [www.wiley interscience.](#)

Suggested Broad Topics for Master's and Doctoral Research

- Environmental stress physiology- Salt, Drought, Heat, Freezing, and Heavy Metal
- Nodulation and nitrogen fixation in leguminous plants
- Physiology of senescence and abscission in crop plants especially in cotton
- Phytoremediation, especially with reference to salt and heavy metal stress
- Ecophysiology of tree species to evaluate bio-drainage potential of plants underwaterlogged saline area
- Growth and development of crop plants
- Mineral nutrition in crop plant
- Application of plant growth regulators to improve crop productivity
- Photosynthesis, respiration and related processes for crop improvement

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AGRON 505 AGRONAGROMETEOROLOGY AND CROP WEATHER 2+1
FORECASTING

Objective

To impart knowledge about agro-meteorology and crop weather forecasting to meet the challenges of aberrant weather conditions.

Theory

UNIT I

Agro meteorology - aim, scope and development in relation to crop environment; composition of atmosphere, distribution of atmospheric pressure and wind.

UNIT II

Characteristics of solar radiation; energy balance of atmosphere system; radiation distribution in plant canopies, radiation utilization by field crops; photosynthesis and efficiency of radiation utilization by field crops; energy budget of plant canopies; environmental temperature: soil, air and canopy temperature.

UNIT III

Temperature profile in air, soil, crop canopies; soil and air temperature effects on plant processes; environmental moisture and evaporation: measures of atmospheric temperature and relative humidity vapor pressure and their relationships; evapo-transpiration and meteorological factors determining evapotranspiration.

UNIT IV

Modification of plant environment: artificial rain making, heat transfer, controlling heat load, heat trapping and shading; protection from cold, sensible and latent heat flux, controlling soil moisture; monsoon and their origin, characteristics of monsoon; onset, progress and withdrawal of monsoon; weather hazards, drought monitoring and planning for mitigation.

UNIT V

Weather forecasting in India – short, medium and long range; aerospace science and weather forecasting; benefits of weather services to agriculture, remote sensing; application in agriculture and its present status in India; atmospheric pollution and its effect on climate and crop production; climate change and its impact on agriculture.

Practical

- Visit to agro-meteorological observatory and to record sun-shine hours, wind velocity, wind direction, relative humidity, soil and air temperature, evaporation, precipitation and atmospheric pressure
- Measurement of solar radiation outside and within plant canopy
- Measurement/estimation of evapo-transpiration by various methods
- Measurement/estimation of soil water balance
- Rainfall variability analysis
- Determination of heat-unit requirement for different crops
- Measurement of crop canopy temperature
- Measurement of soil temperatures at different depths
- Remote sensing and familiarization with agro-advisory service bulletins
- Study of synoptic charts and weather reports, working principle of automatic weather station
- Visit to solar observatory

Suggested Readings

- Chang Jan Hu 1968. *Climate and Agriculture on Ecological Survey*. Aldine Publ.
- Critchfield HJ.1995. *General Climatology*. Prentice Hall of India.
- Das PK.1968. *The Monsoons*. National Book Trust Publ.
- Lal DS.1998. *Climatology*. Sharda Pustak Bhawan.
- Lenka D.1998. *Climate, Weather and Crops in India*. Kalyani.
- Mavi H.S.1994. *Introduction to Agro-meteorology*. Oxford & IBH.
- Mavi HS & Tupper GJ. 2004. *Agrometeorology: Principles and Application of Climate Studies in Agriculture*. Haworth Press.
- Menon PA.1991. *Our Weather*. National Book Trust Publ.
- Sahu DD. *Agrometeorology and Remote Sensing: Principles and Practices*.Agrobios.
- Variraju R & Krishnamurty 1995. *Practical Manual on Agricultural Meteorology*. Kalyani.
- Varshneya MC & Balakrishana Pillai P. 2003. *Textbook of Agricultural Meteorology*. ICAR.

AGRON 511 CROPPING SYSTEMS AND SUSTAINABLE AGRICULTURE 2+0

Objective

To acquaint the students about prevailing cropping systems in the country and practices to improve their productivity.

Theory

UNIT I

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use.

UNIT II

Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

UNIT III

Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture.

UNIT IV

Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system.

UNIT V

Plant ideotypes for drylands; plant growth regulators and their role in sustainability.

Suggested Readings

- Palaniappan SP & Sivaraman K. 1996. *Cropping Systems in the Tropics; Principles and Management*. New Age.
- Panda SC. 2003. *Cropping and Farming Systems*. Agrobios.
- Reddy SR. 2000. *Principles of Crop Production*. Kalyani.
- Sankaran S & Mudaliar TVS. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ. Co.
- Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.
- Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1997. *Soil Fertility and Fertilizers*. Prentice Hall.

Objective

To study the principles and practices of organic farming for sustainable crop production.

Theory

UNIT I

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; land and water management - land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry.

UNIT II

Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers.

UNIT III

Farming systems, crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.

UNIT IV

Control of weeds, diseases and insect pest management, biological agents and pheromones, biopesticides.

UNIT V

Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

Practical

- Aerobic and anaerobic methods of making compost
- Making of vermicompost
- Identification and nursery raising of important agro-forestry trees and trees for shelter belts
- Efficient use of biofertilizers, technique of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter*, *Azospirillum*, and PSB cultures in field
- Visit to an organic farm
- Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms

Suggested Readings

Ananthakrishnan TN. (Ed.). 1992. *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford & IBH.

Gaur AC. 1982. *A Manual of Rural Composting*, FAO/UNDP Regional Project Document, FAO. Lampin N. 1990. *Organic Farming*. Press Books, Ipswich, UK. Palaniappan SP &

Anandurai K. 1999. *Organic Farming – Theory and Practice*. Scientific Publ.

Rao BV Venkata. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*: Publ.3, Parisaraprajna Parishtana, Bangalore.

Publ.3, Parisaraprajna Parishtana, Bangalore.

Reddy MV. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.

Sharma A. 2002. *Hand Book of Organic Farming*. Agrobios.
Singh SP. (Ed.) 1994. *Technology for Production of Natural Enemies*.
PDDB, Bangalore. Subba Rao NS. 2002. *Soil Microbiology*. Oxford & IBH. Trivedi RN.1993.
A Text Book of Environmental Sciences, Anmol Publ.
Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable
Agriculture*. Association for Promotion of Organic Farming, Bangalore.
WHO. 1990. *Public Health Impact of Pesticides Used in Agriculture*.
WHO. Woolmer PL & Swift MJ. 1994. *The Biological Management of Tropical Soil Fertility*.
TSBF & Wiley.

Objective

To teach students about optimization of irrigation in different crops under variable agroclimatic conditions.

Theory

UNIT I

Water resources of India, irrigation projects; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.

UNIT II

Soil-plant-water relationships, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity.

UNIT III

Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.

UNIT IV

Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.

UNIT V

Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies.

UNIT VI

Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.

Practical

- Determination of water infiltration characteristics and water holding capacity of soil profiles
- Moisture extraction pattern of crops
- Consumptive use, water requirement of a given cropping pattern for optimum/variable productivity
- Crop planning at the farm and project level
- Agronomic evaluation of irrigation projects, case studies

Suggested Readings

FAO. 1984. *Irrigation Practice and Water Management*. Oxford & IBH.

