



**SIKKIM UNIVERSITY**  
**Department of Horticulture**

**Doctoral Programme in Horticulture**

**PhD (Horticulture)**

**Revised Syllabus 2020**

## ORGANIZATION OF COURSE CONTENTS & CREDIT REQUIREMENTS FOR PhD IN HORTICULTURE

Subject Heads	Credit allotted
Major	15
Minor	09
Compulsory/Supporting	08
Research	45
<b>Total Credits</b>	<b>77</b>

**Major subject:** The subject in which the students want specialization.

**Minor subject:** The subject closely related to student's major subject.

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

Code	Title of the Course	Credit	Semester
	<b>Compulsory for all the Students</b>		
	RESEARCH METHODOLOGY	4	I
HOR RS 690	RESEARCH PROPOSAL AND DOCTORAL SEMINAR	4	II
HOR RS 691	DOCTORAL RESEARCH	45	
HOR RS 692	Comprehensive Examination**		**
	<b>Fruit Science</b>		
HOR RS 601	ADVANCES IN BREEDING OF FRUIT CROPS	2+1	I
HOR RS 602	ADVANCES IN PRODUCTION OF FRUIT CROPS	2+1	I
HOR RS 603	ADVANCES IN GROWTH REGULATION OF FRUIT CROPS	2+1	I
HOR RS 604	GENOMICS AND BIOINFORMATICS IN HORTICULTURE	2+1	II
HOR RS 605	BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS	2+1	II
	<b>Vegetable Science</b>		
HOR RS 611	ADVANCES IN VEGETABLE PRODUCTION	2+1	I
HOR RS 612	ADVANCES IN BREEDING OF VEGETABLE CROPS	2+1	I
HOR RS 613	SEED CERTIFICATION, PROCESSING AND STORAGE OF VEGETABLE CROPS	2+1	I
HOR RS 614	BIOTECHNOLOGY OF VEGETABLE CROPS	2+1	II
HOR RS 615	ABIOTIC STRESS MANAGEMENT IN VEGETABLE CROPS	2+1	II
	<b>Floriculture and Landscaping</b>		
HOR RS 621	ADVANCES IN BREEDING OF FLOWER CROPS	2+1	I
HOR RS 622	ADVANCES IN FLOWER PRODUCTION TECHNOLOGY	2+1	I
HOR RS 623	ADVANCES IN PROTECTED AND PRECISION	2+1	I

	FLORICULTURE		
HOR RS 624	ADVANCES IN LANDSCAPE ARCHITECTURE	1+2	II
HOR RS 625	ADVANCES IN BIOCHEMISTRY AND BIOTECHNOLOGY OF FLOWERS	2+1	II
	<b>Spices, Plantation and Medicinal Crops</b>		
HOR RS 631	ADVANCES IN PRODUCTION OF PLANTATION AND MEDICINAL CROPS	2+1	I
HOR RS 632	ADVANCES IN SPICE PRODUCTION	2+1	I
HOR RS 633	ADVANCES IN BREEDING OF PLANTATION, MEDICINAL AND SPICE CROPS	2+1	I
HOR RS 634	BIOTECHNOLOGY IN PLANATION CROPS, SPICES AND MEDICINAL CROPS	2+1	II
HOR RS 635	POST HARVEST PROCESSING & EXTRACTION IN MEDICINAL & AROMATIC CROPS	2+1	II

**\*\* Comprehensive examination is compulsory for all the students to submit the thesis. Qualifying marks is 60%.**

### Semester wise credit distribution

Semester	Credits
First	19
Second	13
Total Course Credits	32
Thesis credits	45 (Distributed over the remaining semesters)

**Note: Compulsory Comprehensive exam will be held at the beginning of the third semester. All students need to qualify comprehensive exam. Qualifying marks is 60%.**

## FRUIT SCIENCE

**HOR RS 601 ADVANCES IN BREEDING OF FRUIT CROPS**

**2+1**

### **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, pollen viability tests, pollen germination-isozyme techniques-survey and clonal selection, observations on pest, disease and stress reactions in inbreds and hybrids, use of mutagenes 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 and Subtropical*. 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.

## **HOR RS 603 ADVANCES IN GROWTH REGULATION OF FRUIT CROPS 2+1**

### **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 fruit culture- 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, fruit set 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*. 3<sup>rd</sup> 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*. 4<sup>th</sup> Ed. Wadsworth Publ.

## **HOR RS 604 GENOMICS AND BIOINFORMATICS IN HORTICULTURE 2+1**

### **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.

## **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*. 3<sup>rd</sup> 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.





- 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.

