

DEPARTMENT OF HORTICULTURE

PROGRAMMES

1. M.Sc.
2. Ph.D.

COURSE REQUIREMENTS

M.Sc.

Field of specialization	Field crops, Vegetable Science, Floriculture, Tuber crops, Medicinal and Aromatic Plants.
Core courses	Hort 511, Hort 512, Hort 513, Hort 531
Optional courses	Hort 514, Hort 515, Hort 516, Hort 521, Hort 522, Hort 523, Hort 532, Hort 533,
Minor & supporting courses	Stat 511, Stat 521, Pphys 521 or as per decision of advisory committee in view of research problem
Deficiency courses	Nil or as deemed suitable by advisory committee

Ph.D.

Field of specialization	Field crops, Vegetable Science, Floriculture, Tuber crops, Medicinal and Aromatic Plants.
Core courses	Hort 611, Hort 612,
Optional courses	Hort 621, Hort 622, Hort 623, Hort 624,
Minor & supporting courses	Stat 612, Stat 622, Pphys 522 or as per decision of advisory committee in view of research problem
Non credit compulsory courses	PGS 502, PGS 503 (Exempted if done in M.Sc.)
Deficiency courses	Nil or as deemed suitable by advisory committee

DESCRIPTION OF COURSES

M.Sc.

HORT 511 TROPICAL AND DRY LAND FRUIT PRODUCTION 2+1

Objective

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

Theory

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

Crops

UNIT I: Mango and Banana

UNIT II: Citrus and Papaya

UNIT III: Guava, Sapota and Jackfruit

UNIT IV: Pineapple, Annonas and Avocado

UNIT V: Aonla, Pomegranate, Phalsa and Ber, minor fruits of tropics

Practical

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

Suggested Readings

Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits -Horticulture*. Allied Publ.

Bose TK, Mitra SK & Sanyal D. 2001. (Eds.). *Fruits -Tropical andSubtropical*. Naya Udyog.

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

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

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

Pradeep kumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. Parts I, II. New India Publ. Agency.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.\Singh HP, Negi JP & Samuel JC. (Eds.). 2002. *Approaches for Sustainable Development of Horticulture*. National Horticultural Board.

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

HORT 512 SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION 2+1

Objective

To impart basic knowledge about the importance and management of subtropical and temperate fruits grown in India.

Theory

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

Crops

UNIT I: Apple, pear, quince, grapes

UNIT II: Plums, peach, apricot, cherries, hazlenut

UNIT III: Litchi, loquat, persimmon, kiwifruit, strawberry

UNIT IV: Nuts- walnut, almond, pistachio, pecan

UNIT V: Minor fruits- mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate

Practical

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

Suggested Readings

Bose TK, Mitra SK & Sanyol D. (Ed.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.

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

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

Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons.

Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.
Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagminder Book Agency.

**HORT 513 PRODUCTION TECHNOLOGY OF WARM SEASON
VEGETABLE CROPS**

2+1

Objective

To teach production technology of warm season vegetables.

Theory

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

UNIT I

Tomato, eggplant, hot and sweet peppers

UNIT II

Okra, beans, cowpea and cluster bean

UNIT III

Cucurbitaceous crops

UNIT IV

Tapioca and sweet potato

UNIT V

Green leafy warm season vegetables

Practical

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

Suggested Readings

Bose TK & Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash.

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

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

Brown HD & Hutchison CS. *Vegetable Science*. JB Lippincott Co.