Michael AM. 1978. *Irrigation: Theory and Practice*. Vikas Publ.

Mishra RR & Ahmad M. 1987. *Manual on Irrigation and Agronomy*. Oxford & IBH.

Panda SC. 2003. *Principles and Practices of Water Management*. Agrobios.

Reddy SR. 2000. *Principles of Crop Production*. Kalyani.

Sankara Reddy GH & Yellamananda Reddy 1995. Efficient Use of Irrigation Water. In: Gupta US. (Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.

Singh SS. 2006. Principles and Practices of Agronomy. In: Gupta US.

(Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.

Objective

To teach about the changing weed flora, new herbicides, their resistance, toxicity, antidotes and residue management under different cropping systems.

Theory

UNIT I

Crop-weed competition in different cropping situations; changes in weed flora, various causes and affects.

UNIT II

Physiological and biological aspects of herbicides, their absorption, translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them.

UNIT III

Climatic factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, residue management of herbicides, adjuvants.

UNIT IV

Advances in herbicide application techniques; herbicide resistance; antidotes and crop protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides.

UNIT V

Development of transgenic herbicide resistant crops; herbicide development, registration procedures.

UNIT VI

Relationship of herbicides with tillage, fertilizer and irrigation; bioherbicides, allelochemical herbicide bioassays.

Suggested Readings

Aldrich RJ & Kramer R.J. 1997. *Principles in Weed Management*. Panama Publ.

Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed.

Wiley-Inter Science.

Gupta OP. 2000. *Weed Management – Principles and Practices*. Agrobios. Mandal RC. 1990.

Weed, Weedicides and Weed Control - Principles and Practices. Agro-Botanical Publ.

Rao VS. 2007. *Principles of Weed Science*. Oxford & IBH.

Ross MA & Carola Lembi A. 1999. *Applied Weed Science*. 2nd Ed. Prentice Hall.

Subramanian SAM & Kumar R.J. 1997. *All About Weed Control*. Kalyani.

Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic Press.

AGRON 607 INTEGRATED FARMING SYSTEMS FOR SUSTAINABLE 2+0
AGRICULTURE

Objective

To apprise about different enterprises suitable for different agroclimatic conditions for sustainable agriculture.

Theory

UNIT I

Farming systems: definition and importance; classification of farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises.

UNIT II

Concept of sustainability in farming systems; efficient farming systems; natural resources - identification and management.

UNIT III

Production potential of different components of farming systems; interaction and mechanism of different production factors; stability in different systems through research; eco-physiological approaches to intercropping.

UNIT IV

Simulation models for intercropping; soil nutrient in intercropping; preparation of different farming system models; evaluation of different farming systems.

UNIT V

New concepts and approaches of farming systems and cropping systems and organic farming; case studies on different farming systems.

Suggested Readings

- Ananthakrishnan TN. (Ed.) 1992. *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford & IBH.
- Balasubramanian P & Palaniappan SP 2006. *Principles and Practices of Agronomy*. Agrobios.
- Joshi M & Parbhakarasetty TK. 2005. *Sustainability through Organic Farming*. Kalyani.
- Lampin N. 1990. *Organic Farming*. Farming Press Books.
- Palaniappan SP & Anandurai K. 1999. *Organic Farming - Theory and Practice*. Scientific Publ.
- Panda SC. 2004. *Cropping systems and Farming Systems*. Agribios.
- Reddy MV. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.
- Sharma AK. 2001. *A Hand Book of Organic Farming*. Agrobios.
- Singh SP. (Ed) 1994. *Technology for Production of Natural Enemies*. PDBC, Bangalore.
- Trivedi RN. 1993. *A Text Book of Environmental Sciences*. Anmol Publ. Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture*. Association for Promotion of Organic Farming, Bangalore.
- Venkata Rao BV. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*. Publ. 3. Parisaraprajna Parishatana, Bangalore.

AGRON 608 SOIL CONSERVATION AND WATERSHED MANAGEMENT 2+1

Objective

To teach about different soil moisture conservation technologies for enhancing the agricultural productivity through holistic approach watershed management.

Theory

UNIT I

Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion.

UNIT II

Soil conservation: definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; vegetative barriers; improved dry farming practices; mechanical measures - bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts.

UNIT III

Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas.

UNIT IV

Land use capability classification, alternate land use systems; agro-forestry; ley farming; *jhum* management - basic concepts, socio-ethnic aspects, its layout.

UNIT V

Drainage considerations and agronomic management; rehabilitation of abandoned *jhum* lands and measures to prevent soil erosion.

Practical

- Study of different types of erosion
- Field studies of different soil conservation measures
- Run-off and soil loss measurements
- Laying out run-off plot and deciding treatments
- Identification of different grasses and trees for soil conservation
- Visit to a soil conservation research centre, demonstration and training centre

Suggested Readings

Arakeri HR & Roy D. 1984. *Principles of Soil Conservation and Water Management*. Oxford & IBH.

Dhruvanarayana VV. 1993. *Soil and Water Conservation Research in India*. ICAR.

FAO. 2004. *Soil and Water Conservation in Semi-Arid Areas*. *Soils Bull.*, Paper 57.

Frederick RT, Hobbs J, Arthur D & Roy L. 1999. *Soil and Water Conservation: Productivity and Environment Protection*. 3rd Ed. Prentice Hall.

Gurmel Singh, Venkataraman CG, Sastry B & Joshi P. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.

Murthy VVN. 1995. *Land and Water Management Engineering*. Kalyani. Tripathi RP & Singh HP. 1993. *Soil Erosion and Conservation*. Wiley Eastern. Yellamanda Reddy T & Sankara

Reddy GH. 1992. *Principles of Agronomy*. Kalyani.

AGRONOMY

List of Journals

- ✓ Advances in Agronomy
- ✓ Agriculture, Ecosystems and Environment
- ✓ Agricultural Systems
- ✓ Agricultural Water Management
- ✓ Agronomy Journal
- ✓ Annual Review of Plant Physiology
- ✓ Applied Ecology and Environment Research
- ✓ Australian Journal of Agricultural Research
- ✓ Australian Journal of Experimental Agriculture
- ✓ Crop Protection
- ✓ Environment and Ecology
- ✓ European Journal of Agronomy
- ✓ Fertilizer Research
- ✓ Field Crops Research
- ✓ Indian Journal of Agricultural Sciences
- ✓ Indian Journal of Agronomy
- ✓ Indian Journal of Ecology
- ✓ Indian Journal of Weed Science
- ✓ Irrigation Science
- ✓ Japanese Journal of Crop Science
- ✓ Journal of Agronomy
- ✓ Journal of Applied Ecology
- ✓ Journal of Experimental Botany
- ✓ Journal of Farming Systems Research
- ✓ Journal of Range Management
- ✓ Journal of Agricultural Science Cambridge
- ✓ Journal of Sustainable Agriculture
- ✓ Netherlands Journal of Agricultural Sciences
- ✓ Nutrient Cycling in Agroecosystems
- ✓ Pesticide Biochemistry and Physiology
- ✓ Plant and Soil
- ✓ Plant Production Science
- ✓ Soil and Tillage Research
- ✓ Swedish Journal of Agricultural Research
- ✓ Tropical Agriculture
- ✓ Weed Research