## Floriculture

### **HOR RS 611 ADVANCES IN BREEDING OF FLOWER CROPS**

**2+1**

#### **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, Plant Variety Protection Act.

**UNIT II:** Specific objectives of breeding in flower crops, Methods of breeding suited to seed and vegetative propagation in flower crops, Introduction, selection, polyploidy and mutation breeding in the evolution of new varieties,

**UNIT III:** Exploitation of heterosis, utilization of male sterility- incompatibility problems, *In Vitro* breeding. 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. Specific breeding problems and achievements made in aster, petunia, lilioms, 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 and environmental pollution; *in-vitro* breeding in flower crops.

#### **Suggested Readings**

- Bhattacharjee S K . 2000. Commercial Floriculture Vol. I-II, Aavishkar Publishers, Jaipur
- Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publishers, Jaipur
- Choudhary RC.1993. *Introduction to Plant Breeding*. Oxford & IBH.
- Singh BD.1990. *Plant Breeding*. Kalyani.
- De L C and Bhattacharjee SK. 2011. Ornamental Crop Breeding, Aavishkar Publishers, Jaipur

**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 CO<sub>2</sub> 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; Floral oil industry, floral concrete production, extraction methods, recent advances. Export potential; Agri Export Zones.

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

**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.

## **HOR RS 613 ADVANCES IN PROTECTED AND PRECISION FLORICULTURE**

**2+1**

### **Objective**

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

### **Theory**

**UNIT I:** Prospects of protected floriculture in India, Protected 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. Water and nutrient management, crop regulation, special horticultural practices under protected cultivation of rose, chrysanthemum, carnation, orchids, anthurium, gerbera, lilioms, cut foliage; Harvest indices – harvesting, PH handling, marketing, export.

**UNIT III:** Precision floriculture, Principles and concepts, crop modeling, enabling technologies of precision farming, GPS, GIS, Remote sensing, sensors.

**UNIT IV:** 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.
- Reddy S, Janakiram B, Balaji T, Kulkarni S, & Misra RL. 2007. *Hightech Floriculture*. Indian Society of Ornamental Horticulture, New Delhi.
- Castilla Nicolas. 2012. *Greenhouse Technology and Management*. 2<sup>nd</sup> Edition. CABI
- Singh Bram, 2019, *Precision Farming and Protected Cultivation*, NIPA Publication.
- Singh J. 2013. *Precision Farming in Horticulture* 1<sup>st</sup> Edition, NIPA Publication.

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

**UNIT II:** 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 III:** 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 IV:** 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**

- Bhattcharjee S K. 2004. Landscape Gardening & Design With Plants, Aavishkar Publishers Distributors
- 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.
- Woodrow MG. 1999. *Gardening in India*. Biotech Books.

## **HOR RS 615 ADVANCES IN BIOCHEMISTRY AND BIOTECHNOLOGY OF FLOWERS**

**2+1**

### **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. Biochemistry and utilization commercial products (select items). Recent trends- Extraction of biocolours and their value addition, uses in food and textile industries. Biochemistry of post harvest management of cut flowers. Quantification and quality analysis of secondary metabolites using HPLC.

**UNIT II:** Biotechnology – tools techniques and role in floriculture industry, physical factors and chemical factors influencing the growth and development of plant cell, tissue and organs, cyto differentiation, organogenesis, somatic embryogenesis. Post harvest biotechnology of flowers, ornamental plants, achievements of bio-technology in flower crops.

**UNIT III:** *In vitro* lines for biotic and abiotic stress – Meristem culture for disease elimination, production of haploids through anther and pollen culture – embryo and ovule culture, wide hybridization and embryo rescue techniques, construction and regeneration of somatic hybrids and cybrids, *in vitro* pollination and fertilization, hardening techniques of tissue culture plants. 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, *in vitro* conservation and cryo- preservation techniques.

**UNIT IV:** Gene cloning, genetic engineering: vectors and methods of transformation – electroporation, particle bombardment, *Agrobacterium* mediated, transgenic plants in flower crops, medicinal and aromatic crops, isolation of DNA, RNA, quantification, Polymerase Chain Reaction for amplification; AGE & PAGE techniques; identification of molecular markers. 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 environmental stress, approaches to improve flower development, pigment production, secondary metabolite production.

### **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*. 2<sup>nd</sup> 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.
- Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ.
- Prasad S. 1999. *Impact of Plant Biotechnology on Horticulture*. 2<sup>nd</sup> 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](http://www.amazon.com)

## **Vegetable Science**

**HOR RS 621 ADVANCES IN VEGETABLE PRODUCTION**

**2+1**

### **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 bio fertilizers; 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:** Okra, onion, peas and beans, amaranths and drumstick

**UNIT IV:** Carrot, beet root and radish, 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 indifferent 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; dry land 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 marketing 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.