- Chadha KL & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture*. Vols. V-X. Malhotra Publ. House.
- Chadha KL. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.
- Chauhan DVS. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad & Sons.
- Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.
- Edmond JB, Musser AM & Andrews FS. 1964. *Fundamentals of Horticulture*. Blakiston Co
- Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
- Gopalakrishanan TR. 2007. *Vegetable Crops*. New India Publ. Agency.
- Hazra P & Som MG. (Eds.). 1999. *Technology for Vegetable Production and Improvement*. Naya Prokash.
- Kaloo G & Singh K (Ed.). 2000. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.
- Nayer NM & More TA 1998. *Cucurbits*. Oxford & IBH Publ.
- Palaniswamy & Peter KV. 2007. *Tuber Crops*. New India Publ. Agency.
- Pandey AK & Mudranalay V. (Eds.). *Vegetable Production in India: Important Varieties and Development Techniques*.
- Rana MK. 2008. *Olericulture in India*. Kalyani.
- Rana MK. 2008. *Scientific Cultivation of Vegetables*. Kalyani.
- Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall.
- Saini GS. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ. House.
- Salunkhe DK & Kadam SS. (Ed.). 1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
- Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.
- Singh DK. 2007. *Modern Vegetable Varieties and Production Technology*. International Book Distributing Co. 33
- Singh NP, Bharadwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distributing Co.
- Singh SP. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre.
- Thamburaj S & Singh N. 2004. *Vegetables, Tuber Crops and Spices*. ICAR.
- Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata Mc Graw Hill.

**HORT 514 PROPAGATION AND NURSERY MANAGEMENT
FOR FRUIT CROPS**

2+1

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

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

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

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

Singh SP. 1989 *Mist Propagation*. Metropolitan Book Co.

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

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

HORT 515 BREEDING OF FRUIT CROPS 2+1

Objective

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

Theory

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

Crops

UNIT I : Mango, banana and pineapple

UNIT II: Citrus, grapes, guava and sapota

UNIT III: Jackfruit, papaya, custard apple, aonla, avocado and ber

UNIT IV: Mangosteen, litchi, jamun, phalsa, mulberry, raspberry, kokam and nuts

UNIT V: Apple, pear, plums, peach, apricot, cherries and strawberry

Practical

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

Suggested Readings

Bose TK, Mitra SK & Sanyal D. (Eds.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.

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

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

Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons.

Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency. 16

Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

HORT 516 BIOTECHNOLOGY OF HORTICULTURAL CROPS

2+1

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

- Bajaj YPS. (Ed.).1989. *Biotechnology in Agriculture and Forestry*. Vol. V, *Fruits*. Springer.
- Brown TA. 2001. *Gene Cloning and DNA Analysis and Introduction*. Blackwell Publ.19
- Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology – Concepts, Methods and Applications*. Oxford & IBH.
- 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, Nazeem PA, Girija D, John PS & Peter KV. 2007. *Recent Trends in Biotechnology of Horticultural Crops*. Vols. I, II. New India Publ. Agency.
- Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash.
- Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ.
- Skoog F & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Culture in vitro*. *Symp. Soc. Exp. Biol.* 11: 118-131
- Vasil TK, Vasi M, While DNR & Bery HR. 1979. *Somatic Hybridization and Genetic Manipulation in Plants*. *Plant Regulation and World Agriculture*. Planum Press.
- Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V. Academic Press.

HORT 521 BIODIVERSITY AND CONSERVATION OF FRUIT CROPS 2+1

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.

UNIT V

GIS and documentation of local biodiversity, Geographical indication.

Crops

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

Practical

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

Suggested Readings

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

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

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

HORT 522 PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS 2+1

Objective

To educate production technology of cool season vegetables.

Theory

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

UNIT I

Potato

UNIT II

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

UNIT III

Root crops: carrot, radish, turnip and beetroot

UNIT IV

Bulb crops: onion and garlic

UNIT V

Peas and broad bean, green leafy cool season vegetables

Practical

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

Suggested Readings

- Bose TK & Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash.
- Bose TK, Som G & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.
- Bose TK, Som MG & Kabir J. (Eds.). 1993. *Vegetable Crops*. Naya Prokash.
- Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.
- Chadha KL & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture* Vols. V-X. Malhotra Publ. House.
- Chadha KL. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.
- Chauhan DVS. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad & Sons.
- Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.
- Edmond JB, Musser AM & Andrews FS. 1951. *Fundamentals of Horticulture*. Blakiston Co.
- Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
- Gopalakrishanan TR. 2007. *Vegetable Crops*. New India Publ. Agency.
- Hazra P & Som MG. (Eds.). 1999. *Technology for Vegetable Production and Improvement*. Naya Prokash.
- Rana MK. 2008. *Olericulture in India*. Kalyani Publ.
- Rana MK. 2008. *Scientific Cultivation of Vegetables*. Kalyani Publ.
- Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall.
- Saini GS. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ. House.
- Salunkhe DK & Kadam SS. (Ed.). 1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
- Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.
- Singh DK. 2007. *Modern Vegetable Varieties and Production Technology*. International Book Distributing Co.
- Singh SP. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre.
- Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*. ICAR.
- Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata McGraw-Hill.