Suggested Broad Topics for Master's and Doctoral Research

- Crop diversification under different agricultural situations
- Development of farming systems for marginal, small and other farmers
- Agricultural information at door step/click of mouse
- Farm-specific nutrient management
- Weed management in different cropping/farming systems
- Nutrient studies in different cropping/farming system
- Biodiversity of farming systems for conservation
- Organic farming systems for different regions
- Modeling for different crop situations
- Conservation agriculture for yield sustainability
- Role of edaphic factors on weeds proliferation and management
- Implications of global warming on weed growth and herbicide behaviour
- Ecological implications of using thresholds for weed management
- Effect of cultivation practices and herbicides on weed flora shift
- GM crops and weed management strategies
- Weed management under reduced moisture regime in major summer/*khariif* crops
- Avoidance of herbicide resistance using IWM

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SOIL SCIENCE

Course Contents

SOILS 510 REMOTE SENSING AND GIS TECHNIQUES FOR 2+1
SOIL, WATER AND CROP STUDIES

Objective

To impart knowledge about the basic concepts of remote sensing, aerial photographs and imageries, and their interpretation; application of remote sensing in general and with special reference to soil, plants and yield forecasting; to impart knowledge about geo-statistical techniques with special reference to krigging, and GIS and applications in agriculture.

Theory

UNIT I

Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter.

UNIT II

Sensor systems - camera, microwave radiometers and scanners; fundamentals of aerial photographs and image processing and interpretations.

UNIT III

Application of remote sensing techniques - land use soil surveys, crop stress and yield forecasting, prioritization in watershed and drought management, wasteland identification and management.

UNIT IV

Significance and sources of the spatial and temporal variability in soils; variability in relation to size of sampling; classical and geo-statistical techniques of evolution of soil variability.

UNIT V

Introduction to GIS and its application for spatial and non-spatial soil and land attributes.

Practical

- Familiarization with different remote sensing equipments and data products
- Interpretation of aerial photographs and satellite data for mapping of land resources
- Analysis of variability of different soil properties with classical and geostatistical techniques
- Creation of data files in a database programme
- Use of GIS for soil spatial simulation and analysis
- To enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning

Suggested Readings

- Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
- Elangovan K. 2006. *GIS Fundamentals, Applications and Implementations*. New India Publ. Agency.
- Lillesand TM & Kiefer RW. 1994. *Remote Sensing and Image Interpretation*. 3rd Ed. Wiley.
- Nielsen DR & Wendroth O. 2003. *Spatial and Temporal Statistics*. Catena Verlag GmbH.
- Star J & Esles J. 1990. *Geographic Information System: An Introduction*. Prentice Hall.

SOILS 511 ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS 0+2

Objective

To familiarize the students with commonly used instruments – their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

Practical

UNIT I

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation-reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

UNIT II

Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils.

UNIT III

Principles of visible, ultraviolet and infrared spectrophotometry, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray diffractometry; identification of minerals by X-ray by different methods.

UNIT IV

Electrochemical titration of clays; determination of cation and anion exchange capacities of soils; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.

UNIT V

Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods.

UNIT VI

Determination of lime and gypsum requirement of soil; drawing normalized exchange isotherms; measurement of redox potential.

UNIT VII

Analysis of soil extracts and irrigation waters for their soluble cations and anions and interpretation of results.

Suggested Readings

Hesse P. 1971. *Textbook of Soil Chemical Analysis*. William Clowes & Sons. Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India. Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.

Kenneth Helrich 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists.

Page AL, Miller RH & Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.

Piper CE. *Soil and Plant Analysis*. Hans Publ.

Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis – A Methods Manual*. IARI, New Delhi.

Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.

Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Waters*. FDCO, New Delhi.

Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman.

Objective

To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

Theory

UNIT I

Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils, and factors responsible.

UNIT II

Morphological features of saline, sodic and saline-sodic soils; characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties.

UNIT III

Management of salt-affected soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils.

UNIT IV

Acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management.

UNIT V

Quality of irrigation water; management of brackish water for irrigation; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality.

UNIT VI

Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

Practical

- Characterization of acid, acid sulfate, salt-affected and calcareous soils
- Determination of cations (Na^+ , K^+ , Ca^{++} and Mg^{++}) in ground water and soil samples
- Determination of anions (Cl^- , SO_4^{--} , CO_3^{--} and HCO_3^-) in ground waters and soil samples
- Lime and gypsum requirements of acid and sodic soils

Suggested Readings

Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.

Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.

USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.

Objective

To impart knowledge about how different fertilizers are manufactured using different kinds of raw materials and handling of fertilizers and manures.

Theory

UNIT I

Fertilizers – production, consumption and future projections with regard to nutrient use in the country and respective states; fertilizer control order.

UNIT II

Manufacturing processes for different fertilizers using various raw materials, characteristics and nutrient contents.

UNIT III

Recent developments in secondary and micronutrient fertilizers and their quality control as per fertilizer control order.

UNIT IV

New and emerging issues in fertilizer technology – production and use of slow and controlled release fertilizers, supergranules fertilizers and fertilizers for specific crops/situations.

Suggested Readings

- Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. Pearson Edu.
Fertilizer (Control) Order, 1985 and the Essential Commodities Act. FAI New Delhi.
Kanwar JS. (Ed.). 1976. *Soil Fertility: Theory and Practice*. ICAR.
Olson RA, Army TS, Hanway JJ & Kilmer VJ. 1971. *Fertilizer Technology and Use*. 2nd Ed. Soil Sci. Soc. Am. Madison.
Prasad R & Power JF. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.
Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. *Soil Fertility and Fertilizers*. McMillan Publ.
Vogel AI. 1979. *Textbook of Quantitative Inorganic Analysis*. ELBS

Objective

To impart knowledge related to various factors and processes of land degradation and their restoration techniques.

Theory

UNIT I

Type, factors and processes of soil/land degradation and its impact on soil productivity, including soil fauna, biodegradation and environment.

UNIT II

Land restoration and conservation techniques - erosion control, reclamation of salt-affected soils; mine land reclamation, afforestation, organic products.

UNIT III

Extent, diagnosis and mapping of land degradation by conventional and modern RS-GIS tools; monitoring land degradation by fast assessment, modern tools, land use policy, incentives and participatory approach for reversing land degradation; global issues for twenty first century.

Suggested Readings

- Biswas TD & Narayanasamy G. (Eds.). 1996. *Soil Management in Relation to Land Degradation and Environment*. Bull. Indian Soc. Soil Sci. 17, New Delhi.
- Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society of America, Madison.
- Greenland DJ & Szabolcs I. 1994. *Soil Resilience and Sustainable Land Use*. CABI.
- Lal R, Blum WEH, Vailentine C & Stewart BA. 1997. *Methods for Assessment of Soil Degradation*. CRC Press.
- Sehgal J & Abrol IP. 1994. *Soil Degradation in India - Status and Impact*. Oxford & IBH.

Objective

To provide knowledge of modern concepts of soil fertility and nutrient use in crop production.

Theory

UNIT I

Modern concepts of nutrient availability; soil solution and plant growth; nutrient response functions and availability indices.

UNIT II

Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.

UNIT III

Chemical equilibria (including solid-solution equilibria) involving nutrient ions in soils, particularly in submerged soils.

UNIT IV

Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.

UNIT V

Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture.

UNIT VI

Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.