## **HOR RS 622 ADVANCES IN BREEDING OF VEGETABLE CROPS**

**2+1**

### **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:** Okra, onion, peas and beans, amaranths and drumstick

**UNIT IV:** Carrot, beet root and radish, Sweet potato, 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 heterosis and combining ability, induction and identification of mutants and polyploids, distant hybridization and embryo rescue techniques.

### **Suggested Readings**

- 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*. 4<sup>th</sup> Ed. WH Freeman & Co.
- Kalloo G & Singh K. 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals and Book Publ. House.
- Kalloo 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.

## **HOR RS 623 PROTECTED CULTIVATION OF VEGETABLE CROPS**

**1+1**

### **Objective**

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

### **Theory**

**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. Crops: Tomato, capsicum, cucumber, melons and lettuce.

**UNIT II:** Regulatory structures used in protected structures; types of greenhouse/ polyhouse/ nethouse, hot beds, cold frames, effect of environmental factors, viz. temperature, light, CO<sub>2</sub> and humidity on growth of different vegetables, manipulation of CO<sub>2</sub>, 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. 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, CO<sub>2</sub>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*. Organized by Institute of Engineers, Ahmednagar. Dec.12-13, 2003.

- Chandra S & Som V. 2000. *Cultivating Vegetables in Green House*. *Indian Horticulture* 45: 17-18.
- Prasad S & Kumar U. 2005. *Greenhouse Management for Horticultural Crops*. 2<sup>nd</sup> Ed. Agrobios.
- Tiwari GN. 2003. *Green House Technology for Controlled Environment*. Narosa Publ. House.

## **HOR RS 624 BIOTECHNOLOGY IN VEGETABLE CROPS**

**2+1**

### **Objective**

To teach 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, soma clones and identification of soma clonal 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 rDNA technology.

**UNIT IV:** Quality improvement, improvement for biotic and abiotic stresses, transgenic plants. Role of molecular markers in characterization of transgenic crops, fingerprinting of cultivars etc., achievements, problems and future thrusts in horticultural 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 celllines; *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. *Biotech and Micro propagation*. 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. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. New India Publ. Agency.
- Panopoulos NJ. (Ed.). 1981. *Genetic Engineering in Plant Sciences*. Praeger Publ.
- Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ.
- Prasad S. 1999. *Impact of Plant Biotechnology on Horticulture*. 2<sup>nd</sup> 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.

## **HOR RS 625 SEED CERTIFICATION, PROCESSING AND STORAGE OF VEGETABLE CROPS 1+1**

### **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, minimum seed certification standards of vegetable crops, field inspection, specification for certification.

**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. Seed marketing, demand forecast, marketing organization, economics of seed production; farmers' rights, seed law enforcement, seed act and seed policy.

### **Practical**

Seed sampling, purity, moisture testing, seed viability, seed vigor tests, seed health testing, 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 know about 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.

## **HOR RS 626 ABIOTIC STRESS MANAGEMENT IN VEGETABLE CROPS 2+1**

### **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. 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.

- Hopkins WG & Huner NPA. 2004. *Introduction to Plant Physiology*. John Wiley & Sons.
- Lerner HR (Ed.). 1999. *Plant Responses to Environmental Stresses*. Marcel Decker.
- Maloo SR. 2003. *Abiotic Stresses and Crop Productivity*. Agrotech Publ. Academy.
- Salisbury FB & Ross C. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ.

## **Spices, Plantation and Medicinal Crops**

### **HOR RS 631 ADVANCES IN PRODUCTION OF PLANTATION AND MEDICINAL CROPS**

**2+1**

#### **Objective**

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

#### **Theory**

##### **UNIT I**

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**

Coffee, tea, Cashew and cocoa, Rubber, palmyrah, oil palm, Coconut and arecanut, Wattle and betelvine

**UNIT II:** Production technology for Senna, Periwinkle, Coleus, Aswagandha, Glory lily, Sarpagandha, Dioscorea sp., Aloe vera, Phyllanthus amarus, Andrographis paniculata, Medicinal solanum, Isabgol, Poppy, Safed musli, Stevia rebaudiana, Mucuna pruriens, Ocimum sp.

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

#### **Practical**

Plantation Crops - 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.

Medicinal Plants- Propagation techniques, Maturity standards, Digital documentation, Extraction of secondary metabolites

### **Suggested Readings**

- 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.