HORT 523 PRODUCTION TECHNOLOGY OF CUT FLOWERS 2+1

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

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

Practical

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

Suggested Readings

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

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

HORT 531 LANDSCAPING AND ORNAMENTAL GARDENING

2+1

Objective

Familiarization with principles and practices of landscaping and ornamental gardening.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

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

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

Nambisan KMP.1992. *Design Elements of Landscape Gardening*. Oxford & IBH.

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Sabina GT & Peter KV. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency.

Valsalakumari et al. 2008. *Flowering Trees*. New India Publ. Agency.

HORT 532 POST HARVEST TECHNOLOGY FOR HORTICULTURALCROPS 2+1

Objective

To facilitate deeper understanding on principles and practices of postharvest management of horticultural crops.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

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

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

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

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

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

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

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

HORT 533 PRODUCTION TECHNOLOGY OF SPICE CROPS 2+1

Objective

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

Theory

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

UNIT I

Black pepper, cardamom

UNIT II

Clove, cinnamon and nutmeg, allspice

UNIT III

Turmeric, ginger and garlic

UNIT IV

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

UNIT V

Tamarind, garcinia and vanilla

Practical

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

Suggested Readings

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

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

Bhattacharjee SK. 2000. *Hand Book of Aromatic Plants*. Pointer Publ.

- Bose TK, Mitra SK, Farooqi SK & Sadhu MK (Eds.). 1999. *Tropical Horticulture*. Vol.I. Naya Prokash.
- Chadha KL & Rethinam P. (Eds.). 1993. *Advances in Horticulture*. Vols IX-X. *Plantation Crops and Spices*. Malhotra Publ. House.
- Gupta S. (Ed.). *Hand Book of Spices and Packaging with Formulae*. Engineers India Research Institute, New Delhi.
- Kumar NA, Khader P, Rangaswami & Irulappan I. 2000. *Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants*. Oxford & IBH.
- Nybe EV, Miniraj N & Peter KV. 2007. *Spices*. New India Publ. Agency.
- Parthasarthy VA, Kandiannan V & Srinivasan V. 2008. *Organic Spices*. New India Publ. Agency.
- Peter KV. 2001. *Hand Book of Herbs and Spices*. Vols. I-III. Woodhead Publ. Co. UK and CRC USA
- Pruthi JS. (Ed.). 1998. *Spices and Condiments*. National Book Trust
- Pruthi JS. 2001. *Minor Spices and Condiments- Crop Management and Post Harvest Technology*. ICAR.
- Purseglove JW, Brown EG, Green CL & Robbins SRJ. (Eds.). 1981. *Spices*. Vols. I, II. Longman.
- Shanmugavelu KG, Kumar N & Peter KV. 2002. *Production Technology of Spices and Plantation Crops*. Agrobios.
- Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*. ICAR.
- Tiwari RS & Agarwal A. 2004. *Production Technology of Spices*. International Book Distr. Co.
- Varmudy V. 2001. *Marketing of Spices*. Daya Publ. House.

HORT 611 ADVANCES IN PRODUCTION OF FRUIT CROPS

2+1

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.

HORT 612 BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS

2+1

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

Seed treatment /hardening practices, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP), analysis of plant stress factors, 27 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.

HORT 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 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.

HORT 623 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, fruitset and fruit development stages.

Suggested Readings

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

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

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

Leopold AC & Kriedemann PE. 1985. *Plant Growth and Development*. 3rd Ed. McGraw-Hill.

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

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

HORT 624 PROTECTED CULTIVATION OF VEGETABLE CROPS

1+1

Objective

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

Theory

Crops: Tomato, capsicum, cucumber, melons and lettuce

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

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

Suggested Readings

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

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

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

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