Suggested Readings

- Barber SA. 1995. *Soil Nutrient Bioavailability*. John Wiley & Sons.
- Barker V Allen & Pilbeam David J. 2007. *Handbook of Plant Nutrition*. CRC / Taylor & Francis.
- Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Educ.
- Cooke GW. 1979. *The Control of Soil Fertility*. Crossby Lockwood & Sons.
- Epstein E. 1987. *Mineral Nutrition of Plants - Principles and Perspectives*. International Potash Institute, Switzerland.
- Kabata- Pendias Alina 2001. *Trace Elements in Soils and Plants*. CRC / Taylor & Francis.
- Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers Technology*. Scientific Publ.
- Mortvedt JJ, Shuman LM, Cox FR & Welch RM. (Eds.). 1991. *Micronutrients in Agriculture*. 2nd Ed. Soil Science Society of America, Madison.
- Prasad R & Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.
- Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients*. John Wiley & Sons.
- Stevenson FJ. (Ed.). 1982. *Nitrogen in Agricultural Soils*. Soil Science Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1990. *Soil Fertility and Fertilizers*. 5th Ed. Macmillan Publ.
- Wild A. (Ed.). 1988. *Russell's Soil Conditions and Plant Growth*. 11th Ed. Longman.

SOILS 606 LAND USE PLANNING AND WATERSHED 2+0
MANAGEMENT

Objective

To teach the better utilization of land for agricultural purposes, and better management of run-off or surplus/excessive rain-water in the catchment area for agricultural purposes in a watershed.

Theory

UNIT I

Concept and techniques of land use planning; factors governing present land use.

UNIT II

Land evaluation methods and soil-site suitability evaluation for different crops; land capability classification and constraints in application.

UNIT III

Agro-ecological regions/sub-regions of India and their characteristics in relation to crop production.

UNIT IV

Water harvesting - concept, significance, types, methodology; use of harvested water in agriculture to increase water productivity.

UNIT V

Watershed development/management - concept, objectives, characterization, planning, execution, community participation and evaluation; rehabilitation of watershed; PRA; developing economically and ecologically sustainable agro-forestry systems for watershed; case studies.

Suggested Readings

- All India Soil and Land Use Survey Organisation 1970. Soil Survey Manual. IARI, New Delhi.
FAO. 1976. A Framework for Land Evaluation, Handbook 32. FAO.
Sehgal JL, Mandal DK, Mandal C & Vadivelu S. 1990. Agro-Ecological Regions of India. NBSS & LUP, Nagpur.
Soil Survey Staff 1998. Keys to Soil Taxonomy. 8th Ed. USDA & NRCS, Washington, DC.
USDA 1974. A Manual on Conservation of Soil and Water Handbook of Professional Agricultural Workers. Oxford & IBH.

SOIL SCIENCE

List of Journals

- ✓ Advances in Agronomy
- ✓ Annals of Arid Zone
- ✓ Australian Journal of Agricultural Research
- ✓ Australian Journal of Soil Research
- ✓ Biology and Fertility of Soils
- ✓ Communications in Soil Science and Plant Analysis
- ✓ Clays and Clay mineral
- ✓ European Journal of Soil Science
- ✓ Geoderma
- ✓ Indian Journal of Agricultural Sciences
- ✓ Journal of Plant Nutrition and Soil Science
- ✓ Journal of the Indian Society of Soil Science
- ✓ Nutrient Cycling in Agroecosystems
- ✓ Plant and Soil
- ✓ Soil and Tillage Research
- ✓ Soil Biology and Biochemistry
- ✓ Soil Science
- ✓ Soil Science Society of America Journal
- ✓ Soil Use and Management
- ✓ Water, Air and Soil Pollution
- ✓ Water Resources Research

Suggested Broad Topics for Master's and Doctoral Research

- Degradation and restoration of soil as natural resource
- Biochemistry of processes at the soil-root interface
- Impact of current agricultural practices and agrochemicals on soil quality/biodiversity
- Integrated nutrient management for sustainable agriculture
- Fertilizer use efficiency in different soil conditions/cropping systems
- Use of remote sensing and GIS as diagnostic tool for natural resource management
- Role of biological agents in soil productivity
- Modeling solute (salt, fertilizer, pesticides) transport in soil
- Use of poor quality waters in Agriculture
- Soil testing and crop response
- Site-specific nutrient management and precision agriculture
- Nutrient dynamics in soil-plant system and modeling nutrient uptake
- Tillage and crop residue management in crop production
- Utilization of urban and industrial wastes/effluents in Agriculture
- Management of problematic soils
- Impact of climate change on soil processes
- Micronutrients in soil, plant and human health
- Water management strategies in different cropping systems
- Simulation models for growth and production of different crops

- Varietals response to soil salinity/ sodicity/ nutrients/ pollutants, etc
- Soil and water pollution - monitoring and control
- Genesis, formation and classification of soils
- Soil conservation, preservation and management for sustainable agriculture
- Remediation of polluted and contaminated soils

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GENETICS AND PLANT BREEDING

Course Contents

GP 504 PRINCIPLES OF QUANTITATIVE GENETICS 2+1

Objective

To impart theoretical knowledge and computation skills regarding component of variation and variances, scales, mating designs and gene effects.

Theory

UNIT I

Mendelian traits vs polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, genotypic and environmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects.

UNIT II

Principles of Analysis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance.

UNIT III

Designs for plant breeding experiments – principles and applications; Genetic diversity analysis – metroglyph, cluster and D₂ analyses - Association analysis - phenotypic and genotypic correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses; Selection indices - selection of parents; Simultaneous selection models- concepts of selection - heritability and genetic advance.

UNIT IV

Generation mean analysis; Mating designs- Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis of genotype x environment interaction - adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis – principles and interpretation.

UNIT V

QTL mapping; Strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in Genetic analysis; Marker assisted selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS.

Practical

Problems on multiple factors inheritance - Partitioning of variance - Estimation of heritability and genetic advance - Covariance analysis - Metroglyph analysis - D₂ analysis - Grouping of clusters and interpretation- Cluster analysis - Construction of cluster diagrams and dendrograms - interpretation - Correlation analysis - Path analysis - Parent-progeny regression analysis - Diallel analysis: Griffing's methods I and II – Diallel analysis: Hayman's graphical approach - Diallel analysis: interpretation of results - NCD and their interpretations - Line x tester analysis and interpretation of results - Estimation of heterosis : standard, mid-parental and better-parental heterosis - Estimation of inbreeding depression - Generation mean analysis:

Analytical part and Interpretation – Estimation of different types of gene actions. Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions -Construction of saturated linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Markerlinkage studies - Working out efficiency of selection methods in different populations and interpretation, Biparental mating, Triallel analysis, Quadriallel analysis and Triple Test Cross (TTC) – use of softwares in analysis and result interpretation, Advanced biometrical models for combining ability analysis, Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model - PrincipalComponent Analysis model - Additive and multiplicative model – Shifted multiplicative model - Analysis and selection of genotypes - Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes.