**HOR RS 632**

**ADVANCES IN SPICE PRODUCTION**

**2+1**

### **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.

## **HOR RS 633 ADVANCES IN BREEDING OF PLANTATION CROPS AND SPICES**

**2+1**

### **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.
- Purseglove JW. 1968. *Tropical Crops – Dictyledons*. Longman.
- Purseglove 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.

**Objective**

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

**Theory**

**Crops:** Coconut, oil palm, coffee, tea, cocoa, pepper, cardamom, turmeric, ginger, vanilla Senna, Periwinkle, Coleus, Aswagandha.

**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; somocloning 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 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.

**UNIT VI:** Metabolomics in spices and medicinal crops.

**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*. 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.
- Gordon H & Rubsall 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.
- Prasad S. 1999. *Impact of Plant Biotechnology on Horticulture*. 2<sup>nd</sup> Ed. Agro Botanica.

**HOR RS 635**

**POST-HARVEST PROCESSING AND EXTRACTION IN  
MEDICINAL AND AROMATIC PLANTS**

**2+1**

**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, thin layer, 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*. 2<sup>nd</sup> 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. 83

## Supporting Courses

### **PPAT RS 101 MOLECULAR BASIS OF HOST-PATHOGEN INTERACTION      2+1**

#### **Objective**

To understand the concepts of molecular biology and biotechnology in relation to host-pathogen interactions.

#### **Theory**

UNIT I: Importance and role of biotechnological tools in Plant Pathology- Basic concepts and principles to study host pathogen relationship.

UNIT II: Molecular basis of host-pathogen interaction- fungi, bacteria and viruses; recognition system, signal transduction.

UNIT III: Induction of defense responses- pathogenesis related proteins, HR, reactive oxygen species, phytoalexins and systemic acquired resistance, Programmed Cell Death, Viral induced gene silencing.

UNIT IV: Molecular basis of gene-for-gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes.

UNIT V: Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.

#### **Practical**

Protein, DNA and RNA isolation, Plasmids extraction, PCR analysis, DNA and Protein electrophoresis, bacterial transformation.

#### **Suggested Readings**

- Chet I. 1993. Biotechnology in Plant Disease Control. John Wiley & Sons, New York.
- Gurr SJ, Mc Pohersen MJ & Bowlos DJ. (Eds.). 1992. Molecular Plant Pathology - A Practical Approach. Vols. I & II, Oxford Univ. Press, Oxford.
- Mathew JD. 2003. Molecular Plant Pathology. Bios Scientific Publ., UK.
- Ronald PC. 2007. Plant-Pathogen Interactions: Methods in Molecular Biology. Humana Press, New Jersey.
- Stacey G & Keen TN. (Eds.). 1996. Plant Microbe Interactions. Vols. I-III. Chapman & Hall, New York; Vol. IV. APS Press, St. Paul, Minnesota.

**Objective**

To teach students the basics of soil biology and biochemistry, including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.

**Theory**

UNIT I: Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interactions; un-culturable soil biota.

UNIT II: Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin, activities and importance; soil characteristics influencing growth and activity of microflora.

UNIT III: Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, humus formation; cycles of important organic nutrients.

UNIT IV: Biodegradation of pesticides, organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil.

UNIT V: Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost.

UNIT VI: Biofertilizers – definition, classification, specifications, method of production and role in crop production.

**Practical**

Determination of soil microbial population, Soil microbial biomass, Elemental composition, fractionation of organic matter and functional groups, Decomposition of organic matter in soil, Soil enzymes, Measurement of important soil microbial processes such as ammonification, nitrification, N<sub>2</sub> fixation, S oxidation, P solubilization and mineralization of other micro nutrients, Study of rhizosphere effect.

**Suggested Readings**

- Alexander M. 1977. Introduction to Soil Microbiology. John Wiley & Sons.
- Burges A & Raw F. 1967. Soil Biology. Academic Press.
- McLaren AD & Peterson GH. 1967. Soil Biochemistry. Vol. XI. Marcel Dekker.
- Metting FB. 1993. Soil Microbial Ecology – Applications in Agricultural and Environmental Management. Marcel Dekker.
- Paul EA & Ladd JN. 1981. Soil Biochemistry. Marcel Dekker.
- Reddy MV. (Ed.). Soil Organisms and Litter in the Tropics. Oxford & IBH.
- Russel RS. 1977. Plant Root System: Their Functions and Interaction with the Soil. ELBS & McGraw Hill.
- Stotzky G & Bollag JM. 1993. Soil Biochemistry. Vol. VIII. Marcel Dekker.