

**DEPARTMENT OF HORTICULTURE  
MPHIL/PHD COURSEWORK SYLLABUS**

<b>Code</b>	<b>Title of the Course</b>	<b>Credit</b>
	<b>Fruit Science</b>	
HOR-RS-601	ADVANCES IN BREEDING OF FRUIT CROPS	2+1
HOR-RS-602	ADVANCES IN PRODUCTION OF FRUIT CROPS	2+1
HOR-RS-603	ADVANCES IN GROWTH REGULATION OF FRUIT CROPS	2+1
HOR-RS-604	GENOMICS AND BIOINFORMATICS IN HORTICULTURE	2+1
HOR-RS-605	BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS	2+1
	<b>Floriculture</b>	
HOR-RS-611	ADVANCES IN BREEDING OF FLOWER CROPS	2+1
HOR-RS-612	ADVANCES IN FLOWER PRODUCTION TECHNOLOGY	2+1
HOR-RS-613	ADVANCES IN PROTECTED AND PRECISION FLORICULTURE	2+1
HOR-RS-614	ADVANCES IN LANDSCAPE ARCHITECTURE	1+2
HOR-RS-615	ADVANCES IN BIOCHEMISTRY AND BIOTECHNOLOGY OF FLOWERS	2+1
	<b>Vegetable Science</b>	
HOR-RS-621	ADVANCES IN VEGETABLE PRODUCTION	2+1
HOR-RS-622	ADVANCES IN BREEDING OF VEGETABLE CROPS	2+1
HOR-RS-623	PROTECTED CULTIVATION OF VEGETABLE CROPS	1+1
HOR-RS-624	BIOTECHNOLOGY OF VEGETABLE CROPS	2+1
HOR-RS-625	SEED CERTIFICATION, PROCESSING AND STORAGE OF VEGETABLE CROPS	1+1
HOR-RS-626	ABIOTIC STRESS MANAGEMENT IN VEGETABLE CROPS	2+1
	<b>Spices, Plantation and Medicinal Crops</b>	
HOR-RS-631	ADVANCES IN PRODUCTION OF PLANTATION AND MEDICINAL CROPS	2+1
HOR-RS-632	ADVANCES IN SPICE PRODUCTION	2+1
HOR-RS-633	ADVANCES IN BREEDING OF PLANTATION, MEDICINAL AND SPICE CROPS	2+1
HOR-RS-634	BIOTECHNOLOGY IN PLANTATION CROPS, SPICES AND MEDICINAL CROPS	2+1
HOR-RS-635	POST HARVEST PROCESSING AND EXTRACTION IN MEDICINAL & AROMATIC CROPS	2+1
	<b>Supporting Courses</b>	
HOR-RS-604	MOLECULAR BASIS OF HOST-PATHOGEN INTERACTION	2+1
HOR-RS-506	SOIL BIOLOGY AND BIOCHEMISTRY	2+1
	<b>Compulsory for all the Students</b>	
HOR-RS-691	DOCTORAL SEMINAR I	1+0
HOR-RS-692	DOCTORAL SEMINAR II	1+0
HOR-RS-699	DOCTORAL RESEARCH	46

## Fruit Science

### **HOR-RS-601: ADVANCES IN BREEDING OF FRUIT CROPS**

#### **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.

### **HOR-RS-602: ADVANCES IN PRODUCTION 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**

### **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*. 4th Ed. Wadsworth Publ.

## **HOR-RS-604 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, X-ray crystallography, 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*. 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.

## **HOR-RS-605 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 CO<sub>2</sub>, 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.

## **Floriculture**

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

#### **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 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.

##### 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, liliiums, 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**

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.

## **HOR-RS-612: ADVANCES IN FLOWER PRODUCTION TECHNOLOGY**

### **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; Export potential; Agri Export Zones.

#### **Unit IV**

Crop specific practices – rose, anthurium, orchids, carnation, gladioli, gerbera, liliiums, 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.

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

### **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, liliams, cut foliage; Harvest indices – harvesting, PH handling, marketing, export.

#### Unit IV

Precision floriculture, Principles and concepts, crop modeling, 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.

## **HOR-RS-614 ADVANCES IN LANDSCAPE ARCHITECTURE**

### **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.

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

#### **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, lilies 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* lines 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 media, 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, medicinal and aromatic 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 environmental 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.
- Gorden 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*. 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

## Vegetable Science

### **HOR-RS-621: ADVANCES IN VEGETABLE PRODUCTION**

#### **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 mals 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**

### **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 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.

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

### **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, 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.

#### 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, 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*. Organised 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*. 2nd Ed. Agrobios.
- Tiwari GN. 2003. *Green House Technology for Controlled Environment*. Narosa Publ. House.

## HOR-RS-624: BIOTECHNOLOGY IN 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, 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.

#### 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.

### 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.

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.

## **HOR-RS-625: SEED 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.

#### Unit V

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**

### **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.

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

### **HOR-RS-631: ADVANCES IN PRODUCTION 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.

Skaria P Baby, Samuel Mathew, Gracy Mathew, Ancy Joseph, Ragin

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.

## **HOR-RS-632: ADVANCES IN SPICE PRODUCTION**

### **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,

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**

### **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 mutagens 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,

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

## **HOR-RS-634: BIOTECHNOLOGY IN PLANTATION CROPS, SPICES AND MEDICINAL CROPS**

### **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; 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 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.

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.

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, While 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.

## **HOR-RS-635: POST-HARVEST PROCESSING AND EXTRACTION IN MEDICINAL AND AROMATIC PLANTS**

### **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. 83

### Supporting Courses

#### **HOR-RS-604: MOLECULAR BASIS OF HOST-PATHOGEN INTERACTION**

##### **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.

#### **HOR-RS-506: SOIL BIOLOGY AND BIOCHEMISTRY**

## **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.

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