Suggested Readings

- Bos I & Caligari P. 1995. *Selection Methods in Plant Breeding*. Chapman & Hall.
- Falconer DS & Mackay J. 1998. *Introduction to Quantitative Genetics*. Longman.
- Mather K & Jinks JL. 1971. *Biometrical Genetics*. Chapman & Hall.
- Mather K & Jinks JL. 1983. *Introduction to Biometrical Genetics*. Chapman & Hall.
- Nadarajan N & Gunasekaran M. 2005. *Quantitative Genetics and Biometrical Techniques in Plant Breeding*. Kalyani.
- Naryanan SS & Singh P. 2007. *Biometrical Techniques in Plant Breeding*. Kalyani.
- Singh P & Narayanan SS. 1993. *Biometrical Techniques in Plant Breeding*. Kalyani.
- Singh RK & Choudhary BD. 1987. *Biometrical Methods in Quantitative Genetics*. Kalyani.
- Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete Population Genetic Data*. Sinauer Associates.
- Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.

Objective

To provide understanding about mechanisms of heterosis and its exploitation for yield improvement through conventional and biotechnological approaches.

Theory

UNIT I

Historical aspect of heterosis - Nomenclature and definitions of heterosis - Heterosis in natural population and inbred population; Evolutionary aspects - Genetic consequences of selfing and crossing in self- and cross-pollinated and asexually propagated crops.

UNIT II

Pre Mendelian and Post-Mendelian ideas - Genetic theories of heterosis –Physiological, Biochemical and molecular factors underlining heterosis; theories and their estimation; - Evolutionary concepts of heterosis.

UNIT III

Prediction of heterosis from various crosses- Inbreeding depression, frequency of inbreeding and residual heterosis in F₂ and segregating populations, importance of inbreeding in exploitation of heterosis – case studies. - Relationship between genetic distance and expression of heterosis – case studies; Divergence and Genetic Distance analyses-morphological and molecular genetic distance in predicting heterosis, Development of heterotic pools in germplasm/genetic stocks and inbreds, their improvement for increasing heterosis.

UNIT IV

Types of male sterility and use in heterosis breeding; Maintenance, transfer and restoration of different types of male sterility; Use of self-incompatibility in development of hybrids; Hybrid seed production system: 3-line, 2-line and 1-line system; Development of inbreds and parental lines- A, B and R lines – functional male sterility; Commercial exploitation of heterosis-maintenance breeding of parental lines in hybrids.

UNIT V

Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops; Male sterile line creation and diversification in self pollinated, cross pollinated and asexually propagated crops; problems and prospects; Apomixis in fixing heterosis-concept of single line hybrid.

UNIT VI

Organellar heterosis and complementation - Creation of male sterility through genetic engineering and its exploitation in heterosis.

UNIT VII

Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops.

Practical

Selection indices and selection differential – Calculations and interpretations - Male sterile line characterization in millets; Using morphological descriptors; Restorer line identification and diversification of male sterile sources - Male sterile line creation in dicots comprising oilseeds, pulses and cotton ; problems in creation of CGMS system; Ways of overcoming them - Male sterile line creation, diversification and restoration in forage crops; Understanding the difficulties in breeding apomicts; Estimation of heterotic parameters in self, cross and asexually propagated crops - Estimation from the various models for heterosis parameters -Hybrid seed

production in field crops – an account on the released hybrids; their potential; Problems and ways of overcoming it; hybrid breeding at National and International level; Opportunities ahead.

Suggested Readings

Proceedings of *Genetics and Exploitation of Heterosis in Crops* – An International Symposium CIMMYT, 1998.

Akin E. 1979. *The Geometry of Population Genetics*. Springer-Verlag.

Ben Hui Lin. 1998. *Statistical Genomics – Linkage, Mapping and QTL Analysis*. CRC Press.

De Jong G. 1988. *Population Genetics and Evolution*. Springer-Verlag. Hartl DL. 2000. *A Primer of Population Genetics*. 3rd Ed. Sinauer Assoc.

Mettler LE & Gregg TG. 1969. *Population Genetics and Evolution*. Prentice-Hall.

Montgomery DC. 2001. *Design and Analysis of Experiments*. 5th Ed., Wiley & Sons.

Richards AJ. 1986. *Plant Breeding Systems*. George Allen & Unwin.

Srivastava S & Tyagi R. 1997. *Selected Problems in Genetics*. Vols. I, II. Anmol Publ.

Objective

To impart knowledge and practical skills to use biotechnological tools in crop improvement.

Theory

UNIT I

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.

UNIT II

Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

UNIT III

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F₂s, back crosses, RILs, NILs and DH).

UNIT IV

Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding.

UNIT V

Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs.

UNIT VI

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.

UNIT VII

Biotechnology applications in male sterility/hybrid breeding, molecular farming.

UNIT VIII

MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights

UNIT IX

Bioinformatics & Bioinformatics tools.

UNIT X

Nanotechnology and its applications in crop improvement programmes.

Practical

Requirements for plant tissue culture laboratory-Techniques in plant tissue culture - Media components and media preparation -Aseptic manipulation of various explants ; observations on the contaminants occurring in media – interpretations - Inoculation of explants;

Callus induction and plant regeneration - Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures - Visit to commercial micropropagation unit. Transformation using *Agrobacterium* strains, GUS assay in transformed cells / tissues. DNA isolation, DNA purity and quantification tests, gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

Suggested Readings

Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology: Concepts, Methods and Applications*. Oxford & IBH.

Gupta PK. 1997. *Elements of Biotechnology*. Rastogi Publ.

Hackett PB, Fuchs JA & Messing JW. 1988. *An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation*. 2nd Ed. Benjamin Publ. Co.

Sambrook J & Russel D. 2001. *Molecular Cloning - a Laboratory Manual*. 3rd Ed. Cold Spring Harbor Lab. Press.

Singh BD. 2005. *Biotechnology, Expanding Horizons*. Kalyani.

Objective

To apprise about various abiotic and biotic stresses influencing crop yield, mechanisms and genetics of resistance and methods to breed stress resistant varieties.

Theory

UNIT I

Importance of plant breeding with special reference to biotic and abiotic stress resistance; Classification of biotic stresses – major pests and diseases of economically important crops - Concepts in insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence responses to pathogen invasions- Biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions; Concept of signal transduction and other host-defense mechanisms against viruses and bacteria.

UNIT II

Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants. Quantitative resistance/Adult plant resistance and Slow rusting resistance - Classical and molecular breeding methods - Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies.

UNIT III

Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications.

UNIT IV

Classification of abiotic stresses - Stress inducing factors –moisture stress/drought and water logging & submergence; Acidity, salinity/alkalinity/sodicity; High/low temperature, wind, etc. Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.

UNIT V

Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable to low water regimes and water logging & submergence, high and low/freezing temperatures; Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton etc; Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/contaminants in soil, water and environment.

UNIT VI

Exploitation of wild relatives as a source of resistance to biotic and abiotic factors in major field crops - Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitinases and Bt for diseases and insect pest management- Achievements.

Practical

Phenotypic screening techniques for sucking pests and chewing pests – Traits to be observed at plant and insect level - Phenotypic screening techniques for nematodes and borers; Ways of combating them; Breeding strategies - Weeds – ecological, environmental impacts on

the crops; Breeding for herbicide resistance - Evaluating the available populations like RIL, NIL etc. for pest resistance; Use of standard MAS procedures - Phenotypic screening methods for diseases caused by fungi and bacteria; Symptoms and data recording; use of MAS procedures - Screening forage crops for resistance to sewage water and tannery effluents; Quality parameters evaluation - Screening crops for drought and flood resistance; factors to be considered and breeding strategies - Screening varieties of major crops for acidity and alkalinity- their effects and breeding strategies; Understanding the climatological parameters and predisposal of biotic and abiotic stress factors- ways of combating them.

Suggested Readings

- Blum A. 1988. *Plant Breeding for Stress Environments*. CRC Press.
- Christiansen MN & Lewis CF. 1982. *Breeding Plants for Less Favourable Environments*. Wiley International.
- Fritz RS & Simms EL. (Eds.). 1992. *Plant Resistance to Herbivores and Pathogens: Ecology, Evolution and Genetics*. The University of Chicago Press.
- Li PH & Sakai A. 1987. *Plant Cold Hardiness*. Liss, New York
- Luginpill P. 1969. *Developing Resistant Plants - The Ideal Method of Controlling Insects*. USDA, ARS, Washington DC.
- Maxwell FG & Jennings PR. (Eds.). 1980. *Breeding Plants Resistant to Insects*. John Wiley & Sons.
- Painter RH. 1951. *Insect Resistance in Crop Plants*. MacMillan, New York. Russel GE. 1978. *Plant Breeding for Pest and Disease Resistance*. Butterworths.
- Sakai A & Larcher W. 1987. *Frost Survival in Plants*. Springer-Verlag.
- Turener NC & Kramer PJ. 1980. *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons.
- van der Plank JE. 1982. *Host-Pathogen Interactions in Plant Disease*. Academic Press.

GENETICS AND PLANT BREEDING

List of Journals

- ✓ Australian Journal of Biological Sciences, Australia
- ✓ Australian Journal of Agricultural Research, Australia
- ✓ Biometrics, UK
- ✓ BioTechniques
- ✓ Cereal Research Communication, Hungary
- ✓ Cotton Research and Development, Hisar, India
- ✓ Crop Improvement, Ludhiana
- ✓ Crop Science, USA
- ✓ Current Science, Bangalore
- ✓ Critical Reviews in Plant Sciences
- ✓ Czech Journal of Plant Breeding Genetics, Prague,
- ✓ Electronic Journal of Biotechnology
- ✓ Euphytica, The Netherlands
- ✓ FABIS Newsletter
- ✓ Forage Research, Hisar, India
- ✓ Genetics, USA
- ✓ Genome, Canada
- ✓ Genetic resources and crop evolution, Netherlands
- ✓ Haryana Agricultural University Journal of Research, Hisar, India
- ✓ Heredity
- ✓ Hilgardia, Sweden,
- ✓ Indian Journal of Agricultural Research, New Delhi
- ✓ Indian Journal of Genetics and Plant Breeding, New Delhi
- ✓ Indian Journal of Plant Genetic Resources, New Delhi
- ✓ International Chickpea Newsletter, ICRISAT
- ✓ International Rice Research Notes, IRRI, Philippines
- ✓ Journal of Agricultural Research, U.K.
- ✓ Journal of Biochemistry and Biotechnology, New Delhi
- ✓ Journal of Genetics and Breeding, Italy
- ✓ Journal of Heredity
- ✓ Journal of Pulses Research, Kanpur
- ✓ Legume Research, Karnal
- ✓ MILWAI Newsletter
- ✓ Madras Agricultural Journal, Coimbatore, India
- ✓ Molecular Breeding, USA
- ✓ Mutation Research
- ✓ National Journal of Plant Sciences, Hisar, India
- ✓ Nucleic Acids Research, USA
- ✓ Oryza, Cuttack, India
- ✓ PGR Newsletter, Syria

- ✓ Plant Breeding, Germany
- ✓ Plant Molecular Biology, The Netherlands
- ✓ Rachis, Syria
- ✓ Sorghum and Millet Newsletter, ICRISAT
- ✓ Theoretical and Applied Genetics, Germany
- ✓ Wheat Research, Japan.

e-Resources

Name of the Journal URL

Agronomy Research <http://www.eau.ee/~agronomy/>
 Asian Journal of Plant Sciences
<http://ansijournals.com/3/c4p.php?id=1&theme=3&jid=ajps>
 Breeding Science <http://www.jstage.jst.go.jp/browse/jsbbs>
 Current Science <http://www.ias.ac.in/currsci/index.html>
 International Journal of Botany
<http://ansijournals.com/3/c4p.php?id=1&theme=3&jid=ijb>
 International Journal of Sociology
 of Agriculture and Food <http://www.csafe.org.nz/ijsaf/>
 Japan Agricultural Research
 Quarterly
<http://ss.jircas.affrc.go.jp/english/publication/jarq/index.html>
 Japanese Journal of Crop Sc. <http://www.jstage.jst.go.jp/browse/jcs>
 Journal of Agronomy <http://ansijournals.com/3/c4p.php?id=1&theme=3&jid=ja>
 Journal of Biosciences <http://www.ias.ac.in/jbiosci/index.html>
 Journal of Cotton Science <http://www.cotton.org/journal/>
 Journal of Genetics <http://www.ias.ac.in/jgenet/index.html>
 Plant Biotechnology <http://www.jstage.jst.go.jp/browse/plantbiotechnology>
 Plant Production Science <http://www.jstage.jst.go.jp/browse/pps>
 Scientia Agraria <http://calvados.c3sl.ufpr.br/ojs2/index.php/agraria>
 Tropicultura <http://www.bib.fsagx.ac.be/tropicultura/>
 Turkish Journal of Agriculture and
 Forestry Sciences <http://journals.tubitak.gov.tr/agriculture/index.php>
 Other Major Portals for Genetics and Plant Breeding
<http://www.icrisat.org/>
<http://121.244.161.11/Search/QuickSearch.asp>
<http://www.plantstress.com/WRFfiles/literaturewr.htm> (portal for several sites)
http://www2.unil.ch/lpc/docs/index_plants.htm (portal for several sites)
<http://www.dnaftb.org/dnaftb/> (portal for several sites)

Suggested Broad Areas for Master's and Doctoral Research

Studies on introgressions, gene transfers, gene identification, location and localization with the application of technologies such as, in situ hybridization, chromosome identification like FISH (Fluorescent In Situ Hybridization), GISH (Genomic In Situ Hybridization), Spectral Karyotyping (SKY) and Multiplex Fluorescence In Situ Hybridization (M-FISH) etc. Studies on stay-green traits in relation to genes affecting efficiency of photosynthesis, biotic/abiotic stress tolerance Genetics of AGP system for better photosynthesis and translocation Identification of genes/QTLs for NUE and WUE Molecular markers tagged to genes/QTLs identified for improvement of nutrient use efficiency, water use efficiency MAS based mobilization of transgenes for tolerance to biotic and abiotic stresses into desirable agronomic backgrounds. Breeding methodologies to enhance selection efficiency. Component approaches and development of selection criteria for quantitative trait improvement Stability analyses and methods to estimate the G X E components in breeding Materials Relative efficiency analyses of genetic component estimation for reliable use in developing selection criteria in crop plants. Distance and divergence statistics for identification of similarity assessment among genetic stocks and parental genetic material Linear and quadratic distance measures to identify relative contribution of component traits for complex traits Studies on genetic and molecular bases of stress tolerance to develop molecular diagnostics for screening/identification of stress tolerant genotypes Use of aneuploids for gene location and source for transfer through wild species Development and trisomic and monosomic series in diploids and polyploids Dependable marker systems for detection of introgression in wide crosses with minimized linkage drag Analysis of Resistance Gene analogues and their use in MAS with enhanced disease resistance Analysis of Gene analogues and expression synteny and their use in MAS with enhanced quality and trait expression Refinements in embryo rescue and consequent diploidization for production of double haploids Use of molecular markers in phylogenetic analysis Breeding through distant hybridization route for New Plant Type for breaking yield barriers Genetics of durable, quantitative resistance and adult plant resistance in major crops against known pathogens Development of tools and methodologies for identification of genes responsible for resistance against polyphagous insects Development of alien addition lines and telocentric lines in crops Microarray technique and robotics for identification of useful genes in crops Characterization of germplasm through molecular and serological techniques Induction of novel variation through mutagenesis tools and identify novel genes for different traits Development of heterotic pools for maximized heterosis in cross and self pollinated crops where hybrid seed production tools are available Genetics and traits responsible for terminal and initial heat tolerance in wheat, maize and mustard Genetics of cold tolerance related traits in maize, rice and pigeonpea Widening the QPM base in maize and prebreeding to add value to the genetic stocks of QPM Comparison of relative efficiency of different softwares in analysis of quantitative trait loci and linkages Biochemical and molecular bases of signal transduction in host-pathogen interactions Metal binding proteins for identification of phytoremediators Crop improvement for biomass energy and industrial use Development of cytogenetic stocks through varietal/alien chromosome substitutions

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Supporting Department Courses

AGRICULTURAL STATISTICS Course Contents

STAT 511 STATISTICAL METHODS FOR APPLIED SCIENCES 2+1

Objective

This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques.

Theory

UNIT I

Classification, Tabulation and Graphical Representation of data, Box-Plot and Descriptive Statistics, Exploratory data analysis; Theory of Probability-Random Variable and Mathematical Expectation

UNIT II

Discrete and continuous probability distributions: Binomial, Poisson and Normal distributions and their applications. Concept of sampling distribution: chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions, Large Sample theory.

UNIT III

Introduction to theory of estimation and confidence intervals; Correlation and regression, Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients, Coefficient of Determination, Testing for heterogeneity.

UNIT IV

Non-parametric tests - Sign, Wilcoxon, Mann-Whitney U-test and Wald-Wolfowitz run test; Run test for the randomness of a sequence. Median test, Kruskal-Wallis test, Friedman two-way ANOVA by ranks and Kendall's coefficient of concordance.

UNIT V

Introduction to multivariate analytical tools- Hotelling's T^2 Tests of hypothesis about the mean vector of a multinormal population. Classificatory problems and discriminant function, D^2 -statistic and its applications; Cluster analysis, principal component analysis, canonical correlations and Factor analysis.

Practical

Exploratory data analysis, Box-Cox plots; Fitting of distributions ~ Binomial, Poisson and Normal; Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F ; Confidence interval estimation and point estimation of parameters of Binomial, Poisson and Normal distribution; Correlation and regression analysis; fitting of orthogonal polynomial regression; applications of dimensionality reduction and discriminant function analysis; Nonparametric tests.

Suggested Readings

Anderson TW. 1958. *An Introduction to Multivariate Statistical Analysis*. John Wiley.

Dillon WR & Goldstein M. 1984. *Multivariate Analysis - Methods and Applications*. John Wiley.

Goon AM, Gupta MK & Dasgupta B. 1977. *An Outline of Statistical Theory*. Vol. I. The World Press.

Goon AM, Gupta MK & Dasgupta B. 1983. *Fundamentals of Statistics*. Vol. I. The World Press.

Hoel PG. 1971. *Introduction to Mathematical Statistics*. John Wiley.

Learning Statistics: <http://freeststatistics.altervista.org/en/learning.php>

Electronic Statistics Text Book: <http://www.statsoft.com/textbook/stathome.html>.

Objective

This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory

UNIT I

Need for designing of experiments, characteristics of a good design; Basic principles of designs- randomization, replication and local control.

UNIT II

Uniformity Trials, Size and Shape of Plots and Blocks; Analysis of Variance; Completely Randomized Design, Randomized Block Design and Latin Square Design.

UNIT III

Factorial experiments, (symmetrical as well as asymmetrical), Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

UNIT IV

Split Plot and Strip Plot Designs, Analysis of Covariance and Missing Plot Techniques in Randomized Block and Latin Square Designs; Transformations, Lattice Design - concepts, randomization procedure, analysis and interpretation of results. Response Curves and Surfaces, Experiments with mixtures.

UNIT V

Introduction to Bio-assays with applications- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation

Practical

Uniformity trial data analysis, formation of plots and blocks, Fairfield analysis of data obtained from CRD, RBD and LSD; Analysis of Factorial Experiments without and with Confounding; Analysis with missing data; Split Plot and Strip Plot Designs; Transformation of data; Fitting of response Curves and Surfaces.

Suggested Readings:

Cochran WG & Cox GM. 1957. *Experimental Designs*. 2nd Ed. John Wiley.

Dean AM & Voss D. 1999. *Design and Analysis of Experiments*. Springer.

Federer WT. 1985. *Experimental Designs*. MacMillan.

Fisher RA. 1953. *Design and Analysis of Experiments*. Oliver & Boyd.

Nigam AK & Gupta VK. 1979. *Handbook on Analysis of Agricultural Experiments*. IASRI Publ.

Pearce SC. 1983. *The Agricultural Field Experiment: A Statistical Examination of Theory and Practice*. John Wiley.

Theory

UNIT I

Use of Software packages for: Summarization and tabulation of data; Descriptive statistics; Graphical representation of data, Exploratory data analysis.

UNIT II

Fitting and testing the goodness of fit of discrete and continuous probability distributions; Testing of hypothesis based on large sample test statistics; Testing of hypothesis using chi-square, t and F statistics.

UNIT III

Concept of Analysis Of Variance and Covariance of data for single factor, multi-factor, One-Way and Two-way classified experiments, multiple comparisons, Analyzing crossed and nested classified designs.

UNIT IV

Analysis of mixed models; Estimation of Variance Components; testing Correlation and Regression including Multiple Regression

UNIT V

Discriminant function; Factor analysis; Principal component analysis, fitting of non-linear models; Time series data

Practical

Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data. Robust Estimation, Testing linearity and normality assumption, Estimation of trimmed means etc., Cross tabulation of data including its statistics, cell display and table format and means for different sub-classifications; Fitting and testing the goodness of fit of probability distributions; Testing the hypothesis for one sample t -test, two sample t -test, paired t -test, test for large samples - Chi-squares test, F test, One way analysis of variance, contrast and its testing, pairwise comparisons; Multiway classified analysis of variance - cross-classification, nested classification, factorial set up, fixed effect models, random effect models, mixed effect models, estimation of variance components; Generalized linear models - analysis of unbalanced data sets, testing and significance of contrasts, Estimation of variance components in unbalanced data sets - maximum likelihood, ANOVA, REML, MINQUE; Bivariate and partial correlation, Distances - to obtain a distance matrix, dissimilarity measures, similarity measures; Linear regression, Multiple regression, Regression plots, Variable selection, Regression statistics, Fitting of growth models - curve estimation models, examination of residuals; Discriminant analysis - fitting of discriminant functions, identification of important variables, Factor analysis. Principal component analysis - obtaining principal component, spectral composition; Analysis of time series data - fitting of ARIMA models, working out moving averages. Spatial analysis; Neural networks.

Suggested Readings

- Anderson CW & Loynes RM. 1987. *The Teaching of Practical Statistics*. John Wiley.
Atkinson AC. 1985. *Plots Transformations and Regression*. Oxford University Press.
Chambers JM, Cleveland WS, Kleiner B & Tukey PA. 1983. *Graphical Methods for Data Analysis*. Wadsworth, Belmont, California.
Chatfield C & Collins AJ. 1980. *Introduction to Multivariate Analysis*. Chapman & Hall.

Chatfield C. 1983. *Statistics for Technology*. 3rd Ed. Chapman & Hall.
Chatfield C. 1995. *Problem Solving: A Statistician's Guide*. Chapman & Hall.
Cleveland WS. 1985. *The Elements of Graphing Data*. Wadsworth, Belmont, California.
Ehrenberg ASC. 1982. *A Primer in Data Reduction*. John Wiley.
Erickson BH & Nosanchuk TA. 1992. *Understanding Data*. 2nd Ed. Open University Press, Milton Keynes.
Snell EJ & Simpson HR. 1991. *Applied Statistics: A Handbook of GENSTAT Analyses*, Chapman & Hall.
Sprent P. 1993. *Applied Non-parametric Statistical Methods*. 2nd Ed. Chapman & Hall.
Tufto ER. 1983. *The Visual Display of Quantitative Information*. Graphics Press, Cheshire, Conn.
Velleman PF & Hoaglin DC. 1981. *Application, Basics and Computing of Exploratory Data Analysis*. Duxbury Press.
Weisberg S. 1985. *Applied Linear Regression*. John Wiley.
Wetherill GB. 1982. *Elementary Statistical Methods*. Chapman & Hall.
Wetherill GB. 1986. *Regression Analysis with Applications*. Chapman & Hall.
Learning Statistics: <http://freestatistics.altervista.org/en/learning.php>.
Free Statistical Softwares: <http://freestatistics.altervista.org/en/stat.php>.
Statistics
Glossary http://www.cas.lancs.ac.uk/glossary_v1.1/main.html.

Course on Experimental design:

<http://www.stat.sc.edu/~grego/courses/stat706/>.
Design Resources Server: www.iasri.res.in/design.
Analysis of Data: Design Resources Server.

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COMPULSORY NON-CREDIT COURSES

(Compulsory for Master's programme in all disciplines; Optional for Ph.D. scholars)

Course Contents

PGS 501 LIBRARY AND INFORMATION SERVICES 0+1

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information-Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical Writing –

Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills –

Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings

- Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild English Dictionary. 1995. Harper Collins.
 Gordon HM & Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston.
 Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
 James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
 Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
 Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
 Richard WS. 1969. *Technical Writing*. Barnes & Noble.
 Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*. Abhishek. Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.
 Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH & Maredia K.1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.

Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.

Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.

Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. *Technology Generation and IPR Issues*. Academic Foundation.

Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.

Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccumets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.

Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

- Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.
Punia MS. *Manual on International Research and Research Ethics*. CCS, Haryana Agricultural University, Hisar.
Rao BSV. 2007. *Rural Development Strategies and Role of Institutions -Issues, Innovations and Initiatives*. Mittal Publ.
Singh K.. 1998. *Rural Development - Principles, Policies and Management*. Sage Publ.

Objectives

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

- Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.
Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management*. Routledge.
Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India.

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***e* - Resources in Horticulture**

Australian Society for Horticultural Science	http://www.aushs.org.au/
Agricultural & Processed Food Products Export Development Authority (APEDA)	http://www.apeda.com/
American Society for Horticultural Science	http://www.ashs.org/
Asian Vegetable Research and Development Center (AVRDC)	http://www.avrdc.org.tw/
Australian Society for Horticultural Science	http://www.aushs.org.au/
Central Food Technological Research Institute (CFTRI)	http://www.cftri.com/
Central Institute of Medicinal & Aromatic Plants (CIMAP)	http://www.cimap.org/
Central Institute of Post harvest Engineering and Technology	http://www.icar.org.in/ciphet.html
Central Plantation Crops Research Institute (CPCRI), Kasaragod, Kerala	http://cpcri.nic.in/
Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram, Kerala	http://www.ctcri.org/
Consultative Group on International Agricultural Research, CGIAR	http://www.cgiar.org/
Coffee Board, India http://indiacoffee.org/ Department of Agriculture and Co-operation, India	http://agricoop.nic.in/
Department of Bio-technology, India	http://dbtindia.nic.in
Department of Scientific and Industrial Research, India	http://dsir.nic.in/
FAO	http://www.fao.org/
Global Agribusiness Information Network:	http://www.fintrac.com/gain/
Greenhouse Vegetable Information:	http://www.ghvi.co.nz/
Indian Agricultural Research Institute (IARI)	http://www.iari.res.in/
Indian Council of Agricultural Research (ICAR)	http://www.icar.org.in
Indian Institute of Horticultural Research (IIHR)	www.iihr.res.in
Indian Institute of Spices Research (IISR), Calicut, Kerala	http://www.iisr.org/
Indo-American Hybrid Seeds	www.indamseeds.com
Institute of Vegetable and Ornamental Crops	http://www.igzev.de/
Institute for Horticultural Development, Victoria, Australia	http://www.nre.vic.gov.au/agvic/ih/
Kerala Agricultural University	www.kau.edu

Iowa State University Department of Horticulture	http://www.hort.iastate.edu/
National Bureau of Plant Genetic Resources (NBPGR), India	http://nbpgr.delhi.nic.in/
National Horticulture Board (NHB), India	http://hortibizindia.nic.in/
National Institute of Agricultural Extension Management (MANAGE), India	http://www.manage.gov.in/
National Research Centre for Cashew (NRCC), India	http://kar.nic.in/cashew/
National Research Centre for Mushroom (NRCM), India	http://www.nrcmushroom.com/
National Research Centre for Oil Palm (NRCOP), India	http://www.ap.nic.in/nrcop
North Carolina State University, Dept. of Horticulture	http://www2.ncsu.edu/cals/hort_sci/
Oregon State University, Dept. of Horticulture	http://osu.orst.edu/dept/hort
Pineapple News	http://agrss.sherman.hawaii.edu/pineapple/pineappl.htm
Pomology Resources Center	http://www.bsi.fr/pomologie/english/pomology:
Rubber board, India	http://rubberboard.org.in/
Spice Paprika web site	http://www.paprika.deltav.hu/:
Spices Board, India	http://www.indianspices.com/
Sri Lanka Agribusiness on-line	http://www.agro-lanka.org/
Sustainable Apple Production:	http://orchard.uvm.edu/
Tea Board, India	http://tea.nic.in/
The Horticultural Taxonomy Group	http://www.hortax.org.uk/
The International Society of Citriculture:	http://www.lal.ufl.edu/isc_citrus_homepage.htm
The Internet Garden	http://www.internetgarden.co.uk/
The Rose Resource	http://rose.org/
The USDA Agricultural Research Service	http://www.ars.usda.gov/
University of Florida, Dept. of Environmental Horticulture	http://hort.ifas.ufl.edu/
University of California, Fruit&Nut Research	http://fruitsandnuts.ucdavis.edu/
US Environmental Protection Agency	http://www.epa.gov/:
USDA	http://www.usda.gov/

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